The undergraduate programs in electrical engineering and computer environmental impact of their respective technologies. They must of tomorrow must be aware of the social, economic, ethical and Beyond creating technology, electrical and computer engineers pursue advanced programs in business and management after earning a professional fields such as medicine and law. Many graduates also engineering or computer engineering is an excellent foundation for other students to excel in their careers. Moreover, a degree in electrical engineering encompasses many exciting subdisciplines including energy systems, machines, power electronics, analog electronics, digital electronics, mixed-signal electronics, VLSI chips, instrumentation, sensors, signal processing, machine vision, communications, control systems, robotics, wireless devices, electromagnetic fields, photonics, embedded controllers, networking, software development, biomedical devices, and computer architecture. The School encompasses all of these subdisciplines in its curriculum or research activities.

Computer Engineering is a relatively young engineering discipline that combines a strong foundation in electrical engineering with elements of computer science, including hardware and software integration, and design. Computer engineering includes digital logic design, computer architecture, digital data communications, computer and sensor interfacing, microprocessors, digital control, VLSI circuits and systems, operating and software systems, and computer arithmetic.

The School of Electrical and Computer Engineering (ECE) offers a full range of undergraduate and graduate program choices that allow students to excel in their careers. Moreover, a degree in electrical engineering or computer engineering is an excellent foundation for other professional fields such as medicine and law. Many graduates also pursue advanced programs in business and management after earning a degree in engineering.

Beyond creating technology, electrical and computer engineers of tomorrow must be aware of the social, economic, ethical and environmental impact of their respective technologies. They must also communicate effectively, possess excellent teamwork skills, and understand, perform, and complete the process of engineering design. The undergraduate programs in electrical engineering and computer engineering at Oklahoma State University equip graduates with these critical skills.

Program Educational Objectives
The Program Educational Objectives reflect the aspirational expectations for our electrical engineering and computer engineering graduates after they enter their professional careers. Specifically:

- Our Graduates will be widely employed across the range of subdisciplines within electrical engineering and computer engineering, and will be highly sought after by industrial, academic, non-profit, and governmental organizations.
- Our Graduates will compete in a technologically changing world, collaborate in a diverse workforce, and communicate effectively their knowledge and ideas to colleagues, employers, customers, and stakeholders.
- Our Graduates will be recognized leaders, team players, problem solvers, innovators, and entrepreneurs in their profession.
- Our Graduates will identify and contribute to solving grand-challenge problems that improve the lives of people in Oklahoma, the United States, and around the world, serving their communities and their profession to produce a lasting, significant, and positive impact.
- Our Graduates will abide by the highest ethical standards of professional practice in a technologically changing, professional environment.
- Our Graduates will continue to develop professionally throughout their lives by being adaptive learners with a never ending desire to assimilate new knowledge and embrace new technologies.
- Our Graduates will have the knowledge to earn professional registration or certification in their field or earn an advanced post-graduate or professional degree should they choose.
- Our Graduates will make a positive difference in the world.

Student Learning Outcomes
To support these Program Educational Objectives, the School has established Student Learning Outcomes that are regularly assessed and expected of all students upon completion of their chosen program in Electrical Engineering or Computer Engineering. These include:

a. an ability to apply knowledge of mathematics, science, and engineering
b. an ability to design and conduct experiments, as well as to analyze and interpret data
c. an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
d. an ability to function on multidisciplinary teams
e. an ability to identify, formulate, and solve engineering problems
f. an understanding of professional and ethical responsibility
g. an ability to communicate effectively
h. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
i. a recognition of the need for, and an ability to engage in life-long learning
j. a knowledge of contemporary issues
k. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

The undergraduate electrical engineering and computer engineering programs at Oklahoma State University prepare each graduate for a life-long professional career. During the first two years of study, students enter into Pre-Professional School and complete a carefully designed program consisting of mathematics, physics, chemistry, statics, introductory electrical and computer engineering courses, computer science, and selected courses in the humanities and social sciences. After successfully completing Pre-Professional school, students are admitted into Professional School and enroll in specific electrical engineering and/or computer engineering courses.

Electrical engineering and computer engineering students in Professional School obtain fundamental knowledge and technical skills needed by tomorrow's professionals. For electrical engineering students, these skills are learned in one of five areas of specialization that enable students to customize course choices to gain both a breadth of knowledge and a depth of understanding in a specific chosen area. These specializations areas include a) control systems, digital signal processing, and communication systems, b) energy and power, c) computer systems and digital electronics, d) analog electronics, and e) electromagnetics and optical science. Computer engineering students learn these skills by focusing on their own challenging specialized curriculum, which is also designed to provide breadth and depth within the discipline. Specialized computer engineering topics include microcontrollers, embedded controllers, computer architecture, computer mathematics, digital logic design, networking, cybersecurity, mobile computing, and digital electronics.

By tailoring the program to align student interests with faculty strengths, the School enhances faculty-student interactions to ensure academic excellence. All electrical engineering and computer engineering students receive multiple engineering design experiences throughout Professional School. Instructional laboratories are a central part of the curriculum to grant opportunities for hands-on experience in areas such as microcomputers, digital logic design, electronics, networks, instrumentation, optics, real-time digital signal processing, and electromagnetics.

Engineering design laboratories require students to solve open-ended problems in a manner that demonstrate the students’ ability to apply fundamental concepts, creativity, and imagination, and to solve realistic problems of practical importance. These problems have several possible solutions; students must choose an acceptable approach and demonstrate that the desired outcomes have been met.

The capstone design experience is a two-course sequence typically taken during the student’s last two semesters of the program that gives our students an opportunity to apply and demonstrate the skills that have developed throughout the program. These courses integrate theory analysis, simulation, design, and experimental skills the students have developed during their course of study. Teamwork, communication skills, and the complete engineering design process, from problem definition to prototype that includes both presentation and documentation, are emphasized.

Student teams receive individual project mentoring from an appropriate faculty member who provides project management and supervision. The capstone experience concludes with a formal public design demonstration, oral presentation, and written report. The new ECE Design Commons, an advanced design laboratory available to all students in electrical engineering and computer engineering, provides state-of-the-art capabilities for design, prototyping, testing and diagnostics of advanced hardware and software systems.

Courses

**ECEN 2011 Experimental Methods I**
*Prerequisites:* PHYS 2114; Co-requisite(s): ENSC 2613
*Description:* Basic electrical measurements and instrumentation techniques and devices. Use of voltmeters, ammeters, oscilloscopes, impedance bridges to study resistive, inductive, and capacitive circuit elements in steady state and transient operation. Reinforces ENSC 2613 and introduces design of instrumentation networks. Serves as introduction for non-majors. Previously offered as ECEN 3013.
*Credit hours:* 1
*Contact hours:* Lab: 2
*Levels:* Undergraduate

**ECEN 2714 Fundamentals of Electric Circuits**
*Prerequisites:* MATH 2153 and PHYS 2114.
*Description:* Circuit analysis techniques including equivalent networks and mesh/node formulation of network equations; operational amplifiers; RL, RC and RLC transient and steady-state circuit analysis; energy and power; electrical measurements and instrumentation.
*Credit hours:* 4
*Contact hours:* Lecture: 3 Lab: 2
*Levels:* Undergraduate

**ECEN 3020 Supervised Research Project**
*Prerequisites:* Consent of instructor and ECEN department head.
*Description:* Supervised research project for qualified students. May be repeated no more than three times for a total of three credit hours. Offered for variable credit, 1-3 credit hours, maximum of 3 credit hours.
*Credit hours:* 1
*Contact hours:* Other: 1
*Levels:* Undergraduate

**ECEN 3113 Energy, Environment and Economics**
*Prerequisites:* ECEN 3513 and admission to Professional School.
*Description:* Topics relevant to understanding the close relationship between energy use, its impact on the environment, and overall economic implications. Green energy technologies (wind, solar, hydro) will be considered along with conventional techniques. Both conventional and non-conventional energy technologies will be discussed.
*Credit hours:* 3
*Contact hours:* Lecture: 3
*Levels:* Undergraduate

**ECEN 3513 and admission to Professional School**
*Description:* Basic electrical measurements and instrumentation techniques and devices. Use of voltmeters, ammeters, oscilloscopes, impedance bridges to study resistive, inductive, and capacitive circuit elements in steady state and transient operation. Reinforces ENSC 2613 and introduces design of instrumentation networks. Serves as introduction for non-majors. Previously offered as ECEN 3013.
*Credit hours:* 1
*Contact hours:* Lab: 2
*Levels:* Undergraduate

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**ECEN 2011 Experimental Methods I**
*Department/School:* Elec & Computer Engr
*Schedule types:* Lecture, Lab, Combined lecture and lab
*Contact hours:* Lecture: 3 Lab: 2
*Levels:* Undergraduate

**ECEN 2714 Fundamentals of Electric Circuits**
*Department/School:* Elec & Computer Engr
*Schedule types:* Lecture, lab
*Contact hours:* Lecture: 3 Lab: 2
*Levels:* Undergraduate

**ECEN 3020 Supervised Research Project**
*Department/School:* Elec & Computer Engr
*Schedule types:* Independent Study
*Contact hours:* Other: 1
*Levels:* Undergraduate

**ECEN 3113 Energy, Environment and Economics**
*Department/School:* Elec & Computer Engr
ECEN 3233 Digital Logic Design  
**Description:** Boolean algebra, optimization of logic networks. Design using SSI, and MSI, LSI components. ROM and PLA applications. Analysis and design of clock sequential logic networks. Flip-flops, counters, registers. Asynchronous circuit design and analysis. Laboratory experience in implementing combinational and sequential logic devices.  
**Credit hours:** 3  
**Contact hours:** Lecture: 2 Lab: 2  
**Levels:** Undergraduate  
**Department/School:** Elec & Computer Engr

ECEN 3314 Electronic Devices and Applications  
**Prerequisites:** ECEN 2011, ECEN 3714; degree program requires admission to Professional School prior to enrollment.  
**Description:** Semiconductor electronic components including MOSFETs, BJTs, JFETs, and OpAmps. Emphasis on device models and use of solid state electronic devices to analyze, synthesize and design amplifiers and switching circuits. SPICE simulations are extensively utilized. Basic building blocks for analog and digital applications. Theoretical concepts and methods are demonstrated and reinforced through laboratory exercises. Course previously offered as ECEN 3313.  
**Credit hours:** 4  
**Contact hours:** Lecture: 3 Lab: 2  
**Levels:** Undergraduate  
**Department/School:** Elec & Computer Engr

ECEN 3513 Signal Analysis  
**Prerequisites:** ECEN 3714  
**Description:** Degree program requires admission to Professional School prior to enrollment. Deterministic signals. Fourier series and Fourier transforms. Impulse response, convolution and correlation. Sampling theorem. Analog modulation techniques.  
**Credit hours:** 3  
**Contact hours:** Lecture: 3  
**Levels:** Undergraduate  
**Department/School:** Elec & Computer Engr

ECEN 3613 Electromagnetic Fields  
**Prerequisites:** ENSC 2613, MATH 2163 and MATH 2233  
**Description:** Time-harmonic and transient response of transmission lines. Maxwell equations and their applications to engineering problems in electrostatics, magnetostatics, time-harmonic fields and plane wave propagation.  
**Credit hours:** 3  
**Contact hours:** Lecture: 3  
**Levels:** Undergraduate  
**Department/School:** Elec & Computer Engr

ECEN 3623 Mathematical Foundations of Electromagnetics and Photonics  
**Prerequisites:** ECEN 3613; degree program requires admission to Professional School prior to enrollment.  
**Description:** Mathematical and computational treatment of fundamental electromagnetic theory, with applications to microwave engineering, photonics and semiconductor design. Energy and power; Laplace and Poisson equations; wave equation, including reflection, refraction, and diffraction; and classical electromagnetic radiation at macroscopic and microscopic levels.  
**Credit hours:** 3  
**Contact hours:** Lecture: 2 Lab: 2  
**Levels:** Undergraduate  
**Department/School:** Elec & Computer Engr

ECEN 3714 Network Analysis  
**Prerequisites:** ECEN 2011, ENSC 2613, MATH 2233  
**Description:** Laplace transform, transfer functions, magnetically coupled circuits and two-port networks. Theoretical concepts and methods are demonstrated and reinforced through laboratory exercises. Course previously offered as ECEN 3713.  
**Credit hours:** 4  
**Contact hours:** Lecture: 3 Lab: 2  
**Levels:** Undergraduate  
**Department/School:** Elec & Computer Engr

ECEN 3723 Systems I  
**Prerequisites:** ENSC 2113, ENSC 2613, MATH 2233  
**Description:** Physical and mathematical modeling of electrical and mechanical dynamic systems. Transient response of first and second order systems. Laplace transform techniques for solving differential equations, transfer functions, frequency response and resonance. Course previously offered as ECEN 3413.  
**Credit hours:** 3  
**Contact hours:** Lecture: 3  
**Levels:** Undergraduate  
**Department/School:** Elec & Computer Engr

ECEN 3903 Introduction to Semiconductor Devices  
**Prerequisites:** PHYS 2114 or equivalent.  
**Description:** Crystal structure, the quantum theory of solids. The physics of semiconductor materials and the junction, with an emphasis on applications to semiconductor devices. Same course as PHYS 3313.  
**Credit hours:** 3  
**Contact hours:** Lecture: 3  
**Levels:** Undergraduate  
**Department/School:** Elec & Computer Engr

ECEN 3913 Solid State Electronic Devices  
**Prerequisites:** PHYS 3313 or ECEN 3903  
**Credit hours:** 3  
**Contact hours:** Lecture: 3  
**Levels:** Undergraduate  
**Department/School:** Elec & Computer Engr
ECEN 4010 Technical Problems and Engineering Design
Prerequisites: Consent of instructor.
Description: Individual independent study projects selected in consultation with the instructor; analysis or design problems, literature searches and computer simulations may be involved. Offered for variable credit, 1-12 credit hours, maximum of 12 credit hours.
Credit hours: 1-12
Contact hours: Other: 1
Levels: Graduate, Undergraduate
Schedule types: Independent Study
Department/School: Elec & Computer Engr

ECEN 4013 Design of Engineering Systems
Prerequisites: ECEN 2011, ECEN 3714, ECEN 3314, ECEN 3233 and ENSC 3323 and ENGL 3323 as a co-requisite.
Description: Complete design cycle for several small design projects, each including establishing objectives, synthesis, analysis, construction, testing and evaluation. Use of modern lab equipment and fabrication techniques. Development of communication skills.
Credit hours: 3
Contact hours: Lecture: 1 Lab: 4
Levels: Undergraduate
Schedule types: Lab, Lecture, Combined lecture and lab
Department/School: Elec & Computer Engr

ECEN 4024 Capstone Design
Prerequisites: ECEN 4013; degree program requires admission to Professional School prior to enrollment.
Description: Continuation of ECEN 4013. Student project teams design, build, test and present results for realistic projects from university and industrial sponsors. Formulation of specifications, consideration of alternative solutions, feasibility considerations, detailed system descriptions, economic factors, safety, reliability, aesthetics, ethics and social impact. Course previously offered as ECEN 4023.
Credit hours: 4
Contact hours: Lecture: 3 Lab: 2
Levels: Undergraduate
Schedule types: Lab, Lecture, Combined lecture and lab
Department/School: Elec & Computer Engr

ECEN 4030 Undergraduate Professional Practice
Prerequisites: Approval of ECEN department head.
Description: Experience in application of electrical engineering principles to typical problems encountered in industry. Solutions to the problems by student participation in the role of engineer or engineering intern. Offered for variable credit, 1-8 credit hours, maximum of 8 credit hours.
Credit hours: 1-8
Contact hours: Other: 1
Levels: Undergraduate
Schedule types: Independent Study
Department/School: Elec & Computer Engr

ECEN 4133 Power Electronics
Prerequisites: Degree program requires admission to Professional School prior to enrollment.
Description: Power electronic devices, components, and their characteristics; DC to AC conversion; fundamentals of inverters and waveshaping devices; application aspects; control aspects; characteristics and state-of-the-art of advanced power inverter and power conditioning topologies.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate, Undergraduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 4153 Power System Analysis and Design
Prerequisites: Degree program requires admission to Professional School prior to enrollment.
Description: Power system component models from circuit theory. Formulation and design of the load flow model and the optimum economic generator allocation problem utilizing computer methods.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate, Undergraduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 4213 Embedded Computer Systems Design
Prerequisites: ENSC 3213 and CS 1113
Description: Degree program requires admission to Professional School prior to enrollment. Design of microprocessor-based systems through proper integration of hardware and software. Serial and parallel communications, sensor interfacing, computer control of external devices, and color graphics hardware. Design of PASCAL and assembly language modules for optimum real-time system performance.
Credit hours: 3
Contact hours: Lecture: 2 Lab: 2
Levels: Graduate, Undergraduate
Schedule types: Lab, Lecture, Combined lecture and lab
Department/School: Elec & Computer Engr

ECEN 4233 High Speed Computer Arithmetic
Prerequisites: Degree program requires admission to Professional School prior to enrollment.
Description: Course covers computer arithmetic as applied to general purpose and application-specific processors. Focus is on developing high-speed arithmetic algorithms and understanding their implementation in VLSI technology at the gate level.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate, Undergraduate
Schedule types: Lecture
Department/School: Elec & Computer Engr
ECEN 4243 Computer Architecture
Prerequisites: ENSC 3213 and ECEN 3233.
Description: Degree program requires admission to Professional School prior to enrollment. Functional organization and hardware design of digital computer systems with emphasis on microprocessor-based systems. CPU organization, features of microprocessors including advanced 32-bit CPUs, memory system design including cache, virtual memory, error detection and correction, I/O operations, including direct memory access and peripheral interface design.
Credit hours: 3
Contact hours: Lecture: 2 Lab: 2
Levels: Graduate, Undergraduate
Schedule types: Lab, Lecture, Combined lecture and lab
Department/School: Elec & Computer Engr

ECEN 4273 Software Engineering
Prerequisites: ENSC 3213 or CS 1113, CS 3443.
Description: Degree program requires admission to Professional School prior to enrollment. Functional organization and hardware design of digital computer systems with emphasis on microprocessor-based systems. CPU organization, features of microprocessors including advanced 32-bit CPUs, memory system design including cache, virtual memory, error detection and correction, I/O operations, including direct memory access and peripheral interface design. Same course as CS 4273.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate, Undergraduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 4283 Computer Networks
Prerequisites: ENSC 3213 or CS 3443.
Description: Degree program requires admission to Professional School prior to enrollment. Computer networks, distributed systems and their systematic design. Introduction to the use, structure, and architecture of computer networks. Networking experiments to describe network topology. ISO reference model. Same course as CS 4283.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate, Undergraduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 4303 Digital Integrated Circuit Design
Prerequisites: ECEN 3233 and ECEN 3314; degree program requires admission to Professional School prior to enrollment.
Description: Theory of digital and electronics circuits. Digital logic families TTL, IIL, ECL, NMOS, CMOS, GaAs. Large signal models for transistors. Implementation at RAM and ROM. Circuit design for LSI and VLSI.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate, Undergraduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 4313 Linear Electronics Circuit Design
Prerequisites: ECEN 3314; degree program requires admission to Professional School prior to enrollment.
Description: Class A and B small-signal, push-pull power, complementary symmetry, differential and operational amplifiers, utilizing field-effect transistors, bipolar transistors, tunnel diodes and integrated circuits. Emphasis on amplification in electronic devices, design and analysis of wide-band amplifier circuitry.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate, Undergraduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 4353 Communication Electronics
Prerequisites: ECEN 3314; degree program requires admission to Professional School prior to enrollment.
Description: Degree program requires admission to Professional School prior to enrollment.

ECEN 4413 Automatic Control Systems
Prerequisites: ECEN 3723 or MAE 3723; degree program requires admission to Professional School prior to enrollment.
Description: Properties of feedback control systems, mathematical models of basic components, state-variable models of feedback systems, time-domain analysis, stability, transform analysis, frequency domain techniques, root-locus design of single input single output systems and simple compensation techniques. Same course as MAE 4053.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate, Undergraduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 4503 Random Signals and Noise
Prerequisites: ECEN 3513, ECEN 3714; degree program requires admission to Professional School prior to enrollment.
Description: Analysis of electrical systems using elementary concepts of probability, random variables and random processes. Frequency and time domain response of linear systems driven by random inputs. Statistical properties of electrical noise. Analysis and design of optimum linear systems.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate, Undergraduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 4523 Communication Theory
Prerequisites: ECEN 3513 and ECEN 4503. Degree program requires admission to Professional School prior to enrollment.
Description: Noise in modulation systems. Digital data transmission. Design of optimal receivers. Introduction to information theory.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate, Undergraduate
Schedule types: Lecture
Department/School: Elec & Computer Engr
ECEN 4533 Data Communications
Prerequisites: ECEN 4503 as co-requisite.
Description: Degree program requires admission to Professional School prior to enrollment. Signal detection in noise. Tradeoffs between bandwidth signal-to-noise ratio and rate of information transfer. Transmission multiplexing and error handling. Elements of computer network design. Data link protocols.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate, Undergraduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 4613 Microwave Engineering
Prerequisites: ECEN 3613; degree program requires admission to Professional School prior to enrollment.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate, Undergraduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 4703 Active Filter Design
Prerequisites: ECEN 3613; degree program requires admission to Professional School prior to enrollment.
Description: Introduction to passive filters; operational amplifiers as network elements; filter specifications; design of active filters. Laboratory design projects and computer simulations.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate, Undergraduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 4743 Introduction to Biomedical Engineering Modeling and Systems
Prerequisites: ECEN 3714, ECEN 4763; degree program requires admission to Professional School prior to enrollment.
Description: An overview of the field of biomedical engineering and an introduction of the modeling approaches implemented in biomedical engineering. Topics include bio-electronics, biomechanics, compartmental modeling, bio-signal processing, biomedical optics, etc. The course will demonstrate a few of major fields of activity in which biomedical engineers are engaged and modeling approaches are implemented.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate, Undergraduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 4763 Introduction to Digital Signal Processing
Prerequisites: ECEN 3513; degree program requires admission to Professional School prior to enrollment.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate, Undergraduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 4773 Real Time Digital Signal Processing
Prerequisites: ECEN 4763 or equivalent; degree program requires admission to Professional School prior to enrollment.
Description: DSP Processor architectures and programming. A/D, D/A, polled and interrupt-driven I/O. Realtime implementation of FIR/IIR filters, the FFT, and other DSP algorithms on special purpose DSP hardware from Motorola, Texas Instruments and others. Link between DSP theory and practical implementation.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate, Undergraduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 4823 Design of Optical Systems
Prerequisites: PHYS 2114; degree program requires admission to Professional School prior to enrollment.
Description: Introduction to optics through the design, construction, and characterization of optical systems. Emphasis on geometrical optics and spectroscopy. Course previously offered as ECEN 3813.
Credit hours: 3
Contact hours: Lecture: 2 Lab: 2
Levels: Graduate, Undergraduate
Schedule types: Lab, Lecture, Combined lecture and lab
Department/School: Elec & Computer Engr

ECEN 4843 Design of Lasers and Systems
Prerequisites: ECEN 3613; degree program requires admission to Professional School prior to enrollment.
Description: Introduction of the design of lasers and optical systems based on lasers including the design, construction, and characterization of lasers. Gaussian beams and optics, laser gain materials, laser cavities, advanced topics. Course previously offered as ECEN 4813.
Credit hours: 3
Contact hours: Lecture: 2 Lab: 2
Levels: Graduate, Undergraduate
Schedule types: Lab, Lecture, Combined lecture and lab
Department/School: Elec & Computer Engr

ECEN 5000 Thesis or Report
Description: A student studying for the master's degree will enroll in this course for a maximum of six credit hours. Offered for variable credit, 1-6 credit hours, maximum of 6 credit hours.
Credit hours: 1-6
Contact hours: Other: 1
Levels: Graduate
Schedule types: Independent Study
Department/School: Elec & Computer Engr
ECEN 5030 Professional Practice
Description: Experience in application of electrical engineering principles to typical problems encountered in industry and government engineering design and development projects. Solutions to the problems require participation by the student in the role of junior engineer or engineer-intern. Problem solutions involve economics and ecological considerations as well as technology and must be adequately documented. Offered for variable credit, 1-8 credit hours, maximum of 8 credit hours.
Credit hours: 1-8
Contact hours: 6: Other: 1
Levels: Graduate
Schedule types: Independent Study
Department/School: Elec & Computer Engr

ECEN 5060 Special Topics
Prerequisites: Consent of instructor.
Description: Engineering topics not normally included in existing courses. Repeat credit may be earned with different course subtitles assigned. Offered for variable credit, 1-6 credit hours, maximum of 30 credit hours.
Credit hours: 1-6
Contact hours: Other: 1
Levels: Graduate
Schedule types: Independent Study
Department/School: Elec & Computer Engr

ECEN 5070 Directed Studies
Prerequisites: Consent of instructor.
Description: Investigation outside of the classroom of topics not normally covered in lecture courses. Offered for variable credit, 1-6 credit hours, maximum of 6 credit hours.
Credit hours: 1-6
Contact hours: Other: 1
Levels: Graduate
Schedule types: Independent Study
Department/School: Elec & Computer Engr

ECEN 5113 Power Systems Analysis by Computer Methods
Description: Quasi-static control of power systems and analysis of power systems under abnormal operating conditions. Transient stability studies. Models formulated and solutions outlined for implementation on the computer.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 5123 Power Electronics and Renewables
Description: Modeling and control aspects of power electronics for integrating renewable energy systems. Topics covered here will focus on power converter dynamics, indirect converter topologies, PWM technique, sliding mode control of converters, game theory based control, Maximum power point tracking, control of generators for different renewable energy systems. Simulation tools will be discussed as appropriate.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 5153 Direct Energy Conversion
Description: Energy conversion techniques and applications; thermo-electrics, thermionics, fuel cells, MHD and other processes involving electrical, mechanical and thermal energies. State-of-the-art developments in direct energy conversion using selected papers from journals and other publications. Gives the student a proper perspective of the possibilities and problems associated with satisfying future energy requirements.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 5163 Intro to Smart Grid
Prerequisites: ECEN 5193.
Description: Introduction to smart grid technologies and applications; advance metering infrastructures, demand response, renewable generation, electric vehicles, and cyberattacks.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 5193 Power Economics and Regulation
Prerequisites: Vector calculus, familiarity with complex numbers.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 5223 Digital Systems Testing
Prerequisites: ECEN 3233
Description: Testing of combinational and sequential circuits. Test generation techniques. Design of reliable and testable circuits and systems. Testing for LSI and VLSI.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Elec & Computer Engr
ECEN 5233 Embedded Sensor Networks
Prerequisites: Graduate standing or consent of instructor.
Description: Analysis and design of wireless networks, including the integration of sensing, computation, and wireless communication within an embedded system. Mobile sensor networks and body sensor networks. Real world application and new innovations.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 5253 Digital Computer Design
Prerequisites: ECEN 4243 or graduate standing
Description: Arithmetic algorithms and the design of the arithmetic/logic unit (ALU). Serial and parallel data processing; control and timing systems; microprogramming; memory organization alternatives; input/output interfaces. Same course as CS 5253.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 5263 VLSI Digital Systems Design
Prerequisites: ECEN 4303; ECEN 5253 recommended or graduate standing.
Description: Design of very large-scale digital systems on a single chip. Review of MOS technology. Design rules imposed by fabrication techniques. Systematic structures for control and data flow; system timing; highly concurrent systems. Experimental opportunities available.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 5283 Computer Vision
Description: The development of machine vision and advanced image understanding techniques for robotics, automated inspection, biomedicine. Object recognition, motion analysis, object tracking, segmentation, representation, and 3-D analysis.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 5313 Solid-State Electron I
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 5333 Embedded Sensor Networks
Prerequisites: Graduate standing or consent of instructor.
Description: Analysis and design of wireless networks, including the integration of sensing, computation, and wireless communication within an embedded system. Mobile sensor networks and body sensor networks. Real world application and new innovations.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 5353 Adv Power Electronics
Prerequisites: ECEN 4133
Description: Characteristics of high power semiconductor devices and the application of such devices to power conditioning, inversion and wave shaping at high power levels.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 5363 CMOS Analog Integrated Circuit Design
Prerequisites: ECEN 4313
Description: Advanced study of solid state CMOS linear integrated circuits. Topics include: Op Amps, comparators, multipliers, D/A and A/D converters and Op Amp building blocks. Op Amp building blocks include, differential pairs, current mirrors, gain, output stages, and references. VLSI layout and circuit simulation using SPICE.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 5373 RF Microwave Circuit Design
Prerequisites: ECEN 3314 , ECEN 4613 and ECEN 5333 or equivalent.
Description: Smith chart, single- and multi-port network, filter design, RF/microwave components and modeling, matching and biasing network, amplifier, oscillators and mixers.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 5413 Optimal Control
Prerequisites: ECEN 5713 or MAE 5713.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Elec & Computer Engr
ECEN 5423 Control of Hybrid Systems  
**Prerequisites:** 5713 Linear Systems or consent of instructor.  
**Description:** Introduction and definitions. Modeling of hybrid systems. Analysis of hybrid systems. Stability analysis. Switched control systems. Hybrid control design. Applications in power systems, robotics, transportation and multivehicle systems.  
**Credit hours:** 3  
**Contact hours:** Lecture: 3  
**Levels:** Graduate  
**Schedule types:** Lecture  
**Department/School:** Elec & Computer Engr  

ECEN 5433 Robotics Kinematics, Dynamics and Control  
**Prerequisites:** ECEN 4413 or MAE 4053 or consent of instructor.  
**Credit hours:** 3  
**Contact hours:** Lecture: 3  
**Levels:** Graduate  
**Schedule types:** Lecture  
**Department/School:** Elec & Computer Engr  

ECEN 5463 Nonlinear System Analysis and Control  
**Prerequisites:** ECEN 4413 or MAE 4053  
**Description:** Failure of superposition of effects; phase-plane analysis; limit-cycles; Lyapunov stability; hyperstability and input-output stability; controllability and observability of nonlinear systems; feedback linearization; robust nonlinear control system design. Same course as MAE 5463. Course previously offered as ECEN 5723.  
**Credit hours:** 3  
**Contact hours:** Lecture: 3  
**Levels:** Graduate  
**Schedule types:** Lecture  
**Department/School:** Elec & Computer Engr  

ECEN 5473 Digital Control Systems  
**Prerequisites:** ECEN 4413 or MAE 4053  
**Description:** Input-output and state-space representation of linear discrete-time systems. Approximate methods in discrete-time representation. Stability methods. Controllability, observability, state estimation, and parameter identification. Design and analysis of feedback control system using frequency-domain and state-space methods. Introduction to optimal control. Same course as MAE 5473. Course previously offered as ECEN 6413.  
**Credit hours:** 3  
**Contact hours:** Lecture: 3  
**Levels:** Graduate  
**Schedule types:** Lecture  
**Department/School:** Elec & Computer Engr  

ECEN 5483 Advanced Mechatronics Design  
**Prerequisites:** MAE 4733 or similar course and consent of instructor.  
**Description:** Optimizing C programming code for microcontrollers using the assembly language instruction set. RS-232 microcontroller communication protocol. Controller Area Network (CAN) communication protocol plus hands-on CAN bus development boards, advanced topics which could include but are not limited to sensor design, real-time operating systems, and advanced communication protocols. Same course as MAE 5483.  
**Credit hours:** 3  
**Contact hours:** Lecture: 3  
**Levels:** Graduate  
**Schedule types:** Lecture  
**Department/School:** Elec & Computer Engr  

ECEN 5493 Software Design for Real-Time Distributed Systems  
**Prerequisites:** ECEN 5483 or MAE 5483 or consent of the instructor.  
**Description:** Fundamental concepts associated with the design of software for implementation on distributed computer systems using real-time operating systems. Parallel computing in a real-time environment and control algorithm design. State-of-the-art boards including analog-to-digital and digital-to-analog equipment and newest computer-aided software engineering tools.  
**Credit hours:** 3  
**Contact hours:** Lecture: 3  
**Levels:** Graduate  
**Schedule types:** Lecture  
**Department/School:** Elec & Computer Engr  

ECEN 5513 Stochastic Systems  
**Prerequisites:** ECEN 3513 and ECEN 4503 or STAT 4033  
**Description:** Theory and applications involving probability, random variables, functions of random variables, and stochastic processes, including Gaussian and Markov processes. Correlation, power spectral density, and non-stationary random processes. Response of linear systems to stochastic processes. State-space formulation and covariance analysis. Same course as MAE 5513.  
**Credit hours:** 3  
**Contact hours:** Lecture: 3  
**Levels:** Graduate  
**Schedule types:** Lecture  
**Department/School:** Elec & Computer Engr  

ECEN 5523 Estimation Theory  
**Prerequisites:** ECEN 5513 or MAE 5513  
**Description:** Stochastic model development, parameter estimation and state estimation. The linear model, model order determination, least squares estimation, maximum likelihood estimation, Bayesian estimation, Gaussian random vectors, estimation in linear and Gaussian models, state estimation, the Kalman filter, prediction and smoothing. Same course as MAE 5523.  
**Credit hours:** 3  
**Contact hours:** Lecture: 3  
**Levels:** Graduate  
**Schedule types:** Lecture  
**Department/School:** Elec & Computer Engr
ECEN 5533 Modern Communication Theory  
**Prerequisites:** ECEN 5513  
**Description:** Noise as a random process, analog and digital signal detection in the presence of noise, optimum receiver design using signal space concepts and introduction to information theory. Trade-offs between bandwidth, signal-to-noise ratio and the rate of information transfer. Example system designs include earth satellite, deep space and terrestrial communication systems and computer communication networks.  
**Credit hours:** 3  
**Contact hours:** Lecture: 3  
**Levels:** Graduate  
**Schedule types:** Lecture  
**Department/School:** Elec & Computer Engr

ECEN 5543 Data Transportation and Protection  
**Prerequisites:** Graduate standing or consent of instructor.  
**Description:** Data and its representation; finite field matrices, pseudorandom sequences; information protection; space division networks; synchronization; and channel and error control.  
**Credit hours:** 3  
**Contact hours:** Lecture: 3  
**Levels:** Graduate  
**Schedule types:** Lecture  
**Department/School:** Elec & Computer Engr

ECEN 5553 Telecommunications Systems  
**Prerequisites:** Graduate standing or consent of instructor.  
**Description:** Surveys the ways and means that voice, data and video are moved long distances. Covers computer networks (Ethernet LAN's, Internet WAN's); telephone systems (PSTN, VoIP and cellular telephony); video (MPEG, H.323, and IPTV); and last mile delivery systems.  
**Credit hours:** 3  
**Contact hours:** Lecture: 3  
**Levels:** Graduate  
**Schedule types:** Lecture  
**Department/School:** Elec & Computer Engr

ECEN 5563 Principles of Wireless Networks  
**Prerequisites:** ECEN 4283 or CS 428  
**Description:** Wireless network operation, planning, mobility management, cellular and mobile data networks based on CDMA, TDMA, GSM; IEEE 802-11 WLANS, Adhoc networks, Bluetooth, power management, wireless geolocation and indoor positioning technique. Same course as CS 5813.  
**Credit hours:** 3  
**Contact hours:** Lecture: 3  
**Levels:** Graduate  
**Schedule types:** Lecture  
**Department/School:** Elec & Computer Engr

ECEN 5573 Wireless Communication  
**Description:** Wireless channel characterization: large-scale and small scale fading. Techniques to combat fading; diversity techniques, coding techniques, CDMA, OFDM, MIMO. Cellular concept.  
**Credit hours:** 3  
**Contact hours:** Lecture: 3  
**Levels:** Graduate  
**Schedule types:** Lecture  
**Department/School:** Elec & Computer Engr

ECEN 5613 Electromagnetic Theory  
**Prerequisites:** ECEN 3613  
**Description:** First graduate level treatment of classical electromagnetic theory. Wave equation, potential theory, boundary conditions. Rectangular, cylindrical and spherical wave functions. Conducting and dielectric guiding structures. Scattering and radiation. Introduction to numerical techniques.  
**Credit hours:** 3  
**Contact hours:** Lecture: 3  
**Levels:** Graduate  
**Schedule types:** Lecture  
**Department/School:** Elec & Computer Engr

ECEN 5623 Antenna Theory  
**Prerequisites:** ECEN 3613  
**Description:** Fundamental antenna parameters, including directivity, efficiency, radiation resistance, and pattern. Analysis of dipole, loop, aperture, broad- band, and traveling wave antennas. Array theory. Introduction to numerical techniques used in modern antenna design.  
**Credit hours:** 3  
**Contact hours:** Lecture: 3  
**Levels:** Graduate  
**Schedule types:** Lecture  
**Department/School:** Elec & Computer Engr

ECEN 5633 Radar Theory  
**Prerequisites:** ECEN 3613; ECEN 4503 or ECEN 5513  
**Credit hours:** 3  
**Contact hours:** Lecture: 3  
**Levels:** Graduate  
**Schedule types:** Lecture  
**Department/School:** Elec & Computer Engr

ECEN 5643 Antennas and Propagation for Wireless Communications  
**Prerequisites:** ECEN 3613, ECEN 4503  
**Credit hours:** 3  
**Contact hours:** Lecture: 3  
**Levels:** Graduate  
**Schedule types:** Lecture  
**Department/School:** Elec & Computer Engr
ECEN 5683 Biomedical Optics
Description: Biomedical optics, also often termed as biophotonics, is a highly interdisciplinary subject on applying light for diagnostic detection and manipulation of biological tissue. This course introduces fundamental concepts and principal technologies of biomedical optics or biophotonics to graduate students and upper-level undergraduate students. The course includes three parts: The first part discusses light-tissue interaction. The second part introduces approaches to modeling photon propagation in tissue. The third part details several representative light-based sensing and imaging technologies for probing biological tissues at different spatial, spectral, and temporal scales for either morphological or functional diagnosis. Topics of therapeutic use of light will also be discussed.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 5703 Optimization Applications
Prerequisites: Graduate standing.
Description: A survey of various methods of unconstrained and constrained linear and non-linear optimization. Applications of these methodologies using hand-worked examples and available software packages. This applications oriented course is intended for engineering and science students. Same course as CHE 5703, IEM 5023 & MAE 5703.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 5713 Linear Systems
Prerequisites: Graduate standing or consent of instructor.
Description: Introduction to the fundamental theory of finite-dimensional linear systems with emphasis on the state-space representation. Mathematical representations of systems; linear dynamic solutions; controllability, observability, and stability; linearization and realization theory; and state feedback and state observer. Same course as MAE 5713.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 5733 Neural Networks
Prerequisites: Graduate standing.
Description: Introduction to mathematical analysis of networks and learning rules, and on the application of neural networks to certain engineering problems in image and signal processing and control systems. Same course as CHE 5733 & MAE 5733.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 5753 Digital Processing of Speech Signals
Prerequisites: ECEN 4763 or 5763
Description: Digital signal processing; speech production; digital modeling of speech; short time analysis and synthesis; the short time Fourier transform, linear predictive coding and solution of the normal equations; vocal tract spectrum calculation; speech coding; homomorphic processing; applications of speech processing. Introduction to more advanced topics as time permits.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 5763 Digital Signal Processing
Description: Introduction to discrete linear systems; frequency-domain design of digital filters; quantization effects in digital filters; digital filter hardware, discrete Fourier transforms; high-speed convolution and correlation with application to digital filtering; introduction to Walsh-Fourier theory.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 5773 Intelligent Systems
Prerequisites: ECEN 5733
Description: Introduction to the state-of-the art intelligent control and system successfully deployed to industrial and defense applications. Emerging intelligent algorithms (e.g., NN, FS, GA, EP, DES); intelligent control architecture (e.g., bottom-up, top-down, semiotics); reinforcement learning and hybrid systems; and case studies and design projects. Same course as MAE 5773.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 5783 Medical Imaging
Prerequisites: ECEN 3513, ECEN 4743 or consent of instructor.
Description: A comprehensive introduction to the standard medical imaging modalities used today. Topics include radiation, radiation-interaction with matter, X-ray radiography, ultrasound, computer tomography, image reconstruction and analysis, MRI, nuclear medicine, and radiation therapy. The fundamental mathematics underlying each imaging modality is reviewed and the hardware needed to implement each system is examined.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Elec & Computer Engr
ECEN 5793 Digital Image Processing  
**Prerequisites:** ECEN 4763 or ECEN 5763  
**Description:** Digital image processing including image acquisition and characterization, transforms, coding and compression, enhancement, restoration and segmentation. Use of modern image processing software on Sun and IBM work stations.  
**Credit hours:** 3  
**Contact hours:** Lecture: 3  
**Levels:** Graduate  
**Schedule types:** Lecture  
**Department/School:** Elec & Computer Engr

ECEN 5803 Geometrical Optics  
**Prerequisites:** PHYS 3213 or consent of instructor.  
**Description:** Foundations of geometrical optics, geometrical theory of optical imaging, geometrical theory aberrations, image forming instruments. Same course as PHYS 5123.  
**Credit hours:** 3  
**Contact hours:** Lecture: 3  
**Levels:** Graduate  
**Schedule types:** Lecture  
**Department/School:** Elec & Computer Engr

ECEN 5823 Physical Optics  
**Prerequisites:** PHYS 3213 or consent of instructor.  
**Description:** Multiple beam interference, diffractions, imaging, near field optical probes of matter, surface plasmons, light scattering from random media, optical coherence tomography- biomedical applications, negative materials, perfect lenses and super resolution. Same course as PHYS 5303.  
**Credit hours:** 3  
**Contact hours:** Lecture: 3  
**Levels:** Graduate  
**Schedule types:** Lecture  
**Department/School:** Elec & Computer Engr

ECEN 5833 Fiber-Optic Communication Systems  
**Prerequisites:** Graduate standing or consent of instructor.  
**Description:** Five generations of fiber-optic communication systems described in detail. Technical advances and increased capability of each system. Historical framework of how technical capability at the time forced technical decisions. A systems engineering point of view, emphasizing optimization of all components of the optical fiber link.  
**Credit hours:** 3  
**Contact hours:** Lecture: 3  
**Levels:** Graduate  
**Schedule types:** Lecture  
**Department/School:** Elec & Computer Engr

ECEN 5843 Microelectronic Fabrication  
**Prerequisites:** ECEN 3314  
**Description:** Contamination control and clean-room, vacuum systems, wafer manufacturing. Photolithography and alternative lithographic techniques. Physical and chemical vapor deposition, oxidation, etching, doping, packaging, formation of semiconductor devices and circuits. A series of Fabrication lab projects is conducted starting from bare silicon wafers to fabricate Optoelectronic circuits. Additional flat fee of $120.00 applies.  
**Credit hours:** 3  
**Contact hours:** Lecture: 3  
**Levels:** Graduate  
**Schedule types:** Lecture  
**Department/School:** Elec & Computer Engr

ECEN 5853 Ultrafast Optoelectronics  
**Prerequisites:** Graduate standing or consent of instructor.  
**Description:** Combining ultra fast laser pulses with electronic circuitry. Increased device performance. Optoelectronic/electrical pulses as short as 0.2 psec. High performance areas illustrating the power of advanced techniques in applications.  
**Credit hours:** 3  
**Contact hours:** Lecture: 3  
**Levels:** Graduate  
**Schedule types:** Lecture  
**Department/School:** Elec & Computer Engr

ECEN 6000 Research  
**Prerequisites:** Consent of major professor.  
**Description:** Independent research for students continuing graduate study beyond the level of the MS degree. Offered for variable credit, 1-16 credit hours, maximum of 36 credit hours.  
**Credit hours:** 1-16  
**Contact hours:** Other: 1  
**Levels:** Graduate  
**Schedule types:** Independent Study  
**Department/School:** Elec & Computer Engr

ECEN 6001 PhD Seminar Series  
**Prerequisites:** Approval of ECEN department head.  
**Description:** Seminar series for PhD studies and research.  
**Credit hours:** 1  
**Contact hours:** Lecture: 1  
**Levels:** Graduate  
**Schedule types:** Lecture  
**Department/School:** Elec & Computer Engr

ECEN 6050 Preliminary PhD Research and Proposal  
**Prerequisites:** Consent of adviser.  
**Description:** Independent research and report of an advanced electrical engineering problem. Work performed serves as foundation of the oral PhD preliminary exam.  
**Credit hours:** 3  
**Contact hours:** Other: 3  
**Levels:** Graduate  
**Schedule types:** Independent Study  
**Department/School:** Elec & Computer Engr
ECEN 6060 Advanced Special Topics  
**Prerequisites:** Consent of instructor.  
**Description:** Advanced engineering topics not normally included in existing courses. Repeat credit may be earned with different course subtitles assigned. Offered for variable credit, 1-6 credit hours, maximum of 30 credit hours.  
**Credit hours:** 1-6  
**Contact hours:** Other: 1  
**Levels:** Graduate  
**Schedule types:** Independent Study  
**Department/School:** Elec & Computer Engr  

ECEN 6070 Advanced Directed Studies  
**Prerequisites:** Admission into PhD program and consent of instructor.  
**Description:** Investigation outside of the classroom of topics not normally covered in lecture courses. Offered for variable credit, 1-6 credit hours, maximum of 12 credit hours.  
**Credit hours:** 1-6  
**Contact hours:** Other: 1  
**Levels:** Graduate  
**Schedule types:** Independent Study  
**Department/School:** Elec & Computer Engr  

ECEN 6123 Special Topics in Power Systems  
**Prerequisites:** ECEN 5113.  
**Description:** Selected relevant current topics related to power system operation and planning.  
**Credit hours:** 3  
**Contact hours:** Lecture: 3  
**Levels:** Graduate  
**Schedule types:** Lecture  
**Department/School:** Elec & Computer Engr  

ECEN 6253 Advanced Topics in Computer Architecture  
**Prerequisites:** ECEN 5253 or CS 5253.  
**Description:** Innovations in the architecture and organization of computers, with an emphasis on parallelism. Topics may include pipelining, multiprocessors, data flow, and reduction machines. Same course as CS 6253.  
**Credit hours:** 3  
**Contact hours:** Lecture: 3  
**Levels:** Graduate  
**Schedule types:** Lecture  
**Department/School:** Elec & Computer Engr  

ECEN 6263 Advanced VLSI Design and Applications  
**Prerequisites:** ECEN 5223 and ECEN 5263.  
**Description:** System timing. Designing testable integrated circuits. Specialized parallel processing architectures. Application examples.  
**Credit hours:** 3  
**Contact hours:** Lecture: 3  
**Levels:** Graduate  
**Schedule types:** Lecture  
**Department/School:** Elec & Computer Engr  

ECEN 6363 Analog VLSI for Signal Processing  
**Prerequisites:** ECEN 4273  
**Description:** Continuation of ECEN 5363. Advanced theory and practice of analog VLSI design methodology. Very large scale design and implementation of signal processing solutions, including over sampled A/Ds, neural networks and filters.  
**Credit hours:** 3  
**Contact hours:** Lecture: 3  
**Levels:** Graduate  
**Schedule types:** Lecture  
**Department/School:** Elec & Computer Engr  

ECEN 6423 System Identification  
**Prerequisites:** ECEN 5473 or ECEN 5713 or MAE 5473 or MAE 5713.  
**Description:** Linear and nonlinear system modeling of random systems. Models of linear time-invariant systems, nonparametric methods and preliminary model development, parameter estimation methods, convergence and consistency, asymptotic distributions of parameter estimates. Nonlinear modeling. Same course as MAE 6423.  
**Credit hours:** 3  
**Contact hours:** Lecture: 3  
**Levels:** Graduate  
**Schedule types:** Lecture  
**Department/School:** Elec & Computer Engr  

ECEN 6453 Adaptive Control  
**Prerequisites:** ECEN 5473 or ECEN 5713 or MAE 5473 or MAE 5713  
**Description:** Analysis and design of control techniques that modify their performance to adapt to changes in system operation. Review of systems analysis techniques, including state variable representations, linearization, discretization, covariance analysis, stability, and linear quadratic Gaussian design. On-line parameter estimation, model reference adaptive systems, self-tuning regulators, stable adaptive systems. Same course as MAE 6453. Course previously offered as ECEN 6450.  
**Credit hours:** 3  
**Contact hours:** Lecture: 3  
**Levels:** Graduate  
**Schedule types:** Lecture  
**Department/School:** Elec & Computer Engr  

ECEN 6463 Advances in NonLinear Control  
**Prerequisites:** ECEN 5463 or MAE 5463.  
**Description:** Introduction to vector fields and Lie algebra; controllability and observability of non-linear systems; local decompositions; input-output and state space representation of non-linear systems; feedback linearization; controlled invariance and distribution; control of Hamiltonian systems. Same course as MAE 6463.  
**Credit hours:** 3  
**Contact hours:** Lecture: 3  
**Levels:** Graduate  
**Schedule types:** Lecture  
**Department/School:** Elec & Computer Engr
ECEN 6483 Robust Multivariate Control Systems
Prerequisites: ECEN 5713 or MAE 5713
Description: Introduction to multivariable systems: SISO robustness vs. MIMO robustness; multivariable system poles and zeros; MIMO transfer functions; multivariable frequency response analysis; multivariable Nyquist theorem; performance specifications; stability of feedback systems; linear fractional transformations (LFT’s); parameterization of all stabilizing controllers; structured singular value; algebraic ricatti equations; H2 optimal control; H-infinity controller design. Same course as MAE 6483.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 6523 Information Theory
Prerequisites: ECEN 5513 or consent of instructor.
Description: Mathematical theory of information (Shannon theory) including information measure and transmission rates and capacities. Source coding theory including algebraic and error-correcting codes. Design of waifer-forms for noise immunity. Information transfer in learning systems.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 6803 Photonics I: Advanced Optics
Prerequisites: ECEN 3813 or PHYS 3213 or consent of instructor.
Description: Advanced optics including spectral and time characteristics of detectors, characteristics of lasers, time, spectral and spatial parameters of laser emission, interferometric techniques, and nonlinear effects such as two-photon absorption and second and third harmonic generations. Emphasis on ultrashort laser pulses. Same course as CHEM 6803 & PHYS 6803.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 6810 Photonics II: THz Photonics and THz-TD
Prerequisites: ECEN 6803
Description: Concepts and techniques of driving electronic circuitry with ultra short laser pulses to generate and detect freely propagating pulses of THz electromagnetic radiation using several operational research systems. Same course as CHEM 6810 & PHYS 6810. Course previously offered as ECEN 6811. Offered for fixed credit, maximum of 4 credit hours.
Credit hours: 1
Contact hours: Lab: 2
Levels: Graduate
Schedule types: Lab
Department/School: Elec & Computer Engr

ECEN 6820 Photonics II: Spectroscopy II
Prerequisites: ECEN 6803
Description: Operating principles and applications of laser spectroscopy of atoms, molecules, solids and complex fluids. Absorption, emission, photon correlation, coherence, time resolved Fourier transform. Raman spectroscopy and non-linear optical. Same course as CHEM 6820 & PHYS 6820. Course previously offered as ECEN 6821. Offered for fixed credit, maximum of 4 credit hours.
Credit hours: 1
Contact hours: Lab: 2
Levels: Graduate
Schedule types: Lab
Department/School: Elec & Computer Engr

ECEN 6823 Advanced Optical Techniques
Prerequisites: ECEN 5953
Description: State-of-the-art optical devices and research methodologies. Investigation and discussion of contemporary developments in non-linear optical devices and laser applications. Includes both analytical and experimental techniques.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 6830 Photonics II: Spectroscopy III
Prerequisites: ECEN 6820
Description: Investigation and discussion of contemporary developments in non-linear optical devices and spectroscopy and non-linear optical. Same course as CHEM 6830 & PHYS 6830. Offered for 1 fixed credit hour, maximum of 4 credit hours.
Credit hours: 1
Contact hours: Lab: 2
Levels: Graduate
Schedule types: Lab
Department/School: Elec & Computer Engr

ECEN 6840 Photonics III: Microscopy I
Prerequisites: CHEM 3553 or consent of instructor
Description: State-of-the-art optical devices and research methodologies. The structure and imaging of solid surfaces. Basics of advanced spectroscopic instruments and methods used for investigation of semi-conductors and solid state material. Stimulated emission characterized both in wavelength and in time. Time-resolved fluorescence measurements. Multiphotonic excitations. Fast measuring techniques, including subnanosecond detectors, picosecond streak cameras, and ultra fast four-wave mixing and correlation techniques. Time-dependent photoconductivity measurements. Same course as CHEM 6830 & PHYS 6830. Course previously offered as ECEN 6831. Offered for fixed credit, maximum of 4 credit hours.
Credit hours: 1
Contact hours: Lab: 2
Levels: Graduate
Schedule types: Lab
Department/School: Elec & Computer Engr
Department/School: Elec & Computer Engr
Schedule types: Lecture
Levels: Graduate
Credit hours: 3
Contact hours: Lab: 2
Levels: Graduate
Schedule types: Lab
Department/School: Elec & Computer Engr

ECEN 6843 Advanced Microelectronic Fabrication
Prerequisites: ECEN 5843
Description: Photolithography, wet and dry etching, thermal and electron beam evaporation, photomask design using L-Edit, silicon devices processing, quartz devices processing, silicon-on-sapphire devices processing, GaAs devices processing and MEMS devices processing.
Credit hours: 3
Contact hours: Lecture: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 6850 Photonics III: Microscopy II
Prerequisites: CHEM 3553 or consent of instructor.
Description: Advanced techniques of scanning probe microscopy (SPM). Magnetic force microscopy, Kelvin force microscopy, scanning probe microscopy (STM) in vacuum. Characterization of materials with SPM. Nanolithography with SPM. Device manufacturing and analysis. Same course as CHEM 6850 & PHYS 6850. Course previously offered as ECEN 6851. Offered for 1 fixed credit hour, maximum of 4 credit hours.
Credit hours: 1
Contact hours: Lab: 2
Levels: Graduate
Schedule types: Lab
Department/School: Elec & Computer Engr

ECEN 6860 Photonics III: Microscopy III and Image Processing
Prerequisites: ECEN 5793
Description: Digital image processing, including projects. Image acquisition and display, image enhancement, geometric operations, linear and nonlinear filtering, image restoration, edge detection, image analysis, morphology, segmentation, recognition, and coding/compression. Same course as CHEM 6860 & PHYS 6860. Offered for fixed credit hours, maximum of 4 credit hours.
Credit hours: 1
Contact hours: Lab: 2
Levels: Graduate
Schedule types: Lab
Department/School: Elec & Computer Engr

ECEN 6870 Photonics IV: Synthesis and Devices I
Prerequisites: ECEN 6803 and ECEN 6840
Description: Preparation of functional nanostructures and related optical/electronic devices. Physical and chemical methods of thin film deposition. Engineering of prototypes of light emitting diodes, sensors, optical limiting coatings, lithographic patterns. Same course as CHEM 6870 & PHYS 6870. Course previously offered as ECEN 6871. Offered for 1 fixed credit hour, maximum of 4 credit hours.
Credit hours: 1
Contact hours: Lab: 2
Levels: Graduate
Schedule types: Lab
Department/School: Elec & Computer Engr

ECEN 6880 Photonics IV: Semiconductor Devices, Testing and Characterization
Prerequisites: ECEN 6803 and ECEN 6840
Description: Test and characterization of semiconductor and optoelectronic devices. Hall effect, four point probe, CV and IV measurements, optical pump-probe, photoluminescence and electro-optics sampling. Same course as CHEM 6880 & PHYS 6880. Course previously offered as ECEN 6881. Offered for 1 fixed credit hour, maximum of 4 credit hours.
Credit hours: 1
Contact hours: Lab: 2
Levels: Graduate
Schedule types: Lab
Department/School: Elec & Computer Engr

ECEN 6890 Photonics IV: Semiconductor Synthesis and Devices III
Prerequisites: ECEN 6803
Description: Processing, fabrication and characterization of semiconductor optoelectronic devices in class 100/10000 cleanrooms. Cleanroom operation including general procedure for material processing and device fabrication. Device processing using a variety of processing such as mask aligner, vacuum evaporators and rapid thermal annealer. Testing using optical and electrical testing apparatus such as I-V, C-V, Hall, and optical spectral measurement systems. Same course as CHEM 6890 & PHYS 6890. Course previously offered as ECEN 6891. Offered for fixed 1 credit hour, maximum of 4 credit hours.
Credit hours: 1
Contact hours: Lab: 2
Levels: Graduate
Schedule types: Lab
Department/School: Elec & Computer Engr

Undergraduate Programs

- Computer Engineering, BSCP (http://catalog.okstate.edu/engineering-architecture-technology/electrical-computer-engineering/computer-bscp)
- Electrical Engineering, BSEE (http://catalog.okstate.edu/engineering-architecture-technology/electrical-computer-engineering/electrical-bsee)

Graduate Programs

The School of Electrical and Computer Engineering offers two graduate degrees, both in electrical engineering: Master of Science and Doctor of Philosophy. Specialized MS degree options in

1. control systems and
2. optics and photonics are also available, as are interdisciplinary graduate degrees in several specialties.

These graduate degree programs are flexible in course selection and emphasis.

The Master of Science degree emphasizes advanced mathematics, theory, design, and research. It is intended for students interested in cutting-edge careers or who want to prepare for advanced study associated with the PhD program. This degree combines course work with research that allows students to expand their knowledge in an in-depth area of electrical engineering or computer engineering.

The Doctor of Philosophy degree is designed to prepare students for high-level research and development positions in academia, industry and government and for the teaching profession in engineering. This degree is
Students typically select course work and participate in research and design projects in the following areas:

- Communication systems, cybersecurity, and networks
- Control systems, robotics, and mechatronics
- Analog, mixed-signal, and RF electronics
- Computer architecture, VLSI digital circuits, and arithmetic
- Electromagnetics and THz sciences
- Microcontrollers and embedded control
- Photonics and electro-optics
- Digital signal, image, and video processing
- Energy and power
- Bioengineering

Students may also select a multidisciplinary program that crosses departmental lines and emphasizes the application of electrical and computer engineering to complex problems. These applications serve to promote the interaction of engineering systems and technology with social, economic and environmental processes. Multidisciplinary opportunities exist in control systems and biomedical engineering.

**Admission Requirements**

Admission to the Graduate College, as described under "General Regulations" in the "Graduate College" section of the University Catalog is required. Graduation with high scholastic performance from an electrical engineering or computer engineering curriculum accredited by the ABET qualifies the student for admission to the School of Electrical and Computer Engineering. A recent GRE score is also required as part of the application.

Graduates from non-engineering fields such as mathematics, physics and computer science are also admitted to the School of Electrical and Computer Engineering MS and PhD graduate programs if an evaluation of the applicant’s official transcript indicates that the applicant is prepared to succeed in graduate-level course work in electrical and computer engineering, or can be expected to do so after a reasonable amount of remedial course work. This condition also applies to graduates of unaccredited engineering programs and engineering technology programs.

**Degree Requirements**

The Master of Science degree in Electrical Engineering (MSEE) is awarded to those students who successfully complete an approved plan of study. The degree requires 24 credit hours of course work plus 6 credit hours for the thesis. In addition to the thesis requirement, the plan of study requires, at a minimum, 18 hours of 5000-level courses in electrical and computer engineering. Most plans of study include additional 5000-level courses, depending upon the background and particular educational goals of the student. Each student is encouraged to include courses in supporting disciplines such as mathematics, physics, computer science, or other engineering fields. Additional remedial work in undergraduate electrical and computer engineering courses may be required for students who do not have a sufficient background in electrical engineering.

Students who wish to pursue a non-research, master’s degree are encouraged to contact the Graduate Coordinator of the School of Electrical and Computer Engineering for more information.

The Doctor of Philosophy degree is granted to recognize high achievement in course work selected from the broad field of electrical and computer engineering. The degree is conferred on those who demonstrate the ability to perform independent research in a chosen field of specialization that generates new knowledge, as presented in a dissertation. For this degree the Graduate College requires a minimum of 90 credit hours for acceptable academic work beyond the bachelor's degree, including credit for the dissertation.

The School of Electrical and Computer Engineering also participates in several interdisciplinary degree programs. (See “Graduate Programs” under “Industrial Engineering and Management,” and “Telecommunications Management” the “Graduate College” section of the Catalog.)

**Master of Science in Engineering Technology Management**

Tim Hardin, PhD—Director
Brenda L. Johnson, MS—Assistant Director

OSU’s Master of Science in Engineering Technology Management is a rigorous degree program designed specifically for experienced engineers and scientists who are interested in accelerating their management careers. The curriculum combines academic coursework with the latest business practices and can be tailored to meet an individual student’s needs. Managing today’s global organizations requires a complex set of knowledge and skills. Effective planning, selection, implementation and management of technology, and the teams involved, is essential to the success of any business in today’s time-critical, global markets. OSU-MSETM students learn to apply proven evaluation concepts and implementation strategies to fast moving, technical management decisions that make the difference in both career and business success. The MSETM program specifically addresses the real needs identified by industry leaders. The MSETM curriculum permits you to build a strong degree that directly addresses your needs and prepares you for the future. The degree consists of 32 credit hours. The MSETM program is provided by the OSU colleges of Engineering, Architecture and Technology; Arts and Sciences; and the Spears School of Business.

**Admission Requirements**

The guidelines for admission to the MSETM program are a bachelor's or higher degree, in engineering or the physical/mathematical sciences, with a 3.00 GPA, and at least four years’ employment in a technical field since graduation with a bachelor's degree. Applicants not meeting these standards may be granted provisional admission based upon their overall academic and professional practice history and accomplishments. Since many course assignments are integrated into current issues in the work environment, students must be managing or employed in a technical organization in order to be successful in the program. For this reason, the program is not appropriate for full-time on-campus students. The MSETM student body is made up entirely of full-time employed, technical professionals who receive the courses through distance education technologies. An applicant must submit the following documents to the MSETM office:

1. an official OSU Application for Graduate Admission,
2. an official transcript of all academic work and degrees received,
3. an application fee ($40 domestic, $75 international),
4. MSETM program application,
5. a professional resume,
6. A statement of goals and objectives.

International applicants must also submit official results of the TOEFL with a minimum score of 89 IBT. Application instructions can be found online at http://etm.okstate.edu.

Faculty

Jeffrey L. Young, PhD, PE—Professor and Head
Professor and OSURF Endowed Chair: Jeffrey L. Young, PhD, PE
Regents Professor and PSO/Albrecht Naeter Professor: Rama Ramakumar, PhD, PE
Regents Professors: Subhash Kak, PhD, Gary Yen, PhD
Associate Dean for CEAT Research, Professor and Henry Bellmon Chair: Charles F. Bunting, PhD
Cal and Marilyn Vogt Professor: Guoliang Fan, PhD
Earl and Carolyn Glimp Professor: James Stine, PhD
Professors: H. Jack Allison, PhD, PE (emeritus); Charles M. Bacon, PhD (emeritus); James E. Baker, PhD (emeritus); Richard L. Cummins, PhD (emeritus); Daniel R. Grischkowsky, PhD (emeritus); Martin T. Hagan, PhD, PE; Louis Johnson, PhD (emeritus); Jerzy S. Krasinski, PhD; Daqing Piao, PhD; Ronald P. Rhoten, PhD, PE (emeritus); Keith A. Teague, PhD, PE; James C. West, PhD; Rao Yarlagadda, PhD (emeritus); Weili Zhang, PhD
Associate Professors: Qi Cheng, PhD; Chriswell G. Hutchens, PhD, PE; Carl D. Latino, PhD; George Scheets, PhD (emeritus); Weihua Sheng, PhD
Assistant Professors: Sabit Ekin, PhD; Nishantha Ekneligoda, PhD; Yanmin Gong, PhD; Yuanxiong Guo, PhD; John O’Hara, PhD