

- ED L 855 Applied Research and Evaluation in Higher Education 3(3,0)** Basic issues of measurement emphasizing questionnaire development, scales, and measures commonly used in higher education research, assessment, and program evaluation.
- ED L 885 Selected Topics in Educational Administration 1-3(1-3,0)** Current literature and results of current research. Topics vary from year to year. May be repeated for a maximum of six credits.
- ED L 900 Principles of Educational Leadership 3(3,0)** Advanced leadership theory; the nature of leadership, major theories of leadership, and their application in educational organizations. *Preq:* Admission to PhD program in Educational Leadership.
- ED L 905 Theory and Practice in Educational Leadership 3(3,0)** Advanced organizational and leadership theory; major theories of organization and their applications in understanding the roles of governmental agencies in society. *Preq:* Admission to the doctoral program.
- ED L 910 Introductory Doctoral Seminar 3(3,0)** Educational leadership for beginning doctoral students providing an introduction to the conceptual and theoretical frameworks of educational leadership for both public school and higher education administration. *Preq:* Consent of instructor.
- ED L 915 Educational Planning 3(3,0)** Systems approach to planning and management; the measurement and interpretation of performance results.
- ED L 925 Instructional Leadership 3(3,0)** Preparation for a career in educational leadership; the principal's functions in the effective school's movement as incorporated in instructional leadership.
- ED L 935 History of Higher Education 3(3,0)** Development of higher education from the 11<sup>th</sup> century to the present with emphasis on the United States.
- ED L 950 Educational Policy Studies 3(3,0)** Critical analysis of the sources and nature of educational policy and how policy is developed, administered, and assessed for public schools. *Preq:* Admission to doctoral studies.
- ED L (VT ED) 955 The Two-Year College 3(3,0)** Historical developments, functions, organization, and administration of the two-year college. *Preq:* Admission to doctoral studies or consent of instructor.
- ED L 960 Legal Principles in the Administration of Institutions of Higher Education 3(3,0)** General principles of higher education law from the points of view of statute and common law practice. *Preq:* Admission to doctoral studies or consent of instructor.
- ED L 965 Higher Education Finance 3(3,0)** Higher education finance relative to sources of revenue, expenditures, and planning.
- ED L 970 Foundations of Higher Education 3(3,0)** Survey of American higher education including its historical, political, philosophical, and social aspects. *Preq:* Admission to doctoral studies.
- ED L 972 Ethics in Educational Leadership 3(3,0)** The ethical issues involved in administering educational institutions; moral leadership, ethical work environments, and decision-making models.
- ED L 976 External Effectiveness in Higher Education 3(3,0)** Optimum structures and strategies for fund raising, public relations, constituent relations, governmental affairs, and governing boards necessary for a college or university to communicate effectively with its constituents.
- ED L 980 Current Issues in Educational Leadership 1-3(1-3,0)** Topics and issues as determined by the needs of the students and the instructor. *Preq:* Graduate standing, consent of instructor.
- ED L 985 Internship in Educational Leadership I 3** First in a two-semester internship to provide experience in leadership role under the guidance of an experienced field mentor at the student's chosen level of specialization in educational leadership (public schools or institutions of higher education). *Preq:* ED L 900, 905, 910, or consent of advisor.
- ED L 986 Internship in Educational Leadership II 3** Second in a two-semester internship to provide experience in leadership role under the guidance of an experienced field mentor at the student's chosen level of specialization in educational leadership (public schools or institutions of higher education). *Preq:* ED L 985.
- ED L 989 Advanced Doctoral Seminar I 3(3,0)** Explores educational leadership topics. Culminates in the selection of a topic for presentation and approval and the development of Chapter I of a prospectus. To be taken Pass/Fail only. *Preq:* ED L 900, 905, 910, consent of instructor.
- ED L 990 Advanced Doctoral Seminar II 3(3,0)** Seminar for advanced students focusing on the preparation of dissertation Chapters I–III.
- ED L 991 Doctoral Dissertation Research 1-18**
- ED L 995 Directed Research 1-4(1-4,0)** Research option for graduate students to pursue a line of inquiry in education under the direction of faculty. Specific educational question is investigated and reported using appropriate methodology. To be taken Pass/Fail only. May be repeated for a maximum of four credits. *Preq:* Admission to doctoral studies or consent of instructor.
- ## ELECTRICAL AND COMPUTER ENGINEERING
- E C E 604 Semiconductor Devices 3(3,0)** Consideration of the principles of operation, external characteristics, and applications of some of the more important semiconductor devices available. *Preq:* E C E 320. *Coreq:* MTHSC 311 or 434.
- E C E 606 Introduction to Microelectronics Processing 3(3,0)** Microelectronic processing, MOS and bipolar monolithic circuit fabrication, thick and thin film hybrid fabrication, applications to linear and digital circuits, fundamentals of device design. *Preq:* E C E 320. *Coreq:* MTHSC 311 or 434.
- E C E 610 Modern Control Theory 3(3,0)** Introduction to modern control theory including fundamentals of matrix algebra, state space analysis and design, nonlinear systems, and optimal control. *Preq:* E C E 409.
- E C E 617 Elements of Software Engineering 3(3,0)** Foundations of software design, reasoning about software, the calculus of programs, survey of formal specification techniques, and design languages. *Preq:* E C E 329, MTHSC 419.
- E C E 618 Power System Analysis 3(3,0)** Study of power system planning and operational problems. Subjects covered include load flow, economic dispatch, fault studies, transient stability, and control of problems. System modeling and computer solutions are emphasized through class projects. *Preq:* E C E 360, 380.
- E C E 619 Electric Machines and Drives 3(3,0)** Performance, characteristics, and modeling of AC and DC machines during steady-state and transient conditions. Introduction to power electronics devices and their use in adjustable speed motor drives. *Preq:* E C E 321, 360, 380. *Coreq:* MTHSC 434 or consent of instructor.
- E C E 622 Electronic System Design I 3(2,2)** Emphasizes the application of theory and skills to the design, building, and testing of an electronic system with both analog and digital components. Application varies each semester. Extensive use is made of computer software tools in the design process. *Preq:* E C E 321, 330, 360, 371, 381.
- E C E 629 Organization of Computers 3(3,0)** Computer organization and architecture. Topics include a review of logic circuits, bus structures, memory organization, interrupt structures, arithmetic units, input-output structures, state generation, central processor organization, control function implementation, and data communication. Registered Transfer Language (RTL) for description and design of digital systems. *Preq:* E C E 272 or consent of instructor.
- E C E 630 Digital Communications 3(3,0)** Study of digital communication systems. Topics include error-control coding, synchronization, multiple-access techniques, spread spectrum signaling, and fading channels. *Preq:* E C E 427.
- E C E 631 Digital Electronics 3(2,2)** Electronic devices and circuits of importance to digital computer operation and to other areas of electrical engineering are considered. Active and passive waveshaping, waveform generation, memory elements, switching, and logic circuits are some topics. Experimentation with various types of circuits is provided by laboratory projects. *Preq:* E C E 321. *Coreq:* MTHSC 311 or 434.
- E C E 632 Instrumentation 3(3,0)** Theory and analysis of transducers and related circuits and instrumentation. Generalized configurations and performance characteristics of instruments are considered. Transducer devices for measuring physical parameters such as motion, force, torque, pressure, flow, and temperature are discussed. *Preq:* E C E 321. *Coreq:* MTHSC 311 or 434.
- E C E 636 Microwave Circuits 3(3,0)** Analysis of microwave networks comprising transmission lines, waveguides, passive elements, interconnects, and active solid state microwave circuits. Use of modern CAD tools to design RF/Microwave passive/active networks. Fabrication of typical circuits. *Preq:* E C E 381 or equivalent. *Coreq:* MTHSC 311 or 434.

- E C E 638 Computer Communications 3(3,0)** Digital data transmission techniques, modems and communications channels, communications software and protocols, multiprocessors, and distributed processing; concurrency and cooperation of dispersed processors. *Preq:* Senior standing in Electrical or Computer Engineering or Computer Science or consent of instructor.
- E C E 639 Fiber Optics 3(3,0)** Underlying principles of design for optical fibers in practical systems are covered. Optical fiber as a waveguide is examined using wave optics and ray optics. Design criteria for using mono- and multi-mode fibers are discussed. Other topics include fabrication and measurement. *Preq:* E C E 381. *Coreq:* MTHSC 434 or consent of instructor.
- E C E 640 Performance Analysis of Local Computer Networks 3(3,0)** Introduction to design and performance analysis of local computer networks. Emphasis is on performance analysis of representative multi-access procedures. Three common types of networks are considered in detail. *Preq:* E C E 272, 317.
- E C E 642 Knowledge Engineering 3(3,0)** Introduction to theoretical and practical aspects of knowledge engineering or applied artificial intelligence. Topics include symbolic representation structures and manipulation, unification, production systems and structures, rule-based and expert systems, planning and AI system architectures; system design in PROLOG and LISP. Project is required. *Preq:* E C E 329, 352.
- E C E 646 Antennas and Propagation 3(3,0)** Study of the theoretical and practical aspects of antenna design and utilization, input impedances, structural considerations, and wave propagation. *Preq:* E C E 330, 381 or 436; MTHSC 311 or 434.
- E C E 655 Robot Manipulators 3(3,0)** Analysis of robot manipulator systems with special focus on interaction of these technologies with society. Emphasis is on rigid-link robot manipulator systems. Topics include history of robot technology, kinematics, dynamics, control, and operator interfaces. Case studies reinforce impact of robot technology on society and vice versa. *Preq:* MTHSC 206, 311, or consent of instructor.
- E C E (M E) 656 Fundamentals of Robotics 3(3,0)** See M E 656.
- E C E 659 Integrated Circuit Design 3(2,2)** Design concepts and factors influencing the choice of technology; fundamental MOS device design; silicon foundries, custom and semicustom integrated circuits; computer-aided design software/hardware trends and future developments; hands-on use of CAD tools to design standard library cells; systems design considerations, testing, and packaging. *Preq:* E C E 321. *Coreq:* MTHSC 311 or 434.
- E C E 667 Introduction to Digital Signal Processing 3(3,0)** Introduction to characteristics, design, and applications of discrete time systems; design of digital filters; Fast Fourier Transform (FFT); LSI hardware for signal processing applications. *Preq:* E C E 330.
- E C E 668 Embedded Computing 3(2,2)** Principles of using computing in the larger context of a system. Topics include bus and processor design types (e.g. microprocessor, microcontroller, DSP), co-decs, digital circuit power management, real time scheduling, and embedded operating systems. Lab work consists of projects on embedded hardware (e.g. PC-104+). *Preq:* E C E 371, CP SC 212; or consent of instructor.
- E C E 692 Special Problems 1-3** Special assignment in electrical or computer engineering. Typical assignments include computer programs, term papers, technical literature searches, hardware projects, and design project leadership. May be taken only once for credit.
- E C E 693 Selected Topics 1-3(1-3,0)** Classroom study of current and new technical developments in electrical and computer engineering. May be repeated for a maximum of six credits, but only if different topics are covered. *Preq:* Consent of instructor.
- E C E 701 Master of Engineering Design Project 1-6** Practical problems in engineering analysis and design culminating in the written report required for the MEng degree. To be taken Pass/Fail only. May be repeated for a maximum of six credits.
- E C E 801 Analysis of Linear Systems 3(3,0)** Foundations of linear system analysis; matrix algebra, linear graph theory, and operational mathematics applied to formulation and solution of system equations in time and frequency domains.
- E C E 802 Electric Motor Control 3(3,0)** Dynamic modeling and analysis of electrical machines for design of AC and DC drive systems; implementation of such models on a digital computer; voltage-fed inverters; pulse width modulation and analysis techniques for inverters; harmonic generation and reduction. *Preq:* E C E 434.
- E C E 804 Methods of Applied Optimization and Optimum Control 3(3,0)** Methods of optimizing systems with and without dynamics including linear programming, nonlinear programming, integer programming, gradient and variational calculus, minimum principle, principle of optimality, and dynamic programming. *Coreq:* MTHSC 653.
- E C E 805 Methods of State and Parameter Estimation of Stochastic Systems 3(3,0)** State and parameter estimations of both linear and nonlinear continuous-time and discrete-time systems including model identification: Kalman and Wiener filters, fixed-interval, fixed-point and fixed-lag smoothers, stochastic approximation estimation, nonlinear estimation by statistical linearization, and sensitivity analysis of Kalman filters. *Coreq:* MTHSC 654.
- E C E 807 Computer Methods for Power Systems Analysis 3(3,0)** Electric power system operation; development of models of transmission line components and networks; computer methods for solving linear and nonlinear systems of network equations; operating problems in load flow, scheduling and economic dispatch. *Preq:* E C E 418.
- E C E 811 Integrated Circuit Design 3(2,2)** Design concepts and factors influencing the choice of technology; fundamental MOS device design; silicon foundries; custom and semicustom integrated circuits; computer-aided design software/hardware trends and future developments; the hands-on use of CAD tools to design MOS standard cells; systems design, testing, and packaging. *Preq:* E C E 459.
- E C E 816 Electric Power Distribution System Engineering 3(3,0)** Radial circuit analysis techniques, feeder and transformer modeling, load modeling, loss minimalization and voltage control, causes of power quality problems, motor starting analysis, strategies for analyzing impacts of disturbances. *Preq:* E C E 418, 419, or consent of instructor.
- E C E 817 Power System Transients 3(3,0)** Electrical transients in power systems; frequency domain and time domain techniques for power systems transient analysis; capacitor switching, load switching, fault-induced transients, line reclosing, and single pole switching. *Preq:* Consent of instructor.
- E C E 818 Random Process Applications in Engineering 3(3,0)** Theory of random processes emphasizing engineering applications; stochastic convergence and limit theorems; martingales; mean-square calculus; Karhunen-Loeve expansions; systems with stochastic inputs; Poisson processes; shot noise; Weiner processes; white noise processes; Markov systems; queuing systems; and estimate theory. *Preq:* E C E 317 and 330 or consent of instructor.
- E C E 819 Detection and Estimation Theory 3(3,0)** Theory of statistical testing of hypotheses applied to detection and estimation of communication signal parameters; detection of signals with random amplitude, phase, and arrival time in noise; detection of single and multiple observation; estimates and their properties; signal resolution. *Preq:* E C E 820.
- E C E 820 Digital Communication Systems I 3(3,0)** Modern communications systems emphasizing modulation and methods of taking into account effects of noise on various systems. *Preq:* E C E 428 or equivalent.
- E C E 821 Digital Communication Systems II 3(3,0)** Continuation of E C E 820.
- E C E 822 Information Theory 3(3,0)** Statistical problems encountered in information handling; relations of probability, information, and coding theory; unified treatment of set theory, sample space, random variables, information measure, and capacity applied to communication.
- E C E 823 Integrated Circuit Technology 3(3,0)** Physical and chemical principles underlying the major processing operations used in the fabrication of integrated circuit semiconductor devices, process simulation, diagnostic testing, and factors affecting device yield and reliability. *Preq:* Consent of instructor.

- E C E 824 Power System Protection 3(3,0)** Coordination of power system protection components including microprocessor based relay-adaptive protection of power system, power system disturbance identification and system restoration following a major disturbance. *Preq:* E C E 418 or consent of instructor. *Coreq:* MTHSC 434 or consent of instructor.
- E C E 825 Solid-State Electronics 3(3,0)** Modern physics approach to electrons in solids; elementary quantum mechanics; statistics; plasmas; band theory; application of these principles to modern amplifiers; e.g., the traveling-wave tube, tunnel diode, masers, and parametric amplifiers.
- E C E 828 Guided Waves, Wave Propagation, and Radiation in Stratified Media 3(3,0)** Covers several important topics of applied electromagnetics, including advanced transmission-line theory for guided electromagnetic waves, analysis of electromagnetic wave propagation in layered media, and computation of electromagnetic radiation in stratified regions. *Preq:* E C E 829, 830.
- E C E 829 Special Functions in Engineering 3(3,0)** Complex calculus and analytic functions; origin of special functions in engineering; series and integral representations of special functions; properties and applications of gamma, Bessel, Legendre, Chebyshev, etc. functions; computation of special functions; applications in selected engineering problems. *Preq:* Consent of instructor.
- E C E 830 Electromagnetics 3(3,0)** Wave equations and waves, electromagnetic potentials, theorems and advanced concepts, guided waves, radiation, boundary value problems, and simple Green's functions. *Preq:* E C E 380, 381; or equivalent.
- E C E 831 Advanced Electromagnetic Theory 3(3,0)** Advanced boundary-value problems in cylindrical and spherical coordinates, special functions, Sommerfeld integrals, Green's functions, and integral equations. *Preq:* E C E 830.
- E C E 834 Asymptotic Methods and Diffraction Theory 3(3,0)** Canonical diffraction problems for which exact solutions are available; asymptotic reevaluation of these solutions in terms of incident, reflected and diffracted rays leads to Keller's postulates for an extended theory or geometrical theory of diffraction; application of diffraction from edges and curved surfaces to scattering and antenna problems. *Preq:* E C E 830.
- E C E 835 Finite Element Methods in Electromagnetics 3(3,0)** Finite-element methods (FEM) as applied to electromagnetics; fundamentals of list-linked FEM data structures, sparse matrix solutions, edge-based vector bases, radiation boundary conditions, and perfectly absorbing media. *Coreq:* E C E 830.
- E C E 836 Microwave Circuits and Systems 3(3,0)** Application of the mathematics and physical principles of electromagnetic field theory and electrical circuit analysis to the geometries that are of interest in modern microwave engineering; transmission lines, waveguides, discontinuities, interconnection of multiports, and periodic structures. *Preq:* E C E 436. *Coreq:* E C E 830.
- E C E 837 Advanced Antenna Theory 3(3,0)** The antenna as a radiating and receiving device; examination by classical and numerical techniques of the relations between structure and performance, gain and terminal conditions. *Preq:* E C E 446. *Coreq:* E C E 830.
- E C E 838 Special Topics in Electromagnetics 1(1,0)** Methods of solving selected electromagnetic problems with emphasis on Green's functions, equivalence principle, dynamic potential theory, and boundary value techniques. May be repeated for credit. *Preq:* Consent of instructor.
- E C E 839 Integral Equations in Electromagnetics 3(3,0)** Integral equation formulation in electromagnetics, solution techniques, moment methods, and application to practical problems. *Preq:* E C E 830 or consent of instructor.
- E C E 840 Physics of Semiconductor Devices 3(3,0)** Semiconductor device physics emphasized rather than circuits; detailed analysis of the p-n junction, traps, surface states and conduction processes, and devices; analysis and models of Schottky diode, MIS diode, MOSFET, charge couples devices, and solar cells; charge control concepts, transit time effects, surface-type devices and practical aspects of device process. *Preq:* E C E 404, 406.
- E C E 842 Computer Architecture 3(3,0)** Fundamental issues that arise in the composition of logic elements into computer systems; design and analysis of processors, busses, memory hierarchies, communications controllers, and associated software. *Preq:* E C E 429 or equivalent.
- E C E 844 Digital Signal Processing 3(3,0)** Digital filter design; discrete Hilbert transforms; discrete random signals; effects of finite register length in digital signal processing; homomorphic signal processing; power spectrum estimation; speech processing, radar, and other applications. *Preq:* E C E 467.
- E C E 845 Computer System Design and Operation 3(3,0)** Factors involved in design, acquisition, and operation of a computer system; analysis methods; alternative computer systems; computer economics; performance evaluation; operational requirements. *Preq:* Consent of instructor.
- E C E 846 Digital Processing of Speech Signals 3(3,0)** Application of digital signal processing techniques to problems related to speech synthesis, recognition, and communication; digital models and representations of speech wave forms; Fourier analysis; homomorphic processing; linear predictive coding; algorithms for recognizing isolated words and continuous speech; man-machine communications by voice. *Preq:* E C E 467.
- E C E 847 Digital Image Processing 3(3,0)** Review of fundamental concepts, issues, and algorithms in image processing. Includes image formation, file formats, filters, edge detection, stereo, motion, and color. *Preq:* E C E 467.
- E C E 848 Telecommunication Network Modeling and Analysis 3(3,0)** Protocols, modeling, and analysis of telecommunication networks with emphasis on quantitative performance modeling of networks and systems using packet switching and circuit switching techniques. *Preq:* CP SC 825 or E C E 438.
- E C E 849 Advanced Topics in Computer Communications 3(3,0)** Performance analysis and design of computer communication networks with emphasis on recent developments; routing flow control, error control, and end-to-end performance analysis, local area, packet radio, and long haul store-and-forward networks. *Preq:* E C E 438 or 440, consent of instructor.
- E C E 850 Computation and Simulation 3(3,0)** Computer modeling as related to engineering problems; matching problems and computers to obtain most effective solution.
- E C E 851 Advanced Topics in Computer Architecture 3(3,1)** Analysis and design of multiprocessor and modular computer systems; recent developments in integration, fabrication, and application of multiprocessor systems. *Preq:* E C E 842.
- E C E 852 Software Engineering 3(3,0)** Design, construction verification, and testing of large-scale computer software systems; software science, requirements writing, design graphics, the calculus of programs, verification proofs, and symbolic execution. *Preq:* Computer Engineering major or consent of instructor.
- E C E 854 Analysis of Robotic Systems 3(3,0)** Methods of designing and operating robotics systems for advanced automation; on-line identification and description of 3-D objects by digitized images; off-line collision-free path planning and on-line collision avoidance traveling using artificial intelligence. *Preq:* M E (E C E) 456 or consent of instructor.
- E C E 855 Artificial Intelligence 3(3,0)** Emulating intelligent behavior by computer; models of cognitive processes; logical foundations; constraint satisfaction problems; natural language understanding; pattern-directed inference and chaining paradigms; goal-directed behavior, planning, and search; learning; advanced database structure and inference strategies; examples of LISP, PROLOG, and OPS5. *Preq:* E C E 442.
- E C E 856 Pattern Recognition 3(3,0)** Several approaches to general pattern recognition problems with practical computer-oriented applications; feature extraction; classification algorithms; discriminant functions; learning schemes; statistical methods; information theoretic approaches; applications; current developments.
- E C E 857 Coding Theory 3(3,0)** Principles of algebraic coding and its application to transmission of information over noisy communications channels; introduction to abstract algebra; code performance bounds; code representations; linear codes of the Hamming and Bose-Chandhuri types and burst-error correcting codes; problems of implementation and decoding. *Preq:* E C E 317 or equivalent.
- E C E (M E) 859 Intelligent Robotic Systems 3(3,0)** Integration and fusion of data from multiple sensors on multiple robots; intelligent decision making on motion planning and execution based on sensed data involving mutual compliance; simultaneous force and position controls using computers. *Preq:* E C E (M E) 854.

- E C E 860 Advanced Coding Theory 3(3,0)** Introduction to convolutional codes and trellis-coded modulation. Topics include code generation and representation, distance properties, decoding techniques, performance analysis, multidimensional codes and lattice theory, and coding for fading channels; applications to wireline communications and mobile communications. *Preq:* E C E 828, 857.
- E C E 862 Real Time Computer Application in Power Systems 3(3,0)** Principles of monitoring, control, and operation of power systems; load frequency control, on-line load flow, power system state estimation, unit commitment, and load forecasting. *Preq:* E C E 418.
- E C E 863 Power System Dynamics and Stability 3(3,0)** Modeling of synchronous machines and their control systems; power system stability for small and large disturbances; excitation systems, governor control, power system stabilizers, and state variables formulation for power systems dynamic stability studies. *Preq:* E C E 418, 419.
- E C E 869 Advanced Kinematics in Robotics 3(3,0)** Complex robotic systems, such as multi-fingered robot hands, dual-armed robots and multi-joint "snakelike" robots; kinematic redundancy, load distribution, and dexterous manipulation; effective modeling and solution techniques for these types of underconstrained systems. *Preq:* E C E 409, M E (E C E) 656, or consent of instructor.
- E C E 872 Artificial Neural Networks 3(3,0)** Design, analysis, and application of artificial neural networks, neuron models, network architectures, training (supervised and unsupervised), and hardware implementation; extended studies of selected applications and simulation exercises. *Preq:* MTHSC 311 or consent of instructor, graduate standing.
- E C E 873 Parallel and Distributed Systems 3(3,0)** Design, analysis, and evaluation of algorithms for parallel and distributed computer systems; time complexity, speedup, efficiency, and isoefficiency; communication costs; numerical algorithms including solving systems of equations (both sparse and dense) as well as symbolic algorithms; substantial parallel programming projects.
- E C E 874 Advanced Nonlinear Control 3(3,0)** Basics of nonlinear control based on Lyapunov techniques; adaptive control design, robust control design, and observer design; understanding and development of Lyapunov control design tools. *Preq:* E C E 801 or equivalent.
- E C E 877 Computer Vision 3(3,0)** Investigation into fundamental concepts, issues, and algorithms in computer vision. Includes segmentation, texture, detection, 3-D reconstruction, camera calibration, shape, and energy minimization. *Preq:* E C E 847
- E C E 890 Engineering Report Research 1-3** Research culminating in writing an engineering report to satisfy one of the requirements for the nonthesis option for the MS degree. To be taken Pass/Fail only.
- E C E 891 Master's Thesis Research 1-12**
- E C E 892 Special Problems in Electrical and Computer Engineering 1-3(1-3,0)** Term paper, special design, or other problems in electrical and computer engineering approved by the instructor. May not be used for investigation associated with the MS thesis or the engineering report. May be repeated for credit.
- E C E 893 Selected Topics in Electrical and Computer Engineering 1-3(1-3,0)** Topics not covered in other courses; current literature and results of current research. Topics vary from year to year in keeping with developments in the field. May be repeated for credit. *Preq:* Consent of instructor.
- E C E 903 Computer Architecture Seminar 1(1,0)** Recent research publications related to computer architecture including parallel systems, distributed computing, reconfigurable architectures, and software development for high performance computing. Students read and discuss one research paper weekly and present one research paper each semester. May be repeated for a maximum of three credits. *Preq:* Consent of instructor.
- E C E 904 Computer Vision Seminar 1(1,0)** Review of recent research publications related to computer vision including tracking, correspondence, reconstruction, and segmentation. Students read and discuss one research paper per week and present one research paper each semester. May be repeated for a maximum of three credits.
- E C E 991 Doctoral Dissertation Research 1-12**

## ELEMENTARY EDUCATION

- ED EL 760 Curriculum Development in the Elementary School 3(3,0)** Analysis of trends and practices relative to elementary curriculum planning. Designed to develop an understanding of the essential elements of curriculum decisions followed by the process of improving the curriculum. *Preq:* ED F 701, 702, or consent of instructor.
- ED EL 804 Advanced Methods of Teaching in the Elementary School 3(3,0)** Principles and practices involved in promoting effective learning in elementary schools; analysis and evaluation of educational models and research. *Preq:* ED EL 760 or consent of instructor.
- ED EL 826 Advanced Methods in Elementary Science Teaching 3(3,0)** Provides in-depth study of current research and trends in elementary science teaching methods and curriculum development. Students examine recent literature and standards for science teaching and develop strategies to implement recommended practices in their own classrooms. *Preq:* Admission to MEd program or consent of instructor.
- ED EL 831 Advanced Methods in Elementary School Social Studies Education 3(3,0)** Techniques, resources/materials, theories, and research for teaching social studies in the elementary/middle school classroom; current research trends in social studies education, national, and state standards, addressing the needs of a diverse student population, fostering a classroom community, and developing an integrated approach to social studies education. *Preq:* Admission to the MEd program or consent of instructor.

- ED EL 890 Education Research Project 3(2,3)** Students select, with approval of professor, and conduct research on an education issue of suitable scope. Oral, written, and visual presentation of the research project is required. Students must enroll during final semester. *Preq:* Consent of instructor.
- ED EL 892 Advanced Methods in Elementary School Mathematics 3(3,0)** Research-based course which examines trends in mathematics teaching and learning and the relationship between theory and practice; developing appropriate teaching strategies; analysis and evaluation of educational models and research; and improving staff development based on current research. *Preq:* Admission to MEd program or consent of instructor.
- ED EL 937 Designing Elementary Curriculum 3(3,0)** Theoretical issues and guidelines for educators engaged in the curriculum development process at the elementary level. *Preq:* Admission to the PhD program in Curriculum and Instruction, ED 954, 955, 956.
- ED EL 938 Teacher as Researcher 3(3,0)** Various methodologies of field-based research. Students complete a literature review and design a field-based research project. *Preq:* Admission to the PhD program in Curriculum and Instruction, ED 878, 879, EX ST 801, one of the following: EDSEC 846, 847, 848, 849, READ 944.

## ENGINEERING GRAPHICS

- E G 612 Interactive Computer Graphics 3(3,0)** Graphics hardware and display technology; reduction and presentation of engineering data; techniques of geometrical transformations, perspective, and model manipulation; methodology of computer-aided design; application of higher-level software to engineering problems. *Preq:* E G 208 and MTHSC 208 or consent of instructor.
- E G 690 Special Topics in Engineering and Computer Graphics 1-3(1-3,0)** Comprehensive study of any computer-aided topic in engineering graphics not covered in other courses. May be repeated for a maximum of six credits. *Preq:* Consent of instructor.

## ENGLISH

- ENGL 600 The English Language 3(3,0)** Studies in English usage and historical development of the language. *Preq:* ENGL 310 or consent of instructor.
- ENGL 601 Grammar Survey 3(3,0)** Survey of modern grammars, focusing on the impact of structural grammar on traditional grammar. Recommended for English teachers. *Preq:* ENGL 310 or consent of instructor.
- ENGL 607 The Medieval Period 3(3,0)** Selected works of Old and Middle English literature, excluding Chaucer. *Preq:* ENGL 310 or consent of instructor.
- ENGL 608 Chaucer 3(3,0)** Selected readings in Middle English from *The Canterbury Tales* and other works by Chaucer. *Preq:* ENGL 310 or consent of instructor.

- ENGL 610 Drama of English Renaissance 3(3,0)** Selected readings in non-Shakespearean dramatic literature of the 16<sup>th</sup> and 17<sup>th</sup> centuries. *Preq:* ENGL 310 or consent of instructor.
- ENGL 611 Shakespeare 3(3,0)** Study of selected tragedies, comedies, and history plays of Shakespeare. Required of all English majors. *Preq:* ENGL 310 or consent of instructor.
- ENGL 614 Milton 3(3,0)** Development of Milton's art and thought from the minor poems and selected prose through *Paradise Lost*, *Paradise Regained*, and *Samson Agonistes*, set against the background of the late Renaissance. *Preq:* ENGL 310 or consent of instructor.
- ENGL 615 The Restoration and Eighteenth Century 3(3,0)** Readings in Dryden, Swift, Pope, and Dr. Johnson. *Preq:* ENGL 310 or consent of instructor.
- ENGL 616 The Romantic Period 3(3,0)** Readings from the poetry and critical prose of Blake, Wordsworth, Coleridge, Byron, Shelley, Keats, and other representative figures. *Preq:* ENGL 310 or consent of instructor.
- ENGL 617 The Victorian Period 3(3,0)** Readings from the poetry and nonfiction prose of selected Victorian authors, including works of Carlyle, Tennyson, Browning, Arnold, and other representative figures. *Preq:* ENGL 310 or consent of instructor.
- ENGL 618 The English Novel 3(3,0)** Study of the English novel from its 18<sup>th</sup> century beginnings through the Victorian period. *Preq:* ENGL 310 or consent of instructor.
- ENGL 619 Post-Colonial Studies 3(3,0)** Selected readings in post-colonial literature and theory, focusing on issues of nationalism, migration, resistance, race, language, and master narratives. *Preq:* ENGL 310 or consent of instructor.
- ENGL 625 The American Novel 3(3,0)** Survey of the most significant forms and themes of the American novel from its beginnings to 1900. *Preq:* ENGL 310 or consent of instructor.
- ENGL 626 Southern Literature 3(3,0)** Intellectual and literary achievement of the South from 1607 to the present, with emphasis upon the writers of the 19<sup>th</sup> century. *Preq:* ENGL 310 or consent of instructor.
- ENGL 627 Agrarianism and the Humanistic Tradition 3(3,0)** Focuses on the importance of agriculture and rural life to the humanistic tradition of Western Civilization from antiquity through the early years of the American republic. *Preq:* ENGL 310 or consent of instructor.
- ENGL 628 Contemporary Literature 3(3,0)** Focuses on American, British, and other fiction, poetry, and drama from the Post-World War II to the present. *Preq:* ENGL 310 or consent of instructor.
- ENGL 629 Dramatic Literature I 3(3,0)** Selected reading in dramatic literature from the classical era of Greece and Rome to the Renaissance. *Preq:* ENGL 310 or consent of instructor.
- ENGL (THEA) 630 Dramatic Literature II 3(3,0)** Principles and progress of drama from the Restoration to the present; analysis of representative plays; critical reports; discussion of trends in dramatic literature. *Preq:* ENGL 310 or consent of instructor.
- ENGL 631 Modern Poetry 3(3,0)** The modern tradition in English and American poetry from Yeats to the present; relevant critical essays. *Preq:* ENGL 310 or consent of instructor.
- ENGL 632 Modern Fiction 3(3,0)** American and British novels and short stories of the 20<sup>th</sup> century. *Preq:* ENGL 310 or consent of instructor.
- ENGL 633 The Anglo-Irish Literary Tradition 3(3,0)** Exploration of the unique literary heritage and achievement of English-language Irish writers in the 19<sup>th</sup> and 20<sup>th</sup> centuries. Major figures of the Irish tradition: W. B. Yeats, James Joyce, Samuel Beckett, and other writers; consideration of the specifically Irish aspects of their works. *Preq:* ENGL 310 or consent of instructor.
- ENGL 634 Environmental Literature 3(3,0)** Survey of literature that examines the relationship between human beings and the natural world, including analysis of environmental themes in myths and legends and in selected poetry and prose of 19<sup>th</sup>- and 20<sup>th</sup>-century England and America. *Preq:* ENGL 310 or consent of instructor.
- ENGL 635 Literary Criticism 3(3,0)** Major critical approaches to literature. *Preq:* ENGL 310 or consent of instructor.
- ENGL 636 Feminist Literary Criticism 3(3,0)** Introduction to the germinal works of feminist literary theory and criticism. Outlines the development of modern literary criticism by studying feminist versions of the major critical methodologies. *Preq:* ENGL 310 or consent of instructor.
- ENGL 637 Directed Studies 1-3(1-3,0)** Class and tutorial work for students with special interests or projects in American, British, or European literature outside the scope of existing courses. Applications must be approved during the registration period of the semester preceding the one in which directed studies will occur. May be repeated by arrangement with the department. *Preq:* ENGL 310 or consent of instructor.
- ENGL 640 Literary Theory 3(3,0)** Examination of how approaches such as Marxism, Psychoanalysis, Feminism, Deconstruction, New Historicism, Post-Colonialism, Cultural Studies, and Queer Theory answer the question, "What is literature?" *Preq:* ENGL 310 or consent of instructor.
- ENGL 642 Cultural Studies 3(3,0)** Investigation of the similarities and connections between a wide variety of cultural products, events, and practices—from fast food through opera to on-line shopping—using theories ranging from Marxism to hybridity. *Preq:* ENGL 310 or consent of instructor.
- ENGL 644 Renaissance Literature 3(3,0)** Selected readings in non-Shakespearean British literature from 1500–1660. Includes drama, poetry, and prose. *Preq:* ENGL 310 or consent of instructor.
- ENGL 645 Fiction Workshop 3(3,0)** Workshop in the creative writing of prose fiction. May be repeated once for credit. *Preq:* ENGL 345 or consent of instructor.
- ENGL 646 Poetry Workshop 3(3,0)** Workshop in the creative writing of poetry. May be repeated once for credit. *Preq:* ENGL 346 or consent of instructor.
- ENGL (THEA) 647 Playwriting Workshop 3(0,3)** See THEA 647.
- ENGL 648 Screenwriting Workshop 3(2,3)** Workshop in the creative writing of screenplays. May be repeated once for credit. *Preq:* ENGL 348 or consent of instructor.
- ENGL 649 Creative Non-Fiction 3(3,0)** Advanced workshop in writing non-fiction prose for magazine and freelance markets. *Preq:* ENGL 312 or 334 or consent of instructor.
- ENGL 650 Film Genres 3(2,3)** Advanced study of films that have similar subjects, themes, and techniques, including such genres as the Western, horror, gangster, science fiction, musical, and/or screwball comedy. Also considers nontraditional genres, screen irony, genre theory, and historical evolution of genres. Topics vary. *Preq:* ENGL 357 or consent of instructor.
- ENGL (COMM) 651 Film Theory and Criticism 3(2,3)** Advanced study into the theory of film/video making emphasizing understanding a variety of critical methods to approach a film. Examines the history of film theory and defines the many schools of film criticism, including realism, formalism, feminism, semiotics, Marxism, and expressionism. *Preq:* ENGL 357 or consent of instructor.
- ENGL 652 Great Directors 3(2,3)** Intensive study of one to three film directors with an emphasis on understanding the entire canon of each director. Students study similarities in techniques, shifts in thematic emphasis, and critical methodologies for approaching the works of each director. Topics vary. *Preq:* ENGL 357 or consent of instructor.
- ENGL 653 Sexuality and the Cinema 3(2,3)** Examination of male/female sexual roles and their evolution in American genre films, avant-garde cinema, and international films. Includes the study of movies in relation to cultural values and social stereotypes, introduction to feminist film theory, and consideration of film pornography. *Preq:* ENGL 357 or consent of instructor.
- ENGL 655 American Humor 3(3,0)** Native American humor of the 19<sup>th</sup> and 20<sup>th</sup> centuries. *Preq:* 310 or consent of instructor.
- ENGL (HUM) 656 Literature and Arts of the Holocaust 3(3,0)** Addresses the Holocaust through literature, art, architecture, music, and film. Beginning with historical, political, and economic forces that contributed to the Holocaust, course then focuses on highly diverse creative responses to this event—responses that often reflect the difficulties and politics of these commemorative gestures. *Preq:* ENGL 310 or consent of instructor.
- ENGL 659 Advanced Special Topics in Language, Literature, or Culture 3(3,0)** Advanced studies in topics not central to other English courses, such as certain authors, works, genres, themes, or areas of knowledge and culture. Specific topics are announced when offered. May be repeated once for credit with department chair's consent. *Preq:* ENGL 310 or consent of instructor.

- ENGL 663 Topics in American Literature 3(3,0)**  
Selected readings in American literature from a variety of time periods for focused study of authors, movements, themes, critical approaches, and genres specific to the American experience. Topics vary and are constructed by individual faculty. May be repeated for a maximum of six credits, but only if different topics are covered. *Preq:* ENGL 310 or consent of instructor.
- ENGL 664 Topics in British Literature I 3(3,0)**  
Selected readings in British literature to the Romantics for focused study of authors, movements, themes, critical approaches, and genres specific to the British experience. Topics vary and are constructed by individual faculty. May be repeated for a maximum of six credits, but only if different topics are covered. *Preq:* ENGL 310 or consent of instructor.
- ENGL 665 Topics in British Literature II 3(3,0)**  
Selected readings in British literature from the Romantics to the present for focused study of authors, movements, themes, critical approaches, and genres specific to the British experience. Topics vary and are constructed by individual faculty. May be repeated for a maximum of six credits, but only if different topics are covered. *Preq:* ENGL 310 or consent of instructor.
- ENGL 675 Writing for Electronic Media 3(3,0)**  
Workshop in new forms of writing and hypertextual design for interactive electronic media. May be repeated once for credit at the undergraduate level. *Preq:* ENGL 310 or consent of instructor.
- ENGL 678 Digital Literacy 3(3,0)** Examines how electronic texts differ from and resemble print texts. Includes reading, studying, and analyzing print and digital texts to determine how digital techniques change patterns of reading and how readers make sense of electronic texts. *Preq:* ENGL 310 or consent of instructor.
- ENGL 682 African American Fiction and Nonfiction 3(3,0)** Critical examination of the various forms and genres of African American prose including the novel, short fiction, autobiography, nonfiction, and oratory with some attention to emerging theories about African American culture and its impact on American cultural life in general. *Preq:* ENGL 310 or consent of instructor.
- ENGL 683 African American Poetry, Drama, and Film 3(3,0)** Studies in the various forms, themes, and genres of African American poetry, drama, and film with some attention to emerging theories about African American culture and its impact on American cultural life in general. *Preq:* ENGL 310 or consent of instructor.
- ENGL 685 Composition for Teachers 3(3,0)** Practical training in teaching composition: finding workable topics, organizing and developing observations and ideas, evaluating themes, and creative writing. *Preq:* ENGL 310 or consent of instructor.
- ENGL 688 Genre and Activity Theory 3(3,0)** Examination of the forms that texts take, of the print and digital media in which they are composed, and of the ways they circulate among experts, in the public, and around the world. *Preq:* Junior standing.
- ENGL 689 Special Topics in Writing and Publication Studies 3(3,0)** Selected readings from topics in writing and publication studies, emphasizing areas such as major theories, practices, research, and critical approaches. May be repeated for a maximum of six credits, but only if different topics are covered. *Preq:* ENGL 310 or consent of instructor.
- ENGL 690 Advanced Technical and Business Writing 3(3,0)** Advanced work in writing proposals, manuals, reports, and publishable articles. Students produce work individually and in groups. *Preq:* ENGL 314 or consent of instructor.
- ENGL (COMM) 691 Classical Rhetoric 3(3,0)** Study of the major texts in classical rhetoric. Examines the nature and functions of rhetoric in Greek and Roman societies. Traces the development of rhetoric from Protagoras through Isocrates, Plato, Aristotle, Cicero, and Quintilian and considers questions essential to understanding persuasive theory and practices. *Preq:* ENGL 310 or consent of instructor.
- ENGL (COMM) 692 Modern Rhetoric 3(3,0)** Examines the “new rhetorics” of the 20<sup>th</sup> century, which are grounded in classical rhetoric but which include findings from biology, psychology, linguistics, and anthropology, among other disciplines. Considers the theories and applications of communication. *Preq:* ENGL 310 or consent of instructor.
- ENGL 694 Writing About Science 3(3,0)** Advanced work in scientific writing and editing for peer and lay audiences. *Preq:* ENGL 310 or consent of instructor.
- ENGL 695 Technical Editing 3(3,0)** Practical experience in editing and preparing technical manuscripts for publication. General introduction to the functions of the technical editor. *Preq:* ENGL 314 or consent of instructor.
- ENGL 698 Studio Composition and Communication 3(3,0)** Preparation for students to work in the Class of 1941 Studio for Student Communication. *Preq:* Sophomore standing or consent of instructor.
- ENGL 700 Children’s Literature for Teachers 3(3,0)** Literature for preschool through junior high.
- ENGL 800 Introduction to Research 1(1,0)** Literary history and research; use of libraries and bibliographical tools; exposition of scholarship. Required of all candidates for the Master of Arts degree and Master of Education degree with a concentration in Secondary Education–English.
- ENGL 801 Topics in Composition 3(3,0)** Principal theories and practices in modern grammar, stylistics, and semantics related to teaching composition.
- ENGL 802 Topics in Literary Genres 3(3,0)** Principal literary genres.
- ENGL 803 Topics in Rhetorical Theory 3(3,0)** Major rhetorical theories, figures, and historical movements.
- ENGL (COMM) 804 Fundamentals of Health Communication 3(3,0)** Fundamentals of health communication and the Health Communication Certificate; two theoretical bases underlying this interdisciplinary program in health communication, one based on social science theory and one based on humanities, i.e. rhetorical theory; history of both theoretical bases. *Preq:* Graduate standing or consent of Health Communication Coordinator.
- ENGL 805 Topics in Medieval Literature 3(3,0)** Principal works in verse and prose from c. 1100–1500.
- ENGL 806 Medical Rhetoric and Writing 3(3,0)** Issues in medical writing and health communication, including writing for visual and electronic media; general and specific forms and documents for professional writers in health professions. *Preq:* Graduate standing or consent of Health Communication Coordinator.
- ENGL (COMM) 807 Health Communication Campaign Planning and Evaluation 3(3,0)** Application of theories, practices, and tools developed in ENGL 804 and 806 to planning, implementing, and evaluating a public health campaign that targets a particular health practice. *Preq:* ENGL 804 and 806 or consent of Health Communication Certificate Coordinator.
- ENGL 808 Topics in Renaissance and Restoration Literature 3(3,0)** Principal works in verse and prose from c. 1500–1700.
- ENGL 811 Topics in Neoclassic and Romantic Literature 3(3,0)** Principal works in verse and prose from c. 1700–1832.
- ENGL 814 Topics in Victorian and Modern British Literature 3(3,0)** Principal works in verse and prose from c. 1832 to present.
- ENGL 820 Topics in American Literature to 1865 3(3,0)** Significant authors; works in poetry and prose; literary-intellectual such as Puritanism, the Enlightenment, Romanticism, and Transcendentalism from c. 1607–1865.
- ENGL 823 Topics in American Literature Since 1865 3(3,0)** Significant authors; works in poetry and prose; literary-intellectual movements such as realism, naturalism, modernism, and postmodernism from 1865 to the present.
- ENGL 831 Special Topics 3(3,0)** Topics not covered in other courses.
- ENGL 832 Topics in Scientific, Technical, and Business Writing 3(3,0)** Seminar in areas such as professional editing and publishing, writing for government and industry, teaching technical writing, and writing for journals, magazines, and newspapers.
- ENGL 833 Rhetoric of Science 3(3,0)** Rhetorical approaches to understanding science and scientific rhetorics.
- ENGL 834 Usability Testing Methodologies in Professional Communication 3(3,0)** Research methodologies used in testing the usability of professional communication.
- ENGL 835 Topics in Literary Criticism 3(3,0)** Principal statements of literary critics from the classical era to the present.

- ENGL 836 Digital Publishing Technologies: Theories in Practice 3(3,0)** User-centered design theories applied to multimedia interfaces and on-line documents for professional communicators.
- ENGL 838 Global Professional Communication 3(3,0)** Implications of professional communication in a global economy; theories of global professional communication; research methods for studying communication in the global workplace; models for global communicative practices.
- ENGL 839 Writing Proposals and Grant Applications 3(3,0)** Practice in reading requests for proposals, analyzing rhetorical contexts and theories of proposals, and writing proposals and grant applications.
- ENGL (A A H, COMM) 840 Selected Topics 3(3,0)** Independent/directed study; tutorial work in linguistics or American, British, or European literature not offered in other courses. *Preq:* Consent of director of MA in English program.
- ENGL 850 Research and Studies in Scientific, Business, and Technical Writing 3(3,0)** Theories of professional communication and methods of inquiry; readings and research into the ways that the writing of professionals creates new knowledge and affects the daily life of others; research methods emphasize humanistic inquiry.
- ENGL 851 Seminar in Professional Writing 3(3,0)** Advanced seminar in the principles and practice of writing and editing documents for government, industry, and the sciences; students produce projects suitable for publication, typically chosen from document design, scientific or technical journalism, and public policy writing.
- ENGL 852 Rhetoric and Professional Communication 3(3,0)** Theories of communication that have existed since classical times and that inform effective decision-making strategies in professional communication.
- ENGL 853 Visual Communications 3(3,0)** Understanding the language of images used in textual and extratextual communication; theories of perception, methods of visual persuasion, gender analysis, and cognitive and aesthetic philosophies of visual rhetoric.
- ENGL 854 Teaching Professional Writing 3(3,0)** Teaching professional writing and examining theories and practices of written, graphic, and oral communication. Students prepare course descriptions, rationales, and syllabi for teaching various forms of business, scientific, and technical writing.
- ENGL 856 Theories and Practices of Workplace Communication 3(3,1)** Workplace cultures and their theoretical and practical applications for professional communication.
- ENGL 860 The Rhetoric of Web Publishing 3(3,0)** Seminar in the theory and practice of communicating on the World Wide Web. *Preq:* ENGL 853.
- ENGL 871 Principles of Writing Assessment 3(3,0)** Focuses on a wide range of issues in writing assessment including an introduction to assessment theory, classroom issues such as grading and response, programmatic issues such as student placement and writing program assessment, and political and social contexts surrounding the highly-charged field of writing assessment.
- ENGL 872 Print and Digital Portfolios 3(3,0)** Focuses on theories, development, construction, and assessment of print and digital portfolios in educational contexts including the classroom, school reform, and other large-scale efforts, programmatic assessments, and personal/professional development. Special attention is given to ways the medium shapes reflection, presentation, connections, and artifacts within the portfolio.
- ENGL 873 Assessment of Digital Texts 3(3,0)** Writing assessment of texts integrating written, visual, audio, and digital media. Also considers implications of machine-read, -scored, and -generated texts on writing assessment.
- ENGL 874 Program Assessment 3(3,0)** Addresses practical and theoretical issues surrounding the administration and assessment of writing programs in secondary and post-secondary education. Special emphasis is given to the placement of college students into first-year writing courses and Writing Across the Curriculum program assessment.
- ENGL 875 Research Methods in Writing Assessment 3(3,0)** Presents a variety of qualitative and quantitative methods with direct applications to research in writing and program assessment. Includes constructing and implementing a multimodal research project on an assessment area.
- ENGL 876 Special Topics in Writing Assessment 3(3,0)** Selected readings from topics in writing assessment for focused study of relevant theories, research, and best practices. May be repeated for a maximum of six credits, but only if different topics are covered.
- ENGL 885 Composition Theory 3(3,0)** Teaching college-level courses, stressing contemporary composition theory, research, and practice. Required of all MA in English and MAPC Teaching Assistants.
- ENGL 886 Composition Practicum 1(1,0)** Problems in teaching Composition I and Composition II, with focus on translating theoretical concepts into creating assignments, designing curriculum, and grading. Two-semester sequence to be taken fall and spring of teaching assistantship year. Does not count toward degree. *Preq:* Graduate teaching assistantship and ENGL 885 or equivalent.
- ENGL 887 Writing Center Theory and Practice 1(1,0)** Prepares graduate students in English and Professional Communication Programs to work with students in the Writing Center. *Preq:* Graduate standing or consent of instructor.
- ENGL 891 Master's Thesis Research 1-12**
- ENGL 892 Master's Project 1-3** Required for nonthesis option in MA in Professional Communication. Requires writing a document for the professional world and keeping a log or journal as a record of the project. Students present projects to advisor. A maximum of three credits may be counted toward the degree.
- ENGL 899 Doctoral Dissertation Research 1-18**
- ENTOMOLOGY**
- ENT (BIOSC) 600 Insect Morphology 4(3,3)** Study of insect structure in relation to function and of the variation of form in insects. Offered fall semester of even-numbered years only. *Preq:* ENT 301.
- ENT 601 Insect Pests of Ornamental Plants and Shade Trees 3(2,3)** Recognition, biology, damage, and control of insect pests of woody and other ornamental plants and shade trees. Offered fall semester only. *Preq:* ENT 301.
- ENT 604 Urban Entomology 3(2,3)** Study of pests common to the urban environment with emphasis on biology, damage, control, and identification of household, structural, stored products, and food pests. Students learn both theoretical and practical aspects of urban pest management and the pest-control industry. Offered fall semester of even-numbered years only. *Preq:* ENT 301.
- ENT (PL PA) 606 Diseases and Insects of Turf-grasses 2(2,0)** See PL PA 606.
- ENT 607 Applied Agricultural Entomology 4(3,3)** Topics include recognition, biology, damage, and control of economically important insects and mites found on major Southeastern field, fruit, nut, and vegetable crops. Principles and practices of crop protection including pesticide application, economic basis for decision making, and development of scouting programs are introduced. Offered fall semester of even-numbered years only. *Preq:* ENT 301 or equivalent.
- ENT (PL PA) 608 Diseases and Insects of Turf-grasses Laboratory 1(0,3)** See PL PA 608.
- ENT (BIOSC) 615 Insect Taxonomy 3(1,6)** Identification of the principal families of the major orders of adult insects. Laboratory work consists of intensive practice of such identification; lecture material deals with theoretical discussion of taxonomic features observed in the laboratory. Offered spring semester of odd-numbered years only. *Preq:* ENT (BIOSC) 400 or consent of instructor.
- ENT (ENTOX) 630 Toxicology 3(3,0)** See ENTOX 630.
- ENT (BIOSC) 636 Insect Behavior 3(2,3)** Fundamentals of insect behavior in an evolutionary and ecological perspective. Laboratory emphasizes generation and testing of hypotheses and observation, description, and quantification of insect behavior. Offered fall semester of odd-numbered years only. *Preq:* ENT 301 or consent of instructor.
- ENT (BIOSC) 655 Medical and Veterinary Entomology 3(2,3)** Insects and their arthropod relatives which are of economic importance in their effect on man and animals. Offered fall semester of odd-numbered years only. *Preq:* ENT 301 or consent of instructor.
- ENT (BIOSC, W F B) 669 Aquatic Insects 3(1,6)** Identification, life history, habitats, and interrelationships of aquatic insects; techniques of qualitative field collecting; important literature and research workers. Offered spring semester of odd-numbered years only. *Preq:* ENT 301 or consent of instructor.
- ENT (GEN) 695 Insect Biotechnology 3(3,0)** Considers many unique features exhibited by insects and describes applications of biotechnology to enhance useful products from insects and to affect the control of destructive insects. *Preq:* ENT 301, GEN 302.

**ENT 700 Entomology for Teachers 3(2,2)**

General entomology course for secondary school science teachers with emphasis on collecting and identifying the more common insects; insect morphology, physiology, metamorphosis, and methods available for control of destructive species. Not open to Entomology majors pursuing the MS or PhD degrees. Offered spring semester only. *Preq:* Consent of instructor.

**ENT 808 Taxonomy of Immature Insects 3(1,6)**

Identification of immature insects emphasizing the Holometabola. Identified collection is required. Offered fall semester of odd-numbered years only.

**ENT 809 Seminar in Entomology 1(1,0)**

Current literature and research in entomology. Class attendance is mandatory. May be repeated for credit. To be taken Pass/Fail only.

**ENT 810 Selected Topics 1-4(1-4,0)**

Current areas of entomological research and pest management. Course may be repeated for credit. *Preq:* Consent of instructor.

**ENT 843 Insect Pathology 3(2,3)**

Insect diseases, their etiology, symptomatology, and epizootiology; infectious diseases caused by viruses, bacteria, fungi, and protozoa; ecological significance of these pathogens; their practical applications in medicine and agriculture. Offered fall semester of odd-numbered years only. *Preq:* ENT 301 or consent of the instructor.

**ENT 853 Applied Systematics 3(2,3)**

Application of evolutionary principles to resolution of contemporary zoological problems; legal issues and technical skills for efficient operation of international zoological information storage and retrieval system. Offered spring semester of even-numbered years only. *Preq:* Taxonomic course in entomology or zoology or consent of instructor.

**ENT 860 Insect Pest Management 3(3,0)**

Application of ecological principles to the management or control of insect populations; major factors influencing insect population fluctuations; integrated systems including biological, cultural, physical, chemical, and other techniques forming a unified multifaceted approach based on applied ecology. Offered spring semester of even-numbered years only.

**ENT 863 Special Problems in Entomology 1-3(0,3-9)**

Entomological research not related to thesis. *Preq:* Consent of instructor.

**ENT 870 Insect Physiology and Molecular Biology 4(3,3)**

Advanced instruction on the structure and function of insect physiological processes at the molecular, cellular, and tissue levels; physiological and molecular mechanisms underlying the various internal systems of insects. The laboratory emphasizes hands-on experimentation and the scientific writing technique to report experimental findings. *Preq:* BIOL 111, CH 223, ENT 301, 495, or consent of instructor.

**ENT 891 Master's Thesis Research 1-12****ENT 991 Doctoral Dissertation Research 1-12****ENVIRONMENTAL AND NATURAL RESOURCES****E N R (BIOSC) 613 Restoration Ecology 3(3,0)**

Applies ecological principles to the restoration of disturbed terrestrial, wetland, and aquatic ecosystems. Includes the restoration of soils and waterways, of flora and fauna, and of natural ecological processes such as plant succession and nutrient cycling. *Preq:* Introductory course in ecology or conservation biology, consent of instructor.

**E N R (FOR) 616 Forest Policy and Administration 2(2,0)**

See FOR 616.

**E N R (FOR) 634 Geographic Information Systems for Landscape Planning 3(2,3)**

See FOR 634.

**E N R 650 Conservation Issues 3(3,0)**

Interactive study and discussion of issues related to the conservation of natural resources, emphasizing current issues in the conservation of biodiversity, identification of conflicting issues between consumptive and nonconsumptive resource management, and development of viable solutions for conservation of resources. *Preq:* W F B (BIOSC) 313 or consent of instructor.

**ENVIRONMENTAL DESIGN AND PLANNING****EDP 801 Advanced Theory in Environmental Design and Planning 3(3,0)**

Critical assessment of history and theory in the fields of design, planning, and construction. Topics include scientific knowledge, interpretive and critical inquiry, theories of urban form and human settlement. *Preq:* Master's-level course in theory related to design, planning, and construction.

**EDP 805 Readings in Architecture 3(3,0)**

Historical and contemporary readings in architecture designed to provide exposure and depth of coverage for important works in the field. May be repeated for a maximum of six credits. *Preq:* EDP 801 and consent of instructor.

**EDP 806 Readings in Landscape Architecture 3(3,0)**

Historical and contemporary readings in landscape architecture designed to provide exposure and depth of coverage for important works in the field. May be repeated for a maximum of six credits. *Preq:* EDP 801 and consent of instructor.

**EDP 807 Readings in City and Regional Planning 3(3,0)**

Historical and contemporary readings in city and regional planning designed to provide exposure and depth of coverage for important works in the field. May be repeated for a maximum of six credits. *Preq:* EDP 801 and consent of instructor.

**EDP 809 Research Workshop in Environmental Design and Planning 3-6(1-2,6-12)**

Students participate in an interdisciplinary, semester-long project to develop and apply a systematic approach to a real-world design and planning issue. A project report and presentation are prepared.

**EDP 810 Contemporary Issues in Environmental Design and Planning 3(3,0)**

Interdisciplinary seminar providing an overview of theory and methods related to environmental design and planning. With that background, focus is on important contemporary and emerging issues affecting the built environment. *Preq:* PO ST (C R P) 870 or consent of instructor.

**EDP 812 Seminar in Environmental Design and Planning 1(1,0)**

Weekly colloquium to provide a forum for faculty, students, and invited speakers to address important issues of the day. May be repeated for a maximum of four credits.

**EDP 815 Research Design in Environmental Design and Planning 3(3,0)**

Philosophy and method of scientific research. Within that context, students prepare a preliminary proposal for their dissertation research. *Preq:* EDP 801, EX ST 801, or equivalent.

**EDP 820 Instructional Design Delivery 1(1,0)**

Presents information on teaching technique including discussions of cognitive learning, motivation, course organization, interactive lecturing, and experiential learning.

**ENVIRONMENTAL ENGINEERING AND SCIENCE****EE&S 601 Environmental Engineering 3(3,0)**

Introduction to the field of environmental engineering. Topics include environmental phenomena, impact of pollutants in the aquatic environment, solid-waste management, air pollution control, radiological health, and simple water and wastewater treatment systems. *Preq:* Junior standing in engineering or consent of instructor. *Coreq:* C E 341, C H E 311, M E 308 or consent of instructor.

**EE&S 602 Water and Waste Water Treatment Systems 3(3,0)**

Study of fundamental principles, rational design considerations, and operational procedures of the unit operations and processes employed in water and waste water treatment. Both physiochemical and biological treatment techniques are discussed. Introduction to the integration of unit operations and processes into water and waste treatment systems. *Preq:* EE&S 401; and C E 341, C H E 311, M E 308, or equivalent; or consent of instructor.

**EE&S 610 Environmental Radiation Protection 3(3,0)**

Fundamental principles of radiological health and radiation safety. Topics include radiation fundamentals, basic concepts of environmental radiation protection, internal and external dosimetry, environmental dose calculations, and radiation protection standards. Offered fall semester only. *Preq:* Consent of instructor.

**EE&S 611 Ionizing Radiation Detection and Measurement 3(2,3)**

Laboratory exercises in ionizing radiation detection and measurements. Topics include nuclear electronics; counting statistics; radiation interactions; basic gas, scintillation, and semiconductor detectors; gamma-ray spectroscopy; health physics survey instrumentation; and thermoluminescent dosimetry. Offered spring semester only. *Preq:* EE&S 410 or consent of instructor.

- EE&S 630 Air Pollution Engineering 3(3,0)** Introductory course in air pollution and its control. Topics include air pollutants and effects, sources, dispersion models, engineering controls, and air-quality legislation. *Preq:* Senior standing in engineering or physical sciences.
- EE&S (B E, FOR) 651 Newman Seminar and Lecture Series in Natural Resources Engineering 1(0,2)** See B E 651.
- EE&S 680 Environmental Risk Assessment 3(3,0)** Quantitative estimation of the human health risk posed by the release of a contaminant to the environment. Topics include methods for analyzing emission rate, environmental transport, exposure, and health effects; methods of uncertainty analysis; and the role of risk assessment in environmental regulation and environmental decision making. *Preq:* EE&S 401 or consent of instructor.
- EE&S (B E) 684 Municipal Solid Waste Management 3(3,0)** Introduction to the problems, regulations, collection, handling, recycling, and disposal of municipal solid wastes in the urban and rural sectors. Emphasis is on integrated waste-management systems with resource recovery, composting, incineration, landfill disposals, and their costs. *Preq:* Senior standing in engineering or science or consent of instructor.
- EE&S 685 Hazardous Waste Management 3(3,0)** Introduction to problems, regulations, treatment, and ultimate disposal of hazardous and toxic materials. Spill cleanup, groundwater transport, land disposal, incineration, and treatment technologies are discussed. Offered spring semester only. *Preq:* EN SP 200 or EE&S 401 or consent of instructor; two semesters of general chemistry.
- EE&S 686 Pollution Prevention and Industrial Ecology 3(3,0)** Topics include pollution prevention technology, the role of pollution prevention within a corporation, source reduction and recycling, pollution prevention assessments, treatment to reduce disposal, life-cycle assessment, design for environment, industrial ecology. Emphasis is on case studies. *Preq:* Senior standing in College of Engineering and Science.
- EE&S 690 Special Projects 1-3(1-3,0)** Studies or laboratory investigations on special topics in the environmental engineering and science field. Arranged on a project basis with a maximum of individual student effort and a minimum of staff guidance. May be repeated for a maximum of three credits. *Preq:* Consent of instructor.
- EE&S 701 Special Problems 1-6(1-6,0)** Environmental engineering problems selected to meet the interests and experience of students and instructor. Formal report is required. Restricted to MEng students. To be taken Pass/Fail only.
- EE&S 802 Environmental Engineering Principles 3(3,0)** Fundamental principles required for simulation and modeling of environmental engineering phenomena; mass transfer, reactor kinetics, simulation techniques, and applications to various natural and engineered systems. Offered fall semester only.
- EE&S 803 Physicochemical Operations in Water and Wastewater Treatment Systems 3(3,0)** Principles of physicochemical operations used in water and wastewater treatment including sedimentation, filtration, mixing, gas transfer, adsorption, ion exchange, coagulation, precipitation, disinfection, and oxidation. Offered spring semester only. *Preq:* EE&S 802, 843.
- EE&S 804 Biochemical Operations in Wastewater Treatment Systems 3(3,0)** Principles of biochemical operations used in wastewater treatment; modeling of ideal biochemical reactors and design criteria for aerated lagoons, activated sludge, trickling filters, rotating biological contactors, nitrification, denitrification, and digestion. Offered spring semester only. *Preq:* EE&S 802, 851.
- EE&S 805 Laboratory in Water and Wastewater Treatment Operations 3(0,6)** Laboratory exercises in selected water and wastewater treatment operations including sedimentation, filtration, adsorption, coagulation, softening, aeration, activated sludge, aerobic digestion, and anaerobic digestion. Offered spring semester only. *Coreq:* EE&S 803 or 804.
- EE&S 806 Process and Facility Design for Environmental Control Systems 2-4(2-4,0)** Integration of unit operations into complex systems for treatment of industrial/domestic water and wastewater, contaminated groundwater or air, landfill leachate, and toxic liquid wastes. Student teams design an integrated system for either water/wastewater or a hazardous/toxic waste. Offered fall semester only. *Preq:* EE&S 803, 804.
- EE&S (GEOL) 808 Groundwater Modeling 3(3,0)** See GEOL 808.
- EE&S (GEOL) 809 Subsurface Remediation Modeling 3(3,0)** See GEOL 809.
- EE&S (GEOL) 810 Analytical Methods for Hydrogeology 3(3,0)** See GEOL 810.
- EE&S 812 Environmental Nuclear Engineering 3(3,0)** Environmental aspects of nuclear technology emphasizing nuclear reactors and the nuclear fuel cycle; environmental transport of radioactive materials; radioactive effluents from nuclear power plants; nuclear power plant safety; environmental aspects of fuel cycle activities; waste management. Offered fall semester only. *Preq:* EE&S 610, consent of instructor.
- EE&S 813 Environmental Radiation Protection Laboratory 1(0,3)** Continuation of EE&S 611; advanced experiments in radiation detection, radiation protection, health physics, and environmental monitoring. Offered fall semester only. *Preq:* EE&S 611 and consent of instructor.
- EE&S (CH E) 814 Applied Numerical Methods in Process Simulation 3(3,0)** See CH E 814.
- EE&S 815 Actinide Chemistry 3(3,0)** Chemical and physical aspects of actinide metals and compounds (including properties, structure and bonding, reactions, kinetics, thermodynamics), coordination and solution chemistry, behavior and speciation in the environment, separation and purification, chemistry of the nuclear fuel cycle and waste treatment, and related topics; fundamental concepts, history, and recent developments. *Preq:* CH 402, MTHSC 208, PHYS 221, or consent of instructor.
- EE&S 832 Air Pollution Meteorology 3(3,0)** Applications of meteorology to air pollution; micrometeorology; plume rise modeling; atmospheric diffusion; deposition and washout of pollutants; air chemistry; applications of diffusion modeling to air quality planning. *Preq:* Consent of instructor.
- EE&S 833 Air Pollution Control Systems 3(3,0)** Principles and design of air pollution control equipment including mechanical collectors, electrostatic precipitators, baghouse filters, wet scrubbers, adsorbers, and incinerators. Offered spring semester only. *Preq:* EE&S 430 or consent of instructor.
- EE&S 834 Particles in the Atmosphere 3(3,0)** Chemical and physical behavior of atmospheric particles and their interaction with other particles, gases and light; generation, measurement methods, and control strategies of atmospheric particles. *Preq:* EE&S 630, MTHSC 208, or consent of instructor.
- EE&S 837 Biodegradation and Bioremediation 3(3,0)** Basic principles of biodegradation for major classes of organic contaminants including halogenated aliphatics and aromatics, fuel hydrocarbons, pesticides, and nitrated energetic compounds; biotransformations of metals; biodegradation principles applied to the development of bioremediation technologies including intrinsic, in situ, and on-site engineered approaches. *Preq:* EE&S 851.
- EE&S 843 Environmental Engineering Chemistry I 3(3,0)** Principles of chemical kinetics and thermodynamics applied to fundamental understanding of aqueous environmental samples including natural waters, wastewaters, and treated waters; factors controlling chemical concentrations, acid-base equilibria, solubility equilibria, complex formation, electrochemistry, adsorption phenomena. Offered fall semester only. *Preq:* CH 102 or equivalent.
- EE&S 844 Environmental Engineering Chemistry Laboratory I 3(2,3)** Laboratory experience in basic analytical methods used in water quality studies; experimental design, sampling, wet-chemical analytical techniques, data collection and analysis, data interpretation, and data quality techniques. Offered fall semester only. *Preq:* Two semesters of general chemistry.
- EE&S 845 Environmental Engineering Chemistry II 3(3,0)** Application of parameters that describe the equilibrium distribution and exchange rates for environmentally significant organic compounds to the modeling of processes in engineered and natural systems, including environmental parameter estimation techniques, structure-activity relationships, and integration of environmental processes to model contaminant distribution and residence time in environmental systems. Offered spring semester only. *Preq:* Two semesters of general chemistry, EE&S 843 or equivalent.
- EE&S 847 Advanced Environmental Chemistry 3(3,0)** Advanced principles and methods in environmental engineering chemistry with applications to both natural and treatment systems; current investigative and study techniques; nature, fluxes, and controlling processes of chemical species and radionuclides in environmental systems. *Preq:* EE&S 843 or equivalent.

**EE&S 849 Environmental Engineering Chemistry Laboratory II 2(0,6)** Theory and applications of instrumental methods of analysis as applied to measurements for environmental control; spectroscopy and spectrophotometric techniques; electrochemical analyses; chromatographic methods of analysis; light scattering and electrophoretic measurements. Offered fall semester only.

**EE&S 850 Stream and Estuarine Analysis 3(3,0)** Physical, chemical, and biological processes and relationships which exist in streams and estuaries; estuarine environment; free-flowing streams; mechanisms describing transport of conservative and nonconservative materials through estuarine systems; the estuary as a resource and techniques for its management. Offered fall semester only.

**EE&S 851 Biological Principles of Environmental Engineering 3(3,0)** Basic principles of biology and biochemistry as applied to problems of environmental control and wastewater treatment; kinetic and energetic aspects. Offered fall semester only.

**EE&S 852 Subsurface and Wetland Hydraulics 3(3,0)** Hydraulics of subsurface water including hydraulic head and gradient concepts, Darcy's Law, saturated/unsaturated flow, flow in aquifers and aquitards, flow to wells, and interactions with surface water in wetlands including discharge and development of seepage faces. Mathematics is at the level of elementary ordinary and partial differential equations. *Preq:* Differential equations, fluid mechanics or EE&S 802 or consent of instructor.

**EE&S 855 Surface and Subsurface Transport 3(3,0)** Quantitative analysis of reactive transport and biodegradation in ground water and surface water; applications of the advection-dispersion equation with reaction terms including classical chemical reactions, radioactive decay, and reactions mediated by microbes. *Preq:* C E 340 and MTHSC 208 or equivalent.

**EE&S 856 Pollution of the Aquatic Environment 3(3,0)** Effects of domestic and industrial water pollution on the physical, chemical, and biological characteristics of natural waters; associated environmental determinants of human disease, toxicology, and epidemiology of chronic disease. Offered fall semester only.

**EE&S 861 Environmental Engineering and Science Seminar 1(1,0)** Current advances and research developments in various areas of environmental engineering and science. Off-campus speakers, students, and faculty participate. To be taken Pass/Fail only.

**EE&S 880 Environmental Risk Assessment 3(3,0)** Methodology of quantitative risk assessment including identification and quantification of the source term, calculation of environmental transport, and estimation of health effects. Applications involve various classes of contaminants in atmospheric and aquatic environmental pathways. Offered spring semester only. *Preq:* MTHSC 208, graduate standing in engineering or science.

**EE&S 881 Special Problems 1-4** Problems selected to meet interests and experiences of student and instructor.

**EE&S 883 Selected Topics in Environmental Engineering 1-4(1-4,0)** Topics in environmental engineering not covered in other courses. Topics vary to keep pace with current developments. May be taken concurrently with EE&S 884, which (if offered) would be a different topic.

**EE&S 884 Selected Topics in Environmental Engineering 1-4(1-4,0)** Topics in environmental engineering not covered in other courses. Topics vary to keep pace with current developments. May be taken concurrently with EE&S 883, which (if offered) would be a different topic.

**EE&S 891 Master's Thesis Research 1-12**

**EE&S 961 Environmental Engineering and Science Doctoral Student Seminar 1(1,0)** Current advances and research developments in various areas of environmental engineering and science. Doctoral students are required to enroll each semester that the course is offered and present one seminar per year. To be taken Pass/Fail only.

**EE&S 991 Doctoral Dissertation Research 1-12**

## ENVIRONMENTAL SCIENCE AND POLICY

**EN SP 672 Environmental Planning and Control 2(2,0)** Application of planning and control to effective environmental quality improvement. Water supply and treatment, wastewater treatment and disposal, solid waste disposal, air pollution abatement, and land use and zoning are considered from the standpoint of control. Not intended for graduate students in engineering. *Preq:* Consent of instructor.

## ENVIRONMENTAL TOXICOLOGY

**ENTOX 600 Wildlife Toxicology 3(3,0)** Assessment of impacts of toxic substances on reproduction, health, and well-being of wildlife species; acute and chronic effects of agricultural chemicals, pesticides, hazardous waste, industrial waste, and oil releases are discussed. *Preq:* BIOCH 305 or organic chemistry, one year of general biology, W F B 350 or consent of instructor.

**ENTOX 621 Chemical Sources and Fate in Environmental Systems 3(3,0)** Chemical cycles in the environment are discussed on global and microcosm scales. The dependence of fate processes on physical and chemical properties and environmental conditions is examined. Breakdown, movement, and transport of selected toxicants are addressed to illustrate the mechanisms that govern chemical fate. *Preq:* Organic and analytical chemistry or consent of instructor.

**ENTOX (ENT) 630 Toxicology 3(3,0)** Basic principles of toxicology including quantitation of toxicity, toxicokinetics, biochemical action of poisons, and environmental toxicology are studied. Acute and chronic effects of various classes of poisons are discussed (e.g., pesticides, drugs, metals, and industrial pollutants) in relation to typical routes of exposure and regulatory testing methods. Offered fall semester of odd-numbered years only. *Preq:* Organic chemistry, one year of general biology, or consent of instructor.

**ENTOX 637 Ecotoxicology 3(3,0)** Study of the effects of stressors on the ecosystem. Explores the integrative relationships that comprise the field of ecotoxicology in a hierarchical format that focuses on the various levels of ecological organization. *Preq:* ENTOX 430 or consent of instructor.

**ENTOX 801 Advanced Wildlife Toxicology 3(1,6)** Interactions between chemical contaminants and wildlife species focusing on effects at the organismal, species, trophic, community, and ecosystem level. Field and laboratory techniques that professional wildlife toxicologists use are emphasized. *Preq:* ENTOX 400, 430.

**ENTOX (BIOSC) 811 Immunotoxicology 3(3,0)** Study of how environmental contaminants, drugs, and natural biotoxins affect the immune system of man and animals; cellular and molecular mechanisms of action by immunotoxic agents. *Preq:* AVS 825, ENTOX 630, consent of instructor.

**ENTOX 822 Analytical Toxicology Laboratory 3(1,6)** Laboratory instrumentation, procedures, and experimental methods used for identification and quantitation of toxic substances and their transformation products in environmental and biological samples; application of these procedures in the isolation, detection, and quantitation of toxicants in authentic samples. *Preq:* Organic and analytical chemistry or consent of instructor; instrumental analysis recommended.

**ENTOX (BIOSC) 830 Mechanistic Toxicology 3(3,0)** Detailed biochemical toxicology: control, regulation, and activity of metabolic enzymes; molecular and cellular mechanisms of toxic action; proposed mechanisms for initiation and development of cancer; mode of action and kinetics of cholinesterase inhibitors; structure/activity relationships of ion channel blockers; biochemical and molecular biomarkers. *Preq:* ENTOX (BIOSC, ENT) 430.

**ENTOX (BIOSC) 831 Biomarkers in Toxicology 3(1,6)** Methodology used in biomarker identification and evaluation of the effects of toxic substances on living systems using biomarkers in sentinel organisms and surrogate biomarkers. *Preq:* Organic chemistry and biochemistry with laboratory; ENTOX 400 or (BIOSC, ENT) 430; or consent of instructor.

**ENTOX 841 Procedures and Techniques in Ecological Risk Assessment 2(1,3)** Evaluation and application of the procedures and techniques used in ecological risk assessments, including laboratory and field methods, to determine, measure, and evaluate the risks to aquatic, terrestrial, and avian species; impacts to biota within, and resulting from, chemical waste disposal facilities and hazardous waste sites. *Preq:* CH 223, 224, 313; EX ST 804 or 805; ENTOX (BIOSC, ENT) 630; or consent of instructor.

**ENTOX 852 Ecological Models 3(2,3)** Systems analysis applied to ecology; construction of models which predict ecological consequences of stresses to the environment; frequency response analysis, energy models, information flow, and transfer functions for population interactions. *Preq:* Course in ecology and in computer programming or consent of instructor.