985. Counseling Pre-Practicum

Spring. 3(2-1) Doctoral status in college counseling or related area and approval of department.

Seminar emphasizing establishing good interpersonal relationships, self-understanding, an understanding of psychodynamics, and test interpretation as preparation for assuming counseling responsibilities. Approach is didactic and experiential with limited contacts with clients.

986A. Counseling Practicum I

Fall. 3(0-3) 985 or approval of department.

Supervised experience working with college students in a counseling relationship. Group discussions, group supervision and observation of counseling interviews, and individual supervision.

986B. Counseling Practicum II

Winter. 3(0-3) 986A.

Supervised experience working with college students in a counseling relationship. Group discussions, group supervision and observation of counseling interviews, and individual supervision.

986C. Counseling Practicum III

Spring. 3(0-3) 986B.

Supervised experience working with college students in a counseling relationship in the residence halls. Individual supervision, increased client contact hours, and participation in staff activities.

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.

988. 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.

990A. Field Experience: Special Education Administration Simulation

Spring. 3(0-9) Approval of department.

Supervised graduate practicum in administration of the Special Education program of a simulated school district.

990B. Field Experience: Special Education Administration

Fall, Winter, Spring, Summer. 3 to 12 credits. May re-enroll for a maximum of 18 credits. Approval of department.

Supervised graduate practicum or internship in special education administration.

990C. Field Experience: Special Education

Spring. 3 to 12 credits. May re-enroll for a maximum of 18 credits. Approval of department.

Supervised graduate practicum in special education teacher training.

999. Research

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

ELECTRICAL ENGINEERING AND SYSTEMS SCIENCE

College of Engineering

Electrical Engineering — E E

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. Sinusoids and the phasor concept. Bridges.

301. Electric Circuits II

Winter, Spring. 4(4-0) 300, MTH 214.

Sinusoidal 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

(384.) Winter, Spring. 1(0-3) 300 or concurrently.

Electronic test equipment and measurement fundamentals. Experimental verification of topics covered in 300 and 301. Computer-aided circuit analysis and design.

304. Electronics Laboratory II

(386.) Fall. 1(0-3) 302.

Experimental verification of topics covered in 302. Single-stage and multistage transistor amplifier design and analysis. Applications of linear integrated circuits. Computer-aided circuit design.

305. Electromagnetic Fields and Waves I

Fall, Winter. 3(3-0) MTH 215, PHY 288.

Vector analysis. Electrostatic fields: EM sources, scalar potential, Poisson's and Laplace's equations, dielectric media, capacitance, and energy storage. Boundary value problems for electrostatic 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.

Application of Maxwell's equations: radiation, propagation, reflection, and power flow of plane EM waves; EM boundary value problems. Transmission line theory: transient and steady state waves, standing and traveling waves, reflections and standing-wave-ratio.

308. Fields and Waves Laboratory

Spring, Summer. 1(0-3) 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, Spring. 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.

415. Control Systems

Winter. 3(3-0) SYS 313.

Formulation of automatic control problems; review of modeling method; specifications, controllability and stability; controller design via root locus and state-vector methods; survey of digital control.

418. Introduction to Network Synthesis

Spring. 3(3-0)

Overview: specification, approximation, synthesis. Physical realizability of passive two-element kind one-port and two-port functions. Foster and Cauer one-port syntheses. Lattice, ladder and cascade two-port syntheses. Selected active network synthesis.

419. Physical Phenomena and Electronic Instrumentation I

Winter. 4(3-3) PHY 289 or 293B; MTH 215. Interdepartmental with and administered by the Physics Department.

Concepts of electronics relative to uses in investigations of physical phenomena and their subsequent applications to provide reliable instrumentation. Nuclear radiation detectors, photometers and magnetometers are examples of specific topics covered.

430. Digital Electronics I

Fall. 3(3-0) 302.

Characteristics and applications of digital integrated circuits. Number systems and Boolean algebra. Gates, flip-flops, clocks, counters, shift registers, A/D and D/A converters. Basic applications of these devices.

431. Digital Electronics II

Winter. 3(3-0) 430 or CPS 421.

Basics of minicomputer and microcomputer based systems. Programming fundamentals. The I/O bus. Interfacing, data acquisition, data storage, and data communication. Practical design problems.

433. Digital Electronics Laboratory

Winter, Spring. 1(0-3) 431 or concurrently.

Design, construct and test representative digital electronic circuits. Hands-on experience with minicomputer, microcomputers and programmable calculators. Applications in data acquisition and control.

435. Guided Transmission Systems

Fall. 3(3-0) 308.

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 concurrenly.

Circuit theory for wave-guiding systems: impedance description of microwave one and N-port networks, scattering matrix, excitation and coupling. Radiation and scattering: radiation fields, fields and impedance of cylindrical antennas and arrays, microwave antennas.

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.

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.

464. Control Systems Laboratory

Fall. 2(1-3) SYS 313. Interdepartmental with Systems Science.

Experimental investigations of feedback systems. Study of solid state controllers. Properties and applications of phase lock loops. Introduction to digital control.

466. Control System Laboratory

Winter. 1(0-3) 415.

Experiments in control of processes with a digital controller. Simulation of control systems.

467. Communication Theory Laboratory

Spring. 1(0-3) 456; 457 concurrently.

Experimental investigations on communication theory and information transmission topics from 455, 456, and 457.

474. Physical Properties of Electronic Devices I

Fall. 3(3-0)

Energy levels in atoms and crystals. Destiny of states and elementary particle statistics. Transport properties of bulk materials. PN junction diode and bipolar junction transistor—low and high frequency.

475. Physical Properties of Electronic Devices II

Winter. 3(3-0) 474.

Continuation of 474. Physics, models, and elementary applications of a variety of solid-state devices. Field-effect transistors, SCR's, diacs, varactors, and high-frequency and optical devices.

476. Physical Properties of Electronic Devices III

Spring. 3(3-0) 307 and 475.

Continuation of 475. Klystrons, space-charge and traveling waves, solid-state micro-wave devices, parametric amplification, and lasers.

480. Integrated Circuits: Operational Amplifiers

Spring. 3(3-0) 302.

Integrated circuits: design principles and fabrication. Differential-amplifier stage signal characteristics. Properties and models of operational amplifiers. Applications: signal conditioners, signal processors, signal generators, and special-purpose circuits.

484. Electronic Devices Laboratory I

Fall. 1(0-3) 474 concurrently.

Introduction to materials handling and preparation techniques. Fabrication of electronic devices. Measurement of bulk properties of materials. Computer-aided analysis of transport phenomena in semiconductors.

490. Special Topics in Electrical Engineering

Fall, Winter, Spring, Summer. 1 to 4 credits. May re-enroll for a maximum of 12 credits. Approval of department.

Exposition of special topics in electrical engineering.

495. Independent Study

Fall, Winter, Spring, Summer. 1 to 3 credits. May re-enroll for a maximum of 3 credits in E E 495 and SYS 495 combined. Approval of department.

Independent study of a topic in electrical engineering of particular interest of the student.

499. Undergraduate Research

Fall, Winter, Spring, Summer. 1 to 3 credits. May re-enroll for a maximum of 6 credits in E E 499 and SYS 499 combined. Approval of department.

Independent undergraduate research in contemporary areas of electrical engineering such as: alternative energy, monitoring and control, bioengineering, power systems, integrated electronics, electromagnetic systems.

801. Special Problems

Fall, Winter, Spring, Summer. 1 to 4 credits. Approval of department.

Investigation of a topic in electrical engineering compatible with the student's prerequisites, interest, and ability.

811. Noise and Fluctuation Phenomena

Spring of even-numbered years; Summer of odd-numbered years. 3(3-0) Approval of department.

Nyquist formulation of thermal noise; noise phenomena associated with electron tubes, transistors, beam and parametric devices, amplifiers, mixers, and detectors; techniques and equipment for noise measurements.

831. Foundations of Network Synthesis

Fall. 3(3-0) Approval of department.

One-port networks; RL, RC, LC and RLC networks; driving point immitances; positive real properties; realization procedures.

832. Filter Synthesis I

Winter. 3(3-0) 831.

Two-port LC networks; transmission characteristics; filter design techniques based on image parameters; Cauer filters.

833. Filter Synthesis II

Spring. 3(3-0) 832.

Scattering parameters; Butterworth, Chebyshev and elliptic filters, phase equalizers synthesis based on insertion functions.

835. Electromagnetic Theory I

Fall. 3(3-0) Approval of department.

Electrostatics, magnetostatics, electrodynamics, Maxwell's equations, force and energy equations, potential functions, Green's function, radiation of electromagnetic waves, plane waves, cylindrical waves, spherical waves.

836. Electromagnetic Theory II

Winter. 3(3-0) 835.

Formulation of electric-circuit theory from viewpoint of electromagnetic theory; calculation of impedance; propagation of electromagnetic wave in isotropic and anisotropic media; skin effects; boundary value problems.

837. Guided Transmission Systems

Spring. 3(3-0) 835.

Electromagnetic fields in open-wire lines, coaxial lines and wave guides; power and energy relationships; orthogonality properties; normal modes; resonant cavities; modes of propagation in stratified media; microwave circuits.

846. Analysis of Random Time Functions

Fall, Winter. 3(3-0)

Mathematical models for time-dependent random phenomena; properties of correlation functions and spectral densities; stationarity and ergodicity; response of linear systems to random inputs; introduction to applied harmonic analysis.

847. Communication Systems

Winter, Spring. 3(3-0) 846.

Comparative analysis of modulation systems; optimal relation between bandwidth and signal-to-noise ratio; telemetry and radar systems.

849. Microwave Electronics

Winter. 3(3-0) 835.

Principles of microwave generators, including klystrons, magnetrons, traveling-wave tubes and particle accelerators; non-linear electron-wave interactions; crossed-field devices; solid state microwave electronics.

850. Ionized Gases

Spring. 3(3-0) 835 or PHY 448. Interdepartmental with the departments of Astronomy and Astrophysics and Physics.

Elastic collision processes; Boltzmann equation; moment equations; basic plasma phenomena; motion of a charged particle in electrical and magnetic field; individual and collective charged particle behavior.

861. Bioelectric Field Theory

Spring. 3(3-0) 306.

Volume conductor fields: quasi-static formulation, bioelectric sources, boundary conditions, field of a single cell, subthreshold neuron phenomena, integral equations for biopotentials. Electrocardiography: bioelectric sources in heart, dipole hypothesis, forward and inverse problems.

874. Physical Electronics

Fall. 4(4-0) Approval of department.

Application of quantum mechanics in solids, band theory of semi-conductors, electrical transport phenomena, induced current concept, charged particle dynamics, electron optics.

875. Solid-State Devices and Circuits

Winter. 3(3-0) 874.

Formulation of operating properties and appropriate models of two-terminal and multi-terminal devices formed with semiconductors and solid-state materials. Basic applications.

880. Signal Analysis

Fall. 3(3-0) Approval of department.

Continuous and discrete signals — generation, representation and classification. Fourier transform, spectral analysis and filtering for continuous and discrete signals. Computer implementation of signal processing.

899. Research

(EGR 899.) Fall, Winter, Spring, Summer. Variable credit. Approval of department.

911. General Automata Theory I

Fall of odd-numbered years. 3(3-0) CPS 423 or SYS 827 or approval of department. Interdepartmental with and administered by the Computer Science Department.

Characterization of machines and programs as automata; mathematical decomposition of finite automata.

912. General Automata Theory II

Winter of even-numbered years. 3(3-0) 911. Interdepartmental with and administered by the Computer Science Department.

Reliability and redundancy of finite automata. Probabilistic sequential machines. Languages definable by probabilistic and deterministic automata. Axioms for equivalence of regular expressions.

913. General Automata Theory III

Spring of even-numbered years. 3(3-0) 912. Interdepartmental with and administered by the Computer Science Department.

Degrees of difficulty of computation. Models of parallel computation. Iterative automata.

926. Antenna Theory I

Winter of even-numbered years. 3(3-0) 837.

Linear antennas; cylindrical dipole antennas as radiating, receiving and scattering elements; current and charge distributions on antennas; electromagnetic fields of antennas; coupled antennas, linear antenna arrays.

927. Antenna Theory II

Spring of even-numbered years. 3(3-0) 926.

Microwave antennas; slot antennas; slot wave guide arrays; horn and reflector-type antennas; frequency independent antennas; pattern theory.

928. Microwave Laboratory

Summer of even-numbered years. 3(2-3) 837, 927, 989.

Experiments on transmission line systems; scattering measurements; antenna measurements; interaction of electromagnetic waves with plasmas; radiation in plasmas; experiments on electron tubes and on lasers.

956. Microelectronics II

Winter of even-numbered years. 3(3-0)

Miniaturized components; thin-film networks; solid-state circuits and operational limitations.

957. Semiconductor Switching Circuits

Spring of even-numbered years. 3(2-3) 956 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) 874.

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 atoms.

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, band width, 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 oscillation; interaction, electromagnetic fields with plasmas, wave propagation in magnetionic media; plasma sheath; radiation of electric source in incompressive and compressive plasmas; electroacoustic waves; magnetohydrodynamics; research topics in plasmas.

999. Research

(EGR 999.) Fall, Winter, Spring, Summer. Variable credit. Approval of department.

Systems Science — SYS

IDC. Introduction to Environmental Systems

For course description, see Interdisciplinary Courses.

311. Introduction to Discrete Systems

Fall, Winter. 3(3-0) MTH 215.

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

312. Response of Discrete and Continuous Linear Systems

Winter, Spring. 3(3-0) 311.

Response of linear discrete-time systems from transfer functions. Digital filters. Discrete and continuous state-space representation; response of linear systems from state models.

313. Analysis of Control Systems

Spring, Summer. 3(3-0) 312.

Mathematical models of physical systems; basic control actions; transient response; error analysis; root locus method; Bode plot techniques.

404. Biological and Ecological Concepts for Engineers and Mathematicians

Winter. 3(3-0) Approval of department. Interdepartmental with and administered by the Zoology Department.

Biological and ecological concepts important to formal analysis of living systems, vital properties, processes, and limitations; population dynamics, selection, competition, and predation; ecological community structure and function; industrialized ecosystem.

410. Systems Methodology

Winter. 3(3-0) IDC 201, MTH 113, CPS 110 or 120. Interdepartmental with the Engineering Department.

The systems approach in multidisciplinary large scale problem solving. The development of useful systems analysis tools; systems design; feasibility study; computer simulation for feasibility evaluation.

411. Systems Project

Spring. 2(3-0) 410. Interdepartmental with the Engineering Department.

Completion of a systems study initiated in 410. The project may involve the design of hardware, simulation of a solution to an interdisciplinary problem, or development of a solution concept.

442. Systems Concepts for Biologists

Winter. 3(3-0) Approval of department.

Basic concepts of systems science important to formal analysis and control of biological communities, with emphasis on modeling and on analysis of behavior through numerical solutions.

464. Control Systems Laboratory

Fall. 2(1-3) 313. Interdepartmental with and administered by Electrical Engineering.

Experimental investigations of feedback systems. Study of solid state controllers. Properties and applications of phase lock loops. Introduction to digital control.

465. Process Optimization Methods

Fall, Spring. 3(3-0) MTH 215, knowledge of linear algebra. Interdepartmental with and administered by the Chemical Engineering Department.

Methods for determining optimum design and operating policies of systems of varying complexity. Includes classical methods, mathematical programming and modern methods.