BIOENGINEERING

BIO E 612 Orthopaedic Engineering and Pathology 3(3,0) Interdisciplinary study of clinical orthopaedic cases (bone growth, bone remodeling, osteoarthritis, implant fixation and joint replacements); biomechanical, biomaterials, tribology and clinical diagnosis of failed implants (total joint replacements, fracture fixation and spinal instrumentation); basic concepts of orthopaedic pathology for engineers. Preq: BIO E 302, 320, BIOSC 315.

BIO E (C M E) 615 Research Principles and Concepts 1(1,0) Introduces seniors and graduate students to principles and practices of scientific research. Topics include developing scientific concepts, developing projects, pursuing research, collaborating in multidisciplinary teams, patenting and publishing technical and scientific information and reviewing professional and ethical standards of performance. To be taken Pass/Fail only.

BIO E 623 Cardiovascular Engineering and Pathology 3(3,0) Medical and bioengineering aspects of artificial cardiovascular and vascular devices; physiology and pathological aspects of patients with need for such devices; diagnostic techniques and surgical management of diseases and pathology; design aspects of current devices and selection; state of the art in experiments and human clinical trials. Preq: BIO E 302, 320, 370, BIOSC 315.

BIO E 640 Biotechnology for Bioengineers 3(3,0) Explores the principles necessary to use microorganisms, tissue culture and enzymes in bioengineering applications, including molecular techniques, fermentation, process scale-up, purification processes and FDA regulations. Emphasizes production of biopharmaceuticals derived from recombiant systems, including uses in medical systems. Preq: BIOCH 305 or consent of instructor.

BIO E 671 Biomedical Imaging in Biophotonics 3(3,0) Biophotonics is an interdisciplinary subject of applying photonics to study biological samples from individual cells to the entire body. Course introduces fundamental and frontier topics in optical imaging aspects of biophotonics to senior-level undergraduates and graduate students to gain the ability to solve bioimaging-related biomedical problems. Preq: MTHSC 208; PHYS 221; E C E 320 or consent of instructor.

BIO E 682 Biomaterial Implantology 3(3,0) Provides training in the planning and conduct of experimental surgery, including laws and regulations; institutional requirements; selection of animal models; ethical considerations of animal research; preparation of animals for surgery; general and special surgical techniques; aseptic surgical techniques; and basic and applied instrumentation. Preq: Junior standing in Bioengineering.

BIO E 800 Seminar in Bioengineering Research 1(2,0) Original research in bioengineering; weekly one-hour seminar associated with weekly recitation covering seminar preparation, presentation, professional writing, bioengineering ethics and related topics. To be taken Pass/Fail only.

BIO E 801 Biomaterials 3(3,0) Structure and properties of the main classes of materials used in artificial organs and surgical implants; metals, ceramics, polymers, composites and materials of biological origin; mechanical properties, corrosion and design. Preq: Consent of instructor.

BIO E 802 Compatibility of Biomaterials 3(1,6) Determining compatibility of biomaterials with the physiological environment; optical microscopy, microradiography and ultraviolet fluorescence; normal histology of tissues, basic pathological reactions and tissue reactions to materials.

BIO E 803 Polymeric Biomaterials 3(3,0) Interplay of physicochemical properties of polymeric materials and the design of biomedical devices and their in vitro and in vivo performance; critical manufacturing aspects of selected augmentation and prosthetic devices for soft and hard tissues; analysis of case studies and reports on recent research findings. Preq: Consent of instructor.

BIO E 807 Nanotechnology and Biomaterials 3(3,0) The emerging field of nanotechnology and its relation to solving bioengineering and health-related problems is treated. Also considers the promise of nanotechnology in the creation and utilization of materials and devices at the level of atoms and molecules. New scientific approaches, research tools, clinical tools, and devices are presented.

BIO E 820 Structural Biomechanics 3(3,0) Mechanical functions of the human body treated as an engineering structure and the devices used to assist and supplement these functions. Movement of the musculoskeletal system; locomotion; gait; prehension; lifting; function of artificial limbs, orthopedic prostheses and braces; effect of vibration and impact on the body; mathematical and other models of the body. Preq: Consent of instructor.

BIO E 824 Cellular and Molecular Analysis in Tissue Engineering 3(3,3) Discusses the molecular basis for cell regulation by extracellular stimuli including growth factors, matrix and force. Also describes the theoretical and laboratory instruction in research methods to analyze cellular signaling and functional response in the design and evaluation of tissue engineering constructs. Preq: BIO E 849 or consent of instructor.

BIO E 846 Biomedical Basis for Engineered Replacement 3(3,0) Form and function of human organs, major systems and examples of engineering repair and replacement methods are presented in the context of pathological or traumatic organ malfunction. Core course for all Bioengineering graduate students, taken preferably during their first fall semester.

BIO E 847 Transport Processes in Bioengineering 4(3,0) Mathematical modeling of blood flow through capillaries and solute transfer from capillaries to tissues by diffusion and convection, pharmacokinetic analysis of drug adsorption, transport and elimination routes in body, and analysis of the design and performance of extracorporeal devices for organ replacement, including hemodialysis, blood oxygenation and immobilized enzyme reactors. Preq: MTHSC 208 or equivalent.

BIO E 848 Cellular Interactions with Biomaterials 4(2,2) Cell biological concepts and issues relevant to cell-biomaterial interactions; methods for studying cell structure and function including basic cell culture techniques and in vitro bioocompatibility analyses; biomaterial physico-chemical properties which influence cellular interactions; interactions between implant materials and host tissues at the cellular and molecular level; overview of tissue engineering.

BIO E 849 Tissue Engineering 3(3,0) Principles and practices of bioartificial organ and tissue development; cellular/material interaction and translation of information from two-dimensional surfaces to three-dimensional scaffolds; selection and processing of biomaterials to form tissue scaffolds; analysis of tissue engineered devices, standards and regulations. Preq: BIO E 801, 846.

BIO E 850 Selected Topics in Biomedical Engineering 1-4(0,4,120) Advanced topics in bioengineering intended to develop in-depth areas of particular student interest. Credit may be earned for more than one semester. Preq: Consent of instructor.

BIO E 870 Bioinstrumentation 3(2,2) Concepts and techniques of instrumentation in bioengineering emphasizing effects of instrumentation on the biological system under investigation; transducers and couplers; data conversion; conditioning and transmission; experimental problems in acute and chronic procedures with static and dynamic subjects.

BIO E 882 Biomaterials Implantology 4(2,6) All phases of experimental surgery including selection of animal models, preparation of animals for surgery, general and special surgical techniques, and basic and applied instrumentation. Preq: BIOSC 459 or equivalent.

BIO E 890 Internship 1-5 Observation and assignment in a medical college, dental college, hospital, veterinary clinic, dental clinic, health service, or industrial department. Preq: Consent of department chair.

BIO E 891 Master's Thesis Research 1-12 BIO E 892 Nonthesis Independent Study in Bioengineering 1-6 Independent study in bioengineering for work necessary to complete requirements for thesis. Preq: Consent of instructor.

BIO E 991 Doctoral Dissertation Research 1-12

BIOLICAL SCIENCES

BIOSC (ENT) 600 Insect Morphology 4(3,3) See ENT 600.

BIOSC 601 Plant Physiology 3(3,0) Relations and processes that pertain to maintenance, growth and reproduction of plants, including absorption of matter and energy, water relations of the plant, utilization of reserve products and liberation of energy. Preq: BIOL 104/106 or 111 or BIOSC 205 and CH 102. Coreq: BIOSC 602.

BIOSC 602 Plant Physiology Laboratory 1(0,3) Laboratory exercises and experiments designed to indicate the relations and processes that pertain to maintenance, growth and reproduction of plants, including absorption of matter and energy, water relations of the plant, utilization of reserve products and liberation of energy. Coreq: BIOSC 601.

BIOSC (GEN) 605 Molecular Genetics of Eukaryotes 3(3,0) See GEN 605.

BIOSC 606 Introductory Plant Taxonomy 3(3,0) Introduction to the basic principles and concepts of plant systematics with emphasis on the plants of South Carolina. Preq: BIOL 104/106 or 111 or BIOSC 205. Coreq: BIOSC 607.
BIOSC 660 Systems Physiology Laboratory 2(1,2) Modern and classical experimental methods are used to demonstrate fundamental physiological principles discussed in BIOSC 659. Students are introduced to computer-aided data acquisition and computer simulations of physiological function. Preq or Coreq: BIOSC 659.

BIOSC 661 Cell Biology 3(3,0) In-depth analysis of how and where intracellular and extracellular molecules control general and specific cellular functions such as gene expression, secretion, motility, signaling, cell cycle control and differentiation. Taught and graded at a level where students are expected to infer from and integrate cellular events. Preq: BIOL 301 or consent of instructor.

BIOSC 662 Cell Biology Laboratory 2(1,2) Accompanies BIOSC 661; focuses on molecular and microscopic analysis of eukaryotic cells. Coreq: BIOSC 661.

BIOSC 664 Mammalogy 4(3,3) Origin, evolution, distribution, structure and function of mammals with laboratory emphasis on mammals of the Southeast. Field trips and live trapping of mammals are required. Preq: BIOSC 303 or consent of instructor.

BIOSC (GEN, HORT) 665 Plant Molecular Biology 3(3,0) See HORT 665.

BIOSC 666 Evolution of Human Behavior 3(3,0) Familiarizes students with the evolutionary basis of human behavior. Examines topics such as altruism, cooperation, mating systems, parental investment and social systems using diverse examples, from hunter-gatherer to technological societies. Preq: ANTH 351, BIOSC 335, 470, or PSYCH 201; or consent of instructor.

BIOSC 668 Herpetology 3(2,3) Systematics, life history, distribution, ecology and current literature of amphibians and reptiles. Laboratory study of morphology and identification of world families and U.S. genera, as well as all southeastern species. Field trips are required. Preq: BIOSC 303 or consent of instructor.

BIOSC (ENT, W F B) 669 Aquatic Insects 3(1,6) See ENT 669.

BIOSC 670 Behavioral Ecology 3(0,0) Historical and modern developments in animal behavior emphasizing the evolutionary and ecological determinants of behavior. A synthesis of ethology and comparative psychology. Preq: BIOSC 302 or 303 or consent of instructor.

BIOSC 671 Behavioral Ecology Laboratory 2(1,2) Laboratory exercises that explore the behavior of animals. Emphasizes behavioral observation and analysis and presentation of findings in a report format. Includes a semester-long independent research project. Preq or Coreq: BIOSC 670 or consent of instructor.

BIOSC 672 Ornithology 4(3,3) Biology of birds: their origin and diversification, adaptations, phylogeny, classification, structure and function, behavior, ecology and biogeography. Field identification is emphasized and field trips are required. Preq: BIOSC 303 or consent of instructor.

BIOSC 673 History of Modern Biology 3(3,0) Examines the intellectual and social factors defining the study of life from the scientific revolution of the 1600s to the modern biological sciences. Investigates the historical origins of biological disciplines and explores the differing cultures, methodologies and philosophical commitments of these communities. Preq: Introductory course in biology or consent of instructor.

BIOSC 674 Primatology 4(3,3) Biology of human primates, including their evolution, taxonomy, physiology, life history, behavioral ecology and conservation. Three field trips are required, during which students conduct behavioral observations and later analyze their data and present it in report format. Preq: ANTH 351, BIOSC 303, 335.

BIOSC 675 Comparative Physiology 3(3,0) Physiological systems of invertebrates and vertebrates with emphasis on environmental adaptation. Physiological principles as they relate to metabolism, thermoregulation, osmoregulation, respiration, and neural and integrative physiology. Preq: One year each of biology, chemistry and physics or consent of instructor.

BIOSC 676 Comparative Physiology Laboratory 2(1,2) Modern classical experimental methods demonstrate fundamental physiological principles discussed in BIOSC 475. Students are introduced to computer-aided data acquisition and manipulation as well as computer simulations of physiological function. Preq or Coreq: BIOSC 675.

BIOSC 677 Ichthyology 3(2,3) Systematics, life history, distribution, ecology and current literature of fish. Laboratory study of morphology and identification of U.S. genera and all Southeastern species. Field trips are required. Preq: BIOSC 303 or consent of instructor.

BIOSC (AVS) 680 Vertebrate Endocrinology 3(3,0) Introduction to the basic principles of neuroendocrine integration and homeostatic maintenance in vertebrates. Comparative morphology and physiology of various endocrine tissues and hormone chemistry and modes of action are considered. Preq: BIOSC 303, organic chemistry or consent of instructor.

BIOSC 681 Web Design for the Life Sciences 3(2,2) Modern software technologies and methods are used to help teachers develop sites suitable for life science and agricultural organizations. Service-learning is used with student projects. Preq: AG ED 200, CP SC 120, or consent of instructor.

BIOSC 682 Laboratory Techniques for Teaching Science 3(1,6) Focuses on basic lab skills needed to plan, prepare, and conduct inquiry-based laboratory and to familiarize pre-service teachers with a variety of scientific equipment and their methodologies. Topics include ways to integrate technology into the classroom, lab safety, and the development of inquiry-based classroom activities. Preq: BIOL 104/106 or 111.

BIOSC 684 Human and Comparative Vertebrate Embryology 3(3,0) Study of human and comparative embryology with an introduction to related clinical correlations. Students develop an understanding of normal and abnormal human and comparative vertebrate embryonic development. Preq: BIOL 111 or consent of instructor.

BIOSC 687 Electron and Optical Microscopy Theory 3(2,2) Offers a theoretical and practical introduction to light and electron microscopy. Topics include Koehler illumination, polarization, interference, phase contrast, DIC epifluorescence, laser scanning light microscopy, SEM, TEM, EDS, ultramicrotomy, tomography and digital imaging. Preq: Consent of instructor.

BIOSC 730 SC Life: Topics for Teachers 3(2,2) Topics relating to the SC Life curriculum. Lectures, laboratories and extensive field studies focus on the natural history and biodiversity of South Carolina. Restricted to elementary and secondary school teachers. May be repeated for credit, but only if different topics are covered. Preq: Consent of instructor.

BIOSC 731 SC Life: DNA Technology for Teachers 3(2,2) Lectures and laboratories focus on applications of DNA technology in society. Restricted to elementary, middle and secondary school teachers. May be repeated for credit, but only if different topics are covered. Preq: Consent of instructor.

BIOSC 732 SC Life: Forensic Science Topics for Teachers 3(2,2) Application of a broad spectrum of forensic science to answer questions of interest to the legal system. Lectures, laboratories and field trips focus on different subdivisions of forensic science. Restricted to elementary and secondary school teachers. May be repeated for credit, but only if different topics are covered. Preq: Consent of instructor.

BIOSC 733 SC Life: Technology Topics for Teachers 3(2,2) Lectures and laboratories focus on ways to help teachers integrate technology into the classroom. Restricted to elementary, middle, and secondary school teachers. May be repeated for credit, but only if different topics are covered. Preq: Consent of Instructor.

BIOSC 802 Conservation Genetics 3(3,0) An introduction to theoretical population genetics and empirical studies of evolutionary genetics. Emphasizes exploring conservation genetics issues from an applied perspective by doing exercises using real data sets and population genetics analyses programs as well as discussions of empirical studies of species of conservation concern. Preq: BIOSC 335, GEN 300 or 302, or consent of instructor.

BIOSC 803 Population Dynamics 4(2,6) Fundamental mechanisms basic to regulation of natural animal populations. Laboratory research project in population dynamics complements theory.

BIOSC 810 Behavioral Ecology 3(3,0) Behavior of animals and the ecological context in which various behaviors are shown; empirical and theoretical aspects of behavioral ecology at individual, population and community levels. Preq: BIOSC 441 and 470 or consent of instructor.

BIOSC (ENTOX) 811 Immunotoxicology 3(3,0) See ENTOX 811.
BIOSC 812 Seminar 1(1,0) Review and presentation of current literature in biological sciences. May be repeated for a maximum of four credits. To be taken Pass/Fail only. Prq: Consent of instructor.

BIOSC 813 Graduate Teaching Assistant Colloquium 1(1,0) Designed for graduate teaching assistants (GTAs) during their first year of laboratory instruction. Covers a variety of topics designed to prepare GTAs for departmental instructional duties, as well as information concerning safety and professional ethics in the laboratory classroom. To be taken Pass/Fail only. Prq: Graduate teaching assistant in Biological Sciences.

BIOSC 816 Advanced Ecosystem Analysis 4(3,3) Description and analysis of ecological systems; biogeochemical, physicochemical and ecological principles emphasizing fundamental unity of ecosystems and their abiotic environment. Laboratory focuses on application of theory to actual field and laboratory research problems. Prq: BIOSC 641, MTHSC 210, 605, or consent of instructor.

BIOSC 820 Community Ecology 3(3,0) Examines species interactions in plant and animal communities and uses experimental, observational and theoretical approaches to study competition, predation, facilitation, habitat selection and succession. Emphasizes how species diversity is maintained and the consequences of diversity at local and regional scales. Prq: BIOSC 441 or equivalent.

BIOSC 825 Comparative and Veterinary Immunology 3(3,0) Survey of the evolutionary relationships, the physiology and the cellular/molecular biology of the immune systems of animals; demonstrations that focus on those animals having high economic input, biomedical importance, or a key ecological position; current research with a historical perspective. Prq: AVS 825, MICRO 614, or consent of instructor.

BIOSC 826 Epigenetics in Eukaryotes 3(3,0) Focuses on epigenetics in eukaryotes and discusses how epigenetic changes modulate gene expression and post-translational modification. Topics include specific decorations of the DNA, the proteins that help compact DNA, and the importance of chromatin structure in maintaining characteristics of cell or organism, such as immortalization or aging. Prq: MICRO 417, H417 or 617, or consent of instructor.

BIOSC (ENTOX) 830 Mechanistic Toxicology 3(3,0) See ENTOX 830.

BIOSC (ENTOX) 831 Biomarkers in Toxicology 3(1,6) See ENTOX 831.

BIOSC 841 Understanding Ecology and Ecosystems 3(3,0) Online course for teachers and others who want to understand ecological interactions and systems. Provides a broad background in ecology that includes populations, habitats, communities, trophic interactions and ecosystems; and provides a foundation for understanding interactions between organisms and their environments.

BIOSC 842 Understanding Cellular Processes 3(3,0) In-depth analysis of essential cell biology topics. Students study how and where intracellular and extracellular molecules control cellular functions such as gene expression, secretion, motility, signaling, cell cycle control and differentiation.

BIOSC 843 Understanding Genetics and Evolutionary Biology 3(3,0) Online course for teachers who want to increase their content knowledge in genetics and evolution. Topics include Mendelian genetics, molecular genetics, gene expression and regulation, population genetics, forces of evolutionary change, and the role of evolutionary change in the origin of new species.

BIOSC 846 Understanding Plant Biology 3(3,0) Online course for teachers and others who want to increase their content knowledge about plants. Study of plants from bryophytes to angiosperms, including growth, photosynthesis, nutrition, reproduction, ecology and evolution. Prq: Consent of instructor.

BIOSC 847 Understanding Microbiology 3(0) Online course for teachers and others who want to increase their knowledge of microorganisms. Topics include prokaryotic cell structure and function, microbial growth and growth control, food microbiology, bacterial genetics, immunology, virology, microbial diseases, and epidemiology. Laboratory concepts are emphasized.

BIOSC (ENTOX) 854 Aquatic Toxicology 3(0) See ENTOX 854.

BIOSC 863 Special Problems 1-4 Research not related to thesis. Prq: Consent of instructor.

BIOSC 871 Selected Topics 1-41(1-4,0) Cellular and developmental biology, ecology, behavior, evolution, biogeography, molecular biology, physiology, biotechnology and other topics of interest to graduate students in the biological sciences. May be repeated for credit, but only if different topics are covered. Prq: Consent of instructor.

BIOSC 872 Selected Topics Laboratory 1-40(2,8) Specialized laboratory experiences in cellular and developmental biology, ecology, behavior, evolution, biogeography, molecular biology, physiology, biotechnology and other topics of interest to graduate students in the biological sciences. May be repeated for credit, but only if different topics are covered. Prq: Consent of instructor.

BIOSC 888 Electron and Light Microscopy Practicum 3(0,5) Continuation of BIOSC 687, offering graduate students practical training on light and electron microscopes. Proficient students become approved end users by performing approved, independent imaging projects. Prq: BIOSC 687 and consent of instructor.

BIOSC 891 Master's Thesis Research 1-12

BIOSC 991 Doctoral Dissertation Research 1-12

BIOMEMOLECULAR ENGINEERING

BMOLE 603 Biotransport Phenomena 3(3,0) Analysis of single and multidimensional steady-state and transient problems in momentum, mass and energy transfer in biological systems. Mathematical similarities and differences in these mechanisms are stressed and mathematical descriptions of physiological and engineering systems are formulated. Prq: CH E 330, MTHSC 208.

BMOLE 621 Bioseparations 3(3,0) Study of principal methods of separation and purification of bioproducts, such as proteins, amino acids and pharmaceuticals. Topics include analytical bioseparations, membrane separations, sedimentation, cell disruption, extraction, adsorption, chromatography, precipitation, crystallization and drying. Prq: BIOCH 301, 305, or 423; CH E 330; or consent of instructor.

BMOLE 625 Biomolecular Engineering 3(3,0) Introduction to basic principles of biomolecular engineering: the purposeful manipulation of biological molecules and processes applied to problems and issues in the life sciences, biotechnology and medicine. Topics include carbohydrates, proteins, nucleic acids and lipids with emphasis on their structure-property-function relations; molecular recognition; biochemical pathway engineering; and cell growth. Prq: CH E 230 and 319 or consent of instructor.

BMOLE 626 Biosensors and Bioelectronic Devices 3(3,0) Development of methodologies used to design, fabricate and apply biosensors and bioelectronic devices for the environmental, medical and chemical industries. Application of the fundamentals of measurement science to optical, electrochemical, mass and thermal means of signal transduction. Use of the fundamentals of surface science to interpret bioimmobilization and biomolecule-surface interactions. Prq: CH E 330, and BMOLE 301 or 305, or consent of instructor.

BMOLE 627 Membranes for Biotechnology and Biomedicine 3(3,0) Students learn principles of membrane science and technology and study membrane applications in the biotechnology and biomedical industries. Advanced topics include surface modification of membranes, synthesis of porous membranes for biomedical applications such as tissue engineering, environmentally responsive membranes and membrane-based biomedical devices. Prq: CH E 330 or equivalent or consent of instructor.

BMOLE 810 Biosensors and Bioelectronic Devices 3(3,0) Study of methodologies in design, fabrication and application of biosensors and bioelectronic devices for monitoring the environmental, medical and chemical industries. Includes measurement science fundamentals applied to optical, electrochemical, mass and thermal means of signal transduction. Also considers surface science fundamentals to interpret bioimmobilization, biofouling and nonspecific interactions of enzymes, antibodies and DNA at surfaces. Prq: Consent of instructor.

BI OSYSTEMS ENGINEERING

B E (CSENV) 608 Land Treatment of Wastewater and Sludges 3(3,0) See CSENV 608.

B E 610 Biological Kinetics and Reactor Modeling 3(2,3) Fundamentals of microbial and biochemical kinetics used in analysis and design of biological systems. Topics include mathematical and computer modeling of biological kinetics and systems, estimating model coefficients, and development of microbial kinetic models as basis for batch and continuous reactor design. Prq: B E 212, MTHSC 208.
Courses of Instruction

B E 612 Heat and Mass Transport in Biosystems Engineering 3(3,0)
Fundamentals of heat and mass transport used in engineering design and analysis of biological systems; principles of steady state and transient energy and mass balances including chemical and biological generation terms. Preq: B E 312, MTHSC 208. Coreq: M E 310.

B E 614 Biosystems Engineering Unit Operation 3(2,3)
Applies the basic principles of statics, dynamics and thermodynamics to design of mechanical and electrical systems supporting biological operations and processes. Preq: B E 314, M E 310.

B E 615 Instrumentation and Control for Biosystems Engineers 4(3,3)
Overview of modern instrumentation techniques and digital electronic components and subsystems to integrate them into digital data acquisition and control systems for biosystems. Emphasizes laboratory use of equipment. Topics include characteristics of instruments, signal conditioning, transducer theory and applications, programmable logic controllers, and digital data acquisition and control. Preq: E E C E 307.

B E 617 Applied Instrumentation and Control for Biosystems 2(1,3)
Study of hardware and software implementation of digital data acquisition and control systems for application to agriculture, aquaculture, biotechnology and other biosystems. Topics include digital electronic circuits and components, microcomputer architecture, interfacing and programming. Preq: B E 415 or consent of instructor.

B E 622 Hydrologic Modeling of Small Watersheds 3(3,0)
Design of structures and development of best management practices for runoff, flood and sediment control from rural and urban areas, including natural and disturbed watersheds. Topics include modeling of prismatic and non-prismatic channels, culverts and detention/retention ponds. Preq: B E 322 or consent of instructor.

B E (CH E) 628 Biochemical Engineering 3(3,0)
Use of microorganisms and enzymes for the production of chemical feedstocks, single-cell protein, antibiotics and other fermentation products. Topics include kinetics and energetics of microbial metabolism, design and analysis of reactors for microbial growth and enzyme-catalyzed reactions, and considerations of scale-up, mass transfer and sterilization during reactor design. Preq: B E 312, MICRO 305; Coreq: (for Biosystems Engineering majors) B I O C H 301 or 305; (for Chemical Engineering majors) CH E 330, 450.

B E 635 Applications in Biotechnology Engineering 3(3,3)
Bioengineering principles applied to the expanding fields of agricultural biotechnology, ecotechnology and biomedical technology. Special applications include waste treatment and ecological engineering, bioreactor propagation of plant and animal cells and tissues, applied genomics and synthetic seed production, biosensors and biomonitoring, biological implants and materials biocompatibility. Preq: B E (CH E) 428.

B E 638 Bioprocess Engineering Design 3(2,2)
Design and analysis of systems for processing biological materials. Topics include biotechnology, thermodynamics, transport processes and biological properties related to bioprocess design and computational simulation. Unit operations include basic bioreactor operation, bioseparations, and preservation techniques. Preq: B E 428.

B E 640 Renewable Energy Resource Engineering 3(2,2)
Investigation into merging renewable energy resources, including detailed study of solar, wind and bioenergy alternatives. Also includes principles, technologies and performance evaluation of components for these technologies and an introduction to tidal, hydro, geothermal and other energy; energy conservation; cogeneration; financial, economical and other issues related to alternative energy sources. Preq: Science or engineering major, consent of instructor.

B E 642 Properties and Processing of Biological Products 2(1,3)
Study of engineering properties of biological materials and their uniqueness as design restraints on systems for handling, processing and preserving biological products. Preq: B E 333, GE 341, M E 302, 310.

B E (EE&S, FOR) 651 Newman Seminar and Lecture Series in Natural Resources Engineering 10(0,2)
Topics dealing with development and protection of land, air, water and related resources are covered by seminar with instructors and invited lecturers. Current environmental issues or resource conservation issues are addressed. Preq: Senior standing, consent of instructor.

B E 664 Non-Point Source Management in Engineered Ecosystems 3(3,0)
Fundamentals of non-point source pollution including quantification of environmental impact and ecosystem management related to contaminants and nutrients and to planning and design of ecological systems. Preq: MICRO 315, senior standing in engineering, or consent of instructor.

B I O C H 684 Municipal Solid Waste Management 3(3,0)
See EES & S 684.

B I O C H 681 Special Problems 1-3(1-3,0)
Students select subjects and conduct library, laboratory and/or field research. A technical report documenting the study is required. May be repeated for a maximum of six credits. Preq: Master’s degree candidate in Engineering.

B I O C H 835 Industrial Biotechnology Techniques 4(3,3)
Introduces industrial biotechnology techniques with emphasis on bioproduction, pilot bioprocessing equipment operation, biopharmaceutical storage, process simulation and economics, project management, good laboratory practice (GLP), and current good manufacturing practice (cGMP) geared toward the biotechnology industry. Preq: B E 638 or BIOCH 633, GEN (BIOSC) 616, or consent of instructor.

B E 838 Advanced Bioprocess Engineering 3(3,0)
Advanced bioprocessing techniques with emphasis on processing and modeling aspects of eukaryotic systems and associated bioprocesses. Modules include thermal processing, supercritical fluid extraction, and advanced biological thermodynamics, chromatography and spectroscopy. Preq: B E 438/638 or consent of instructor.

B E 865 Advanced Biological Transport Processes 3(3,0)
Study of transient transport processes in biological materials and systems. Incorporates mathematics describing active and passive cellular transport. Emphasizes numerical solution techniques for coupled transport relationships in non-ideal, heterogeneous systems, including biological kinetic and thermodynamic considerations. Preq: BIOCH 305, CH E 601, MTHSC 634, or consent of instructor.

B E 871 Selected Topics in Biosystems Engineering 1-3(1-3,0)
Supervised, in-depth study of an area related to biosystems engineering not covered in other courses. May be repeated for a maximum of six credits.

B E 991 Master’s Thesis Research 1-12

BOTANY

B O T 821 Inorganic Plant Metabolism 3(3,0)
Study of plant, soil, water and nutrient relations. Topics include permeability, uptake and translocation, transpiration and mineral nutrition. Offered fall semester of odd-numbered years only. Preq: BIOSC 601 and 602 or consent of instructor.

B O T 822 Organic Plant Metabolism 3(3,0)
Discusses respiration and photosynthesis; synthesis, translocation, storage, transformation and degradation of organic materials, fats, carbohydrates, proteins, pigments and nucleic acids. Offered spring semester of even-numbered years only. Preq: BIOSC 601 and 602 and BIOCH 623 or consent of instructor.

B O T 823 Plant Growth and Development 3(3,0)
Considers vegetative and reproductive growth and development from seed to maturity, flowering, fruiting and senescence; natural and synthetic growth regulators; and morphogenesis. Offered fall semester of even-numbered years only. Preq: BIOSC 601, 602, and organic chemistry or consent of instructor.

B O T (CSENV) 824 Mode of Action of Growth Substances 4(3,3) Study of the physiology and biochemistry of both natural and synthetic growth regulators, hormones, growth retardants, herbicides and other inhibitors. Considers methodology and mechanism of action. Offered spring semester of odd-numbered years only. Preq: BIOSC 601 and 602 and general biochemistry or BOT 822 or consent of instructor.
Courses of Instruction

BOT 831 Advanced Plant Taxonomy 4(3,3) Study of the principles of plant classification including relationships and characteristics of major groups of vascular plants. Students collect and identify spring flora of the area. Offered spring semester of odd-numbered years only. Preq: BIOSC 606 or consent of instructor.

BOT 850 Plant Tissue and Cell Culture 3(2,3) Methods and principles of plant tissue and cell culture; cloning, embryogenesis, protoplast fusion, plant regeneration, potential of plant genetic engineering. Offered fall semester of odd-numbered years only. Preq: Introductory plant physiology or consent of instructor.

BOT 860 Plant Anatomy and Cell Biology 4(3,3) Covers the subcellular structure and the comparative organization and function of plant cell types, tissues and organs. Emphasizes the interplay between the environment and the plant body and among genomes, membrane compartments and the cytoplasm as these relate to the highly orchestrated stages in development. Offered spring semester of even-numbered years only.

BUSINESS ADMINISTRATION

M B A 803 Statistical Analysis of Business Operations 3(3,0) Application of modern statistical inference in business operations. Topics include testing statistical hypotheses, consequences of making decisions with incomplete information, univariate and multivariate regression with emphasis on business applications and design of experiments and analysis of variance. Special attention is given to efficient and relevant data collection and interpretation.

M B A 805 Enterprise, Government and the Public 3(0) Regulatory environment of business and how it evolves. Through use of economic logic and business cases, students are equipped to understand the all-pervading nature and importance of government regulation in the economy.

M B A 806 Operations Management 3(3,0) How firms create value and how decisions in the areas of capacity, facilities, technology, vertical integration, workforce, quality, production planning/materials control, and organization influence a firm’s ability to add value; decisions and analysis tools used for these decisions. Preq: M B A 818 and 830, or equivalent, or consent of instructor.

M B A 807 Financial Management 3(3,0) Theory of financial management as it relates to the financial problems faced by business concerns. Concepts developed are used to assess the validity of emerging formalized techniques for improving decision making in the financial area. Topics include financial planning, short- and longterm fund raising, capital budgeting, the administration of working capital, recapitalization, listing of securities and reorganization. Case material and problems are used. Preq: M B A 804 or 854 or equivalent, and M B A 803 or 853 or equivalent.

M B A 809 Organizational Behavior and Human Resources Management 3(3,0) Theories and models of behavior; human resources management concepts and processes as they apply to managing individual and workgroup behavior in organizations. Organizational behavior topics include leadership, motivation and teamwork. Human resource management topics include human resources strategy, selection, performance evaluation, reward systems and employee development.

M B A 811 International Business Management 3(3,0) Survey and analysis of managerial theory and the practice of international business, including the influence of cultural, economic, political and financial factors affecting the management of the firm. Case studies of companies engaged in international business are discussed.

M B A 812 Financial Markets and Institutions 3(3,0) Topics critical to the proper management of financial institutions including financial regulations, financial security types and their yields, interest rate theories, interest rate risk management, foreign currency risk management, stock index futures and numerous operating functions in banking. Preq: M B A 807 or consent of instructor.

M B A 814 Directed Research in Quantitative Analysis 3(3,0) M B A 815 Directed Research in Qualitative Analysis 3(3,0)

M B A 817 Business Forecasting Techniques and Applications 3(3,0) Study of forecasting techniques and their application for developing and assessing forecasts. Topics include economic data sources, multiple regression and time series analysis, and interpretation of forecasts for management and other clients. Preq: M B A 802 and 803, or equivalent.

M B A 819 Introduction to Accounting and Finance 3(3,4) Basic concepts of accounting and finance with emphasis on using financial data for decision making; measuring, processing, reporting and analysis of financial information; use of financial tools to manage cash flows in valuation and the measurement of risk and return. Designed for MBA students lacking background in accounting and finance. Preq: Consent of MBA director.

M B A 826 Business Marketing 3(3,0) Strategic marketing as it applies to industrial, organizational and institutional markets; consumer marketing versus business-to-business marketing; current business marketing literature and practices. Preq: Principles of marketing or equivalent or consent of instructor.

M B A (MKT) 828 Services Marketing 3(3,0) Nature of services marketing and the special requisites that distinguish successful services marketing from goods marketing. Topics include promoting and making the service tangible, designing optimal service operations, the ideal service worker, pricing of services and critical points of services delivery. Preq: Principles of marketing or equivalent or consent of instructor.

M B A 829 Marketing Foundations 2(2,0) Principles and concepts involved in planning, pricing, promoting and distributing goods and services. Preq: Consent of MBA director.

M B A (FIN) 832 International Financial Management 3(3,0) Factors that influence the financial management of multinational corporations. Topics include international parity conditions, currency exposure management, capital budgeting of international projects and political risks. Preq: M B A 807 or 857 or consent of instructor.

M B A 833 Real Estate Investments 3(3,0) Study of real estate investment analysis and decision making featuring the use of the discounted cash flow model and other tools to evaluate investment alternatives from the perspective of an equity real estate investor. Emphasizes market analysis, ownership alternatives and financing considerations. Preq: M B A (FIN) 836.


M B A (FIN) 836 Real Estate Principles 3(3,0) Advanced survey course to acquaint students with the theories, practices and principles of real estate. Topics include urban economics, real estate law, brokerage, real estate valuation, financial institutions, tax issues, investment analysis, and development. Preq: M B A 807 or 819 or consent of instructor.

M B A 837 Legal Environment of Business 2(2,0) Legal and case analysis of court systems and dispute resolution, contracts, business torts, EEOC, Age Discrimination in Employment Act, Americans with Disabilities Act, Employment-at-Will compared to union participation; international legal considerations as these topics relate to business concerns. May not be used for credit toward a graduate degree. Preq: Consent of MBA director.

M B A 839 Business Negotiations and Legal Dispute Resolution 3(3,0) Negotiation and dispute resolution in the business environment. Negotiation techniques and practices, negotiation team building, international negotiation issues, as well as alternative dispute resolutions as applied to legal issues within the business environment. Preq: M B A 837, 838 or consent of instructor.

M B A 841 Real Estate Finance 3(3,0) The application of financial analysis and theory to real estate, mortgage credit analysis and current financing techniques for residential and commercial properties is emphasized. Topics include financial institutions, mortgage financing techniques, financial decisions and construction financing. Preq: M B A (FIN) 836.

M B A 842 Real Estate Valuation 3(3,0) Study of real estate appraisal with primary emphasis on two student projects: a house appraisal and a commercial property appraisal. Topics include highest and best use analysis, the three approaches to value, advanced capitalization techniques, discounted cash flow analysis and the standards of professional practice. Preq: M B A (FIN) 836.
Courses of Instruction

M B A (MGT) 845 Technology and Innovation Management 3(3,0) Interdisciplinary examination of problems and issues in integrating technology and innovation into processes and products; evaluating tangible and intangible aspects of new technology adoption; management research and development; and functional integration of marketing and operations.

M B A 846 Use of Derivatives in Financial Engineering 3(3,0) The valuation and use of basic derivative securities such as futures and options; the financial engineering of securities combinations such as swaps, spreads and straddles; applications of derivatives and financial engineering in managing financial risks. Prereq: M B A 807 or 867 or consent of instructor.

M B A 850 Business Communications 1(1,0) Techniques, skills, problems and approaches for effective business communications; strengths and weaknesses of various communications forms with concentration on informative and persuasive models. Includes practical experience in written work and presentations, video and verbal feedback, teamwork, problem solving and situational presentations. Prereq: Consent of MBA director.

M B A 854 Managerial Accounting 3(3,0) Analysis, interpretation and use of accounting information for planning and control in business and nonprofit organizations. Includes profit planning, budgeting and standards; product and segment costing and evaluation; and case studies and computer-based assignments. Offered spring semester only. Prereq: M B A 819 or equivalent or consent of instructor.

M B A 859 Managerial Decision Modeling 3(3,0) Survey of decision modeling techniques useful in managerial decision making, including linear programming, project management, queuing models, transportation problems and Monte Carlo simulation. Prereq: Consent of MBA director.

M B A 860 Advanced Marketing Strategy 3(3,0) Advanced marketing theory and critical thinking skills applied to support strategic decision making. Data analysis and advanced marketing models are employed with emphasis on building analytic and assessment skills. Offered spring semester only. Prereq: M B A 858 or MKT 865 or consent of instructor.

M B A (MGT) 861 Information Systems 3(3,0) The critical role of information systems in contemporary business organizations; key information systems and technologies; their impacts both within and across organizational settings.

M B A 862 Managerial Economics 3(3,0) Use of economic analysis in managerial decision making. Topics include the theory of cost, production, industrial organization, coordination and control of the firm, from theoretical concepts to actual decision making. Offered fall semester only. Prereq: Consent of MBA director.

M B A 863 Advanced Managerial Economics 3(3,0) Advanced economic analysis for managerial decision making. Topics include advanced price theory, theory of firm, internal organization of the firm, the economics of strategic behavior in the market and the empirical estimation of demand and cost functions. Prereq: M B A 862 or consent of instructor.

M B A 870 Strategic Management 3(3,0) Investigation of the ongoing process of positioning a firm for competitive advantage in its changing business environment focusing on the role of general managers in formulating and implementing strategies for single and multibusiness firms. Business cases, class discussions and group projects are used to integrate content from previous business courses. Offered spring semester and summer session only. Prereq: M B A 807, 809, 838, 854, 856, 861, 862, or consent of instructor.

M B A 871 Programming and System Development 3(3,0) Programming concepts and structures in developing information systems applications. Specific techniques and tools covered are updated to incorporate the newest technologies. Prereq: Consent of instructor.

M B A 872 Entrepreneurial Finance 3(3,0) Topics include business valuation, financial forecasting, financing strategies and business harvesting. Includes case studies and computer modeling. Prereq: ECON 855 or M B A 807.

M B A (MGT) 874 Managing Continuous Improvement 3(3,0) How to initiate and lead change toward a total quality environment; basic tools of quality management; use of teams to achieve change; quality function deployment; ISO 9000; supplier development; and use of survey methods to track progress of change. Prereq: MGT 803 or consent of instructor.

M B A 875 Entrepreneurial Development 3(3,0) Studies the entrepreneurial process from conception to birth of new venture emphasizing discovery, searching for opportunities and gathering resources to convert opportunity to business. Students learn how to evaluate entrepreneurs and their plans by working in teams to write a business plan for a new venture.

M B A 876 Electronic Marketing 3(3,0) Application of the concepts and theories of marketing to e-commerce, challenges facing marketing in business-to-business and business-to-consumer contexts, strategic application of marketing mix variables in e-business environment. Prereq: Consent of instructor.

M B A 880 MBA Seminar 1-3(1-3,0) Presents various topics, such as professional development for MBA students, project research methods for graduate research assistants, and other special topics. To be taken Pass/Fail only. May be repeated for a maximum of four credits. Prereq: Consent of instructor.

M B A 881 Seminar on Ethics and Leadership 1(1,0) Exposes MBA students to various ethical, leadership and personal development venues through a combination of speakers, networking activities, workshops, competitions, personal development exercises and other related activities. May be repeated for a maximum of two credits. Prereq: Consent of instructor.

M B A 888 Internship in Business Administration 2-6 Preplanned, preapproved, faculty-supervised internship designed to give students on-the-job learning in support of classroom education. A two-credit hour internship must be no fewer than 120 contact hours (e.g., four weeks, 30 hours per week; or eight weeks, 15 hours per week; or 15 weeks, eight hours per week) with the same internship provider. To be taken Pass/Fail only. May be repeated for a maximum of six credits. Prereq: Thirty semester hours of graduate credit and consent of MBA director.

M B A 899 Selected Topics in Business Administration 1-6(1-6,0) Current topics in business administration as they relate to the manager. Topics may come from a single functional area or may integrate two or more functional areas (accounting, economics, finance, management, or marketing). May be repeated for a maximum of nine credits.

CAREER AND TECHNOLOGY EDUCATION

CTE 610 Selected Topics 1-3(1-3,0) Subject areas may be organized according to program needs. Content is planned cooperatively by the University and the school system or agency requesting the course. May be repeated for a maximum of 18 credits, but only if different topics are covered. Prereq: Consent of instructor.

CTE 613 Contemporary Technological Problems 3(3,0) Provides students with an understanding of the problems and contributions of technology. Examples of these relationships are taken from historical accounts and from analyses of contemporary technological intervention both in industrialized and nonindustrialized countries.

CTE 615 History and Philosophy of Career and Technology Education 3(3,0) Study of career and technology education programs with the intent of developing a sound individual philosophy. General topics include history, local, state and federal legislation; types of career and technology programs; professional organizations and career guidance.

CTE 620 Manufacturing II: Computer-Integrated Manufacturing 3(3,2) Study of computer-integrated manufacturing and its related concepts, including robotics, computer numeric control, electronic pneumatic and sensor systems, programmable logic controllers, and ancillary devices. Prereq: CTE 220 or consent of instructor.

CTE 630 Construction Technology II: Practices and Systems 3(2,3) Study of industrial practices and systems affecting man, materials and equipment associated with construction industries. Activities are directed toward developing a working knowledge of construction technology and a framework for incorporating this instruction into programs in the public and private sectors. Prereq: CTE 230.

CTE 640 Power Technology II: Transmission and Control Systems 3(2,3) Continuation of CTE 240. Instruction in transmitting and controlling power for utilization in such areas as manufacturing, communications, construction and transportation. Introduces concepts of automation and robotics to enable classroom teachers and industry personnel to gain necessary insights into this important area of technology. Prereq: CTE 240.
CTE 660 Developing Training Programs for Industry 3(3,0) Identification, selection and organization of subject matter for industrial training programs. Emphasizes analysis techniques, session and demonstration planning, written instructional materials development, trainee evaluation, and planning instructional schedules. Preq: Senior standing in Career and Technology Education or consent of instructor.

CTE 665 Conducting and Evaluating Training Programs 3(3,0) Basic concepts of supervision, administration and management of training programs. Emphasis is on determining training requirements, planning, directing and evaluating training programs. Preq: CTE 160, 460 or consent of instructor.

CTE 668 Public Relations 3(3,0) Emphasizes techniques and methods of effective public and industrial relations which contribute to understanding and cooperation of labor, business, professional, educational and industrial groups.

CTE 670 Course Organization and Evaluation 3(3,0) Problems, techniques and procedures in the preparation, selection and organization of subject matter for instructional purposes. Methods, techniques and evaluation of materials used in the preparation of student achievement in industrial education subjects.

CTE 671 Teaching Career and Technology Education 3(3,0) Effective methods for teaching and training in career and technology education. Emphasis is given to class organization, preparation of lesson outlines and audiovisual aids. Preq: ED F 335.

CTE 673 Assessment in Career and Technology Education 3(3,0) Study of competency testing in career and technology education which includes educational objectives and measurement; construction and use of oral, objective, short answer, matching, essay and performance tests; and treatment of test data for grade assignments and statistical analysis.

CTE 680 Digital Technology in the 21st Century Classroom 3(2,2) See ED F 680.

CTE 681 Advanced Educational Applications of Microcomputers 3(2,2) See ED F 682.

CTE 683 Architectural Drafting for Career and Technology Education 3(1,6) Study of the major aspects of architectural drawing such as plot, floor and foundation plans; wall sections; and elevations. Preq: CTE 180.

CTE 684 Communications Technology II: Systems 3(2,2) Continuation of CTE 280. Includes theory and operation of communications systems: telegraph, telephone, radio, television, satellites, sound/video recorders, lasers and computers. Instruction on strategies for interpreting this area of technology to trainees and students is emphasized. Preq: CTE 280.

CTE 686 Instructional Media Development 3(1,4) Basic instructional media development techniques. Students develop material using authoring software such as HyperCard, transparencies using Persuasion and/or PowerPoint, and fully storyboarded, scripted and edited digital as well as analog video.

CTE 692 Advanced Projects 16 Students gain depth in content by completing projects under the supervision of an instructor in career and technology education. Written project approval is required before registering. May be repeated twice for a maximum of six credits. Preq: Consent of instructor.

CTE (ED) 700 Supervising the Student Teacher in the Public School 2-3(2-3,0) See ED 700.

CTE 815 Seminar in Industrial Education 1(1,0) Students and faculty discuss and study new technological and professional advances. May be repeated for a maximum of three credits. To be taken Pass/Fail only.

CTE 820 Recent Process Developments 3(3,0) Study of recent technological innovations, inventions, processes and products and their impact on our industrial, labor, educational and social institutions.

CTE (H R D) 845 Needs Assessment for Education and Industry 3(3,0) See H R D 845.

CTE (H R D) 846 Applied Public Relations 3(3,0) See H R D 846.

CTE (H R D) 847 Instructional Systems Design 3(3,0) See H R D 847.

CTE 851 Current Topics in Communication Technology 1-3(1-3,0) Recent technological processes in the communication industry such as CAD, desktop publishing and interactive video for teachers and industrial personnel.

CTE 852 Current Topics in Manufacturing Technology 1-3(1-3,0) Contemporary manufacturing practices for public school teachers and industry personnel.

CTE 853 Current Topics in Construction Technology 1-3(1-3,0) Contemporay applications of power and energy for public school teachers and industry personnel.

CTE 860 Instructional Materials Development 3(3,0) See H R D 860.

CTE 865 American Industries 3(3,0) Concepts and principles of American industry and technology. Industrial plant visits supplement study of industrial organization, economics, management, production and products.

CTE (H R D) 870 Consulting for Education and Industry 3(3,0) See H R D 870.

CTE (AG ED, ED F) 889 Research in Education 3(3,0) See AG ED 889.

CTE 894 Project Research 1-6(1-6,0) Research related to departmental projects. Open only to students planning to pursue advanced graduate study. Joint use with CTE 895, 896 is not permitted for degree.

CTE 895 Special Problems I 3(3,0) Special problems in industrial education varying with interests, experiences and needs of students. Preq: Submission of a written proposal, completion of nine hours in the major and consent of advisor.

CTE 896 Special Problems II 3(3,0) Continuation of CTE 895. Preq: CTE 895, written proposal and consent of advisor.

CERAMIC AND MATERIALS ENGINEERING

C M E 602 Solid State Materials 3(3,0) Discussion of the properties of solids as related to structure and bonding with an emphasis on electronic materials. Band structure theory, electronic and optical properties are treated. Preq: C M E 326, MTHSC 208, PHYS 221.

C M E (BIO E) 615 Research Principles and Concepts 1(1,0) See BIO E 615.

C M E 616 Electrical Properties of Materials 3(3,0) Covers a range of topics dealing with electrical and magnetic materials. Topics include metal and polymer conductors, insulators, ceramic and polymer materials for dielectric applications, and ferroelectric, piezoelectric, pyroelectric and electrooptic materials. Metal and ceramic magnetic materials are also discussed.

C M E 622 Mechanical Behavior of Materials 3(3,0) Covers the microstructural basis of deformation and fracture in ceramic, metallic and polymeric systems. Preq: E M 201, MTHSC 208, consent of instructor.

C M E 624 Optical Materials and Their Applications 3(3,0) Introduces the interaction of materials with light. Specific topics include fundamental optical properties, materials synthesis, optical fiber and planar waveguides, and the componentry and systems-level aspects of optical communication systems. Preq: C M E 402, 413.

C M E 690 Special Topics in Ceramic Engineering 1-3(1-3,0) Study of topics not ordinarily covered in other courses. Taught as the need arises. Typical topics include current research in a specific area or technological advances. May be repeated for a maximum of six credits, but only if different topics are covered. Preq: Consent of instructor.

C M E 809 High-Temperature Materials 3(3,0) Properties of oxides, carbides, nitrides, borides and silicides; obtainment and measurement of high temperatures; measurement of properties at high temperatures.

C M E 815 Colloidal and Surface Science 3(3,0) Theory and application of colloidal and surface chemistry to ceramic materials and processes.

C M E 816 Constitution and Structure of Glasses 3(3,0) Modern concepts of glass structure and properties.

C M E 821 X-Ray Diffractometry 3(2,3) Theory and application of powder X-ray diffractometry to ceramic and materials problems.

C M E 822 Scanning Electron Microscopy 3(2,3) Theory and application of scanning electron microscopy to ceramic and materials problems.

C M E 823 Transmission Electron Microscopy 3(2,3) Advanced course in electron microscopy for materials science incorporating all aspects of transmission techniques: basics, diffraction, imaging and spectrometry. Preq: C M E 821 and 822 or consent of instructor.
Courses of Instruction

CHEMICAL ENGINEERING

CH E 601 Transport Phenomena 3(3,0) Mathematical analysis of single and multidimensional steady-state and transient problems in momentum, energy, and mass transfer. Both the similarities and differences in these mechanisms are stressed. Preq: CH E 312, MTHSC 208.

CH E 612 Polymer Engineering 3(3,0) Design-oriented course in synthetic polymers. Topics include reactor design used in polymer production, effect of step versus addition kinetics on reactor design, epoxy curing reactions, polymer solubility, influence of polymerization and processing conditions on polymer crystallinity. Preq: CH 224 and 332 or consent of instructor.

CH E 645 Selected Topics in Chemical Engineering 3(3,0) Topics not covered in other courses, emphasizing current literature, research and practice of chemical engineering. Topics vary from year to year. May be repeated, but only if different topics are covered. Preq: Consent of instructor.

CH E 650 Chemical Reaction Engineering 3(3,0) Review of kinetics of chemical reactions and an introduction to the analysis and design of chemical reactors. Topics include homogeneous and heterogeneous reactions, batch and continuous flow reaction systems, catalysis, and design of industrial reactors. Preq: CH E 312, 321, CH 332.

CH E 803 Advanced Transport Phenomena 3(3,0) Analysis of heat, mass and momentum transfer: derivation and application of the governing equations; solution of steady and unsteady-state multi-dimensional problems in fluid flow, heat transfer and mass transfer.

CH E 804 Chemical Engineering Thermodynamics 3(3,0) Study of equilibria of physical and chemical systems and generalized properties of hydrocarbons. Includes application of thermodynamic methods in equipment design.

CH E 805 Chemical Engineering Kinetics 3(3,0) Kinetics of chemical reactions, particularly in design and operation of chemical reactors.

CH E (E&ES) 814 Applied Numerical Methods in Process Simulation 3(3,0) Numerical solution techniques as applied to chemical process systems; finite difference techniques for partial differential equations stressing applied numerical methods rather than theoretical numerical analysis. Standard methods for ordinary differential equations are reviewed. Preq: Consent of instructor.

CH E 818 Polymer Processing 3(3,0) Processing of polymeric materials: polymer flow characterization; extrusion; mixing; filtration; injection molding; fiber and film formation; physical science principles such as fluid flow, heat transfer, crystallization and rheology applied to polymer processing operations.

CH E 819 Viscoelastic Properties of Polymers and Polymeric Composites 3(3,0) Time- and frequency-dependent behavior of structural polymers and their composites; interrelationship between various viscoelastic properties; influence of aging; prediction of composite viscoelastic response by application of the Viscoelastic Correspondence Principle. Preq: Consent of instructor.

CH E 823 Mass Transfer and Stagewise Contact Operations 3(3,0) Stagewise contact operations emphasizing distillation; vapor-liquid equilibria; integral and differential distillation; binary and multicomponent rectification; analytical methods; batch rectification; axiometric and extractive distillation.

CH E 834 Advanced Chemical Engineering Thermodynamics 3(3,0) Classical and statistical thermodynamics applied to problems in chemical engineering emphasizing modern methods of predicting thermophysical properties of gases and liquids. Students’ and instructor’s interests influence course content but usually include fundamentals of applied statistical mechanics, molecular theory of dense fluids, description of intermolecular forces, gas-liquid and liquid-liquid critical phenomena, theories of interfacial phenomena and adsorption, statistical mechanics of polymer systems, statistical mechanics of polyelectrolyte systems, computer simulation of fluids by Monte Carlo, molecular dynamics and stochastic dynamics methods. Preq: CH E 804 or equivalent.

CH E 845 Selected Topics in Chemical Engineering 3(3,0) Topics not covered in other courses emphasizing current literature and results of current research. Topics vary from year to year to keep pace with developments. May be repeated for credit.

CH E 890 Special Projects 1-6 Comprehensive analytical and/or experimental treatment of phenomena of current interest in chemical engineering emphasizing modern technological problems. May be repeated for a maximum of six credits. To be taken Pass/Fail only. Preq: Consent of instructor and department chair.

CH E 891 Master’s Thesis Research 1-12

CH E 895 Chemical Engineering Graduate Seminar 1(1,0) Series of weekly, one-hour seminars given by students, faculty and guests on topics of current interest. Credits earned in this course do not apply to or alter the required minimum of six research hours for the MS degree or the required 30 research credit hours for the PhD degree. To be taken Pass/Fail only.

CH E 945 Selected Topics in Chemical Engineering 3(3,0) More comprehensive study of topics first covered in CH E 845.

CH E 991 Doctoral Dissertation Research 1-12

CHEMISTRY

CH 602 Inorganic Chemistry 3(3,0) Basic principles of inorganic chemistry are discussed with special emphasis on atomic structure, chemical bonding, solid state, coordination chemistry, organometallic chemistry, and acid-base theories. The chemistry of certain selected elements is treated. Offered fall semester only. Preq: CH 331, 332.

CH 604 Bioinorganic Chemistry 3(3,0) Covers fundamentals of bioinorganic chemistry with review of necessary inorganic and biochemical concepts. Topics include metal uptake, transport and storage in biological systems; functions of metals in proteins; metal ion interactions with nucleic acids; physical methods used in bioinorganic chemistry; heavy element toxicity, radiopharmaceuticals and other metalloids. Preq: BIOCH 301 or CH 205.

CH 611 Instrumental Analysis 3(3,0) Principles of operation and application of modern chemical instrumentation in the field of analytical chemistry. Topics include basic electronics, statistics, optical, mass, magnetic resonance, electron and x-ray spectrosocopy, radiochemistry, and separation science. Preq: CH 331, 332.

CH 614 Bioanalytical Chemistry 3(3,0) Survey of selected areas of importance in bioanalytical chemistry. Includes fundamental principles, advanced topics and applications of analytical measurements of biomolecules, bioassays, immunoassays, separations, mass spectrometry, method validation, macromolecular crystallography, microscopy and imaging. Preq: CH 313, 411, or consent of instructor.

CH 621 Advanced Organic Chemistry 3(3,0) Survey of modern organic chemistry with an emphasis on synthesis and mechanisms. Preq: CH 224, 332 or equivalent.

CH 625 Medicinal Chemistry 3(3,0) Survey of the pharmaceutical drug discovery process. Covers discovery of candidate compounds, bioassy methods, associated regulatory and commercial issues. Case studies are selected from the current literature. Preq: CH 224 or equivalent or consent of instructor.

CH 627 Organic Spectroscopy 3(2,3) Survey of modern spectroscopic techniques used in the determination of molecular structure. Emphasis is on the interpretation of spectra: nuclear magnetic resonance, ultraviolet, infrared, mass spectroscopy, optical rotationary dispersion and circular dichroism. Preq: One year each of organic chemistry and physical chemistry.

CH 635 Atomic and Molecular Structure 3(3,0) Introduction to quantum theory and its application to atomic and molecular systems. Topics include harmonic oscillator, hydrogen atom, atomic and molecular orbital methods, vector model of the atom, atomic spectroscopy and molecular spectroscopy. Offered spring semester only. Preq: CH 332 or consent of instructor.

CH 651 Frontiers in Polymer Chemistry 3(3,0) Survey of selected areas of current research in polymer science with particular emphasis on polymer synthesis. Although a text is required for review and reference, course is primarily literature based and focused on areas of high impact to multidisciplinary technology. Preq: CH 223, 224, PFC 415 or consent of instructor.
CH 704 Selected Topics for Chemistry Teachers 1-6(1-6,1-6) Directed individual study in designing experiments and teaching materials or an in-depth study of one or more advanced topics. For graduate students in Elementary and Secondary Education. May be repeated, but only if different topics are covered. Offered spring semester of odd-numbered years only.

CH 800 Professional Development Issues in Chemistry 1(1,0) Covers development of professional behavior for graduate students in chemistry, including communication skills, teaching techniques, research ethics, career management, "grantmanship," and intellectual property issues in science. Prereq: Graduate standing in Chemistry.

CH 807 Theoretical Inorganic Chemistry 3(3,0) Application of group theory to structure and properties of inorganic molecules. Offered spring semester of odd-numbered years only. Prereq: CH 435 and 804 or consent of instructor.

CH 821 Organic Chemistry I 3(3,0) Theoretical concepts of organic chemistry, stereochemistry, and mechanisms of organic reactions. Offered fall semester only. Prereq: CH 421 or satisfactory performance on the organic chemistry placement examination.

CH 822 Organic Chemistry II 3(3,0) Continuation of CH 821; mechanisms of organic reactions including photochemistry and Woodward-Hoffmann rules; modern synthetic organic chemistry. Offered spring semester only. Prereq: CH 821 or consent of instructor.

CH 830 Fundamentals of Physical Chemistry 3(3,0) Principles of classical thermodynamics, chemical kinetics, and quantum chemistry. Offered fall semester only. Prereq: CH 831 or equivalent.

CH 831 Chemical Thermodynamics 3(3,0) Classical thermodynamics emphasizing theory and significance of energetics and systems of variable composition. Offered fall semester of odd-numbered years only. Prereq: CH 331 or equivalent.

CH 832 Statistical Thermodynamics 3(3,0) Study of statistical thermodynamics including ensemble method, ideal gases, internal degrees of freedom, solid state, imperfect gases, distribution function method in fluids, and time-dependent fluctuations. Prereq: CH 831.

CH 835 Chemical Kinetics 3(3,0) Rate processes and reaction mechanisms; order of reaction; theory of rate processes; relation of reaction rates to mechanism; homogeneous and heterogeneous catalysis; experimental methods; chain reactions; diffusion; effects of solvent, temperature and pressure on reaction rates and mechanisms. Lectures are supplemented by assigned problems, paper and oral examination of topic of special interest to the student. Offered spring semester of odd-numbered years only.

CH 837 Quantum Chemistry 3(3,0) Mathematical and conceptual formulation of quantum theory of electronic structure of atoms and molecules; eigenvalue solution of one-dimensional Schrodinger equation and application of this method to chemical problems. Offered fall semester of odd-numbered years only.

CH 838 Computational Chemistry 3(3,0) Theoretical methods and software used in computational chemistry; quantum chemical methods including molecular orbital methods and density functional theory; classical simulation techniques including potential energy functions, molecular mechanics, molecular dynamics and Monte Carlo. Advanced topics vary with interests of students. Prereq: CH 331 and 332 or equivalent.

CH 840 Techniques of Experimental Chemistry 3(3,0) Theory and practice in major experimental techniques used in chemical research; chromatography; NMR, IR, visible, UV, and ORD/CD spectrophotometry; glassblowing and high vacuum techniques; mass spectrometry; ESR; Mossbauer spectrometry and tracer analysis.

CH 841 Chemical Applications of NMR Spectroscopy 3(3,0) Basic concepts of NMR spectroscopy with application to organic, inorganic, physical and analytical chemistry; design of spectroscopic experiments and interpretation of spectra; modern techniques including multipulse, multinuclear and two-dimensional methods. Offered fall semester only. Prereq: CH 331 and 332 or consent of instructor.

CH (E&S) 842 Actinide Chemistry 3(3,0) See E&S 842.

CH 851 Graduate Student Seminar 1-2(1-2,0) Students and faculty review current topics in chemistry. May be taken more than one semester.

CH 852 Departmental Seminar 1-2(1-2,0) Off-campus speakers are invited to present aspects of their research to the chemistry faculty and graduate students every week during the academic year. Some of these talks may form the basis for cumulative examination questions. Attendance is mandatory. May be taken more than one semester. Prereq: Approved bachelor’s degree.

CH 860 Chemical Biology 3(3,0) Covers fundamentals of chemical biology by examining the structure, function, bonding and reactivity of nucleic acids, proteins, carbohydrates and lipids. Topics are covered from the perspective of organic, inorganic, physical and analytic chemistry. Credit will be given for only one of CH 860, BIOCH 631. Prereq: Undergraduate coursework in organic, inorganic, physical and analytic chemistry; or consent of instructor.

CH 891 Master’s Thesis Research 1-12

CH 900 Selected Topics in Inorganic Chemistry 1-4(1-4,0) Metal-metal bonding; homogeneous catalysis; photochemistry; bioinorganic chemistry; solid state chemistry. Topics vary with interests of students. May be repeated for credit if different topics are covered.

CH 910 Selected Topics in Analytical Chemistry 1-4(1-4,0) New techniques and their applications in analytical chemistry; laser methods; data acquisition processing; electronics, instrument/computer interfacing; field methods of sampling and analysis. Topics vary with interests of students. May be repeated for credit, but only if different topics are covered.

CH 920 Selected Topics in Organic Chemistry 1-4(1-4,0) Heterocyclic compounds; stereochemistry; natural products; organometallic chemistry; photochemistry. Topics vary with interests of students. May be repeated for credit, but only if different topics are covered.
CITY AND REGIONAL PLANNING

C R P 601 Introduction to City and Regional Planning 3(3,0)
Introduces students from other disciplines to City and Regional Planning. Spatial and nonspatial areas of discipline are explored through a wide ranging lecture/seminar program. Preq: Consent of instructor.

C R P 603 Seminar on Planning Communication 3(3,0)
In-depth analysis of methods to communicate planning and policy decisions effectively. Familiarizes students with the various communication skills needed by planners, policy makers and other professionals to become successful practitioners. Preq: Consent of instructor.

C R P (C E) 612 Urban Transportation Planning 3(3,0)
See C E 612.

C R P 634 Geographic Information Systems for Landscape Planning 3(1,6)
Develops competence in geographic information systems technology and its application to various spatial analysis problems in landscape planning. Introduces basic principles of GIS and their use in spatial analysis and information management. Topics include database development and management, spatial analysis techniques, cartography, critical review of GIS applications and hands-on projects.

C R P 800 Human Settlement 3(3,0)
Overview of forces and trends affecting community growth and change—historical, ecological, economic, demographic, design and development—pertaining to human settlement patterns and their interrelationship in the urbanization process, especially at the national, regional, townscape and neighborhood scale. Teams taught from various perspectives. Intended as a foundation core course for Master’s in Real Estate Development, City and Regional Planning, and Landscape Architecture. Preq: Consent of instructor.

C R P 801 Planning Process and Legal Foundations 3(3,0)
Introduction to the city and regional planning profession and related processes with the legal foundation for comprehensive planning and tools of implementation. Preq: Consent of instructor.

C R P 802 Site Planning and Infrastructure 3(3,0)
Covers the principles and practice of site planning, including site analysis, site design, infrastructure planning; exploration of site planning options for residential, commercial, office, industrial and mixed-use projects; street network, civic space, and open space planning; emphasis on walkable, mixed-use, transit-oriented, sustainable development. Preq: Consent of instructor.

C R P 803 Quantitative Analysis 4(2,6)
Basic tools of quantitative analysis and planning methods in the context of analytical, procedural and institutional needs of the planner. Students learn data collection, analysis and interpretation of different planning problems. Emphasis is placed on understanding the logic of statistical analysis, methods of planning analysis and policy formation. Preq: Consent of instructor.

C R P 804 Land Use Analysis and Assessment 4(2,6)
Introduction to basic methods of land use planning including land suitability analysis, land market forecasts and formulating alternative land use plans. Development impact assessment and project appraisal methods are introduced to evaluate land use plans. Preq: C R P 803.

C R P 805 Planning Theory and History 3(3,0)
Development of the planning practice and theories of planning process: historical evolution of planning practice in the U.S., social issues in planning, theories of planning and critiques of those theories and ethical issues in planning practice. Preq: Consent of instructor.

C R P 806 Urban Systems and Growth Management 3(3,0)
Overview of basic principles of resource allocation including public finance and project appraisal techniques. Introduces infrastructure planning and capital improvement plans followed by basic concepts of growth management and an overview of growth management laws and tools. Course is team-taught to address diverse subject matter. Preq: Consent of instructor.

C R P 807 Professional Studio 4(2-3,6-9)
Serves as a vehicle for synthesis and application of skills developed in other courses and includes participation in one or more real-world planning projects in addition to seminars and readings devoted to development of professional practice skills. Preq: Consent of instructor.

C R P 809 Current Issues in Planning 1(1,0)
Students are exposed to current practice issues in various fields of the planning profession through a series of guest speakers representing various areas of planning practice. The course is organized around the various concentration areas of the Clemson MCRP program. Preq: MCRP status.

C R P 813 Fundamentals of Transportation Planning 3(3,0)
Identifies issues and questions transportation planners face, characterizes policy shaping transportation, instructs on methods to solve transportation planning problems and portrays the political and organizational environment in which transportation planners operate. Students integrate concepts and considerations via a systems approach with sensitivity to the transportation planning environment. Preq: Consent of instructor.

C R P 814 Public Transit 3(3,0)
Familiarizes students with core concepts and practices in public transit. Course modules examine modes and design, planning issues and organizational environments inherent to public transit, and technical operations. Course concludes with an examination of comprehensive transit systems. Preq: Consent of instructor.

C R P 815 Transportation Innovation 3(3,0)
Through lectures, seminar discussions and collaborative learning activities, course interaction develops students’ transportation knowledge, research and ideas. Students are encouraged to use information already obtained to create visionary thinking and interaction skills needed to become transportation leaders. Preq: C R P 813.

C R P 820 Negotiation and Development Dispute Resolution 3(3,0)
Skill-building course in conflict resolution and consensus building through bargaining and negotiation, primarily in the design professions. Students play active roles in discovering, applying, reflecting on and critiquing the theories, styles and techniques of conflict resolution and consensus building that work in different types of disputes. Preq: Graduating standing in a design related field.

C R P 822 Urban Design 3(3,0)
Urban design theory and practice covering both project design and regulatory frameworks; analysis of historical precedents and current theories; review of the urban design process, including urban landscape analysis, problem identification, development of alternatives, and plan generation; special focus on form-based codes. Preq: Consent of instructor.

C R P 832 Problems in Site Planning 3(1,6)
Advanced site planning and design concept studies developed through site projects; concentration on industrial, residential and recreational facilities. Emphasis is on usespecific site analysis and generation of development alternatives. Preq: Consent of instructor.

C R P 834 Spatial Modeling Using GIS 3(2,3)
Use of geographic information systems (GIS) in spatial analysis, information management and synthesis of spatial patterns and processes. Emphasizes developing an operational understanding of the modeling techniques and data used in different applications such as land use allocation, corridor location, site location and market analysis, environmental assessment and cost-benefit analysis. Preq: C R P 634 or 804; or consent of instructor.

C R P 835 GIS and Remote Sensing Applications for Trend Analysis 3(2,3)
Principles of remote sensing and land information systems in trend analysis. Addresses aspects of change detection for monitoring natural resources and urban growth. Designed for those interested in planning, natural resources management and environmental analysis. Lectures and hands-on laboratory work emphasize the use of imagery for database generation and analysis. Preq: C R P 634, 804, or 834; or consent of instructor.

C R P 840 Seminar in Coastal Planning 3(3,0)
Issues relating to development and conservation of coastal environments, focusing on inherent tradeoffs between growth and environmental quality. Discusses ecology and carrying capacity of coastal areas and appropriate management approaches to balance coastal resource demand. Preq: Consent of instructor.