Course Catalog - Spring 2006

Chemical and Biomolecular Engineering

101 ***Hidden World of Engineering*** Credit: 3 hours.

Tells the stories of everyday objects: bathtubs, pop cans and screws. These simple objects shape our lives, yet are engineering masterpieces. To unveil this hidden world the course uses a humanistic approach. Designed to appeal to all majors, it uses human stories - filled with failures and triumphs - to reveal the methods of engineers. The course enchants with tales of ancient steel making, today's pop cans, huge stone monuments, and salt. The course will change how a student looks at his or her world. Several sessions focus on women engineers and the environment.

This course satisfies the General Education Criteria for aPhysical Sciences course.

121 ***CHBE Profession*** Credit: 1 hours.

Lectures and problems on the history and scope of chemical engineering endeavors; decisions and criteria for process development and plant design. Approved for both letter and S/U grading. Prerequisite: CHEM 102 or 202.

199 ***Undergraduate Open Seminar*** Credit: 1 to 5 hours.

Approve for both Standard and S/U grading. May be repeated.

201 ***Cooperative Education Planning*** Credit: 0 hours.

Same as CHEM 291. See CHEM 291.

202 ***Cooperative Education Practice*** Credit: 0 hours.

Same as CHEM 293. See CHEM 293.

210 ***CHBE Internship*** Credit: 0 hours.

Full-time practice of chemical science in an off-campus industrial setting or research laboratory environment. Summary report required. May be repeated. Approved for S/U grading. Prerequisite: Completion of freshman year or equivalent, or consent of Director of Cooperative Education in Chemical and Biomolecular Engineering.

221 ***Principles of CHE*** Credit: 3 hours.

Lectures and problems on material and energy balances. Prerequisite: CHEM 104 or 204; credit or concurrent registration in CS 101.

297 ***Individual Study Sophomores*** Credit: 1 to 3 hours.

Individual study of problems related to Chemical and Biomolecular Engineering. May be repeated to a maximum of 6 hours. Prerequisite: Sophomore standing and consent of instructor.

321 ***Thermodynamics*** Credit: 4 hours.

Fundamental concepts and the laws of thermodynamics; the first and second law applications to phase equilibrium and chemical equilibrium and other applications in the Chemical and Biomolecular Engineering profession. Prerequisite: CHBE 221.

397 ***Individual Study for Juniors*** Credit: 1 to 3 hours.

Individual study of problems related to Chemical and Biomolecular Engineering. May be repeated to a maximum of 6 hours. Prerequisite: Junior standing and consent of instructor.

421 ***Momentum and Heat Transfer*** Credit: 4 hours.

Introduction to fluid statics and dynamics; dimensional analysis; design of flow systems; introduction to heat transfer; conduction, convection, and radiation. Prerequisite: CHBE 221 or consent of instructor.

422 ***Mass Transfer Operations*** Credit: 4 hours.

Introduction to mass transfer processes and design methods for separation equipment. Prerequisite: CHBE 421 or consent of instructor.

424 ***Chemical Reaction Engineering*** Credit: 3 hours.
Chemical kinetics, chemical reactor design, and the interrelationship between transport, thermodynamics, and chemical reaction in open and closed systems Prerequisite: Credit or registration in CHBE 422.

430 ***Unit Operations Laboratory*** Credit: 4 hours.
Experiments and computation in fluid mechanics, heat transfer, mass transfer, and chemical reaction engineering. Exercises in effective Chemical and Biomolecular Engineering communications. Prerequisite: CHBE 422; credit or concurrent registration in CHBE 424; senior standing in Chemical and Biomolecular Engineering.
This course satisfies the General Education Criteria for aAdvanced Composition course.

431 ***Process Design*** Credit: 4 hours.
Capstone design course where students apply principles from previous courses to the design of complete chemical process systems. Topics include: techniques used in the synthesis and analysis of chemical processes, process simulation and optimization, effective communication in a chemical process engineering environment. Prerequisite: CHBE 422; credit or concurrent registration in CHBE 424.
This course satisfies the General Education Criteria for aAdvanced Composition course.

440 ***Process Control and Dynamics*** Credit: 4 hours.
Techniques used in the analysis of process dynamics and in the design of process control systems; includes Laplace transforms, stability analysis, and frequency response methods. Laboratory emphasizes on-line data acquisition and control. Prerequisite: CHBE 421 and senior standing in Chemical and Biomolecular Engineering; MATH 385; CS 101.

451 ***Transport Phenomena*** Credit: 3 hours.
Unifying treatment of physical rate processes with particular emphasis on the formulation and solution of typical boundary value problems associated with heat, mass, and momentum transport. Prerequisite: CHBE 421; MATH 385.

452 ***Chemical Kinetics & Catalysis*** Credit: 3 hours.
Problems in chemical kinetics; techniques for the prediction and measurement of rates of reactions; and homogeneous and heterogeneous catalysis chain reactions. Prerequisite: CHEM 442 or CHBE 321.

453 ***Electrochemical Engineering*** Credit: 2 or 3 hours.
Fundamentals of analysis, design, and optimization of electrochemical systems. Prerequisite: Senior standing in physical science or engineering.

454 ***CHBE Projects*** Credit: 2 hours.
Laboratory; development of an individual project. Prerequisite: Senior standing in Chemical and Biomolecular Engineering.

456 ***Polymer Science & Engineering*** Credit: 3 hours.
Fundamentals of polymer science and engineering: polymerization mechanisms, kinetics, and processes; physical chemistry and characterization of polymers; polymer rheology, mechanical properties, and processing. Credit is not given for both CHBE 456 and MSE 450, or MSE 451. Prerequisite: CHBE 321; credit or concurrent registration in CHBE 421; CHEM 444.

457 ***Microelectronics Processing*** Credit: 3 hours.
Introductory survey of chemical processing principles applied to microelectronic fabrication. Key concepts originate from chemical kinetics; thermodynamics; mass and energy balances; transport of mass, momentum and heat; and process synthesis and integration. Prerequisite: Junior or senior standing in Chemical and Biomolecular Engineering, Electrical and Computer Engineering, or Materials Science and Computer Engineering.

460 ***Process Development*** Credit: 3 hours.
Experimental design projects. Topics include statistical design of experiments, parameter estimation, scale-up, design optimization, process simulation, and statistical quality control. Prerequisite: Senior standing in Chemical

and Biomolecular Engineering.

471 ***Biochemical Engineering*** Credit: 3 to 4 hours.

Applications of chemical engineering principles to biological processes. Topics include enzyme mechanisms and kinetics, bioreactor design, cellular growth and metabolism, fermentation, and bioseparations. 3 undergraduate hours. 4 graduate hours. Prerequisite: Junior, senior, or graduate standing, or consent of instructor.

472 ***Techniques in Biomolecular Eng*** Credit: 3 or 4 hours.

Study of the engineering principles that underlie many of the powerful tools in biotechnology, and addresses how scientific discoveries and engineering approaches are being used in current industrial applications. Topics addressed include: physical principles that govern self-organization and repair in biological systems; the tools that have been developed to characterize, manipulate, and quantify biomolecules; and the use of analytical tools and genetic manipulation in modern bioengineering and biotechnology applications. Same as BIOE 472. 3 undergraduate hours. 4 graduate hours. Prerequisite: CHEM 202, CHEM 203, CHEM 204 or equivalent; MATH 220; PHYS 211, PHYS 214 or equivalent; MCB 350.

473 ***Biomolecular Engineering*** Credit: 3 to 4 hours.

Fundamental principles of biomolecular engineering and its applications in pharmaceutical, agriculture, chemical and food industries. Topics include gene discovery, rational design, directed evolution, pathway engineering, and functional genomics and proteomics. 3 undergraduate hours. 4 graduate hours.

474 ***Metabolic Engineering*** Credit: 3 or 4 hours.

Introduction to the principles and methodology of metabolic engineering. Topics include experimental and mathematical techniques for the quantitative description, modeling, control, and design of metabolic pathways. 3 undergraduate hours. 4 graduate hours. Prerequisite: MATH 225 and 385 or consent of instructor.

494 ***Special Topics*** Credit: 1 to 3 hours.

Study of topics in chemical engineering; content varies from term to term. Typical topics include optimization, chemical kinetics, phase equilibrium, biochemical engineering, kinetic theory, and transport properties. May be repeated. Prerequisite: Senior standing in Chemical and Biomolecular Engineering, or consent of instructor.

497 ***Individual Study for Seniors*** Credit: 1 to 3 hours.

Individual study of problems related to Chemical and Biomolecular Engineering. 3 undergraduate hours. May be repeated to a maximum of 6 hours. Prerequisite: Senior standing and consent of instructor. No graduate credit.

499 ***Senior Thesis*** Credit: 1 to 6 hours.

Limited in general to seniors in the curriculum in chemical and biomolecular engineering. Any others must have the consent of the head of the department. Each student taking the course must register in a minimum of 5 hours either in one term or divided over two terms. A maximum registration of 10 hours in two terms is permitted. In order to receive credit, a thesis must be presented by each student registered in CHBE 499. No graduate credit.

521 ***Applied Mathematics in CHBE*** Credit: 3 or 4 hours.

Development of mathematical models and a survey of modern mathematical methods currently used in the solution of chemical and biomolecular engineering problems; topics include the application of vectors and matrices, partial differential equations, numerical analysis, and methods of optimization in Chemical and Biomolecular Engineering. Prerequisite: Consent of instructor.

522 ***Fluid Dynamics*** Credit: 4 hours.

Basic concepts in fluid dynamics with special emphasis on topics of interest to chemical and biomolecular engineers; derivation of the Navier-Stokes equations; solutions for creeping flow, for perfect fluids, and for boundary layers; non-Newtonian fluids; and turbulence. Prerequisite: Consent of instructor.

523 ***Heat and Mass Transfer*** Credit: 3 or 4 hours.

Principles of transfer operations developed in terms of physical rate processes; boundary layer heat and mass transfer, eddy diffusion, phase changes, and separation processes. Prerequisite: Consent of instructor.

551 ***Chemical Kinetics & Catalysis*** Credit: 4 hours.
Rates and mechanisms of chemical reactions, treatment of data, steady state and unsteady behavior predictions of mechanisms, prediction of rate constants and activation barriers. Introduction to catalysis. Catalysis by solvents, metals, organometallics, acids, enzymes, semiconductors. Same as CHEM 582. Prerequisite: An undergraduate course in chemical kinetics.

552 ***Non-Newtonian Fluid Mechanics*** Credit: 4 hours.
In-depth treatment of continuum and molecular dynamics of non-Newtonian fluids, particularly polymeric systems. Topics include linear and non-linear viscoelasticity, rheometry and rheo-optics, and molecular rheology. Applications to the processing of rheologically complex materials. Prerequisite: CHBE 521.

553 ***Surface Chemistry*** Credit: 4 hours.
Introduction to the behavior of molecules adsorbed on solid surfaces; the structure of surfaces and adsorbate layers. The bonding of molecules to surfaces; adsorbate phase transitions; trapping and sticking of molecules on surfaces. An introduction to surface reactions; kinetics of surface reactions. A review of principles of chemical reactivity; reactivity trends on surfaces; prediction of rates and mechanisms of reactions on metals, semiconductors, and insulators. Same as CHEM 586. Prerequisite: CHEM 444.

565 ***CHBE Seminar*** Credit: 1 hours.
Required of all graduate students whose major is Chemical and Biomolecular Engineering. Approved for both letter and S/U grading. Prerequisite: CHBE 422.

571 ***Bioinformatics*** Credit: 4 hours.
Same as ANSC 543, MCB 571, and STAT 530. Prerequisite: MATH 225, MATH 242 and MATH 461; or consent of instructor.

572 ***Metabolic Systems Engineering*** Credit: 4 hours.
Prerequisite: MATH 225, MATH 242 and MATH 385; or consent of instructor.

580 ***Lab Techs in Bioinformatics*** Credit: 2 hours.
Prerequisite: MCB 150 and MCB 151; or consent of instructor.

593 ***Individual Study*** Credit: 0 to 4 hours.
Study under the supervision of a staff member in areas not covered in course offerings. Approved for both letter and S/U grading. Prerequisite: Consent of the staff member under whom the study is to be made.

594 ***Special Topics*** Credit: 1 to 4 hours.
Various advanced topics; generally taken during the second year of graduate study. Typical topics include turbulence, hydrodynamic instability, process dynamics, interfacial phenomena, reactor design, cellular bioengineering, properties of matter at high pressure, and phase transitions. May be repeated. Prerequisite: Consent of instructor.

597 ***Special Problems*** Credit: 2 to 16 hours.
Individual work on problem-oriented projects not included in theses. This could be research, engineering design, or professional work in chemical and biomolecular engineering which has educational values. The work must be done under the supervision of a staff member with the approval of the department head. Approved for both letter and S/U grading.

598 ***Research Seminar*** Credit: 0 to 4 hours.
Discussion of recent developments of importance to different areas of chemical and biomolecular engineering research. The course is divided into a number of sections, and subject matter differs from section to section and from time to time. May be repeated. Approved for both letter and S/U grading. Prerequisite: Consent of instructor.

599 ***Thesis Research*** Credit: 0 to 16 hours.
Candidates for the master's degree who elect research are required to write a thesis. A thesis is always required for the Doctor of Philosophy. Not all candidates for thesis work necessarily are accepted. Any student whose major is

in another department must receive permission from the head of the Department of Chemical and Biomolecular Engineering to register in this course. Approved for S/U grading only.