ECE - ELECTRICAL AND COMPUTER ENGINEERING

ECE 2610 Digital Logic I Cr. 4
Introduction to Boolean algebra; Logic Gates; Minimization of Boolean Functions; K-Map of up to 4 variables; Basic digital circuits like adder, subtractor, multiplexers, decoders etc.; Sequential circuits; Memories; PLAs; Counters using different flip-flops such as D, T, R-S and J-K; Design of simple computer; Introduction to Verilog and FPGAs. Offered Every Term.
Prerequisites: ([PHY 2185 with a minimum grade of D-] OR [PHY 2180 with a minimum grade of D-]) AND (May be taken concurrently: [CSC 2000 with a minimum grade of D-])
Restriction(s): Enrollment is limited to Undergraduate level students.
Course Material Fees: $10

ECE 3040 Numerical Methods for Engineers Cr. 3
Developing numerical algorithms to provide solutions to engineering problems. Derivation of numerical algorithms and investigation of their stability, accuracy, efficiency and scalability. Programming numerical algorithms in Matlab. Topics include: Machine Round-off error, truncation error, root finding, solution of systems of linear and nonlinear algebraic equations, Taylor and Chebyshev series and rational function approximation, interpolation, regression, numerical differentiation, numerical integration, numerical solution of ordinary differential equations, and Monte Carlo methods. Offered Every Term.
Prerequisites: ([BE 1200 with a minimum grade of C-]) AND ([MAT 2030 with a minimum grade of C-]) AND (May be taken concurrently: [MAT 2150 with a minimum grade of C] OR [MAT 2250 with a minimum grade of C] AND [MAT 2350 with a minimum grade of C])
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.
Course Material Fees: $15

ECE 4050 Algorithms and Data Structures Cr. 4
Introduction to problem solving methods and algorithm development; data abstraction for structures such as stacks, queues, linked lists, trees, and graphs; searching and sorting algorithms and their analysis. Offered Yearly.
Prerequisite: CSC 2000 with a minimum grade of C-
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.
Equivalent: CSC 5050

ECE 3330 Electrical Circuits II Cr. 4
Sinusoidal steady-state response; three-phase systems; complex frequency concepts; frequency responses; resonant and coupled circuits; application of Fourier transforms and Laplace transform to electrical circuits. Offered Every Term.
Prerequisites: (May be taken concurrently: [MAT 2150 with a minimum grade of C-] OR [MAT 2250 with a minimum grade of C-] AND [MAT 2350 with a minimum grade of C-])
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.

ECE 3570 Electronics Cr. 4
DC and small signal analysis of diodes, MOSFETs, and BJTs circuits; operational amplifiers, single-stage amplifiers, differential pair, gain, input resistance, output resistance, and bandwidth of amplifiers. Offered Every Term.
Prerequisite: ECE 3330 (may be taken concurrently) with a minimum grade of C- or ECE 3300 with a minimum grade of C-
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.
Course Material Fees: $15

ECE 3620 Introduction to Microcomputers Cr. 4
Basics of digital systems, number systems, functional blocks of microcomputers, assembly language and machine code, applications of microcomputers and experimental demonstrations. Introduction to digital logic. Offered Every Term.
Prerequisites: ([BE 1200 with a minimum grade of D-]) AND ([ECE 2610 with a minimum grade of D-] OR [ECE 3610 with a minimum grade of D-])
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Industrial Engineering, BS in Mechanical Engineering.
Course Material Fees: $25

ECE 3610 Introduction to Microcomputers Cr. 4
Basics of digital systems, number systems, functional blocks of microcomputers, assembly language and machine code, applications of microcomputers and experimental demonstrations. Introduction to digital logic. Offered Every Term.
Prerequisites: ([BE 1200 with a minimum grade of D-]) AND ([ECE 2610 with a minimum grade of D-] OR [ECE 3610 with a minimum grade of D-])
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Industrial Engineering, BS in Mechanical Engineering.
Course Material Fees: $25

ECE 4040 Introduction to Electrical Circuits Cr. 4
Electrical signals and waveforms; resistance and Ohm's law; networks and Kirchhoff's laws; network equivalents; nodal and mesh analysis; Thevenin's theorem and other network theorems. First- and second-order differential equations, and Monte Carlo methods. Offered Every Term.
Prerequisites: ([BE 1200 with a minimum grade of D-]) AND ([ECE 2610 with a minimum grade of D-] OR [ECE 3610 with a minimum grade of D-])
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.
Course Material Fees: $25

ECE 3570 Electronics Cr. 4
DC and small signal analysis of diodes, MOSFETs, and BJTs circuits; operational amplifiers, single-stage amplifiers, differential pair, gain, input resistance, output resistance, and bandwidth of amplifiers. Offered Every Term.
Prerequisite: ECE 3330 (may be taken concurrently) with a minimum grade of C- or ECE 3300 with a minimum grade of C-
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.
Course Material Fees: $15

ECE 3620 Introduction to Microcomputers Cr. 4
Basics of digital systems, number systems, functional blocks of microcomputers, assembly language and machine code, applications of microcomputers and experimental demonstrations. Introduction to digital logic. Offered Every Term.
Prerequisites: ([BE 1200 with a minimum grade of D-]) AND ([ECE 2610 with a minimum grade of D-] OR [ECE 3610 with a minimum grade of D-])
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Industrial Engineering, BS in Mechanical Engineering.
Course Material Fees: $25

ECE 3610 Introduction to Microcomputers Cr. 4
Basics of digital systems, number systems, functional blocks of microcomputers, assembly language and machine code, applications of microcomputers and experimental demonstrations. Introduction to digital logic. Offered Every Term.
Prerequisites: ([BE 1200 with a minimum grade of D-]) AND ([ECE 2610 with a minimum grade of D-] OR [ECE 3610 with a minimum grade of D-])
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Industrial Engineering, BS in Mechanical Engineering.
Course Material Fees: $25

ECE 3320 Introduction to Electrical Circuits Cr. 4
Electrical signals and waveforms; resistance and Ohm's law; networks and Kirchhoff's laws; network equivalents; nodal and mesh analysis; Thevenin's theorem and other network theorems. First- and second-order differential equations, and Monte Carlo methods. Offered Every Term.
Prerequisites: ([PHY 2185 with a minimum grade of C-] OR [PHY 2180 with a minimum grade of C-]) AND (May be taken concurrently: [MAT 2150 with a minimum grade of C-])
ECE 4330 Linear Systems and Signals Cr. 4
Content includes: continuous-time and discrete-time linear systems and signals; properties of linear systems; classical analysis methods and convolution; system analysis method for zero-state and zero-input response; Laplace transform and its application to linear system analysis; Fourier series expansion of periodic signals; Fourier transform and the steady-state response; application to analog filters, control and communication systems; solution of linear difference equations; z-transform analysis method; sampling theory; discrete-time Fourier transform and its application in digital filter design. Offered Every Term.
Prerequisites: ([ECE 3330 with a minimum grade of C-]) AND (May be taken concurrently: [ECE 3040 with a minimum grade of C-] OR [BE 2550 with a minimum grade of C-])
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.

ECE 4340 Microcomputer-Based Instrumentation Laboratory Cr. 2
Multipurpose personal-computer-based approach to real time instrumentation. Current interfacing and software used for data acquisition, transmission, analysis and report writing. Offered Every Term.
Prerequisites: ([ECE 2610 with a minimum grade of C-] OR [ECE 3610 with a minimum grade of C-]) AND ([ECE 3570 with a minimum grade of C-]) AND ([ECE 3330 with a minimum grade of C-])
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.
Course Material Fees: $10

ECE 4470 Control Systems I Cr. 4
System representations; feedback characteristics; time-domain characteristics; signal flow graph, Routh-Hurwitz criteria; Root Locus Plots; Nyquist criteria, Bode plots; PID, phase-lead and phase-lag controller design. Offered Every Term.
Prerequisite: ECE 4330 with a minimum grade of C-
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.

ECE 4570 Fundamentals of Microelectronic Devices Cr. 4
Aspects of electrical properties of semiconductors, the physical electronics of P-N junction, bipolar, field effect transistors, and device fabrication technology essential to understanding semiconductor active devices and integrated circuits. Introduction to the behavior of semiconductor and electronics devices. Offered Every Term.
Prerequisites: ([ECE 3300 with a minimum grade of C-]) AND ([MAT 2150 with a minimum grade of C-])
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.

ECE 4600 (WI) Capstone Design I Cr. 4
Design principles, subsystems of microcontrollers; designing products using microcontrollers, sensors and actuators. Offered Every Term.
Prerequisite: ENG 3050 with a minimum grade of C- and ECE 3620 with a minimum grade of C-
Restriction(s): Enrollment limited to students with a class of Senior; enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.

ECE 4680 Computer Organization and Design Cr. 4
Introductory course. Instruction set design, basic processor implementation techniques, hardwired and microprogrammed control, performance analysis, memory hierarchy and cache design, pipelined processor design, I/O. Offered Yearly.
Prerequisites: ([BE 2100 with a minimum grade of C-]) AND ([ECE 2610 with a minimum grade of C-]) AND ([ECE 3620 with a minimum grade of C-])
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.

ECE 4700 Introduction to Communication Theory Cr. 4
Prerequisite: (BE 2100 with a minimum grade of C- or BE 3220 with a minimum grade of C-) and ECE 4330 with a minimum grade of C-
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.

ECE 4800 Electromagnetic Fields and Waves I Cr. 4
Fundamentals of electromagnetic engineering, static electric and magnetic fields using vector analysis and fields of steady currents, Maxwell's equations and boundary value problems. Basic principles of plane waves, transmission lines and radiation. Offered Every Term.
Prerequisite: ECE 3330 with a minimum grade of C-
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.

ECE 4850 Fiber Optics Cr. 4
Light-wave fundamentals, optical fibers and waveguides, basic optical transmitters and receivers, couplers and switches, basic fiber optic networks, optic link design. Offered Yearly.
Prerequisite: ECE 3330 with a minimum grade of C-
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.
**ECE 4990 Directed Study Cr. 1-4**
Supervised study and instruction in a field selected by the student. Offered Every Term.
**Restriction(s):** Enrollment limited to students with a class of Senior; enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.
**Repeatable for 4 Credits**

**ECE 5020 Matrix Computation I Cr. 4**
Background matrix algebra; linear system sensitivity; basic transformations; Gaussian elimination; symmetric systems; positive definite systems; Householder method for least squares problems; unsymmetric eigenvalue problems; the QR algorithm. Offered Irregularly.
**Prerequisites:** ([BE 2550 with a minimum grade of C] OR [CSC 2110 with a minimum grade of C])
**Equivalent:** CSC 6620

**ECE 5100 Quantitative Physiology Cr. 4**
The basic principles of human physiology presented from the engineering viewpoint. Bodily functions, their regulation and control discussed in quantitative terms and illustrated by mathematical models when feasible. Offered Winter.
**Prerequisites:** ([BME 5005 with a minimum grade of C] OR [BME 2010 with a minimum grade of C])
**Equivalent:** BME 5010, CHE 5100, IE 5100, ME 5100

**ECE 5280 Introduction to Cyber-Physical Systems Cr. 3**
Topics include: modeling, design, analysis, and implementation of cyber-physical systems; dynamic behavior modeling, state machine composition, and concurrent computation; sensors and actuators; embedded systems and networks; feedback control systems; temporal logic and model checking. Offered Fall, Winter.
**Prerequisites:** ([CSC 3100 with a minimum grade of C] OR [CSC 3110 with a minimum grade of C])
**Restriction(s):** Enrollment limited to students in the College of Engineering.
**Equivalent:** CSC 5280

**ECE 5330 Modeling and Control of Power Electronics and Electric Vehicle Powertrains Cr. 4**
Basic methodologies for modeling, control system design of renewable power sources and power electronics systems. Offered Fall.
**Restriction(s):** Enrollment is limited to Graduate or Undergraduate level students; enrollment limited to students in the College of Engineering.
**Equivalent:** AET 5330, EVE 5430

**ECE 5370 Mechatronic System Design I Cr. 4**
Students work in small groups to design and build "smart" devices or systems. These products will integrate sensors, digital logic and/or microprocessors, and user interfacing. The products will be requested by a "client" and the students will work as part of a cross-disciplinary team. Offered Fall.
**Prerequisites:** ([ECE 4600])
**Equivalent:** BME 5530

**ECE 5380 Mechatronic System Design II Cr. 4**
Students work in small groups to design and build "smart" devices or systems. These products will integrate sensors, digital logic and/or microprocessors, and user interfacing. The products will be requested by a "client" and the students will work as part of a cross-disciplinary team. Offered Winter.
**Prerequisites:** ([ECE 4600])
**Equivalent:** BME 5540

**ECE 5410 Power Electronics and Control Cr. 4**
Control of electric energy using power electronic semiconductor devices; mathematical analysis of circuits containing these devices; design, modeling and control of power converters; applications of power electronic converters. Offered Spring/Summer.
**Prerequisites:** ([ECE 4330 with a minimum grade of C])
**Restriction(s):** Enrollment is limited to Graduate or Undergraduate level students; enrollment limited to students in the College of Engineering.
**Equivalent:** EVE 5410

**ECE 5425 Introduction to Robotic Systems Cr. 4**
Introduction to robot kinematics and control. Computational algorithms for robot movement, sensor fusion, and intelligent behavior, which are needed to build a system that performs actions and interacts with its environment. Offered Fall.
**Prerequisites:** ([BE 2550 with a minimum grade of D] OR [BE 1500 with a minimum grade of D] OR [BME 5020 with a minimum grade of D] OR [ECE 3040 with a minimum grade of D])

**ECE 5430 Electric Energy Systems Engineering Cr. 4**
**Prerequisites:** ([ECE 4330 with a minimum grade of C])

**ECE 5440 Computer-Controlled Systems Cr. 4**
Introduction to z-transform and sampling theory. Digital controller design using both transfer function techniques and state space methods. Implementation aspects of computer-controlled systems. Offered Yearly.
**Prerequisites:** ([ECE 4470 with a minimum grade of C] OR [CHE 4600 with a minimum grade of C] OR [ME 5540 with a minimum grade of C])

**ECE 5460 Stochastic Processes in Engineering Cr. 4**
**Prerequisites:** (1 of ECE 4330, ME 5000) AND ([IE 3220 with a minimum grade of C])

**ECE 5470 Control Systems II Cr. 4**
State space representation of systems; stability and Liapunov methods, controllability and observability, pole placement design using state feedback, observer design, optimal control, linear quadratic regulators, Kalman filter. Offered Yearly.
**Prerequisites:** ([ECE 4470 with a minimum grade of C])
ECE 5550 Solid State Electronics Cr. 4
Physical basis for the opto-electric properties of solids with particular emphasis on semiconductors. Basic principles associated with solid-state devices. Extrinsic and intrinsic semiconductors. Behavior of P-N junctions, bi-polar and field-effect transistors. PC-based simulation of device characteristics using the PC1D simulator. Offered Every Term.
**Prerequisites:** (ECE 4570 with a minimum grade of C- and ECE 4800 with a minimum grade of C-)

ECE 5575 Introduction to Micro and Nano Electro Mechanical Systems (MEMS/NEMS) Cr. 4
General and specialized micro/nanofabrication techniques; basic sensing and actuating mechanisms (piezoresistive, piezoelectric, capacitive, electrostatic, thermal, etc.); and design and operation of various MEMS/NEMS devices for automotive and biomedical applications; fabrication and characterization of basic MEMS structures. Offered Winter.

ECE 5610 Introduction to Parallel and Distributed Systems Cr. 4
Fundamentals of paralleled and distributed systems. Programming experience in both computing environments. Offered Yearly.

ECE 5620 Embedded System Design Cr. 4
Microcontroller architecture and its subsystems. Wired and wireless protocols for vehicular networking applications. Design and implementation of real-time embedded systems. Offered Every Term.
**Prerequisites:** (ECE 4600 with a minimum grade of C-)

ECE 5650 Computer Networks and Programming Cr. 4
**Prerequisites:** (ECE 4050 with a minimum grade of C-)

ECE 5680 Computer-Aided Logical Design and FPGAs Cr. 4
Topics include: review of digital design; advanced applications of Boolean algebra techniques; Computer-Aided Logical Design for large Boolean functions and simplification; threshold function; linear sequential machines; design using Verilog and FPGAs; introduction to cadence. Offered Winter.

ECE 5690 Introduction to Digital Image Processing Cr. 4
Provide college engineering seniors and first-year graduate students with introductory preparation in mathematical analysis, vectors, matrices, probability, statistics, sequences and series, and computer programming. Includes concepts of digital image processing from an operational perspective with good exposure to theory, accessibility of DIP to engineering, and a detailed review of current techniques. Offered Fall.
**Prerequisites:** (IEE 2100 with a minimum grade of C, ECE 4050 with a minimum grade of C, and ECE 4330 with a minimum grade of C-)

ECE 5700 Digital Communications Cr. 4
Digital modulators and demodulators, M-ary PSK, M-ary FSK, optimal receiver for AWGN channel, correlator receiver, matched filter receiver, analysis of probability of bit errors for digital communication systems, Shannon limit, simulation of digital communication system. Offered Irregularly.
**Prerequisites:** (ECE 4700 with a minimum grade of C-)

ECE 5770 Digital Signal Processing Cr. 4
Analysis of discrete signals and systems. Applications to digital filtering, active filters, digital communication and encoding. Offered Yearly.
**Prerequisite:** ECE 4700 with a minimum grade of C-

ECE 5870 Optical Communication Networks Cr. 4
Laser and detectors; modulation and demodulation; optical transmitters and receivers; optical filters; optical amplifiers; architecture and network control; multi-access networks; FDDI networks, SONET/SDH, ATM, system performance. Offered Yearly.
**Prerequisite:** ECE 4700 with a minimum grade of C- and ECE 4850 with a minimum grade of C-

ECE 5990 Directed Study Cr. 1-4
Supervised study and instruction in the field selected by the student. Offered Every Term.
**Restriction(s):** Enrollment is limited to Graduate level students.
Repeatable for 4 Credits

ECE 5995 Special Topics in Electrical and Computer Engineering I Cr. 1-4
Special subject matter in electrical and computer engineering. Topics to be announced in Schedule of Classes. Offered Every Term.
Repeatable for 8 Credits

ECE 6100 Enabling Technology Cr. 3,4
Principles of application of enabling technology: across life stages, for differing ethnic and cultural backgrounds, for individuals with varying functional abilities. Offered Yearly.
**Equivalent:** BME 6500

ECE 6180 Biomedical Instrumentation Cr. 4
Engineering principles of physiological measurements, signal conditioning equipment, amplifiers, recorders and transducers. Recent advances in instrumentation. Offered Winter.
**Prerequisites:** (1 of BME 5010, BMS 6550) AND (BME 5020 with a minimum grade of C- and ECE 3300 with a minimum grade of C-)
**Equivalent:** BME 6480, IE 6180, ME 6180

ECE 6570 Smart Sensor Technology I: Design Cr. 4
Introduction to various types of sensors and the design of basic analog VLSI circuit building blocks. Offered for graduate credit only. Offered Fall.
**Restriction(s):** Enrollment is limited to Graduate level students.
**Equivalent:** BME 6470, PHY 6570

ECE 6660 Introduction to VLSI Systems Cr. 4
Survey of very large scale integrated circuit components and design procedures. MOS fabrication, MOS gates, circuit architecture, device design, manufacturing and interface techniques. Offered Yearly.
**Prerequisite:** ECE 4680 with a minimum grade of C-
**Course Material Fees:** $30

ECE 6991 Industrial Internship Cr. 1-4
Internship experience that satisfies the curricular practical training requirements. Offered for graduate credit only. Offered Every Term.
**Restriction(s):** Enrollment is limited to Graduate level students.
Repeatable for 4 Credits

ECE 7030 Mathematical Methods in Engineering I Cr. 4
**Restriction(s):** Enrollment is limited to Graduate level students.

ECE 7100 Mathematical Modeling in Impact Biomechanics Cr. 3-4
Review of models created for impact simulations. Regional impact simulation models. Human and dummy models subject to various restraint systems. Offered Winter.
**Prerequisite:** ECE 5100 with a minimum grade of C or BMS 6550 with a minimum grade of C
**Restriction(s):** Enrollment is limited to Graduate level students.
**Equivalent:** BME 7100, IE 7100, ME 7100
ECE 7160 Impact Biomechanics Cr. 4
Biomechanical response of the body regions and the whole body to impact. Mechanisms of injury in blunt impact. Effects of restraints on injury reduction. Development of test surrogates such as dummies. Offered Fall.
Prerequisite: BME 5010 with a minimum grade of C or BMS 6550 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.
Equivalent: BME 7160, ME 7160

ECE 7400 Medical Robotics and Systems Cr. 4
Technology that interfaces computer engineering and electronics with surgery; introduction of key concepts in the field, including medical robotics, image-guided surgery, segmentation/3D modeling, medical simulation, and medical sensors. Offered Winter.
Prerequisite: ECE 5020 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.
Equivalent: BME 7400

ECE 7420 Nonlinear Control Systems Cr. 4
Provide examples of nonlinear dynamical control systems, perform system analysis using phase-portrait, and examine stability using Lyapunov's direct method and invariant set theorems (local and global stability). Introduce describing function method, feedback linearization technique, internal dynamics, and zero-dynamics. Design nonlinear robust controllers. Offered Winter.
Prerequisite: ME 5550 with a minimum grade of C or ECE 5470 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.
Equivalent: ME 7590

ECE 7430 Control of Discrete Event Systems Cr. 4
Automation model of discrete event systems; formal languages and regular expressions; supervisory control; controllability and observability; decentralized control and co-observability; timed discrete event systems; performance analysis; applications to manufacturing systems and power systems. Offered Biannually.
Prerequisite: ECE 5440 with a minimum grade of C or ECE 5470 with a minimum grade of C or ME 5550 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

ECE 7440 Dynamic Systems and Optimal Control Cr. 4
Formulation of optimal control problems. Pontryagin's maximum principle and necessary conditions for optimality, with applications. Dynamic programming; Hamilton-Jacobi equation; optimal feedback control. Offered Irregularly.
Prerequisite: ECE 5440 with a minimum grade of C or ECE 5470 with a minimum grade of C or ME 5550 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

ECE 7570 Smart Sensor Technology II: Characterization and Fabrication Cr. 4
Integration of ongoing research in integrated technology of smart sensors. Design of smart sensor devices using computer simulation. Fabrication of smart sensor. Offered Winter.
Prerequisite: ECE 6570 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.
Course Material Fees: $50
Equivalent: BME 7470, PHY 7580

ECE 7590 Biomedical Microsystems Cr. 4
Biomedical microsystems, with a focus on microfluidics and lab-on-a-chip technologies for medical diagnostics and biological research. Broad coverage of microscale physics; microfabrication methods; separation, purification, and other on-chip processes; biosensing. Offered Fall.
Prerequisite: ECE 5575 with a minimum grade of C or ECE 6570 with a minimum grade of C or BME 6470 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.
Equivalent: BME 7490, CHE 7490

ECE 7610 Advanced Parallel and Distributed Systems Cr. 4
Advanced topics in parallel and distributed computing, multicore and parallel architecture, communication, synchronization, parallel algorithms and programming, load balancing and scheduling, security. Offered Winter.
Prerequisite: ECE 5610 or ECE 5650
Restriction(s): Enrollment is limited to Graduate level students.

ECE 7650 Scalable and Secure Internet Services and Architecture Cr. 4
Advanced principles of distributed and cloud computing systems, the Internet, Internet server and data center, content delivery networks, performance scalability, energy-aware resource management, security and privacy, cost-effective engineering design. Offered Winter.
Prerequisite: ECE 5610 with a minimum grade of C and ECE 5650 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

ECE 7660 Parallel Computer Architecture Cr. 4
Review of parallel computer architectures, including symmetric multiprocessors and scalable machines. Parallel software basics for various architectures. Fundamental issues including cache coherence, interconnection network, and synchronization; influence of these on performance of applications. Offered Yearly.
Prerequisite: ECE 5610 with a minimum grade of C and ECE 5620 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

ECE 7680 Advanced Digital Image Processing and Applications Cr. 4
Advanced aspects, algorithms, methods in digital image processing and their corresponding applications in different fields. Students develop comprehensive skills and knowledge in digital image processing. Offered Yearly.
Prerequisite: ECE 5690 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

ECE 7690 Fuzzy Systems Cr. 4
From basic fuzzy set theory to advanced topics such as neuro-fuzzy systems. Offered Yearly.
Restriction(s): Enrollment is limited to Graduate level students.

ECE 7700 Statistical Communication Theory Cr. 4
Decision theory, binary decisions with single and multiple observations, signals in additive Gaussian noise, sequential decision theory, estimation theory, Kalman filtering. Offered Yearly.
Prerequisite: ECE 5700 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

ECE 7730 Telematics Cr. 4
Introduction to automotive telematics, mobile communication channels, error correction, automatic crash response, vehicle diagnostics, vehicle tracking, vehicle safety, navigation, and current topics in telematics. Offered Winter.
Prerequisites: (ECE 5700 with a minimum grade of C)
Restriction(s): Enrollment is limited to Graduate level students.
ECE 7740 Medical Imaging Systems Cr. 3
Exposes students to the world of medical and biomedical imaging with emphasis on principles, approaches and applications of each modern imaging modality. Basic knowledge of MATLAB programming language is required. Offered Fall.
Restriction(s): Enrollment is limited to Graduate level students.
Equivalent: BME 7730

ECE 7850 Fiber and Integrated Optics Cr. 4
Prerequisite: ECE 5870 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

ECE 7990 Directed Study Cr. 1-8
Supervised study and instruction in an advanced topic. Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 12 Credits

ECE 7995 Special Topics in Electrical and Computer Engineering II Cr. 1-4
A consideration of special subject matter in electrical and computer engineering. Topics to be announced in Schedule of Classes. Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 12 Credits

ECE 7996 Research Cr. 1-8
Design, investigation and experimental work on some phase of electrical and computer engineering. Written report required. Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 8 Credits

ECE 8570 Smart Sensor Technology Seminar Cr. 1
Technological advances. Interaction of research experience in smart sensors and integrated devices. Offered Winter.
Prerequisite: ECE 6570 with a minimum grade of C and ECE 7570 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.
Equivalent: BME 8470

ECE 8999 Master's Thesis Research and Direction Cr. 1-8
Offered Every Term.
Restriction(s): Enrollment limited to students with a class of Candidate Masters; enrollment is limited to Graduate level students.
Repeatable for 8 Credits

ECE 9990 Pre-Doctoral Candidacy Research Cr. 1-8
Research in preparation for doctoral dissertation. Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 12 Credits

ECE 9991 Doctoral Candidate Status I: Dissertation Research and Direction Cr. 7.5
Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students.

ECE 9992 Doctoral Candidate Status II: Dissertation Research and Direction Cr. 7.5
Offered Every Term.
Prerequisite: ECE 9991 with a minimum grade of S
Restriction(s): Enrollment is limited to Graduate level students.

ECE 9993 Doctoral Candidate Status III: Dissertation Research and Direction Cr. 7.5
Offered Every Term.
Prerequisite: ECE 9992 with a minimum grade of S
Restriction(s): Enrollment is limited to Graduate level students.

ECE 9994 Doctoral Candidate Status IV: Dissertation Research and Direction Cr. 7.5
Offered Every Term.
Prerequisite: ECE 9993 with a minimum grade of S
Restriction(s): Enrollment is limited to Graduate level students.

ECE 9995 Candidate Maintenance Status: Doctoral Dissertation Research and Direction Cr. 0
Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students.
Course Material Fees: $348.67
Repeatable for 0 Credits

ECE 9997 Doctoral Seminar Cr. 1-4
Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 4 Credits