974. College Student Personnel Administration II
Winter. 3(3-0) Approval of department.
Student organizations and activities; student unions; on- and off-campus living environments. Emphasis on planning, organization, financing, research, evaluation and administration of these programs and services.

975. College Student Personnel Administration III
Spring. 3(3-0) Approval of department.
Analysis of student rights and responsibilities; academic freedom; regulation of student conduct; systems of governance and judicial processes; legal basis for student personnel programs and administration.

976. Student Counseling Seminar
Fall, Winter, Spring, Summer. Variable credit. Approval of department.
Seminars in the various fields of emphasis.

977. Counseling Pre-Practicum
Fall, Winter, Spring, Summer. 3(3-0) 968B 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.

978. Counseling Practicum I
Fall. 3(0-3) 968A 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.

979. Counseling Practicum II
Winter. 3(0-3) 968A.
Supervised experience working with college students in a counseling relationship. Group discussions, group supervision and observation of counseling interviews, and individual supervision.

980. Counseling Practicum III
Spring. 3(0-3) 968B.
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.

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

982. Seminar: Continuing Education in Higher Education Institutions
Winter. 3(3-0) May re-enroll for a maximum of 6 credits. Major 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.

983. 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, ethical materials, and instructional management.

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

985. Laboratory and Field Experience in Education
Fall, Winter, Spring, Summer. Variable credit. Approval of department.
Supervised advanced graduate practicum, observation, internships, and externships in the various areas of emphasis.

986. Electrical Engineering
Fall, Winter, Spring, Summer. 3(3-0) 275.

987. Introduction to Electronic Instrumentation Systems
Fall. 3(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.

988. Current Topics in Electrical Engineering
Winter. 1(2-0) May re-enroll for a maximum of 3 credits. Approval of department.
Topics include communication systems, instrumentation systems and data management, advanced laboratory technique, modeling, circuit design, computer analysis.

989. 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.

990. Control Systems
Fall. 3(3-0) MIE 344.
Formulation of automatic control problems; review of modeling method; specifications, controllability and stability, controller design via root locus and state-space methods; survey of digital control.

991. Introduction to Network Synthesis
Descriptions — Electrical Engineering and Systems Science

850. Ionized Gases
Spring. 3(3-0) 835 or PHY 448. Interdepartmental with the Astronomy and Physics Department.
Elastic collision processes; Boltzmann equation; moment equations; basic plasma phenomenology; 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 neural 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 approximate models of two-terminal and multi-terminal devices with emphasis on semiconductor and solid-state materials. Basic applications.

880. Signal Analysis
Fall. 3(3-0) Approval of department. Continuous and discrete signals — generation, representation, characterization by 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 SYL 527 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 radiator, reflector, and scatterer elements; radiation 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, 938. Experiments on transmission line systems; testing measurements; antenna measurements; interaction of electromagnetic waves with plasma; radiation in plasmas; experiments on electron tubes and on lasers.

947. Space Communications
Spring of odd-numbered years. 3(3-0) 847. 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.

956. Microelectronics II
Winter of even-numbered years. 3(3-0) 955. Miniaturized components; thin-film networks; solid-state circuits and operational limitations.

957. Semiconductor Switching Circuits
Spring of even-numbered years. 3(2-3) 955 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. Transmission; 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, omission, 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. Plasmas oscillation, interaction, electromagnetic fields with plasmas, wave propagation in magnetonic media; plasma sheath; radiation of electric source in incompressive and compressive plasmas; plasma-echo waves; magnetohydrodynamics; research topics in plasmas.

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

311. Introduction to Discrete Systems
Fall, Winter. 3(3-0) MTH 215. Properties of linear discrete-time systems; z-transformations; 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; Boole plot techniques.

403. Special Problems
Fall, Winter, Summer. 1 to 4 credits. Approval of department. Investigation of a topic in systems science compatible with the student's academic background, interest and ability.

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 ecosystems.

410. Systems Methodology
Winter. 3(3-0) IDC 261, MTH 112, 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 analysis of behavior through numerical solutions.

465. Process Optimization Methods
Fall, Spring. 3(3-0) MTH 315, 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. 4(4-0) MTH 215, CPS 120. 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.
Special Problems
Fall, Winter, Spring, Summer. 1 to 4 credits. May re-enroll for a maximum of 8 credits. Approval of department.

Introduction to Linear System Theory
Fall. 3(3-0) MTH 214. Interdepartmental with Computer Science Department and Social Science (College of).
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, and applications to physical, economic, and social systems.

System Methodology and Simulation
Winter. 3(0-0) 810, STT 441, Interdepartmental with the Computer Science Department and Social Science (College of).
Problem definition, design of abstract models for system design and control, simulation of systems described by differential and difference equations, generation of random variables, simulations of object of study (stochastic systems, simulation languages, applications to physical, economic, and social systems).

System Project
Spring. 2(3-6) 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.

System Dynamics and Control
Spring. 4(4-0) MTH 215; knowledge of matrices and Laplace transforms.
Fundamentals of continuous and discrete dynamic control systems; feedback principles; transform and state variable design techniques; introduction to optimal control design.

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

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

Optimization of Static Nonlinear Systems
Summer. 4(4-0) Students may not receive credit for both SYS 826 and MGT 835, CHE 485 or knowledge of linear programming. Interdepartmental with the Department of Chemical Engineering.
Problem formulation, classification, convexity and applications; Kuhn-Tucker theory in nonlinear programming; constrained and unconstrained problems; techniques for quadratic, integer and geometric programming; gradient and search techniques.

Optimization of Urban Traffic Flow
Fall. 3(3-0) Approval of department. Interdepartmental with Civil Engineering.
Traffic flow models are used in design of computerized traffic control systems. Optimal freeway ramp metering algorithms. Offline and online optimization of traffic signal timing.

Ecosystem Analysis, Design and Management
Spring. 3(3-0) 442 or ZCL 404, Interdepartmental with the Zoology Department.
Group of students from various biological and non-biological disciplines will synthesize and analyze models of selected biological systems. Projects should yield information relevant to solution of contemporary ecological problems.

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

Optimal Control Theory I
Fall. 3(3-0) 827, 828 or approval of department; MTH 426.
Formulation of the general control problem; controllability, observability and normality in discrete-state and continuous-state systems; performance functionals; typical control problems.

Optimal Control Theory II
Winter. 3(3-0) 861
Optimum continuous-state and discrete-state systems; necessary and sufficient conditions for optimal solutions, geometric interpretation, relation to calculus of variations; typical applications.

Optimal Control Theory III
Spring. 3(0-0) 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.

Special Topics in Optimal Process Theory
Spring of odd-numbered years. 3(3-0) 828 or approval of department, Interdepartmental with and administered by the Chemical Engineering Department.
Continuation of 828 and special topics from the literature in non-linear, stochastic, and dynamic programming.

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

Ecosystem Analysis, Design and Management (Continued)
Spring. 3(3-0) 442 or ZCL 404, Interdepartmental with the Zoology Department.
Group of students from various biological and non-biological disciplines will synthesize and analyze models of selected biological systems. Projects should yield information relevant to solution of contemporary ecological problems.

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

Optimal Control Theory I (Continued)
Fall. 3(3-0) 827, 828 or approval of department; MTH 426.
Formulation of the general control problem; controllability, observability and normality in discrete-state and continuous-state systems; performance functionals; typical control problems.

Optimal Control Theory II (Continued)
Winter. 3(3-0) 861
Optimum continuous-state and discrete-state systems; necessary and sufficient conditions for optimal solutions, geometric interpretation, relation to calculus of variations; typical applications.

Optimal Control Theory III (Continued)
Spring. 3(0-0) 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.

Special Topics in Optimal Process Theory (Continued)
Spring of odd-numbered years. 3(3-0) 828 or approval of department, Interdepartmental with and administered by the Chemical Engineering Department.
Continuation of 828 and special topics from the literature in non-linear, stochastic, and dynamic programming.

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

EGR
College of Engineering

Orientation for Engineering Cooperative Education
Winter. 1(1-0) Approval for the College of Engineering Cooperative Education program.
Engineering careers, philosophy of cooperative education, rights and responsibilities of engineers.

Engineering Communications
Fall, Winter, Spring. 4(1-6) MTH 106 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.

Mechanical Drawing
Fall, Winter, Spring. 3(0-4)
Lettering and use and care of instruments. Orthographic projection, working drawings, machine sketching and isometric drawing.

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

Technology and Society
Winter. 3(3-0) One term 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.

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

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

Engineering Drawing
Fall, Winter, Spring. 3(0-6)
The development of the ability to communicate graphically, pictorially, and verbally. Orthographic projection, freehand sketching, oral reports and creative problem solving techniques are employed to enhance learning.

Architectural Drafting I
Fall, Winter, Spring. 3(0-6)
House construction detailing. Analysis and drawing of typical standard details.

Computer Graphics
Spring. 3(3-0) 110 or 120, or approval of department.
Use of computer controlled display systems for the solution of multidimensional problems.

Technology and Utilization of Energy
Winter. 3(3-0) Initial course in any sequence of courses in the Department of Natural Science. Interdepartmental with and administered by the Mechanical Engineering Department.
Problems of energy technology and its impact: energy sources, conversions, waste and environmental effects, future outlook for mankind.

Interior Lighting Design
Fall, Spring. 3(2-2) HED 213, approval of department.
Interdepartmental with and administered by the Department of Human Environment and Design.
The basic principles and practices of interior design lighting, light control, distribution, quality and quantity of light as it affects man's near environment.

Architectural Drafting II
Winter. 3(0-6) 567.
Functional and standard procedure in the layout of floor plans in traditional and modern houses. Rendered plot plan and required details.