976A. Fieldwork Research in Educational Settings I
Fall. 3(3-0) Approval of instructor.
Substantive and methodological issues in planning and conducting fieldwork research in educational settings. Knowledge and skills necessary to evaluate quality of fieldwork research. Critical review of examples of research reports.

976B. Fieldwork Research in Educational Settings II
Winter. 3(3-0) ED 976A or approval of instructor.
Supervised fieldwork research in educational settings. Techniques of field data collection and analysis. Research question formulation, entry, evidence, and ethics.

976C. Fieldwork Research in Educational Settings III
Spring. 3(3-0) ED 976B.
Supervised analysis and reporting of fieldwork research data. Literature review, model construction, analysis of field notes and other data. Preparing narrative reports addressed to scientific audiences and to audiences of practitioners.

977. Teacher Assessment and Development
Fall. 3(3-0) Completion of 27 credits at graduate level.
Concepts of teacher assessment, techniques and instruments for analysis of teaching, current assessment practices, and strategies for teacher development based on needs.

978. Professional Lectures in Educational Administration
Fall. 3(3-0) Graduate students in Educational Administration.
Lectures by faculty in Educational Administration in individual faculty, research and service interests, exploration of recent research and other scholarly publications.

979. Community College Administration
Fall, Spring, Summer. 3(3-0) ED 922A.
Functional areas of community college administration with emphasis upon instruction, finance and student services including the importance of local, state and federal influences.

982. Seminars in Education
Fall, Winter, Spring, Summer. Variable credit. Approval of department.
Seminars in the various fields of emphasis.

983. Readings and Independent Study in Education
Fall, Winter, Spring, Summer. Variable credit. Approval of department.
Study on an individual or group basis in the various fields of emphasis.

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

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 experimental with limited contacts with clients.

986. Group Processes in Counseling Psychology
Fall. 3(3-0) Graduate students.
Didactic-experiential format to explore group dynamics, interpersonal processes within groups, differential effect of various leadership styles, facilitation of group interaction, impact of different theoretical approaches, application to counseling/school settings.

986A. Counseling Practicum I
Fall. 3(3-0) ED 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(3-0) ED 985A.
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(3-0) ED 985B.
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 reenroll 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 reenroll 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 reenroll 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.

989. Laboratory and Field Experience in Counseling Psychology
Fall. 3(2-4) Counseling psychology majors.
Applied aspects of counseling through case conferences and presentations of cases by representatives of various counseling orientations.

990. 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 reenroll for a maximum of 18 credits. Approval of department.
Supervised graduate practicum or internship in special education administration.

991. Higher Education Internship
Fall, Winter, Spring, Summer. 3(0-9) May reenroll for a maximum of 12 credits. Doctoral and Educational Specialist students in Higher Education and approval of instructor.
Students intern in on- and off-campus offices and agencies as observers of and participants in the administrative programs particular to their major field of study.

996. Physiological Measurement in Counseling Psychology
Spring. 3(2-2) ED 414 and approval of department.
Physiological measurement in counseling psychology treatment, training, and research.

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

ELECTRICAL ENGINEERING AND SYSTEMS SCIENCE

College of Engineering

Electrical Engineering

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

300. Electric Circuits I
Fall, Winter. 4(4-0) MTH 113.

301. Electric Circuits II
Winter. Spring. 4(4-0) E 300, MTH 214.

302. Basic Electronic Circuits
Spring, Summer. 4(4-0) E 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
Winter, Spring. 1(0-3) E 300; E 301 concurrently.
Electronic test equipment and measurement fundamentals. Experimental verification of topics covered in E 300 and E 301. Computer-aided circuit analysis and design.
304. **Electronics Laboratory II**  
Fall. 1(0-3) E E 302.  

305. **Electromagnetic Fields and Waves I**  
Fall. Winter. 3(3-0) MTH 310, 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) E E 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 EM boundary-value problems.

307. **Electromagnetic Fields and Waves III**  
Spring. Summer. 3(3-0) E E 306, E E 308 concurrently.  
Application of Maxwell's equations; radiation, propagation, reflection, and power flow of plane EM waves; EM boundary 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) E E 306; E E 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.

419. **Physical Phenomena and Electronic Instrumentation I**  
Winter. 4(3-3) PHY 289, PHY 298 or approval of department. MTH 215. Interdepartmental with and administered by the Department of Physics.  
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.

420. **Electromechanical Energy Conversion**  
Winter. 3(3-0) E E 301, E E 305.  
Review of electromagnetics; design, specification, and use of d.c. machines in industrial and servo-control applications; synchronous generators and transformers for power systems; phase stability, phase control, power systems, three phase power, per unit notation.

421. **Power System Analysis**  
Spring. 3(3-0) E E 309.  
Model of power system components; analysis and planning techniques including load flow, short circuit, transient stability; voltage and frequency control; economic operation of power systems.

430. **Digital Electronics I**  
Fall. 3(3-0) E E 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) E E 430 or CPS 421.  

432. **Digital Electronics Laboratory**  
Winter. Spring. 1(0-3) May enroll for a maximum of 2 credits. E E 430 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) E E 307.  
Guided wave theory: normal modes, propagation characteristics in rectangular and circular waveguides. Stripline and microstrip. Electromagnetic resonators; frequency and Q. Circuit theory of waveguiding systems. Scattering matrix; system applications.

436. **Radiation and Propagation of Electromagnetic Waves**  
Winter. 3(3-0) E E 307.  
Radiation, propagation, scattering and reception of electromagnetic waves. Circuit and radiation characteristics of wire and microwave antennas; radiation fields, self and mutual impedances of antennas and arrays; microwave aperture antennas.

438. **Transmission and Radiation Laboratory**  
Winter. 1(0-3) E E 435; E E 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.

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) E E 435 or approval of department.  

457. **Statistical Communication Systems**  
Spring. 3(3-0) E E 456; E E 467 concurrently.  
Representation, processing and filtering of random signals. Performance of digital systems with noise. Optimal digital communication systems. Signal detection, information concepts, coding. Communication systems such as radar, television, PCM, and telephony.

464. **Control Systems Laboratory**  
Fall. 2(1-3) E E 303 or E E 345; SYS 313. Interdepartmental with Systems Science.  
Experimental investigations of feedback systems. Study of solid state controllers. Properties and applications of phase locked loops. Introduction to digital control.

467. **Communications Laboratory**  
Spring. 1(0-3) E E 455; E E 457 concurrently.  
Experimental investigations on communication theory and information transmission topics from E E 453, E E 456, and E E 457.

474. **Physical Principles of Electronic Devices**  
Fall. 3(3-0) E E 302; E E 305.  

475. **Electronic Devices and Circuits I**  
Winter. 3(3-0) E E 474.  
Analysis and design of devices and circuits based on principles discussed in E E 474. Physical models and operations for BJT's, FET's and other semiconductor devices.

476. **Electronic Devices and Circuits II**  
Spring. 3(3-0) E E 307, E E 475.  
Continuation of topics covered in E E 475. Power semiconductor devices, solid state energy conversion devices, optoelectronic devices and applications. High-frequency device design, models and applications.

477. **Electro-optic Devices**  
Spring of odd-numbered years. 3(3-0) E E 306.  
Atomic origin and the optical characteristics of light sources and detectors. Basic design considerations for gas and solid state lasers. Methods of optical detection, applications.
912. General Automata Theory II  
Winter of even-numbered years. 3(3-0)  
CPS 912. Interdepartmental with and administered by the Department of Computer Science.  

913. General Automata Theory III  
Spring of even-numbered years. 3(3-0)  
CPS 913. Interdepartmental with and administered by the Department of Computer Science.  

921. Advanced Computer Systems I  
Fall of odd-numbered years. 3(2-3)  
CPS 921; graduate course in operating systems. Interdepartmental with and administered by the Department of Computer Science.  
Models of single and multiple processors, their computational power, and measures of performance. Interconnection networks, data driven machines, and pipelines.

922. Advanced Computer Systems II  
Winter of even-numbered years. 3(2-3)  
CPS 922. Interdepartmental with and administered by the Department of Computer Science.  
Design and characterization of parallel algorithms. Matching of algorithms with appropriate hardware configurations. Programming languages which support parallel computation.

926. Antenna Theory I  
Winter of even-numbered years. 3(3-0)  
E E 835.  
Wire antennas as radiating, receiving and scattering elements; analytical and numerical integral equation methods; coupled antennas and arrays; transient phenomena.

927. Antenna Theory II  
Spring of even-numbered years. 3(3-0)  
E E 926.  
Radiation by equivalent aperture fields: aperture antennas, slot antennas, horn and reflector antennas, frequency independent antennas, pattern theory, scattering from various objects.

929. Advanced Topics in Electromagnetics  
Fall, Winter, Spring, Summer. 2 to 4 credits. May be rolled for a maximum of 4 credits. E E 655 and approval of department.  
Topics will be drawn from contemporary research areas such as transient electromagnetics (SEM solutions), open-boundary waveguides, solid-state lasers, and microwave plasmas.

931. Discrete-Time Systems  
Fall, Winter, Spring. 3(3-0) MTH 215.  
Discrete-time system modeling, discrete-time signals, difference equations, convolution summations, z-transform, transfer functions, stability analysis, digital filters.

932. Continuous-Time Systems  
Winter, Spring. 3(3-0) SYS 311.  

933. Analysis of Control Systems  
Spring, Summer. 3(3-0) SYS 312.  
Control system characteristics, performance criteria, transient and steady-state responses, error analysis, stability, root locus method, frequency response techniques, gain and phase margins.

940. Biological and Ecological Concepts for Engineers and Mathematicians  
Winter. 3(3-0) Approval of department. Interdepartmental with and administered by the Department of Zoology.  
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.

404. Systems Science  
SYS 311.  
Discrete-Time Systems  
Fall, Winter, Spring. 3(3-0) MTH 215.  
Discrete-time system modeling, discrete-time signals, difference equations, convolution summations, z-transform, transfer functions, stability analysis, digital filters.

941. Systems Project  
Spring. 2(3-0) SYS 410. Interdepartmental with Engineering.  
Completion of a systems study initiated in SYS 410. The project may involve the design of hardware, simulation of a solution to an interdisciplinary problem, or development of a solution concept.
801. Special Problems  
Fall, Winter, Spring, Summer. 1 to 4 credits. May reenroll for a maximum of 8 credits. Approval of department.

810. Introduction to Linear System Theory  
Fall. 3(3-0) MTH 214, Interdepartmental with 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, applications to physical, economic and social systems.

811. System Methodology and Simulation  
Winter. 3(3-0) SYS 810, 441. Interdepartmental with Social Science (College of). Problem definition, design of abstract models for system design and control, simulation of systems described by differential 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) SYS 811. Interdepartmental with Social Science (College of). Individual or team application of simulation methods to system design and/or management.

814. Advanced System Methodology and Simulation  
Spring. 3(3-0) SYS 811. Simulation of a class of time-varying distributed parameter processes; organization and design of large simulation models; optimization and parameter estimation in large simulation models; applications to economic, social and biological systems; other topics of current interest.

826. Advanced Linear Systems Analysis  
Fall. 4(4-0) MTH 310, MTH 334. Interdepartmental with Electrical Engineering. Unified analysis of linear continuous-time and discrete-time systems for both time-invariant and time-varying models; mathematical descriptions; transforms; state models; transition matrices; solution techniques; controllability; observability; stability.

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

829. Modern Control Systems  
Spring. 4(4-0) SYS 441, SYS 826. Stochastic processes and white noise; analysis of linear continuous-time control systems; state feedback design; state observer design; optimal linear control and Kalman filter; linear discrete-time control systems.

835. Nonlinear Optimization Models  
Winter, Summer. 4(4-0) Students may not receive credit for both SYS 835 and MTH 835. MTH 215 or MTH 228; MGT 834 or CHE 445. Interdepartmental and jointly administered with the Department of Management, Interdepartmental with the Department of Chemical Engineering.  

841. Optimization of Urban Traffic Flow  
Fall of odd-numbered years. 3(3-0) Approval of department. Interdepartmental with Civil Engineering. Traffic flow models used in design of computerized traffic control systems. Optimal freeway ramp metering algorithms. Off-line and on-line optimization of traffic signal timing.

843. Dynamic Systems Analysis, Design and Management  
Spring. 3(3-0) SYS 442 or ZOL 404. Interdepartmental with the Department of Zoology. Groups of students from various biological and non-biological disciplines will synthesize and analyze models of selected biological systems. Project should yield information relevant to solution of contemporary ecological problems.

847. Communication Engineering  

848. Communication Theory  

851. Modeling of Engineering Systems I  
Fall. 3(3-0) M E 458 or E E 415. Interdepartmental with and administered by the Department of Mechanical Engineering. Modeling of engineering components and dynamic systems; mechanical, electrical, fluid, thermal, and transducer effects. Linear state-space responses, impedance methods. Simulation of linear models. Design project.

852. Modeling of Engineering Systems II  
Winter. 3(3-0) M E 851. Interdepartmental with and administered by the Department of Mechanical Engineering. Continuation of M E 851. Modeling of nonlinear dynamic systems. Applications of phase-plane and linearization methods. Simulation of nonlinear systems. Design project.

863. Analysis of Stochastic Systems  
Winter. 3(3-0) E E 415, E E 425. Interdepartmental with Electrical Engineering. Analysis and modeling of stochastic signals and systems. Topics include stochastic models, description of processes, stationarity, ergodicity, correlation and power spectrum, linear stochastic systems, harmonics analysis, Markov processes.

870. Signal Analysis  
Winter. 3(3-0) Approval of department. Interdepartmental with and administered by Electrical Engineering. 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. Master's Thesis Research  
Fall, Winter, Spring, Summer. Variable credit. Approval of department.

917. Topics in Communications  
Fall of odd-numbered years. 3(3-0) May reenroll for a maximum of 6 credits. E E 848. Interdepartmental with and administered by Electrical Engineering. Advanced treatment of a topic or group of topics of current research interest in the field of communications, information theory and signal processing.

961. Optimal Control Theory  
Fall. 3(3-0) SYS 827, MTH 426. Optimal control, performance measures, principle of optimality, dynamic programming, Hamilton-Jacobi-Bellman equation, variational approach, constrained extrema, Pontryagin principle, necessary conditions, solution techniques, singular cases.

962. Computational Techniques for Optimal Control  
Winter of odd-numbered years, 3(3-0) SYS 861. Computational methods of optimal controls, steepest descent, variation of extremals, quasilinearization, gradient projection, dynamic programming, convexity techniques, support functions for reachable sets, current literature.

963. Dynamic System Identification and Control  
Spring of odd-numbered years. 3(3-0) SYS 863, SYS 829. System identification, dynamic programming, stochastic and adaptive control. Topics under identification include review of statistics background, dynamic system models, identification methods, recursive algorithms, input design, and structure discrimination.

964. Large Scale Dynamic Systems  
Winter of even-numbered years, 3(3-0) SYS 961. Model simplification; stability of large scale systems; decentralized control; optimization by decomposition and coordination; multilevel hierarchical control; applications.

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