ECEN 2011 Experimental Methods I
Prerequisites: PHYS 2114 with a 'C' or better or concurrent enrollment advisor permission required.
Description: Laboratory associated with ECEN 2714 taken mostly by transfer students who have completed a similar course as ECEN 2714 without the accompanying laboratory. Previously offered as ECEN 3013.
Credit hours: 1
Contact hours: Lab: 2 Contact: 2
Levels: Undergraduate
Schedule types: Lab
Department/School: Elec & Computer Engr

ECEN 2714 Fundamentals of Electric Circuits
Prerequisites: MATH 2153 with a 'C' or better and (PHYS 2114 and MATH 2233 with a 'C' or better or concurrent enrollment).
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 Contact: 5
Levels: Undergraduate
Schedule types: Lab, Lecture, Combined lecture and lab
Department/School: Elec & Computer Engr

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: Contact: 1 Other: 1
Levels: Undergraduate
Schedule types: Independent Study
Department/School: Elec & Computer Engr

ECEN 3113 Energy, Environment and Economics
Prerequisites: ECEN 3714 with a 'C' or better.
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 Contact: 3
Levels: Undergraduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 3213 Computer Based Systems in Engineering
Prerequisites: CS 2433 with a 'C' or better.
Description: A comprehensive introduction to technology and applications of microprocessors. Topics include computer hardware, software, programming, computation, interfacing, I/O, communication, data acquisition, data representation, and numerical analysis. Applications of general-purpose and application-specific processors in various disciplines of engineering and engineering problem solving. Previously offered as ENSC 3213.
Credit hours: 3
Contact hours: Lecture: 2 Lab: 2 Contact: 4
Levels: Undergraduate
Schedule types: Lab, Lecture, Combined lecture and lab
Department/School: Elec & Computer Engr

ECEN 3233 Digital Logic Design
Credit hours: 3
Contact hours: Lecture: 2 Lab: 2 Contact: 4
Levels: Undergraduate
Schedule types: Lab, Lecture, Combined lecture and lab
Department/School: Elec & Computer Engr

ECEN 3314 Electronic Devices and Applications
Prerequisites: ECEN 3714 and ENSC 2611 with a 'C' or better and (PHYS 3313 or ECEN 3903 with a 'C' or better).
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 Contact: 5
Levels: Undergraduate
Schedule types: Lab, Lecture, Combined lecture and lab
Department/School: Elec & Computer Engr

ECEN 3513 Signal Analysis
Prerequisites: ECEN 3714 with a 'C' or better.
Credit hours: 3
Contact hours: Lecture: 3 Contact: 3
Levels: Undergraduate
Schedule types: Lecture
Department/School: Elec & Computer Engr
ECEN 3913 Applied Fields and Waves I
Prerequisites: MATH 2163 and ECEN 3714 with a ‘C’ or better.
Description: Circuit model of transmission lines, wave propagation, energy transfer, impedance mismatch, and transients. Field analysis of voltage, current, resistance, capacitance, and inductance. Coupled circuits.
Credit hours: 3
Contact hours: Lecture: 3 Contact: 3
Levels: Undergraduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 3913 Solid State Electronic Devices
Prerequisites: ECEN 3714 with a ‘C’ or better and (PHYS 3313 or ECEN 3903 with a ‘C’ or better).
Credit hours: 3
Contact hours: Lecture: 3 Contact: 3
Levels: Undergraduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 3613 Applied Fields and Waves II
Prerequisites: ECEN 3613.
Credit hours: 3
Contact hours: Lecture: 3 Contact: 3
Levels: Undergraduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 3714 Network Analysis
Prerequisites: MATH 2233 and ECEN 2714 and PHYS 2114 with a grade of ‘C’ or better.
Description: Advanced mathematical analysis techniques used in circuit analysis including Laplace transforms, Fourier transforms, and Fourier series. Circuit frequency response, Bode plots, and filters, including passive, active, low-pass, high-pass, and band-pass filters. Theory of linear circuits; two-port circuit models and parameters. Course previously offered as ECEN 3713.
Credit hours: 4
Contact hours: Lecture: 3 Lab: 2 Contact: 5
Levels: Undergraduate
Schedule types: Lab, Lecture, Combined lecture and lab
Department/School: Elec & Computer Engr

ECEN 3723 Systems I
Prerequisites: ENSC 3714 and ENSC 2113 with a ‘C’ or better and (MATH 3013 with a ‘C’ or better or concurrent enrollment).
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 Contact: 3
Levels: Undergraduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 3724 Capstone Design
Prerequisites: ECEN 4013.
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: Lab: 8 Contact: 8
Levels: Undergraduate
Schedule types: Lab
Department/School: Elec & Computer Engr

ECEN 4013 Design of Engineering Systems
Prerequisites: (ECEN 3213 or ENSC 3213), ECEN 3233, and ECEN 3714 with a grade of ‘C’ or better and ECEN 3613, ECEN 3513, ECEN 3314 and (ENGL 3323 with a grade of ‘C’ or better or concurrent enrollment).
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: 1-12
Contact hours: 1-12 Other: 1-12
Levels: Undergraduate
Schedule types: Independent Study
Department/School: Elec & Computer Engr

ECEN 4010 Special Topics
Prerequisites: ECEN 3233, and (ECEN 3213 or ENSC 3213) and ECEN 3714 with a ‘C’ or better or advisor permission.
Description: Engineering topics not normally included in existing courses. Repeat credit may be earned with different course subtitles assigned. Offered for variable credit, 1-12 credit hours, maximum of 12 credit hours.
Credit hours: 1-12
Contact hours: Contact: 1-12 Other: 1-12
Levels: Undergraduate
Schedule types: Independent Study
Department/School: Elec & Computer Engr

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

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

ECEN 3903 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: Contact: 1-8 Other: 1-8
Levels: Undergraduate
Schedule types: Independent Study
Department/School: Elec & Computer Engr

ECEN 4024 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: Contact: 1-8 Other: 1-8
Levels: Undergraduate
Schedule types: Independent Study
Department/School: Elec & Computer Engr
ECEN 4133 Power Electronics  
Prerequisites: ECEN 3714 with a grade of ‘C’ or better.  
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 Contact: 3  
Levels: Undergraduate  
Schedule types: Lecture  
Department/School: Elec & Computer Engr

ECEN 4153 Power System Analysis and Design  
Prerequisites: ECEN 3714, ‘C’ or better.  
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 Contact: 3  
Levels: Undergraduate  
Schedule types: Lecture  
Department/School: Elec & Computer Engr

ECEN 4213 Embedded Computer Systems Design  
Prerequisites: (ECEN 3213 or ENSC 3213), ECEN 3233 and ECEN 3714 with a ‘C’ or better.  
Description: 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 Contact: 4  
Levels: Undergraduate  
Schedule types: Lab, Lecture, Combined lecture and lab  
Department/School: Elec & Computer Engr

ECEN 4243 Computer Architecture  
Prerequisites: (ECEN 3213 or ENSC 3213), ECEN 3233, and ECEN 3714 with a ‘C’ or better.  
Description: Functional organization and hardware design of digital computer systems with emphasis on microprocessor-based systems. CPU organization, features of microprocessors including advanced 32-bit CPU’s, 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 Contact: 4  
Levels: Undergraduate  
Schedule types: Lab, Lecture, Combined lecture and lab  
Department/School: Elec & Computer Engr

ECEN 4273 Software Engineering  
Prerequisites: (ECEN 3213 or ENSC 3213), ECEN 3233, CS 3653, and ECEN 3714 with a ‘C’ or better.  
Description: Functional organization and hardware design of digital computer systems with emphasis on microprocessor-based systems. CPU organization, features of microprocessors including advanced 32-bit CPU’s 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 Contact: 3  
Levels: Undergraduate  
Schedule types: Lecture  
Department/School: Elec & Computer Engr

ECEN 4283 Computer Networks  
Prerequisites: (ECEN 3213 or ENSC 3213), ECEN 3233 and ECEN 3714 with a ‘C’ or better.  
Description: 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 Contact: 3  
Levels: Undergraduate  
Schedule types: Lecture  
Department/School: Elec & Computer Engr

ECEN 4303 Digital Integrated Circuit Design  
Prerequisites: ECEN 3314 and (ECEN 3233 with a ‘C’ or better).  
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 Contact: 3  
Levels: Undergraduate  
Schedule types: Lecture  
Department/School: Elec & Computer Engr

ECEN 4233 High Speed Computer Arithmetic  
Prerequisites: ECEN 3233, (ECEN 3213 or ENSC 3213) and ECEN 3714 with a ‘C’ or better.  
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 Contact: 3  
Levels: Undergraduate  
Schedule types: Lecture  
Department/School: Elec & Computer Engr
ECEN 4313 Linear Electronics Circuit Design
Prerequisites: ECEN 3314.
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 Contact: 3
Levels: Undergraduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 4353 Communication Electronics
Prerequisites: ECEN 3314.
Description: Design of tuned voltage and power amplifiers, oscillators and mixers, modulation and detection, and parametric amplifiers.
Credit hours: 3
Contact hours: Lecture: 3 Contact: 3
Levels: Undergraduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 4413 Automatic Control Systems
Prerequisites: ECEN 3723 or (MAE 3723 or MAE 3724).
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 Contact: 3
Levels: Undergraduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 4503 Random Signals and Noise
Prerequisites: ECEN 3513.
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 Contact: 3
Levels: Undergraduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 4533 Data Communications
Prerequisites: ECEN 4503 prerequisite or concurrent enrollment.
Credit hours: 3
Contact hours: Lecture: 3 Contact: 3
Levels: Undergraduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 4613 Microwave Engineering
Prerequisites: ECEN 3613.
Description: Review of EM and transmission line theory. Microwave network theory. Impedance and admittance matrices, scattering matrix and S-parameters, ABCD and transfer matrices. Signal-flow diagrams. Matching circuits and microwave filters. Passive microwave devices: power dividers, hybrids, couplers, resonators, isolators, and circulators. Class projects such as radar, communication, imaging, or sensing systems.
Credit hours: 3
Contact hours: Lecture: 3 Contact: 3
Levels: Undergraduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 4703 Active Filter Design
Prerequisites: ECEN 3714 with a ‘C’ or better.
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 Contact: 3
Levels: Undergraduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 4743 Introduction to Biomedical Engineering Modeling and Systems
Prerequisites: ECEN 4763.
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 Contact: 3
Levels: Undergraduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 4763 Introduction to Digital Signal Processing
Prerequisites: ECEN 3513.
Credit hours: 3
Contact hours: Lecture: 3 Contact: 3
Levels: Undergraduate
Schedule types: Lecture
Department/School: Elec & Computer Engr
ECEN 4773 Real Time Digital Signal Processing  
**Prerequisites:** ECEN 4763.  
**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 Contact: 3  
**Levels:** Undergraduate  
**Schedule types:** Lecture  
**Department/School:** Elec & Computer Engr  

ECEN 4823 Design of Optical Systems  
**Prerequisites:** ECEN 3714 with a 'C' or better.  
**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 Contact: 4  
**Levels:** Undergraduate  
**Schedule types:** Lab, Lecture, Combined lecture and lab  
**Department/School:** Elec & Computer Engr  

ECEN 4843 Design of Lasers and Systems  
**Prerequisites:** ECEN 3613.  
**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 Contact: 4  
**Levels:** 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:** Lecture: 1-6 Contact: 1-6  
**Levels:** Graduate  
**Schedule types:** Lecture  
**Department/School:** Elec & Computer Engr  

ECEN 5060 Special Topics  
**Prerequisites:** Advisor permission.  
**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 6 credit hours.  
**Credit hours:** 1-6  
**Contact hours:** Contact: 1-6 Other: 1-6  
**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:** Contact: 1-6 Other: 1-6  
**Levels:** Graduate  
**Schedule types:** Independent Study  
**Department/School:** Elec & Computer Engr  

ECEN 5080 Fundamental Topics  
**Prerequisites:** Advisor permission.  
**Description:** Fundamental topics that are typically introduced in the senior year curriculum with additional depth and breadth commensurate with the graduate program. Repeat credit may be earned with difference course subtitles assigned. Offered for variable credit, 1-6 credit hours, maximum of 9 credit hours.  
**Credit hours:** 1-6  
**Contact hours:** Lecture: 1-6 Contact: 1-6  
**Levels:** Graduate  
**Schedule types:** Lecture  
**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 Contact: 3  
**Levels:** Graduate  
**Schedule types:** Lecture  
**Department/School:** Elec & Computer Engr  

ECEN 5123 Engineering Systems Reliability Evaluation  
**Description:** Techniques and concepts needed for evaluating the long-term and short-term reliability of a system. Topics include static and spinning generation capacity; transmission, composite, interconnected, and dc system reliability evaluations; and power system security. Applications to systems other than power systems included. For students with little or no background in probability or statistics.  
**Credit hours:** 3  
**Contact hours:** Lecture: 3 Contact: 3  
**Levels:** Graduate  
**Schedule types:** Lecture  
**Department/School:** Elec & Computer Engr  

ECEN 5123 Engineering Systems Reliability Evaluation  
**Description:** Techniques and concepts needed for evaluating the long-term and short-term reliability of a system. Topics include static and spinning generation capacity; transmission, composite, interconnected, and dc system reliability evaluations; and power system security. Applications to systems other than power systems included. For students with little or no background in probability or statistics.  
**Credit hours:** 3  
**Contact hours:** Lecture: 3 Contact: 3  
**Levels:** Graduate  
**Schedule types:** Lecture  
**Department/School:** Elec & Computer Engr
ECEN 5133 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  
**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  
**Department/School:** Elec & Computer Engr

ECEN 5163 Cyber Physical Systems and 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  
**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  
**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  
**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  
**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  
**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  
**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  
**Department/School:** Elec & Computer Engr

ECEN 5313 Analog Integrated Circuits  
**Description:** Advanced studies of analog CMOS IC design with an emphasis on EDA. Topics include bandgap reference, oscillators, PLL, linear regulators, DC-OC converters, low voltage, low power, and energy harvesting techniques.  
**Credit hours:** 3  
**Contact hours:** Lecture: 3  
**Levels:** Graduate  
**Department/School:** Elec & Computer Engr
ECEN 5333 Semiconductor Devices
Prerequisites: ECEN 3314 and PHYS 3313 or equivalent.
Description: Semiconductor crystal structure and device fabrication, carrier distribution and transport, pn junction and diode, metal-semiconductor heterojunction, MOSFET, BJT and optoelectronic devices.
Credit hours: 3
Contact hours: Lecture: 3 Contact: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 5363 Mixed-Signal Integrated Circuits
Description: Analysis and design of CMOS mixed-signal IC for VLSI systems. Topics include comparators, switched-capacitor circuits, sample-and-hold, Nyquist and oversampling ADC/DAC, delta-sigma modulation, and digital calibration techniques.
Credit hours: 3
Contact hours: Lecture: 3 Contact: 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 Contact: 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 Contact: 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 Contact: 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 Contact: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 5473 Digital Control Systems
Prerequisites: ECEN 4413 or MAE 4053.
Credit hours: 3
Contact hours: Lecture: 3 Contact: 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 Contact: 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 Contact: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

Electr & Computer Engineering (ECEN) 7
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 Contact: 3  
Levels: Graduate  
Schedule types: Lecture  
Department/School: Elec & Computer Engr

ECEN 5543 Data Transportation and Protection  
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 Contact: 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 Contact: 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 Contact: 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 Contact: 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 Contact: 3  
Levels: Graduate  
Schedule types: Lecture  
Department/School: Elec & Computer Engr

ECEN 5533 Radar Theory  
Prerequisites: ECEN 3613; ECEN 4503 or ECEN 5513.  
Credit hours: 3  
Contact hours: Lecture: 3 Contact: 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 Contact: 3  
Levels: Graduate  
Schedule types: Lecture  
Department/School: Elec & Computer Engr

ECEN 5683 Biomedical Optics  
Description: Biomedical optics, also often termed as biophotonics, is 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 Contact: 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 Contact: 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 Contact: 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 Contact: 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 Contact: 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 topography, 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 Contact: 3
**Levels:** Graduate
**Schedule types:** Lecture
**Department/School:** Elec & Computer Engr

ECEN 5793 Digital Image Processing
**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 Contact: 3
**Levels:** Graduate
**Schedule types:** Lecture
**Department/School:** Elec & Computer Engr

ECEN 5823 Physical 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 Contact: 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 Contact: 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 Contact: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Elect & 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 Contact: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Elect & Computer Engr

ECEN 5923 Introduction to MEMS
Prerequisites: ECEN 5843 or consent of instructor.
Description: Fundamentals of Microsystems. Topics include: energy transduction mechanisms, energy dissipation modeling, energy methods, mechanics of small scale, fabrication process design, micromachining, electronic interface.
Credit hours: 3
Contact hours: Lecture: 3 Contact: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Elect & 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: Contact: 1-16 Other: 1-16
Levels: Graduate
Schedule types: Independent Study
Department/School: Elect & 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 Contact: 1
Levels: Graduate
Schedule types: Lecture
Department/School: Elect & 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: Contact: 3 Other: 3
Levels: Graduate
Schedule types: Independent Study
Department/School: Elect & Computer Engr

ECEN 6060 Special Topics
Prerequisites: Advisor permission.
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 12 credit hours.
Credit hours: 1-6
Contact hours: Contact: 1-6 Other: 1-6
Levels: Graduate
Schedule types: Independent Study
Department/School: Elect & 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: Contact: 1-6 Other: 1-6
Levels: Graduate
Schedule types: Independent Study
Department/School: Elect & 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 Contact: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Elect & 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 Contact: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Elect & 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 Contact: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Elect & 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 Contact: 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 Contact: 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 waiver-forms for noise immunity. Information transfer in learning systems.
Credit hours: 3
Contact hours: Lecture: 3 Contact: 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 Contact: 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 Contact: 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 Contact: 2
Levels: Graduate
Schedule types: Lab
Department/School: Elec & Computer Engr

ECEN 6823 Advanced Optical Techniques
Prerequisites: ECEN 5853.
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 Contact: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Elec & Computer Engr

ECEN 6830 Photonics II: Spectroscopy III
Prerequisites: ECEN 6803.
Description: 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 1 fixed credit hour, maximum of 4 credit hours.
Credit hours: 1
Contact hours: Lab: 2 Contact: 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:** The structure and imaging of solid surfaces. Basics of scanning probe microscopy (SPM). Contact and non-contact atomic force microscopy (AFM). Scanning tunneling microscopy (STM) in air. Same course as CHEM 6840 & PHYS 6840. Course previously offered as ECEN 6841. 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 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