Descriptions — Education of Courses

956C. Counseling Practicum III
Fall, Winter, Spring. (3-0-3) 966B.
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.

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

ELECTRICAL ENGINEERING AND SYSTEMS SCIENCE

College of Engineering

Electrical Engineering

305. Electromagnetic Fields and Waves I
Fall, Winter. (3-0-3) 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 electrostatic fields.

306. Electromagnetic Fields and Waves II
Fall, Winter. (3-0-3) 205.
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. (3-0-3) 305; 306; 308 concurrently.

308. Fields and Waves Laboratory
Spring, Summer. (1-0-3) 306; 307 concurrently.
Experimetal 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.

311. Fundamentals of System Modeling
Fall, Winter. (3-0-3) MTH 334; PHY 288.
System measurement, signal representations, mathematical models for systems of lumped physical components, topological equations for electrical networks; linear graph theory and its application to modeling electrical, mechanical, hydraulic, and other systems.

312. Analysis of Linear Systems
Winter, Spring. (3-0-3) 311.
State Models for general systems; numerical and analytical solutions.

313. Analysis of Large Scale Systems
Spring, Summer. (3-0-3) 312.
Stability, pulse and frequency response characteristics; analysis by Laplace and Z transforms, subassemblies of multi-terminal components.

321. Analog and Digital Computation Laboratory
Fall, Winter. (1-0-3) MTH 334, PHY 288; 311 concurrently.
Numerical solution of electrical systems problems, component modeling by digital computer, analog computer simulation.

345. Instrumentation and Computation Laboratory
Fall, Winter. Spring. (4-3-3) PHY 288.
Signal measuring and generating devices; accuracy and error considerations in laboratory measurements; terminal characteristics of components from measurements; use of analog computers.

374. Electronics I
Fall, Winter. Spring. (4-4-0) PHY 288.
Current, voltage and power, DC, AC and transistor RLC circuit analysis. Resonance phenomena: bridges; nonlinear circuits; two-port networks and their equivalent circuits. Computer-aided analysis and design of circuits.

375. Electronics II
Winter, Spring. (4-4-0) PHY 288.

376. Electronics III
Spring, Summer. (3-0-3) 375.
Boolean algebra and logic circuits. Design, analysis, and evaluation of monostable, astable, and bistable multi-vibrator circuits, logic circuits and systems. Aspects of reliability.

384. Electronics Laboratory I
Fall, Winter. (1-0-3) 374 concurrently.
Experimental and measurement procedures, as appropriate to topics covered in 374.

386. Electronics Laboratory II
Spring, Summer. (1-0-3) 376 concurrently.
Experimental investigations of topics covered in 375 and 376. Computer-aided analysis and design of electronic circuits.

403. Special Problems
Fall, Winter, Spring. Summer. 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. (3-0-3) 313 or M E 455, MTH 334.
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.

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

418. Introduction to Network Synthesis
Spring. (3-0-3) 313.

435. Guided Transmission Systems
Fall. (3-0-3) 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. (3-0-3) 435; 438 concurrently.

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

438. Transmission and Radiation Laboratory
Winter. (1-0-3) 435; 438 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. (3-0-3) 374 or 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 communication systems and demodulation; for example, AM, FM, PCM.

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

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

*Effective March 1, 1969.
460. Introduction to Electromagnetics
Spring. 3(3-0) PHY 258.
Electric and magnetic fields; boundary conditions; Maxwell's equations; Electromagnetic waves. Wave propagation and cavities. Charged particles in an electromagnetic field.

466. Control Systems Laboratory
Winter. 1(0-3) 415; 416 concurrently.
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) 376.

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

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

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

485. Electronic Devices Laboratory II
Winter. 1(0-3) 475 concurrently.

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, lasers and parametric devices, amplifiers, mixers, and detectors; techniques and equipment for noise measurements.

816. Quantum Electronics
Fall. 3(3-0) Approval of department.
Quantum wave motion; Hamiltonian function and operator; hydrogen atom and energy states; transition probabilities; spontaneous and induced transitions; statistical physics; transport phenomena; hand theory applied to conductors, semi-conductors and insulators.

818. Electrical Properties of Materials I
Winter of odd-numbered years. 3(3-0)
Study of atomic and molecular properties affecting the conductivity, permittivity, permeability, absorptivity and radioactivity of materials, classical and quantum considerations.

819. Electrical Properties of Materials II
Spring of odd-numbered years. 3(3-0)
Temperature and frequency effects on conduction, dielectric constant, and dielectric loss; temperature, frequency and bias effects on the behavior of ferroelectric materials; stimulated emission and absorption in materials.

831. Foundations of Network Synthesis
Fall. 3(3-0) Approval of department.
One-port networks; RL, RC, LC and RLC networks; driving point functions; 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; filter synthesis based on insertion functions.

835. Electromagnetic Theory I
(594.) Fall. 3(3-0) Approval of department.
Physical concepts and mathematical solution of Maxwell equations; boundary conditions; force and energy equations; potential equations; Green's function; wave equations; radiation and propagation of electromagnetic waves.

836. Electromagnetic Theory II
Winter. 3(3-0) 835.
Formulation of electro-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
(812.) 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.

845. Mathematical Models for Random Phenomena
Fall. Summer. 3(3-0) Approval of department.
Generation of mathematical models that employ probabilistic notions to describe control, communication, and related systems, with emphasis on distributions of random variables, conditioning, and properties of random sequences.

846. Analysis of Random Time Functions
Fall. Winter. 3(3-0) 845.
Mathematical models for time-dependent random phenomena; properties of correlation functions and spectral densities; stationarity and ergodicity; linear systems to random inputs; introduction to applied harmonic analy.

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.

848. Physical Electronics
Fall. 3(3-0) Approval of department.
Types of electron emission; electron motion in electromagnetic fields; beam focusing; longitudinal and transverse beam waves; concepts of interaction between electrons and fields; basic principles of parametric electronics.

849. Microwave Electronics
(812.) Winter. 3(3-0) 846. 848.
Principles of microwave generators, including klystrons, magnetrons, traveling-wave tubes and particle accelerators; non-linear electronic interactions; crossed-field devices; solid state microwave electronics.

850. Ionized Gases
Spring. 3(3-0) or PHY 448. Interdepartmental with the Astronomy Department.
Electron collision processes; Boltzmann equation; moment equations; basic plasma phenomena; motion of a charged particle in electromagnetic and magnetic field; individual and collective charged particle behavior.

852. Semiconductor Devices
Winter. 3(3-0) 816.
Applications of the diffusion and continuity equations to semiconductor devices; delineation of the device terminal properties including transient operation.

853. Semiconductor Applications
Spring. 3(3-0) 852.
Equivalent circuits; analysis of circuit operation including high frequency effects; noise properties, nonlinear effects.

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

911. General Automata Theory I
(981.) Fall of even-numbered years. 3(3-0) CFS 453 or 825 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
(982.) Winter of even-numbered years. 3(3-0) 911. 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 antenna; 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 waveguide arrays; horns and reflector-type antennas; frequency independent antennas; pattern theory.

928. **Microwave Laboratory**
Summer of even-numbered years. 3(2-3)
837, 927, 965.
Experiments on transmission line systems; scattering measurements; antenna measurements; interaction of electromagnetic waves with plasma; radiation in plasmas; experiments on electronic tubes and lasers.

945. **Mean Square Filtering and Prediction**
Fall of even-numbered years. 3(3-0)
845.
Stationary and ergodic ensembles of signals; correlation functions; Wiener's solution to optimum filtering and prediction problems.

946. **Extraction of Signals from Noise**
Winter of odd-numbered years. 3(3-0)
945.
Auto-correlation and cross-correlation in detecting signals in noise; application of decision theory to the detection problem; measurement of message characteristics in noise.

947. **Space Communications**
Spring of odd-numbered years. 3(3-0)
847, 946.
Communication theory and switching theory applied to the study of communications in space; rate of information and error probability in pulse modulation systems for long distance communications.

955. **Microelectronics I**
Fall of odd-numbered years. 3(3-0)
855.
Basic physical principles underlying the operation, design, and fabrication of microelectronic devices.

956. **Microelectronics II**
Winter of even-numbered years. 3(3-0)
956.
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 circuit 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)
816.
Tensors; four-vector formulation of classical electrodynamics; relativistic electrodynamics; Lagrangian and Hamiltonian—classical and relativistic; Schrödinger's equation—classical and relativistic; quantization of wave fields, hydrogen atoms.

976. **Lasers and Masers**
Spring of odd-numbered years. 3(3-0)
976.
Coherence, emission, absorption and amplification of radiation; energy levels for optically active materials; threshold, bandwidth, excitation modes and other operating characteristics; applications and recent developments.

989. **Waves and Radiations in Plasmas**
Fall of even-numbered years. 3(3-0)
830.
Interdepartmental with the Astronomy Department.
Plasma oscillations; interaction, electromagnetic fields with plasmas, wave propagation in magnetostatic media, plasma shear; radiation of electric sources in incompressive and compressive plasmas; electroacoustic waves; magnetohydrodynamic; research topics in plasmas.

990. **Electromagnetic Wave Propagation I**
Winter of odd-numbered years. 3(3-0)
635.
Electromagnetic plane waves, collimated beams and pulses, phase velocity, group and signal velocity, velocity of energy transport, propagation of plane waves in homogeneous dispersive media, reflection of spherical wave from homogeneous boundaries; propagation in wave guides with complex boundaries.

991. **Electromagnetic Wave Propagation II**
Spring of odd-numbered years. 3(3-0)
990.
Propagation in monochromatically 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**
(FGR 999.) Fall, Winter, Spring, Summer. Variable credits. Approval of department.

Systems Science

493. **Process Optimization Methods**
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.

475. **Introduction to Operations Research**
Winter. 3(3-0) MTH 215, CPR 130, Interdepartmental with and administered by the Agricultural Engineering Department.
Methodology and basics of operations research; formulation and analysis of probabilistic models of inventory, waiting line, and reliability processes; random process simulation and network planning models.

501. **Special Problems**
Fall, Winter, Spring, Summer. 1 to 4 credits. May re-enroll for a maximum of 8 credits. Approval of department.

810. **Introduction to Linear System Theory**
(Fall.) Fall. 3(3-0) MTH 214, Interdepartmental with the Computer Science Department and Social Science Department.
A first course in system theory for students from a range of disciplines. Mathematical representation of system variables, transform and state space method of analysis, introduction to control theory, applications to physical, economic and social systems.

811. **System Methodology and Simulation**
Winter. 3(3-0) 810, STT 441. Interdepartmental with the Computer Science Department and Social Science Department.
Problem 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 systems, simulation languages, applications to physical, economic and social systems.

826. **Linear Concepts in Systems Science**
Fall. 3(3-0) 826.
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**
Spring. 3(3-0) 826.
Existence, uniqueness and stability; autonomous systems and the phase space; linearization, perturbation, describing functions and harmonic balance procedures; numerical solutions.

828. **Introduction to Static and Dynamic Optimization and Control**
Summer. 3(3-0) MTH 215, 334, or approval of department.
Problem formulation and classification; cost functionals; application of Lagrange multipliers, gradient methods, mathematical programming, direct search and other optimization techniques; necessary conditions for optimal control of constrained dynamic systems.

847. **Analysis of Stochastic Systems**
Spring. 3(3-0) EE 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.

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

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

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

962. **Optimal Control Theory II**
Winter. 3(3-0) 861.
Optimal control theory in continuous-state and discrete-state systems; necessary and sufficient conditions for optimal solutions, geometric interpretations related 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
108 or 111 or concurrently.

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 instruments. Orthographic projection, working drawings, machine sketching and isometric drawing.

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

200. Technology and Society
Fall. 3(3-0) EGR 111.
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.

260. Machine Drawing
Fall, Winter, Spring. 3(0-6)
Advanced orthographic projection, detail, and assembly drawing, sections and conventions, tracings, illustration and other pictorial drawings of mechanical elements.

263. Structural Drafting
Winter. 3(0-6) An engineering graphics course.
A comprehensive study of space planning relating to residential and light-commercial interiors. Building materials, fixtures, and mechanical equipment will be studied with respect to application and installation.

267. Architectural Drafting I
Fall, Winter, Spring. 3(0-6)

285. Descriptive Geometry
Fall. 3(2-2) 160, 161.
Problems involving relations of points, lines, and planes. Intersections, developments, conic sections, and noncoplanar vectors.

270. Computer Graphics
Spring. 3(3-0) 160 or 161; CSS 110 or 120 or LBC 125; 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.
One-point and two-point perspective, revolved plan, and measuring line methods. Pencil rendering, problems in shade and shadows. House model to scale, optional.

463. Architectural Drafting III
Spring. 3(0-6) 364 or 365.
Traditional and modern elevations. One- and two-point perspective. Functional plans drawn in 364 or 365 required.

480. Special Problems
Fall, Winter, Spring, Summer. 1 to 4 credits. May re-enroll for a maximum of 8 credits. Approval of department.