Chemical and Environmental Engineering

Course Descriptions

CEE 200 Advanced Engineering Computation (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): ENGR 118 or consent of instructor. Problem-solving techniques for basic engineering systems including heat and mass transfer, coupled reactions, fluid flow potential, and control.

CEE 202 Transport Phenomena (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): CHE 114, CHE 116, CHE 120, ENGR 118; or consent of instructor. Topics include transport phenomena, potential flow, and boundary layer theories with applications to simultaneous heat, momentum, and mass transfer. Introduces numerical techniques used to solve advanced transport phenomena problems.

CEE 203 Biomass Conversion to Fuels, Chemicals, Materials, and Power (4) Lecture, 3 hours; term paper, 3 hours. Prerequisite(s): graduate standing or consent of the instructor. Provides current and future sustainable technologies for energy production. Includes key physical and chemical principles governing performance. Considers economics and life cycle implications of energy options. Examines current and projected energy use patterns and impacts on the environment. Considers energy policies that can facilitate introduction of sustainable energy production systems. May be taken Satisfactory (S) or No Credit (NC) with consent of instructor and graduate advisor.

CEE 204 Advanced Kinetics and Reaction Engineering (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): graduate standing or consent of the instructor. For CEE 204 online section: enrollment in the Online Master-of Science in Engineering program. Emphasizes kinetics and mechanisms of heterogeneous reactions in different types of reactors. Specific topics include gas-solid noncatalytic reactions; catalytic surfaces and catalyst characterization; and adsorption, diffusion, reaction, and heat transfer in porous catalysts.

CEE 206 Advanced Chemical Engineering Thermodynamics (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): CHE 130/ ENVE 130 or consent of instructor. For CEE 206 online section; enrollment in the online Master-in-Science in Engineering program. Application of the laws of thermodynamics to phase and chemical reaction equilibrium. Introduction to statistical thermodynamics, molecular simulations, and the evaluation of thermodynamic properties from molecular simulations.

CEE 210 Cell Engineering (4) Lecture, 3 hours; laboratory, 3 hours. Prerequisite(s): CHE 124 or consent of instructor. Introduction to genetic and environmental manipulation of cells for production of proteins and for enhanced biocatalytic and synthetic activities. Topics include cloning and gene expression in different host systems, posttranslational processing, metabolic controls and kinetics, in vivo nuclear magnetic resonance spectroscopy, cell modeling, and sensitivity analysis. Credit is awarded for only one of CEE 210 or CHE 140.

CEE 211 Upstream Processes in Biotechnology (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): CHE 124, CEE 236, graduate standing; or consent of instructor. Introduces the techniques and laboratory practices of upstream processes including mammalian, animal, and plant cell culture, protein engineering, and bioproduct design. Topics covered include

antibody, protein, and biomolecule design, production of proteins and biomolecules by cell culture, and media formulation, sterilization, and quality control of upstream processes.

CEE 212 Bioseparations and Bioprocess Engineering (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): CHE 124 or consent of instructor. Examines fundamentals of separation processes used to isolate and purify biochemical products such as whole cells, enzymes, food additives, and pharmaceuticals. Covers selected aspects of biochemical engineering such as microbial interactions, economics, and mathematical modeling of bioprocesses.

CEE 220 Modeling Chemical, Biochemical, and Environmental Processes (4) Lecture, 2 hours; discussion, 2 hours. Prerequisite(s): graduate standing in Chemical and Environmental Engineering or consent of instructor. Introduces simulation softwares and the use of numerical simulation to solve dynamic chemical, biochemical, and environmental problems. Topics include model formulation and development, model sensitivity studies, and application of simulations to chemical, biochemical, and environmental processes.

CEE 221 Introduction to Microfluidics (4) Lecture, 4 hours. Prerequisite(s): CHE 160A/ ENVE 160A or consent of instructor. Provides a theoretical and practical introduction to microfluidic devices. Covers traditional and new methods for making microfluidic devices and assembly of components into systems. Emphasizes the considerations underlying the design or operation of devices based on pressure-driven or electrokinetic flow. May be taken Satisfactory (S) or No Credit (NC) with consent of instructor and graduate advisor.

CEE 225 Physical-Chemical Separation Processes (4) Lecture, 4 hours. Prerequisite(s): graduate standing in Chemical and Environmental Engineering or consent of instructor. CEE 225 online section; enrollment in the Online Master-in-Science in Engineering program. Covers concepts of physical and chemical processes relevant to engineered and natural environmental systems. Topics include basic colloid chemistry, DLVO theory, coagulation and flocculation, mechanisms of particle removal in filters and transport in porous media, absorption, disinfection, control of disinfection by-products, and advanced treatment processes such as membranes. Credit is awarded for only one of CEE 225 or ENVE 120. CEE 226 Biological Unit Processes (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): CHE 120, ENVE 142; or consent of instructor. CEE 226 online section; enrollment in the Online Master-in-Science in Engineering program. Theory and design of biological unit processes used in environmental engineering. Suspended growth processes, attached growth processes, digestion processes, and nutrient removal systems are covered. Credit is not awarded for CEE 226 if already awarded for ENVE 121.

CEE 230 Biosensors (4) Lecture, 2 hours; laboratory, 6 hours. Prerequisite(s): BCH 110A, BCH 110B, BIOL 121/MCBL 121, CHE 124; or consent of instructor. Introduces the fundamentals and applications of biosensors. Covers enzyme-, whole cell-, tissue-, and antibody- or antigen-based electrochemical, optical, and piezoelectric biosensors.

Applies such knowledge to bioprocess monitoring and control, environmental monitoring, and health care.

CEE 231 Scattering and Reflectometry for Environmental, Material, and Biological Applications (4) Lecture, 3 hours; discussion, 5 hours per quarter; laboratory, 15 hours per quarter. Prerequisite(s): CEE 206 or equivalent. Covers experimental and theoretical aspects of conventional static and dynamic light scattering, small-angle X-ray scattering, small-angle neutron scattering, X-ray and neutron reflectivity for colloids and biological solutions, surfaces, and interfaces. May be taken Satisfactory (S) or No Credit (NC) with consent of instructor and graduate advisor.

CEE 232 Green Engineering (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): CHE 120 or consent of instructor. A study of the design, commercialization, and use of feasible and economical processes and products that minimize risks to human health and the environment. Topics include environmental issues, risk assessment, and regulations; flow of chemical and manufacturing unit processes and flow-sheet analysis for pollution prevention; product life-cycle assessment; and industrial ecology. May be taken Satisfactory (S) or No Credit (NC) with consent of instructor and graduate advisor. Credit is awarded for only one of CEE 132 or CEE 232.

CEE 233 Advanced Air Pollution Control and Engineering (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): CEE 202, CEE 206, CHEM 008A and CHEM 08LA or CHEM 08HA and CHEM 08HLC, CHEM 008B and CHEM 08LB or CHEM 08HB and CHEM 08HLB, ENVE 133, ENVE 134; or consent of instructor. Covers principles necessary to understand the atmospheric behavior of air pollutants. Topics include gas- and aerosol-phase chemistry, atmospheric diffusion, removal processes and residence times, and the formation and fate of gas and aerosol pollutants.
CEE 234 Vehicle Emissions Control Technology, Measurement Procedures, and Alternative Fuels (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): graduate standing or consent of instructor. Covers the nature of gaseous and particulate emissions and the technical aspects of energy efficiency from mobile sources. May be taken Satisfactory (S) or No Credit (NC) with consent of instructor and graduate advisor.

CEE 236 Energy: Production, Use, Economics, and Sustainability (4) Lecture, 3 hours; term paper, 3 hours. Prerequisite(s): graduate standing or consent of instructor. Provides insights into current and future sustainable energy production technologies including key governing physical and chemical principles. Considers economics and life cycle implications of energy options. Also examines current and projected energy use patterns and environmental impacts. Considers energy policies that can facilitate introduction of sustainable energy production systems. May be taken Satisfactory (S) or No Credit (NC) with consent of instructor and graduate advisor.

CEE 238A Bioprocess Design Laboratory I (2) Laboratory, 3 hours; lecture, 1 hour. Prerequisite(s): CHE 124 (CHE 124 may be taken concurrently); graduate standing; or consent of instructor. A detailed introduction to bioprocess

design. Covers plant design and heat, mass, and fluid transport, with a focus on upstream processes including bioreactors and feedstocks. Students (individually or in small teams) propose and design a bioprocess. A written report and an oral presentation of the bioprocess design are required.

CEE 238B Bioprocess Design Laboratory II (3) Lecture, 2 hours; laboratory, 3 hours. Prerequisite(s): CEE 238A, graduate standing; or consent of instructor. Covers plant design, heat, mass, and fluid transport, with a focus on downstream separation processes and technoeconomic analysis. Students (individually or in small teams) propose and design a bioprocess. A written report and presentation are required.

CEE 238C Bioprocess Design Laboratory III (3) Lecture, 2 hours; laboratory, 3 hours. Prerequisite(s): CEE 238B, graduate standing; or consent of instructor. Explores the fundamentals and application of bioprocess design. Covers plant design, process technoeconomic analysis and cost sensitivity, and good manufacturing practices. Students (individually or in small teams) propose and design a bioprocess. A written report and presentation are required.

CEE 241 Aquatic Chemistry (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): CHE 100, ENVE 142; or consent of instructor. CEE 241 online section; enrollment in the Online Master-in-Science in Engineering program. Chemical principles and equilibrium models used to describe the behavior of natural water systems, water and wastewater treatment processes, and pollutant transformations in the aqueous environment. Topics include acid-base chemistry, precipitation, complexation, and redox reactions. Credit is not awarded to CEE 241 if already awarded to ENVE 140.

CEE 242 Pilot Plant Laboratory (4) Lecture, 1 hour; laboratory, 9 hours. Prerequisite(s): ENVE 120, ENVE 121; or consent of instructor. Laboratory investigations of physical, chemical, and biological processes for water treatment, wastewater treatment, and soil remediation.

CEE 243 Advanced Water Treatment Technologies (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): graduate standing or consent of instructor. CEE 243 online section; enrollment in the Online Master-in-Science in Engineering program. Fundamentals of advanced water treatment processes emphasizing membrane separation, advanced oxidation processes, and the application of nanomaterials in environmental engineering applications. Credit is only awarded for one of CEE 243 or ENVE 133.

CEE 245 Advanced Hydraulic Engineering (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): CHE 114, ENVE 142 (ENVE 142 may be taken concurrently); or consent of instructor. An introduction to the basic methods of hydraulic engineering for water quality control. Topics include design and analysis of basic flow and water containment structures, sanitary and storm sewers, pumps and valves, and pipe networks. Emphasis is given to design projects aimed at developing skills in problem specification, modeling, and analysis. May be taken Satisfactory (S) or No Credit (NC) with consent of instructor and graduate advisor.

CEE 246 Surface and Interface Phenomena (4)

Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): CHE 100 or ME 100A or consent of instructor. An introduction to colloid systems, capillarity, surface tension and contact angle, and micelles and microemulsions. Also covers adsorption and desorption at the solid-liquid interface, electrostatic forces, and colloid stability.

CEE 247 Molecular Thermodynamics of Complex Fluids (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): CEE 200 or equivalent, CEE 206, MSE 204/PHYS 212A; or consent of instructor. Introduces recent developments in applied thermodynamics and molecular simulations. Emphasizes current concerns in chemical and environmental engineering such as colloids, polymers, biomacromolecules, and fluids under inhomgeneous conditions.

CEE 248 Quantitative Analysis of Upstream Processes in Biotechnology (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): CEE 211, graduate standing; or consent of instructor. Examines fundamentals of biomolecular ligand binding, enzyme kinetics, enzyme reaction mechanisms, and whole-cell biocatalysis. Topics include the quantitative description of steady state and pre-steady state enzyme kinetics, the effects of mass transfer on enzyme and wholecell biocatalysis, and analytical methods to study enzyme kinetics and protein-ligand binding interactions.

CEE 249 Integration of Computational and Experimental Biology (4) Lecture, 3 hours; laboratory, 3 hours. Prerequisite(s): BIOL 005B; MATH 010B, MATH 046, PHYS 040C; graduate standing. BIEN 249/CEE 249 online section; enrollment in the Online Master-in-Science in Engineering program. A multidisciplinary introduction to computational methods used to analyze experimental biological data. Introduction to mathematical concepts needed to understand protein structure and dynamics, protein-protein interactions (structures and networks), gene regulatory networks, signal transduction networks, metabolic networks, and kinetic modeling of cellular processes. Also covers techniques used to derive experimental data. May be taken Satisfactory (S) or No Credit (NC) with consent of instructor and graduate advisor. Cross-listed with BIEN 249.

CEE 250 Special Topics in Chemical and Environmental Engineering (1 or 2) Seminar, 1 to 2 hours. Prerequisite(s): graduate standing. Seminar in selected topics in chemical and environmental engineering presented by graduate students, staff, faculty, and invited speakers. Students who present a seminar receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable.

CEE 251 Microbial Engineering and Environmental Biotechnology (1 or 2) Seminar, 1 to 2 hours. Discusses the recent development of novel biocatalysts and biological materials for degrading toxic pollutants or synthesizing environmentally friendly chemicals. Students who present a seminar receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable.

CEE 253 Biodegradation and Bioremediation (1 or 2) Seminar, 1 to 2 hours. Prerequisite(s): graduate standing. Reviews current research. Special emphasis is placed on biological techniques for air pollution control, bioremediation of methyl tert-butyl ether, and

molecular techniques for microorganism monitoring. Normally graded Satisfactory (S) or No Credit (NC), but students may petition the instructor for a letter grade on the basis of assigned extra work or examination. Course is repeatable.

CEE 254 Organic Electronic Materials (2) Seminar, 2 hours. Prerequisite(s): graduate standing or consent of instructor. A study of design, synthesis, purification, manufacture, and application of carbon-based electronic materials. Students who present a seminar or submit a term paper receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable. Cross-listed with CHEM 267.

CEE 255 Special Topics in Water Quality Engineering (1 or 2) Seminar, 1 to 2 hours. Prerequisite(s): graduate standing. Involves reports and discussion by students, faculty, and visiting scholars on current research topics in water quality engineering. Students who present a seminar receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable.

CEE 256 Special Topics in Particulate Measurement and Air Quality (1 or 2) Seminar, 1 to 2 hours. Prerequisite(s): graduate standing. Topics include atmospheric chemistry, aerosol chemistry and physics, and measurement techniques used for source and ambient sampling of gases and aerosols. Normally graded Satisfactory (S) or No Credit (NC), but students may petition the instructor for a letter grade on the basis of assigned extra work or examination. Course is repeatable.

CEE 257 Special Topics of BioNanotechnology (1 to 2) Seminar, 1 hour; consultation, 0 to 1 hour. Prerequisite(s): graduate standing or consent of instructor. Focuses on the application of nanotechnology for further developments in bioengineering and medicine. Students complete presentations on the latest developments in nanotechnology. Students who submit a term paper receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable.

CEE 258 Biosensing and Biodetoxification (1 or 2) Seminar, 1 to 2 hours. Prerequisite(s): graduate standing. Involves oral presentations and intensive small-group discussions of current literature on biological detoxification of hazardous chemicals and biological-based sensors for environmental, clinical, food quality, and process monitoring. Graded Satisfactory (S) or No Credit (NC). Course is repeatable.

CEE 259 Special Topics in Materials Electrochemistry (1) Seminar, 1 hour. Prerequisite(s): graduate standing. Topics include nanoelectrochemical systems, electrochemistry, bioelectrochemistry, magnetic materials, spintronics, microelectromechanical systems/ nanoelectromechanical systems (MEMS/NEMS), nanosensor arrays, nanoelectronics, corrosion, fuel cells, batteries, thermoelectric materials, electroenzymology, electrodeposition, electroless deposition, and synthesis of nanowires and nanotubes. Normally graded Satisfactory (S) or No Credit (NC), but students may petition the instructor for a letter grade on the basis of assigned extra work or examination. Course is repeatable as topics change.

Chemical and Environmental Engineering

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CEE 260 Structural Ordering in Colloidal Dispersions (1 or 2) Seminar, 1 to 2 hours. Prerequisite(s): graduate standing. Introduces recent advances in understanding intercolloid forces and self-assembly of colloidal particles for the fabrication of new materials. Students who present a seminar receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable.

CEE 261 Special Topics in Zeolites, Fuel Cells, and Nanostructured Materials (1 or 2) Seminar, 1 to 2 hours. Prerequisite(s): graduate standing. Covers design, synthesis, and engineering of zeolite thin films for applications in semiconductors and in aerospace; development of fuel cell membranes and electrode catalysts and production of hydrogen; and synthesis and manipulation of nanomaterials. Students who present a seminar receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable.

CEE 262 Special Topics in Systems Biology (1 or 2) Seminar, 1 to 2 hours. Prerequisite(s): graduate standing. Consists of oral presentations and intense small-group discussions of the current literature and research on computational and experimental aspects of systems biology. Explores high-throughput experiments, experimental design, numerical methods, model development, written and oral presentation skills, ethics, and laboratory techniques. Students who present a seminar receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable.

CEE 263 Membrane Separations (2) Seminar, 2 hours. Prerequisite(s): graduate standing in Chemical and Environmental Engineering or consent of instructor. Covers theoretical and applied concepts of membrane separation processes. Topics may include basic membrane transport theory, membrane materials and formation processes, advanced colloid and surface chemistry, Derjaguin-Landau-VerweyOverbeek (DLVO) theory on colloid stability, colloidal hydrodynamics, and transport in porous media. Graded Satisfactory (S) or No Credit (NC). Course is repeatable.

CEE 265 Special Topics in Microbial Fate and Transport in Aquatic Environments (1 or 2) Seminar, 1 hour; individual study, 0 to 3 hours. Prerequisite(s): graduate standing or consent of instructor. Explores the theoretical and applied research currently being conducted in the area of microbial pathogen transport in natural and engineered aquatic systems. Topics include the theory of colloid transport and filtration, quantification and analysis of microbial adhesion or deposition kinetics, and whole-cell and molecular-scale microbial analysis techniques. Students who give class presentations receive credit for 2 units; other students receive credit for 1 unit. Graded Satisfactory (S) or No Credit (NC). Course is repeatable.

CEE 266 Special Topics in Biological Conversion of Biomass (1 or 2) Seminar, 1 hour; individual study, 0 to 3 hours. Prerequisite(s): graduate standing. Consists of oral presentations and small group discussions of current and historic literature on biological conversion of biomass to fuels and chemicals. Students who make presentations receive credit for 2 units; other students receive credit for 1 unit. Graded Satisfactory (S) or No Credit

(NC). Course is repeatable as topics change.

CEE 267 Special Topics in Bionanotechnology (2) Seminar, 2 hours. Prerequisite(s): graduate standing. Introduces recent advances in biomimetics, biomineralization, and bio-inspired materials for nanostructures, as well as for energy storage and conversion applications. Students who present a seminar receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable to a maximum of 18 units.

CEE 268 Special Topics in Environmental Chemistry (2) Seminar, 2 hours. Prerequisite(s): graduate standing. Addresses the key role that environmental chemical processes play in water quality, pollutant fate, and the development of strategies for the treatment and reuse of contaminated natural resources. Students who present a seminar receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable to a maximum of 18 units.

CEE 269 Special Topics in Aerosols and Climate (2) Seminar, 2 hours. Prerequisite(s): graduate standing. Introduces research at the interface of particle air quality and climate. Focuses on the effects of particle formation and composition on climate. Normally graded Satisfactory (S) or No Credit (NC), but students may petition the instructor for a letter grade on the basis of assigned extra work or examination. Course is repeatable.

CEE 286 Colloquium in Chemical and Environmental Engineering (1) Colloquium, 1 hour. Prerequisite(s): graduate standing. Lectures on a current research topic in chemical engineering, environmental engineering, and other related fields presented by faculty members and visiting scientists. Graded Satisfactory (S) or No Credit (NC). Course is repeatable.

CEE 290 Directed Studies (1 to 6) Individual study, 3 to 18 hours. Prerequisite(s): graduate standing; consent of instructor and graduate advisor. Individual study, directed by a faculty member, of selected topics in chemical and environmental engineering. Graded Satisfactory (S) or No Credit (NC). Course is repeatable to a maximum of 9 units.

CEE 292 Concurrent Studies in Chemical and Environmental Engineering (1 to 4) Outside research, 3 to 12 hours. Prerequisite(s): consent of instructor. To be taken concurrently with a 100-series course but on an individual basis. Devoted to specific additional projects related to the 100-series course. Faculty provide guidance and evaluation throughout the quarter. Graded Satisfactory (S) or No Credit (NC). Course is repeatable to a maximum of 8 units.

CEE 297 Directed Research (1 to 6) Outside research, 3 to 18 hours. Prerequisite(s): graduate standing; consent of instructor. Research conducted under the supervision of a faculty member on selected problems in chemical and environmental engineering. Graded Satisfactory (S) or No Credit (NC). Course is repeatable to a maximum of 9 units.

CEE 298I Individual Internship (1 to 12) Written work, 1 to 12 hours; internship, 2 to 24 hours. Prerequisite(s): graduate standing; consent of instructor. Individual apprenticeship in chemical and environmental engineering with an approved professional

individual or organization, and a faculty member. A written report is required. Graded Satisfactory (S) or No Credit (NC). Course is repeatable to a maximum of 16 units.

CEE 299 Research for the Thesis or Dissertation (1 to 12) Outside research, 3 to 36 hours. Prerequisite(s): graduate standing; consent of instructor. Research in chemical and environmental engineering for the M.S. thesis or Ph.D. dissertation. Graded Satisfactory (S) or No Credit (NC). Course is repeatable.

Professional Course

CEE 302 Teaching Practicum (1 to 4) Seminar, 1 to 4 hours. Prerequisite(s): appointment as a teaching assistant or associate in Chemical and Environmental Engineering. Topics include effective teaching methods such as those involved in leading discussion sections, preparing and grading examinations, and student-instructor relations in lower- and upperdivision Chemical Engineering and Environmental Engineering courses. Required each quarter of teaching assistants and associates in Chemical and Environmental Engineering. Graded Satisfactory (S) or No Credit (NC). Course is repeatable to a maximum of 12 units.