987A. Seminar: Continuing Education and Social Policy  
Fall, 3(3-0) May re-enroll for a maximum of 6 credits. Majors or approval of department.  
Continuing education, as social force impacting and impacted by government and corporate policy. Examination of domestic and foreign examples of interaction between social policy and continuing education.

987B. Seminar: Continuing Education in Higher Education Institutions  
Winter, 3(3-0) May re-enroll for a maximum of 6 credits. Majors or approval of department.  
Patterns, problems, and potential for continuing education in two and four year colleges. Problems of governance, reward system, leadership roles, etc.

998. Behavioral Counseling Laboratory  
Fall, Winter, Spring. 1 to 6 credits.  
May re-enroll for a maximum of 21 credits.  
Supervised experience in behavioral counseling (individual and group), community consultation, applied behavioral research, journal manuscript preparation, preparing instructional materials, and instructional management.

999. Research  
Fall, Winter, Spring, Summer. Variable credit. Approval of department.

---

**ELECTRICAL ENGINEERING AND SYSTEMS SCIENCE**

**College of Engineering**

**Electrical Engineering** EE

275. Consumer Electronics  
Fall, Winter, Spring. 3(3-0)  
Electronic circuit components and devices; their operation in transmitters, receivers, stereo-amplifiers, etc. Electronic measurements, magnetic recording, speaker systems, and other topics will be considered.

300. Electric Circuits I  
Fall, Winter. 4(4-0) MTH 113.  
Current voltage and power, DC and transient circuit analysis, forced response, Sinuoids and the phasor concept, Bridges.

301. Electric Circuits II  
Winter, Spring. 4(4-0) 300, MTH 214.  
Sinuoidal steady-state response, Average power and rms concepts, Complex frequency response, Magnetically coupled circuits, Two-port networks, Transfer functions.

302. Basic Electronic Circuits  
Spring, Summer. 4(4-0) 301, MTH 215.  
Volt-ampere characteristics of diodes and transistors, Voltage, current and power amplification, Stability, transient and high-frequency effects, Feedback, oscillators and operational amplifiers.

303. Electronics Laboratory I (364) Winter. 1(0-3) 300 or concurrently.  
Experimental and measurement procedures as appropriate to topics covered in 374.

304. Electronics Laboratory II (365) Spring, Summer. 1(0-3) 302 concurrently.  

305. Electromagnetic Fields and Waves I  
Fall, Winter. 3(3-0) MTH 215, PHY 288.  
Vector analysis, Electromagnetic fields: EM sources, scalar potential, Poisson's and Laplace's equations, dielectric media, capacitance, and energy storage. Boundary value problems for electromagnetic fields.

306. Electromagnetic Fields and Waves II  
Winter, Spring. 3(3-0) 305.  
Magnetostatic fields, EM sources, vector potential, Magnetic media, inductance, and energy storage. Time-varying fields and Maxwell's equations, energy conservation, potential theory, and radiation concepts.

307. Electromagnetic Fields and Waves III  
Spring, Summer. 3(3-0) 306; 308 concurrently.  

308. Fields and Waves Laboratory  
Spring, Summer. 1(0-3) 307; 306; 307 concurrently.  
Experimental investigation of: charged particle motion in EM fields, dielectric and magnetic properties and materials, probing of currents and charges, and propagation of transient and steady-state waves. Digital computer solutions for EM field and wave problems.

345. Introduction to Electronic Instrumentation Systems  
Fall, Winter. 4(3-3) PHY 288.  
Basic electronic concepts, passive and active components, operational amplifiers, switching devices, equivalent circuits, transducers, Signal conditioning, recording, data management, basic elements of control.

400. Current Topics in Electrical Engineering  
Winter. 1(0-3) May re-enroll for a maximum of 3 credits. Approval of department.  
Topics include communication systems, instrumentation systems and data management, advanced laboratory techniques, modeling, circuit design, computer analysis.

403. Special Problems  
Fall, Winter, Spring. 1 to 4 credits. Approval of department.  
Investigation of a topic in electrical circuits or systems compatible with the student's prerequisites, interest, and ability.

415. Control Systems  
Fall. 3(3-0) M E 455, MTH 334.  
Formulation of automatic control problems; review of modern methods; specifications, controllability and stability; controller design via root locus and state-vector methods; survey of digital control.

416. Control System Design  
Winter. 3(3-0) 415.  
Realization of linear controllers, consistent models for plant and computer sampling, algorithms for digital control, organization of digital controllers.

418. Introduction to Network Synthesis  
Spring. 3(3-0).  

419. Physical Phenomena and Electronic Instrumentation I  
Winter. 4(3-1) PHY 289 or 293; MTH 215. Interdepartmental with and administered by the Physics Department.

435. Guided Transmission Systems  
Fall. 3(3-0) 309.  
Electric circuit theory from EM field theory. Guided wave theory: normal modes, propagation characteristics, power transport, wave impedances, traveling and standing waves, rectangular and circular waveguides. Electromagnetic resonators: frequency and Q.

436. Microwave Networks and Antennas  
Winter. 3(3-0) 435; 438 concurrently.  

437. Microwave Electronics and Plasma  
Spring. 3(3-0) 436; 439 concurrently.  
Electron dynamics, field-particle interactions, space-charge waves, cyclotron, magnetron, traveling-wave amplifier, quadrupole amplifiers, microwave solid-state devices, gas discharges, plasma, waves in plasma.

438. Transmission and Radiation Laboratory  
Winter. 1(0-3) 435; 436 concurrently.  
Microwave transmission and radiation laboratory: Measurement of frequency, wavelength, standing waves, impedance, and power. Experiments on transmission lines, waveguides, cavity resonators, microwave circuits, and circuit and radiation properties of antennas.

439. Microwave Electronics and Plasma Laboratory  
Spring. 1(0-3) 438; 437 concurrently.  
Experimental investigations on topics from 437. Laboratory experiments on klystron characteristics, traveling wave amplifier, microwave semiconductor oscillator, plasma measurements, and plasma-field interactions.
455. Deterministic Communication Systems  
Fall. 3(3-0) Approval of department.  
Communication systems. Representation of signals in time and frequency domain. Processing of signals by linear, simple nonlinear and time-variant systems. Linear and nonlinear, analog and digital modulation and demodulation; for example, AM, FM, PCM.

456. Applied Probability in Communication Theory  
Winter. 3(3-0) 455 or approval of department.  
Probability theory as applied in the study of communication systems. Representation of random signals and noise as stochastic processes. Autocorrelation and spectral density.

457. Introduction to Statistical Communication Theory  
Spring. 3(3-0) 456; 467 concurrently.  
Representation, processing and filtering of random signals. Performance of analog, linear and nonlinear modulation systems with noise. Optimal digital communication systems.

458. Introduction to Electromagnetics  
Spring. 3(3-0) PHY 288.  

459. Control System Laboratory  
Winter. 1(0-3) 415; 416 concurrently.  
Experiments in control of processes with a digital controller. Simulation of control systems.

460. Communication Theory Laboratory  
Spring. 1(0-3) 456; 457 concurrently.  
Experimental investigations on communication theory and information transmission topics from 455, 456, and 457.

461. Physical Properties of Electronic Devices  
Fall. 3(3-0).  

462. Physical Properties of Electronic Devices II  
Winter. 3(3-0) 474.  

463. Physical Properties of Electronic Devices III  
Spring. 3(3-0) 475.  
Continuation of topics covered in 475. Aspects of integrated-circuit techniques.

464. Electronic Devices Laboratory I  
Fall. 1(0-3) 474 concurrently.  

465. Electronic Devices Laboratory II  
Winter. 3(3-0) 473.  
Formulation of electron-circuit theory from viewpoint of electromagnetic theory; calculation of impedance, propagation of electromagnetic wave in isotropic and anisotropic media, skin effects; boundary value problems.

466. Microwave Electronics  
Winter. 3(3-0) 475.  
Principles of microwave generators, including klystrons, magnetrons, traveling-wave tubes and particle accelerators; non-linear electron-wave interactions, crossed-field devices; solid-state microwave devices.

467. Ionized Gases  
Spring. 3(3-0) PHY 449.  
Elastic collision processes; Boltzmann equation; moment equations; basic plasma phenomena; motion of a charged particle in electrical and magnetic field; individual and collective charge particle behavior.

468. Microwaves  
Spring. 3(3-0) 483.  
Application of the diffusion and continuity equations to semiconductor devices; delineation of the device terminal properties including transient operation.

469. Semiconductor Devices  
Winter. 3(3-0) 483.  
Equivalent circuits; analysis of circuit operation including high frequency effects, noise properties, nonlinear effects.

470. Bioelectric Field Theory  
Spring. 3(3-0) 306.  
Volume conductor fields; quasi-static formulation, bioelectric sources, boundary conditions, field of a single coil, subthreshold neuron phenomena, integral equations for biopotentials. Electrocardiography; bioelectric sources in heart, dipole hypothesis, forward and inverse problems.
957. Semiconductor Switching Circuits
Fall of even-numbered years. 3(3-0)

958. or approval of department.
Switching design considerations; theory and application of device characteristics in switching circuits. Laboratory experiments using transistors and microcircuits.

975. Quantum Electromagnetics
Winter of odd-numbered years. 3(3-0)

916. Tensors; four-vector formulation of classical electromagnetics; relativistic electromagnetics; Lagrangian and Hamiltonian—classical and relativistic; Schrodinger's equation—classical and relativistic; quantization of wave fields, hydrogen atom.

976. Lasers and Masers
Spring of odd-numbered years. 3(3-0)

975. Coherence, emission, absorption and amplification of radiation; energy levels for optically active materials; threshold, wide, narrow excitation modes and other operating characteristics; applications and recent developments.

989. Waves and Radiations in Plasmas
Fall of even-numbered years. 3(3-0)

850. Interdepartmental with the departments of Astronomy and Astrophysics and Physics.
Plasma oscillations; interaction, electromagnetic fields with plasmas, wave propagation in magnetized media; plasma sheath, radiation of electric sources in incompressive and compressive plasmas; electroacoustic waves; magnetohydrodynamics; research topics in plasmas.

901. Electromagnetic Wave Propagation II
Spring of odd-numbered years. 3(3-0)

950. Propagation in nonmonotonically stratified media, propagation in turbulent media (scattering), propagation in stratified media, propagation in quasi-periodic media, Brillouin scattering, pulses in inhomogeneous media, propagation in moving media, complex Doppler effect, coupling between Maxwell equations and continuum equations, depolarization of EM waves.

999. Research
(ERG 999.) Fall, Winter, Spring, Summer. Variable credits. Approval of department.

105. Analysis of Control Systems
For course description, see Interdisciplinary Courses.

311. Introduction to Discrete Systems
Fall. 3(3-0) MTH 213.

Properties of linear discrete-time systems; z-transform; discrete system transfer functions.

312. Response of Discrete and Continuous Linear Systems
Winter. 3(3-0) 311.


313. Analysis of Control Systems
Spring. 3(3-0) 312.

Mathematical models of physical systems; basic control actions; transient response; error analysis; root locus method; Bode plot techniques.
811. System Methodology and Simulation
Winter. 3(3-0) 816, STT 441. Interdepartmental with the Computer Science Department and Social Science (College of). Problems definition, design of abstract models for system design and control, simulation of systems described by differential and difference equations, generation of random variables, simulation of discrete-object stochastic systems, simulation languages, applications to physical, economic, and social systems.

813. System Project
Spring. 3(1-6) 811. Interdepartmental with the Computer Science Department and Social Science (College of). Individual or team application of simulation methods to system design and/or management.

825. Foundations of Systems Science
Spring, Summer. 4(4-0) MTH 215 and 334. Basic definitions; set theory, graph theory, matrices and vector differential and difference equations in system theory; solutions in terms of functions of matrices and operational calculus.

826. Linear Concepts in Systems Science
Fall. 4(4-0) 825. State-space and frequency domain models of interconnected systems; solution of continuous and discrete-time linear systems; response characteristics; stability.

827. Nonlinear Concepts in Systems Science
Fall. 4(4-0) 826. Existence, uniqueness and stability; autonomous systems and the phase space; linearization, perturbation, describing functions and harmonic balance procedures; numerical solutions.

828. Optimization of Static Nonlinear Systems
Winter, Summer. 3(3-0) CHE 485 or knowledge of linear programming. Interdepartmental with the Department of Chemical Engineering.

843. Ecosystem Analysis, Design and Management
Spring. 3(0-4) 442 or ZOL 404. Interoartmental with the Zoology Department.

847. Analysis of Stochastic Systems
Spring. 3(0-0) E E 846. Equilibrium properties of non-stationary random processes; problems or estimation, filtering and prediction; sequential and recursive decision schemes; applications of random process theory to system modeling.

888. Hybrid Computation
Spring. 3(0-0) Approval of department. Hybrid programming techniques, applications in simulation design, control and optimization.

899. Research
Fall, Winter, Spring, Summer. Variable credit. Approval of department.

961. Optimal Control Theory I
Fall. 3(3-0) 827, 828 or approval of department; MTH 486. Formulation of the general control problem; controllability, observability and normality in discrete-state and continuous-state systems; performance functions; typical control problems.

962. Optimal Control Theory II
Winter. 3(3-0) 961. Optimum control theory in continuous-state and discrete-state systems; necessary and sufficient conditions for optimal solutions; geometric interpretations; relation to calculus of variations; typical applications.

963. Optimal Control Theory III
Spring. 3(3-0) 962 or approval of department. Topics selected among: computational methods for optimal controls (solution of selected two-point boundary value problems); stochastic control theory; state estimation, Kalman filtering and related statistical methods; differential game theory.

999. Research
Fall, Winter, Spring, Summer. Variable credit. Approval of department.

ENGINEERING

College of Engineering

160. Engineering Communications
Fall, Winter, Spring. 4(1-6) MTH 106 or 111 or concurrent. Engineering graphics, a means used by engineers to communicate their ideas to others. Freehand sketching, descriptive geometry, and graphical, numerical and computer problem solutions.

161. Mechanical Drawing
Fall, Winter, Spring. 2(0-4) Lettering and use of care of instruments. Orthographic projection, working drawings, machine sketching and isometric drawing.

162. Mechanical Drawing
Fall, Winter, Spring. 2(0-4) 160 or 161. Continuation of 161 with emphasis on freehand lettering and sketching, advanced working drawings.

200. Technology and Society
Winter. 3(3-0) In terms of American Thought and Language. Interdepartmental with the Natural Science Department. An attempt to describe and analyze portions of current technology and its desired and undesired consequences; an exploration of avenues for assessing such consequences for future technologies.

IDC. Introduction to Environmental Systems
For course description, see Interdisciplinary Courses.

201. Introduction to Engineering Mechanics
Winter. 4(4-0) PHY 237. Interdepartmental with and administered by the Mechanical Engineering Department. Laws of mechanics governing the behavior of rigid and deformable bodies emphasizing how these laws influence engineering design. Extensive use of demonstrations.

265. Structural Drawing
Winter. 3(0-6) An engineering graphics course.

267. Architectural Drafting I
Fall, Winter, Spring. 3(6) House construction detailing. Analysis and drawing of typical standard details.

270. Computer Graphics
Spring. 3(3-0) 190 or 160; CFS 110 or 130; or approval of department. Use of computer controlled display systems for the solution of multidimensional problems.

364. Architectural Drafting II
Winter. 3(0-6) 267. Functional and standard procedure in the layout of floor plans in traditional and modern houses. Rendered plot plan and required details.

365. House Planning
Fall, Winter, Spring. 3(1-4) Elementary house architecture. Drawing plans from sketches. Kitchen planning, house styles, elements of design, financing, heating, lighting.

366. Architectural Perspective Drawing
Fall. 3(0-6) Any engineering graphics course.

401. Technology Assessment
Spring. 3(3-0) Seniors or approval of department. Interdepartmental with the Natural Science Department. Socio-technological evaluation of impact of proposed technologies on economic, political, and cultural aspects of society. Identification of technical strategies and social goals. Techniques of assessment.