ELECTRICAL AND COMPUTER ENGINEERING ECE

Department of Electrical and Computer Engineering
College of Engineering

200 Electric Circuits
Fall, Spring. 4(4-0) P:M: (CSE 131 or CSE 231) and (MTH 235 or concurrently or LBS 119 or concurrently or MTH 255H or concurrently) SA: EE 200
Resistive circuits. Loop and nodal analysis. Network theorems. Capacitor and inductor circuits. Transient analysis. Forced response. Sinusoidal steady-state response. Frequency response. Introduction to computer-aided analysis.

230 Digital Logic Fundamentals
Fall, Spring, Summer. 3(3-0) P:M: (CSE 131 or CSE 231) SA: ECE 330
Binary information. Switching algebra, combinational logic, minimization. Programmable logic devices. Sequential system fundamentals and state machines. Arithmetic operations and circuits. Memory elements and systems. Design tools. Design problems.

302 Electronic Circuits
Fall, Spring. 3(3-0) P:M: (ECE 200) RB: (ECE 200) R: Open only to students in the Department of Electrical and Computer Engineering or Department of Computer Science and Engineering. SA: EE 302
Volt-ampere characteristics of diodes and transistors. SPICE modeling. Differential, multistage and integrated circuit amplifiers. High frequency effects.

303 Electronics Laboratory
Fall, Spring. 1(0-3) P:M: (ECE 200) R: Open only to students in the Department of Electrical and Computer Engineering or Department of Computer Science and Engineering. SA: EE 303 C: ECE 302 concurrently.
Electronic test equipment and measurement fundamentals. Experimental verification of topics covered in EE 200 and EE 302.

305 Electromagnetic Fields and Waves I
Fall, Spring. 3(3-0) P:M: (MTH 235 or concurrently or LBS 119 or concurrently or MTH 255H or concurrently) and (PHY 184 or PHY 184B or PHY 234B) R: Open only to students in the Department of Electrical and Computer Engineering. SA: EE 305
Vector analysis. Static electric field and scalar potential. Dielectric materials. Electric force and energy. Potential problems. Steady currents, magnetic field and vector potential. Magnetic materials and circuits. Magnetic force and torque.

306 Electromagnetic Fields and Waves II
Spring, Summer. 4(3-3) P:M: (ECE 305) SA: EE 306, ECE 307
Faraday's law. Maxwell's equations. EM energy conservation. Wave equations and EM waves. Transmission lines. Transient waves. Travelling and standing waves. EM plane waves. EM radiation and antennas. Experimental investigation of topics in electromagnetic fields and waves.

313 Control Systems
Fall, Spring. 3(3-0) P:M: (ECE 200 or ECE 345) R: Open only to juniors or seniors or graduate students in the Department of Electrical and Computer Engineering, the Department of Computer Science and Engineering, and the Manufacturing Engineering major. SA: EE 413, ECE 413
Analysis and design of control systems using transfer functions and state variable methods.

320 Energy Conversion and Power Electronics
Fall, Spring. 3(3-0) P:M: (ECE 302 and ECE 303 and ECE 305) SA: EE 320
Power and energy. Magnetics and transformers. Elementary and induction machines. Power semiconductors. Controlled rectifiers and inverters. Power supplies and motor drives.

331 Microprocessors and Digital Systems
Fall, Spring. 4(3-3) P:M: (CSE 231 and ECE 230) R: Open only to juniors or seniors or graduate students in the Department of Electrical and Computer Engineering. SA: EE 331
Microcomputers. Microprocessor architecture. Addressing modes. Assembly language programming. Parallel and serial input and output. Interfacing. Interrupts. Peripheral device controllers. Applications, design.

345 Electronic Instrumentation and Systems
Fall, Spring, Summer. 3(2-3) P:M: (MTH 235 or MTH 255H or LBS 119) and (PHY 184 or PHY 184B or PHY 234B) and completion of Tier I writing requirement. R: Open only to students in the College of Engineering with the exception of students in the Department of Electrical and Computer Engineering. SA: EE 345
Electrical and electronic components, circuits and instruments. Circuit laws and applications, frequency response, operational amplifiers, semi-conductor devices, digital logic, counting circuits.

360 Signals and Linear Systems
Fall, Spring. 4(4-0) P:M: (ECE 200 or concurrently) and (MTH 235 or concurrently or LBS 119 or concurrently or MTH 255H or concurrently) R: Open only to students in the Department of Electrical and Computer Engineering or Department of Computer Science and Engineering. SA: EE 360
Continuous and discrete signals and systems. Convolution, impulse response, system classifications, state variables, differential and difference equations. Fourier series, Fourier transform, Laplace transform. Z-transform. Transfer functions and stability.

410 VLSI Design
Fall, Spring. 4(3-3) P:M: (ECE 302 and ECE 303 and ECE 230) R: Open only to juniors or seniors or graduate students in the Department of Electrical and Computer Engineering or Department of Computer Science and Engineering. SA: EE 410
Digital integrated circuit design fundamentals. Design specifications: functionality, performance, reliability, manufacturability, testability, cost. Standards, silicon compilers, foundries. Design layout rules, rule checking. Circuit extraction, simulation, verification. Team-based design.

411 Electronic Design Automation
Fall, Spring. 4(3-3) P:M: (CSE 320 or ECE 331) R: Open only to juniors or seniors or graduate students in the Department of Electrical and Computer Engineering or Department of Computer Science and Engineering. SA: EE 411
Electronic circuit design hierarchy and the role of methodology. Application specific integrated circuits. Hardware description languages. Behavioral and structural circuit modeling. Design algorithms and design tools. Design projects.

415 Computer Aided Manufacturing
Fall. 3(2-3) P:M: (ECE 313 or ME 451) R: Open only to juniors or seniors in the Manufacturing Engineering major. SA: EE 415
CAD/CAM fundamentals, programmable controllers, numerical control, NC part programming, sensors, data acquisition systems.

418 Algorithms of Circuit Design
Fall. 3(3-0) P:M: (ECE 302 and ECE 303 and ECE 360) R: Open only to juniors or seniors or graduate students in the Department of Electrical and Computer Engineering. SA: EE 418
Design of analog electrical circuits, filter functions, ladder synthesis, inductor simulation. Vector Newton-Raphson method. Lossy inductance and capacitance. Statistical tolerance analysis. Optimization by multi-dimensional search. Software algorithms.

421 Power System Analysis
Spring. 4(3-3) P:M: (ECE 320) SA: EE 421
Synchronous machines: models and measurements of power components. Symmetrical components. Short circuit analysis and equipment protection. Load flow. Voltage and frequency control. Operation and planning of power systems.

435 Electromagnetic Waves and Applications
Fall. 4(3-3) P:M: (ECE 306) SA: EE 435
Open and closed-boundary waveguides. Resonators. Microwave circuit theory. Scattering parameters. Electromagnetic radiation. Properties of antennas. Wave propagation. Measurement of antenna characteristics. Computer-aided design and testing.

457 Communication Systems
Spring. 3(3-0) P:M: (ECE 302 and ECE 360 and STT 351) R: Open only to juniors or seniors or graduate students in the Department of Electrical and Computer Engineering. SA: EE 457
Representation and processing of signals in the presence of noise. System performance. Modulation, detection, and coding of information. System design applications in radar, sonar, radio, television, satellite communications, digital telephony, and wireless systems.

458 Communication Systems Laboratory
Spring. 1(0-3) P:M: (ECE 303 and ECE 457 or concurrently) SA: EE 458
A projects laboratory in communication systems.

466 Digital Signal Processing and Filter Design
Fall. 3(3-0) P:M: (ECE 360) R: Open only to seniors or graduate students in the Department of Electrical and Computer Engineering. SA: EE 466
Discrete Fourier transforms, sampling theorem, circular convolution, Z-transforms. Design of infinite impulse resistance filters using prototypes and algorithmic methods. Design of finite impulse resistance filters by windowing, frequency sampling.

474 Principles of Electronic Devices
Fall, Spring. 3(3-0) P:M: (ECE 302 and ECE 305) SA: EE 474
Energy levels in atoms. Crystal properties, energy bands and charge carriers, semiconductors, transport properties of bulk materials. P-n junction diodes, bipolar transistors, field effect transistors.

476 Electro-Optics
Fall, Summer. 3(2-3) P:M: (ECE 302 and ECE 303 and ECE 305) SA: EE 476
Operating principles and applications of high frequency and photonic devices including impatt, Gunn, photodetector, light-emitting diodes, semiconductor laser devices. Photonic device applications to fiber optic systems.

477 Microelectronic Fabrication
Fall. 3(2-3) P:M: (ECE 474 or concurrently) R: Open only to juniors or seniors in the Department of Electrical and Computer Engineering. SA: ECE 483
Microelectronic processing fundamentals and simulations. Comparison of current microfabrication technologies and their limitations.

480 Senior Design
Fall, Spring. 5(3-6) P:M: (ECE 302 and ECE 303) and (ECE 331 or ECE 313 or ECE 306) and (ECE 410 or ECE 411 or ECE 421 or ECE 435 or ECE 457 or ECE 466 or ECE 476 or ECE 418) or (CSE 410 or CSE 420 or CSE 422) and completion of Tier I writing requirement. R: Open only to seniors in the Department of Electrical and Computer Engineering. SA: ECE 481, ECE 482, ECE 483
Electrical engineering and computer engineering senior design experience involving contemporary design tools and practices, engineering standards, ethics, cross-functional teaming, oral and written technical communication, lifelong learning.

484 Applications of Analog Integrated Circuits
Spring. 4(3-3) P:M: (ECE 302 and ECE 303) R: Open only to juniors or seniors or graduate students in the Department of Electrical and Computer Engineering. SA: EE 484
Circuit design using analog integrated circuits. SPICE macromodeling. Operational amplifiers, comparators, timers, regulators, multipliers and converters. Design project with hardware and software verification.

485 Digital Control and Robotics
Spring. 4(3-3) P:M: (ECE 331 and ECE 313) R: Open only to juniors or seniors or graduate students in the Department of Electrical and Computer Engineering. SA: EE 485
Robot classifications, kinematics, trajectory planning, digital controller design. Design and implementation of sensor-based robots.

490 Independent Study
Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 3 credits in all enrollments for this course. R: Approval of department. SA: EE 490
Independent study of a topic in electrical engineering or computer engineering.

491 Special Topics
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Open only to students in the Department of Electrical and Computer Engineering. SA: EE 491
Investigation of special topics in electrical engineering or computer engineering.

499 Undergraduate Research
Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 4 credits in all enrollments for this course. R: Approval of department. SA: EE 499
Independent undergraduate research in contemporary areas of electrical engineering or computer engineering.

801 Independent Study
Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 3 credits in all enrollments for this course. R: Approval of department. SA: EE 801
Independent investigation of a topic in electrical engineering compatible with the student's prerequisites, interest, and ability.

802 Selected Topics
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Approval of department. SA: EE 802
Investigation of special topics in electrical engineering.

807 Computer System Performance and Measurement
Spring of odd years. 3(3-0) Interdepartmental with Computer Science and Engineering. Administered by Department of Computer Science and Engineering. RB: (CPS 410 and STT 441) R: Open only to Computer Science or Electrical Engineering majors. SA: EE 807
Queueing network modelling, general analytic techniques, workload characterization, representing specific subsystems, parameterization. Software and hardware monitors, performance measures. Case studies, software packages.

808 Modelling and Discrete Simulation
Fall of even years. 3(3-0) Interdepartmental with Computer Science and Engineering. Administered by Department of Computer Science and Engineering. RB: (CPS 330 and STT 441) R: Open only to Computer Science or Electrical Engineering majors. SA: EE 808
Simulation examples, and languages. Mathematical models, petri nets, model validation, random variate generation. Analysis of simulation data. Case studies.

809 Algorithms and Hardware Implementation
Fall. 3(3-0) Interdepartmental with Computer Science and Engineering. SA: EE 809
Arithmetic, signal processing, and image processing algorithms. Array structures: systolic architecture, data flow structure, neural network architecture. Performance analysis.

813 Advanced VLSI Design
Spring. 3(3-0) Interdepartmental with Computer Science and Engineering. P:M: (ECE 410) SA: EE 813
Advanced topics in digital integrated circuit design. Design specifications: functionality, performance, reliability, manufacturability, testability, cost. Standard cells. Design-rule checking. Circuit extraction, simulation, verification. Team-based design.

818 Robotics
Spring. 3(3-0) RB: (ECE 313 or ME 451) R: Open only to graduate students in the College of Engineering.
Robot modeling, kinematics, dynamics, trajectory planning, programming, sensors, controller design.

820 Advanced Computer Architecture
Fall, Spring. 3(3-0) Interdepartmental with Computer Science and Engineering. Administered by Department of Computer Science and Engineering. RB: (CPS 410 and CPS 420) R: Open only to Computer Science or Electrical Engineering majors. SA: EE 820
Instruction set architecture. Pipelining, vector processors, cache memory, high bandwidth memory design, virtual memory, input and output. Benchmarking techniques. New developments related to single CPU systems.

822 Parallel Processing Computer Systems
Spring. 3(3-0) Interdepartmental with Computer Science and Engineering. Administered by Department of Computer Science and Engineering. RB: (CPS 820) R: Open only to Computer Science or Electrical Engineering majors. SA: EE 822
Massively parallel SIMD processors, multiprocessor architectures, interconnection networks, synchronization and communication. Memory and address space management, process management and scheduling. Parallel compilers, languages, performance evaluation.

823 Power System Stability and Control
Fall of even years. 3(3-0) RB: (ECE 826) SA: EE 823
Analysis and simulation of small and large disturbance stability of power systems. Generator, exciter, voltage regulator models. Design of excitation systems and power system stabilizers.

824 Power System Operation and Control
Fall of odd years. 3(3-0) RB: (ECE 421 and STT 351) SA: EE 824
Operation planning of power systems including loadflow, unit commitment, production cost methods. On line operation and control including automatic generation control, economic dispatch, security assessment, state estimation.

825 Alternating Current Electrical Machines and Drives
Spring of even years. 3(3-0) RB: (ECE 320) SA: EE 825
Analysis, modeling and design of synchronous, induction, and switched reluctance machines. Design drives for motion control and power system applications.

826 Linear Control Systems
Fall. 3(3-0) RB: (MTH 314) SA: EE 826
Vector spaces, representation, system description, solution to the state equations, stability, controllability and observability. Adjoints of linear maps. Eigenstructure assignment. Partial and full order observers. Disturbance decoupling.

827 Nonlinear Systems Analysis
Spring. 3(3-0) RB: (ECE 826) SA: EE 827
Existence, uniqueness and continuity of solutions. Phase portraits. Limit cycles. Linearization. Stability of equilibria and periodic orbits. Lyapunov stability. Describing functions. Perturbation. Averaging. Singular perturbation. Control applications.

829 Optimal Multivariable Control
Spring. 3(3-0) RB: (ECE 826) SA: EE 829
Performance and robustness. Minimum time, minimum energy and regulator. Optimal control and minimum principle. LQG, Nyquist, and H-infinity design methods.

831 Analog Circuit Theory
Fall of even years. 3(3-0) SA: EE 831
Positive real functions. Filter approximations. Passive and active network synthesis. Nullor network analysis and synthesis. Active filters. Stability. Sensitivity.

832 Analog Integrated Circuit Design
Fall of odd years. 3(3-0) SA: EE 832
Technology. Device modeling. Circuit simulation. Integrated circuit building blocks. Amplifiers, comparators, converters. Switched-capacitor filters. Analog signal processing circuits.

835 Advanced Electromagnetic Fields and Waves I
Fall. 3(3-0) SA: EE 835
Electrostatics, magnetostatics, electrodynamics and Maxwell's equations. Potential functions. Eigenfunction expansion. Green's functions. Radiation of EM waves. EM boundary-value problems. TEM waves. Maxwell's equations with magnetic sources.

836 Advanced Electromagnetic Fields and Waves II
Spring. 3(3-0) RB: (ECE 835) SA: EE 836
Theory of guided transmission system. Microstrip lines, metallic and dielectric waveguides. EM cavities. Excitation and discontinuities of waveguides. Surface wave and radiation modes. Integrated optics. Scattering of EM waves.

841 Fourier Optics
Spring of odd years. 3(2-3) RB: (ECE 360) and (ECE 435 or ECE 835) SA: EE 841
Scalar diffraction theory. Fourier expansion of optical fields. Spatial linear systems and information processing. Lenses. Optical imaging systems. Holgraphy. Measurements of optical systems.

842 Quantum Electronics
Fall of even years. 3(3-0) RB: (ECE 835 and ECE 874) SA: EE 842
Quantum and electromagnetic theory of lasers. Optical resonators. Laser oscillation and amplification. Characterization of lasers. Specific laser examples.

847 Analog and Digital Communications
Fall of odd years. 3(3-0) RB: (ECE 457 and ECE 863) SA: EE 847
Optimum signal design in noisy channels, matched filters, quadrature sampling of band-pass signals in noise. Coherent and non-coherent binary modulation such as PSK, FSK, DPSK. M-ary modulation, intersymbol interference, spread spectrum.

850 Electrodynamics of Plasmas
Spring of odd years. 3(3-0) Interdepartmental with Astronomy and Astrophysics; Physics. RB: (ECE 835 or PHY 488) SA: EE 850
Plasma kinetic and macroscopic plasma transport theory. Electromagnetic wave propagation and charged particle diffusion processes in plasma. Electromagnetic energy absorption via elastic and inelastic collisions. Dc, rf, and microwave discharges.

863 Analysis of Stochastic Systems
Fall. 3(3-0) RB: (STT 441) SA: EE 863
Advanced topics in random variable theory. Stochastic processes and stochastic calculus. Optimal systems for filtering and detection.

864 Detection and Estimation Theory
Spring. 3(3-0) RB: (ECE 863) SA: EE 864
Analysis and implementation of statistical estimation and detection methods used in signal processing, communications, and control applications. Bayesian, Neyman-Pearson, and minimax detection schemes. Bayesian, mean-square-error, and maximum-likelihood estimation methods.

865 Analog and Digital Communications
Fall of odd years. 3(3-0) RB: (ECE 457 and ECE 863) SA: EE 865
Optimum signal design in noisy channels, matched filters, quadrature sampling of band-pass signals in noise. Coherent and non-coherent binary modulation such as PSK, FSK, DPSK, M-ary modulation, intersymbol interference, spread spectrum.

874 Physical Electronics
Fall. 3(3-0) SA: EE 874
Applications of quantum mechanics and statistical mechanics in solids. Band theory of semiconductors. Electrical transport phenomena. Pn junctions.

875 Electronic Devices
Spring. 3(3-0) RB: (ECE 874) SA: EE 875
Operating properties of semiconductor devices including DC, AC, transient and noise models of FET, BJT, metal-semiconductor contact, heterostructure, microwave and photonic devices.

885 Artificial Neural Networks
Fall. 3(3-0) Interdepartmental with Computer Science and Engineering. SA: EE 885
Overview of neuro-engineering technology. Basic neural network architectures. Feedforward and feedback networks. Temporal modeling. Supervised and unsupervised learning. Implementation. Basic applications to pattern recognition.

899 Master's Thesis Research
Fall, Spring, Summer. 1 to 8 credits. A student may earn a maximum of 24 credits in all enrollments for this course. SA: EE 899
Master's thesis research.

920 Selected Topics in High Performance Computer Systems
Spring of odd years. 3(3-0) A student may earn a maximum of 9 credits in all enrollments for this course. Interdepartmental with Computer Science and Engineering. Administered by Department of Computer Science and Engineering. RB: (CPS 822) R: Open only to Computer Science or Electrical Engineering majors. SA: EE 920
Design of high performance computer systems. Seminar format.

921 Advanced Topics in Digital Circuits and Systems
Fall, Spring. 3(3-0) A student may earn a maximum of 6 credits in all enrollments for this course. Interdepartmental with Computer Science and Engineering. SA: EE 921
Topics vary each semester.

921A Testable and Fault-tolerant Digital Systems
Fall of odd years. Spring of odd years. 3(3-0) Interdepartmental with Computer Science and Engineering. RB: (ECE 809 and ECE 813) SA: EE 921A
Reliability evaluation. Fault models and test pattern generation. Design for testability. Fault-tolerant design techniques, self-checking circuits and systems, system diagnosis and reconfiguration.

921B Embedded Architectures
Fall of odd years. Spring of odd years. 3(3-0) Interdepartmental with Computer Science and Engineering. RB: (ECE 809 and ECE 813) SA: EE 921B
Embedded computers and architectures for real-time computation and/or robust control. ASICs. Bit-slice architectures. Systolic arrays. Neural networks. Genetic algorithms. Implementation technologies and design issues.

921C Electronic Systems Packaging
Fall of odd years. Spring of odd years. 3(3-0) Interdepartmental with Computer Science and Engineering. RB: A basic background in electronics and electromagnetics.
VLSI packaging technology, thermal management, electrical design, switching noise, multi-chip packaging, materials, device assembly, RF device packaging, and electrical testing.

925 Advanced Topics in Power
Spring. 3(3-0) A student may earn a maximum of 9 credits in all enrollments for this course. SA: EE 925
Topics vary each semester.

925A Intelligent Control Power Systems
Fall of odd years. Spring of odd years. 3(3-0) RB: (ECE 823 and ECE 827 and ECE 829) SA: EE 925A
Stability problems in power systems based on nonlinear dynamical system theory and robust control theory. Direct transient stability methods, voltage collapse, interarea oscillations. Excitation and flexible AC transmission controls.

925B Power System Planning
Fall of odd years. Spring of odd years. 3(3-0) RB: (ECE 824) SA: EE 925B
Methods based on reliability and probability theory. Maintenance scheduling, production cost. Transmission and generation reliability. Adequacy and security, load prediction.

925C Advanced Machine Drives
Fall of odd years. Spring of odd years. 3(3-0) RB: (ECE 825 and ECE 829) SA: EE 925C
Nonlinear drives based on state reconstruction and nonlinear and adaptive control. Sensors, implementation, special computer architectures.

929 Advanced Topics in Electromagnetics
Fall, Spring. 3 to 4 credits. A student may earn a maximum of 10 credits in all enrollments for this course. SA: EE 929
Topics vary each semester.

929A Planar Waveguides and Circuits
Fall of odd years. Spring of odd years. 3(3-0) RB: (ECE 835) SA: EE 929A
Planar open-boundary waveguides and circuits. Surface and microstrip waveguides. Propagation-mode spectrum. Spectral analysis of layered media. Sommerfeld analysis. Integral-operator description of open waveguides and planar circuits.

929B Antenna Theory
Fall of odd years. Spring of odd years. 4(4-0) RB: (ECE 835) SA: EE 929B
Antennas and EM scattering. Radiation by currents and surface fields. Equivalence principle. Receiving antennas. Arrays and synthesis. Integral equations. Current and impedance of wire antennas. Slot, aperture and reflector antennas. Singularity expansion method.

929C Geometrical Theory of Diffraction
Fall of odd years. Spring of odd years. 3(3-0) RB: (ECE 835) SA: EE 929C
Fourier expansion and asymptotic evaluation of two-dimensional electromagnetic fields. Scattering from half-planes, wedges and cylinders. Geometrical optics and ray-tracing. Reflection and transmission matrices. Geometrical diffraction theory.

931 Advanced Topics in Electronic Devices and Materials
Fall, Spring. 1 to 4 credits. A student may earn a maximum of 12 credits in all enrollments for this course. SA: EE 931
Topics vary each semester.

931A VLSI Technology
Fall of odd years. Spring of odd years. 3(3-0) RB: (ECE 875) SA: EE 931A
Oxidation, doping techniques, simulation techniques, film deposition and etching, epitaxial growth, lithography, passivation, and packaging.

931B Microdevices and Microstructures
Fall of odd years. Spring of odd years. 3(3-0) RB: (ECE 875) SA: EE 931B
Technology, modeling and simulation of submicron solid state devices. Microsensors and micromachining. Diamond and superconducting devices. Vacuum microelectronic structures.

931C Properties of Semiconductors
Fall of odd years. Spring of odd years. 3(3-0) RB: (ECE 874) SA: EE 931C
Carrier scattering, single particle and collective transport, quantum effects, hot electron effects, electron-photon and electron-phonon interactions.

932 Advanced Topics in Analog Circuits
Spring of odd years. 3(3-0)
Variable topics in advanced circuit analysis.

960 Advanced Topics in Control
Fall, Spring. 3(3-0) A student may earn a maximum of 6 credits in all enrollments for this course. RB: (ECE 827 and ECE 829) SA: EE 960
Topics vary each semester.

960A Adaptive Control
Fall of odd years. Spring of odd years. 3(3-0) RB: (ECE 827 and ECE 829) SA: EE 960A
Model reference adaptive control in continuous and discrete time. Lyapunov and hyperstability approaches, adaptive observers, self-tuning regulators, design using pole-zero assignments. Minimum variance and LQG control.

960B Nonlinear Control
Fall of odd years. Spring of odd years. 3(3-0) RB: (ECE 827 and ECE 829) SA: EE 960B
Relay control, stabilizing controllers. Design via variable structure, high gain, geometric, and Lyapunov-based methods. Feedback linearization and tracking controls.

963 Advanced Topics in Systems
Fall, Spring. 3(3-0) A student may earn a maximum of 9 credits in all enrollments for this course. SA: EE 963
Topics vary each semester.

963A Sensor Fusion and System Identification and Observation
Fall of odd years. Spring of odd years. 3(3-0) RB: (ECE 826) SA: EE 963A
Model parameterization, adaptive filters, identifiability criteria, equation and output error methods, recursive algorithms, least squares and maximum likelihood identification, convergence analysis, closed-loop system identification, experiment design.

963B Intelligent Control in Robotics and Automation
Fall of odd years. Spring of odd years. 3(3-0) RB: (ECE 818 and ECE 826) SA: EE 963B
Robot dynamics, different formulations. Control types: joint space, task space, force and compliance, robust control. Coordination of multiple robots, mobile robots.

963C Adaptation and Learning in Neural Networks and Systems
Fall of odd years. Spring of odd years. 3(3-0) RB: (ECE 885) SA: EE 963C
Analysis, design. Learning algorithms. Stability, convergence. Possible engineering applications.

966 Advanced Topics in Signal Processing
Fall, Spring. 3(3-0) A student may earn a maximum of 9 credits in all enrollments for this course. SA: EE 966
Topics vary each semester.

966A Discrete Time Processing of Speech Signals
Fall of odd years. Spring of odd years. 3(3-0) RB: (ECE 466 and ECE 863 and ECE 864) SA: EE 966A
Digital speech models. Short term temporal processing. Linear predictive and spectral analysis. Speech coding and synthesis, recognition, enhancement.

966B Multidimensional Signal Processing
Fall of odd years. Spring of odd years. 3(3-0) RB: (ECE 466 and ECE 864) SA: EE 966B
Multidimensional signals and systems concepts. Two-dimensional sampling, windowing, filter design. Fast algorithms for convolution and transforms. Sensor array processing. Interpolation.

966C Advanced Topics in Statistical Signal Processing
Fall of odd years. Spring of odd years. 3(3-0) RB: (ECE 466 and ECE 863 and ECE 864) SA: EE 966C
Communication channels, noise models, hypothesis testing of signals by Bayesian minimax, and Neyman-Pearson criteria. Performance evaluation using ROC. Bayesian and maximum likelihood parameter estimation. Kalman-Bucy filtering.

989 Advanced Topics in Plasma
Fall of odd years. Spring of odd years. 3(3-0) A student may earn a maximum of 6 credits in all enrollments for this course. SA: EE 989
Topics vary each semester.

989A Plasma Processing for IC Fabrication
Fall of odd years. Spring of odd years. 3(3-0) RB: (ECE 835 and ECE 850) SA: EE 989A
Process requirements. Plasma reactors. Etching and deposition applications. Broad ion beam processing.

999 Doctoral Dissertation Research
Fall, Spring, Summer. 1 to 24 credits. A student may earn a maximum of 72 credits in all enrollments for this course. SA: EE 999
Doctoral dissertation research.

ENGINEERING EGR

College of Engineering

101 Preview of Science
Fall. 1(1-0) Interdepartmental with Natural Science; Agriculture and Natural Resources; Social Science. Administered by Natural Science. R: Approval of college.
Overview of natural sciences. Transitional problems. Communications and computer skills. Problem solving skills. Diversity and ethics problems in science. Science and society.

124 Internet and Technology
Fall, Spring, Summer. 2(2-0)
The Internet from a user perspective and from a technical perspective. History and social impact of the Internet. Internet tools.

150 Engineers and the Engineering Profession
Spring. 2(2-0) R: Open only to freshmen or sophomores.
Overview of the engineering profession. Historical background. Engineering specialties. Engineers at work. Professionalism and ethics. Communication skills. Future trends and challenges.

160 Diversity and Engineering
Fall, Spring. 2(2-0) P:M: (MTH 116 or concurrently or MTH 132 or concurrently) R: Open only to freshmen or sophomores in the College of Engineering.
Diversity and engineering. Transitional problems. Career options. Communication skills.

192 Environmental Issues Seminar
Fall, Spring. 1 credit. A student may earn a maximum of 4 credits in all enrollments for this course. Interdepartmental with Natural Science; Agriculture and Natural Resources; Social Science; Communication Arts and Sciences. Administered by Natural Science. R: Open only to students in the College of Agriculture and Natural Resources or College of Engineering or College of Natural Science or College of Communication Arts and Sciences or College of Social Science. Approval of college.
Environmental issues and problems explored from a variety of perspectives, including legal, scientific, historical, political, socio-economic, and technical points of view.