CHE - CHEMICAL ENGINEERING

CHE 1300 Materials Science for Chemical and Biomedical Engineering Cr. 3
Fundamentals of materials science; emphasis on how material properties and behavior affect engineering applications. Offered Fall, Winter.
Prerequisites: CHM 1125 with a minimum grade of C-, CHM 1130 with a minimum grade of C-, PHY 2170 with a minimum grade of C- (may be taken concurrently), and MAT 2020 with a minimum grade of C- (may be taken concurrently)
Corequisite: CHE 1320

CHE 1320 Materials Science for Chemical and Biomedical Engineers Laboratory Cr. 1
Laboratory component of CHE 1300. Offered Every Term.
Corequisite: CHE 1300

CHE 2800 Material and Energy Balances Cr. 4
Material balances, stoichiometry and simultaneous mass energy balances. Offered Fall.
Prerequisites: (PHY 2170 with a minimum grade of C- or PHY 2175 with a minimum grade of C-) and MAT 2020 with a minimum grade of C-
Fees: $10

CHE 3100 Transport Phenomena I Cr. 3
Presents a practical introduction to the field of transport phenomena and its applications, with a primary focus on the transport of momentum and mechanical energy balances in engineering systems. Students will develop the mathematical tools and skills necessary to design and analyze chemical process systems involving the movement or transfer of fluids (i.e., momentum transport) and the interchange among forms of mechanical energy as fluids flow. Offered Fall.
Prerequisites: BE 1600 with a minimum grade of C-, CHE 2800 with a minimum grade of C-, and MAT 2150 with a minimum grade of C-
Restriction(s): Enrollment limited to students in the College of Engineering.

CHE 3220 Measurements Laboratory Cr. 2
Laboratory course in the principles and practice of measuring chemical, physical and thermodynamic properties of importance to chemical engineering problems. Technical reports. Offered Winter.
Prerequisites: BE 1600 with a minimum grade of C-, BE 2100 with a minimum grade of C-, ENG 3050 with a minimum grade of C-, and CHE 3600 with a minimum grade of C- (may be taken concurrently)
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.
Fees: $25

CHE 3300 Thermodynamics: Chemical Equilibria Cr. 4
Qualitative and quantitative treatment of homogeneous and heterogeneous phase and chemical equilibria. Use of chemical activities and activity coefficients relating ideal to actual systems. Use of reference states and excess properties of the prediction of equilibrium diagrams and the determination of feasibility of chemical reactions. Offered Winter.
Prerequisites: BE 1600 with a minimum grade of C-, CHE 2800 with a minimum grade of C-, and MAT 2150 with a minimum grade of C- (may be taken concurrently)
Restriction(s): Enrollment limited to students in the College of Engineering.
Fees: $10

CHE 3400 Kinetics and Reactor Design Cr. 4
Quantitative treatment of complex homogeneous and heterogeneous chemical reactions and the design of batch, stirred and flow reactor systems. Offered Fall.
Prerequisites: BE 1600 with a minimum grade of C-, CHE 3300 with a minimum grade of C-, and MAT 2150 with a minimum grade of C-
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.
Fees: $10

CHE 3510 Co-op Experience Cr. 1-3
Presentation of oral and written report to peer group describing Co-op experience. Attendance required at the CHE and MSE seminar series for the semester. Offered Every Term.
Prerequisites: CHE 4260 with a minimum grade of C-
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.
Repeatable for 3 Credits

CHE 3600 Transport Phenomena II Cr. 3
Presents a practical introduction to the field of transport phenomena and its applications, with a primary focus on the transport of heat and mass of chemical species in engineering systems. Students will develop the mathematical tools and skills necessary to design and analyze chemical process systems involving the movement or transfer of thermal energy (i.e., heat transfer) and movement of a chemical species under a concentration gradient (i.e. mass transfer and diffusion). Offered Winter.
Prerequisites: BE 1600 with a minimum grade of C-, CHE 2800 with a minimum grade of C-, and CHE 3100 with a minimum grade of C-
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.

CHE 3800 Separation Processes Cr. 3
Quantitative treatment of separation processes in which there is simultaneous heat and mass transfer. Offered Winter.
Prerequisites: BE 1600 with a minimum grade of C-, CHE 3100 with a minimum grade of C-, CHE 3300 with a minimum grade of C-, and CHE 3600 with a minimum grade of C- (may be taken concurrently)
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.
Fees: $10

CHE 3820 Chemical Engineering Laboratory Cr. 2
Experimental study of chemical equilibria, reaction kinetics and rate processes. Laboratory case studies. Offered Fall.
Prerequisites: CHE 3220 with a minimum grade of C-, CHE 3400 with a minimum grade of C-, CHE 3800 with a minimum grade of C-, BE 1600 with a minimum grade of C-, and ENG 3060 with a minimum grade of C-
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.
Fees: $100

CHE 4200 Product and Process Design Cr. 3
The overall design of chemical products, systems, and processes. Economic analysis, computational design calculations, and optimization of design based on factors such as economics, environmental protection and waste minimization, and safety. Offered Fall.
Prerequisites: CHE 3400 with a minimum grade of C-, CHE 3600 with a minimum grade of C-, and CHE 3800 with a minimum grade of C-
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.

CHE 4260 Chemical Engineering Seminar I Cr. 0
Offered Fall, Winter.
Prerequisites: CHE 3220 with a minimum grade of C- (may be taken concurrently), CHE 3300 with a minimum grade of C-, and CHE 3600 with a minimum grade of C- (may be taken concurrently)
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.

CHE 4600 Process Dynamics and Simulation Cr. 3
Application of system dynamics and mathematical modeling to design and analysis of chemical processing systems. Offered Fall.
Prerequisites: CHE 3400 with a minimum grade of C-, CHE 3600 with a minimum grade of C-, and CHE 3800 with a minimum grade of C-
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.
Fees: $10

CHE 4800 Chemical Process Integration Cr. 3
Application of engineering and science background to the design of chemical processes. Comprehensive problems deal with sources of data, design principles and optimization techniques. Offered Winter.
Prerequisite: CHE 4200 with a minimum grade of C-
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.

CHE 4860 Chemical Engineering Seminar II Cr. 1
Offered Fall, Winter.
Prerequisite: CHE 4260 with a minimum grade of C-
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.

CHE 4990 Directed Study Cr. 1-9
Students select a field of chemical engineering for advanced study and instruction. Offered Every Term.
Restriction(s): Enrollment limited to students in the following programs: BS in Biomedical Engineering, BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electrical and Comp Engg, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.
Repeatable for 9 Credits

CHE 5050 Statistics and Design of Experiments Cr. 3
Application of modern statistical experimental design methods to improve effectiveness and success in experimental projects, in chemical industry manufacturing, and research and design. Offered Intermittently.
Prerequisites: BE 2100 with a minimum grade of C-, BE 1600 with a minimum grade of C-, (CHE 3200 with a minimum grade of C- or CHE 3600 with a minimum grade of C-), and CHE 3300 with a minimum grade of C-

CHE 5060 Low-Cost Microfluidic and Millifluidic Systems: Design, Fabrication and Testing Cr. 3
This course provides a hands-on, experimental introduction to the field of microfluidic and millifluidic devices. These devices are increasingly used for research, diagnostics, and treatment in cost-sensitive applications and low-resource settings. The content and methods focus on systems of interest for micro-scale biological/chemical processes and lab-on-chip applications. Project building methods employ readily available, low-cost materials and technologies, including 3D printing, polymer casting, and paper-based fluidics. The course consists of several hands-on design and build projects. Each project highlights a fabrication method and/or an analytical or processing objective. Participants work in groups to design, build and subsequently analyze the performance of functional systems using quantitative tools including: cell phone spectroscopy, electrical detection, quantitative image analysis. Not available for graduate credit. Offered Winter.
Restriction(s): Enrollment limited to students with a class of Senior; enrollment is limited to students with a major in Biomedical Engineering, Biomedical Engg Honors, Chemical Engineering Honors or Chemical Engineering; enrollment is limited to Undergraduate level students.
Fees: $50

CHE 5100 Quantitative Physiology Cr. 4
Basic principles of human physiology presented from the engineering perspective. Bodily functions, their regulation and control discussed in quantitative terms and illustrated by mathematical models where feasible. Offered Every Term.
Equivalent: BME 5010, ECE 5100, ME 5100

CHE 5110 Fundamental Fuel Cell Systems Cr. 4
Introduce various types of fuel cells, materials properties of electrodes and polymeric membranes, and electrochemical mechanisms. Reforming of various types of hydrocarbon fuel to hydrogen, and reforming technology. Offered Fall.
Equivalent: AET 5110, EVE 5130, ME 5110

CHE 5120 Fundamentals of Battery Systems for Electric and Hybrid Vehicles Cr. 4
Fundamental electrochemistry and engineering aspects for electric propulsion batteries, including lead acid, nickel metal hydride, and lithium ion technologies. Offered Intermittently.
Equivalent: AET 5310, EVE 5120, ME 5215

CHE 5350 Polymer Science Cr. 3
Fundamental relationships between chemical structure and physical properties of high polymers. Basic structures, states and transitions of polymers. Polymerization reactions and processes. Molecular weight, viscous flow and mechanical properties of polymers. Offered Fall.
Prerequisites: MAT 2150 with a minimum grade of C- (may be taken concurrently)
Fees: $10
Equivalent: MSE 5350

CHE 5360 Polymer Processing Cr. 3
A detailed analysis of polymer processing. Rheology of polymers, flow in tubes, calendering, extrusion, coating and injection molding. Offered Intermittently.
Prerequisites: CHE 3200 with a minimum grade of C-
Fees: $10
Equivalent: MSE 5360

CHE 5995 Special Topics in Chemical Engineering I Cr. 1-4
A consideration of special subject matter in chemical engineering. Topics to be announced in Schedule of Classes . Offered Every Term.
Repeatable for 8 Credits

CHE 5996 Chemical Engineering Research Cr. 1-6
Research project. Offered Every Term.
Restriction(s): Enrollment limited to students in the following programs: BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Industrial Engineering, BS in Mechanical Engineering; enrollment limited to students in the College of Engineering.

CHE 6100 Introduction to Sustainable Engineering Cr. 3
Economic, environmental, social, and technological perspectives relevant to the design, operation and management of engineering activities. Multiple perspectives addressed from a system sustainability view point. Offered Yearly.

CHE 6450 Biochemical Engineering Cr. 3
An introductory study of the principles of chemical engineering, biochemistry and biology which are essential for the design of industrial systems involving biological transformations. Offered Intermittently.
Prerequisites: CHE 3400 with a minimum grade of C- or CHE 3800 with a minimum grade of C-

CHE 6570 Safety in the Chemical Process Industry Cr. 3
Fundamental and practical experience necessary for safe operation of a chemical process plant. Actual industrial case studies conducted under industry supervision. Offered Winter.
Prerequisites: CHE 3400 with a minimum grade of C- or CHE 3800 with a minimum grade of C-

CHE 6810 Chemical Engineering Research Project Cr. 4
Application of engineering and science background to the completion of a senior research project. Methods of research and analysis and interpretation of data. Preparation of a written research paper; oral presentation of research results. Offered Intermittently.
Prerequisite: CHE 4200 with a minimum grade of C- and CHE 4600 with a minimum grade of C-

CHE 7060 Low-Cost Microfluidic Systems: Design, Fabrication, and Computational Analysis Cr. 3
This course provides a hands-on, experimental introduction to the field of microfluidic and millifluidic devices. These devices are used for research, diagnostics, and treatment in cost-sensitive applications and low-resource settings. The content and methods focus on systems of interest for micro-scale biological/chemical processes and lab-on-chip applications. Project building methods employ readily available, low-cost materials and technologies, including 3D printing, polymer casting, and paper-based fluidics. The course consists of several hands-on design and build projects. Each project highlights a fabrication method and/or an analytical or processing objective. Participants will design and build functional fluidic systems and will analyze/optimize system performance of using computational fluid dynamic (CFD) tools. Not available for credit after CHE 5060. Offered Winter.
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.
Fees: $50

CHE 7090 Writing for Engineering Research Cr. 3
Provides an introduction to the basic principles of technical writing for career pursuit in an academic or industry setting, with a focus on professional manuscript and grant writing. Throughout the course, key principles examined will include the writing process, writing structure, making your writing clear and concise, and handling style, tone, and voice. Through assignments and lecture-based learning, students will examine the “dos” and the “don’ts” in preparing manuscripts for journal submission, abstracts, conference papers, letters to editors, and grants. Throughout the semester, students will receive faculty and peer critiques of their manuscript writing. Finally, students will create a foundation/government grant, with preference toward the research area of the faculty in which they work. Offered Yearly.
Restriction(s): Enrollment is limited to Graduate level students.

CHE 7100 Advanced Engineering Mathematics Cr. 3
Presentation, evaluation and use of mathematical methods within the framework of engineering problems; including ordinary and partial differential equations, transforms and vector operations. Offered Fall.
Restriction(s): Enrollment is limited to Graduate level students.
Equivalent: MSE 7100

CHE 7200 Advanced Transport Phenomena Cr. 3
Basic properties of heat, mass and momentum transfer systems; fundamental equations, transforms and vector operations; includes independent study project. Offered Winter.
Prerequisite: CHE 7100 with a minimum grade of B-
Restriction(s): Enrollment is limited to Graduate level students.

CHE 7300 Advanced Thermodynamics Cr. 3
Advanced presentation of the principles of thermodynamics; application to open systems, phase diagrams and chemical equilibria. Offered Fall.
Restriction(s): Enrollment is limited to Graduate level students.
Equivalent: MSE 7300

CHE 7350 Polymer Solutions Cr. 3
Solubility of polymers, configuration of chain molecules, colligative properties of dilute polymer solutions, spectroscopy, optical activity, light and x-ray scattering of polymer solutions, frictional properties of dissolved polymers, solution properties of polyelectrolytes. Offered Every Other Year.
Prerequisite: CHE 5350 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

CHE 7390 Tissue Engineering and Hybrid Systems Cr. 4
Seminar and project based approach to the design, development, analysis and application of organ and tissue replacement systems which incorporate processed materials and living cells. Offered Every Other Year.
Prerequisites: BME 5370 with a minimum grade of C and (BME 5020 with a minimum grade of C or CHE 7100 with a minimum grade of C)
Restriction(s): Enrollment is limited to Graduate level students.
Equivalent: BME 7390

CHE 7400 Advanced Kinetics and Reactor Design Cr. 3
Basic properties of reacting systems including the steady state approximation, the relationship of thermodynamics to kinetics, the treatment of coupled reaction problems and design of chemical reactors; includes independent study project. Offered Winter.
Restriction(s): Enrollment is limited to Graduate level students.
Fees: $10

CHE 7507 Machine Learning for the Chemical Sciences Cr. 3
Presentation of the principles and methods of basic machine learning and introduction to advanced techniques with applications to chemical engineering, materials science, and chemistry with real-world data sets. Foundations of machine learning, including linear algebra, statistics, optimization, and programming. Derivation and application of machine learning principles, including regression, bias-variance trade-off, classification, and dimensionality reduction. Exploration of advanced machine learning techniques, including decision trees, random forests, support vector machines, and neural networks. Requires an independent study project using machine learning techniques to analyze and predict real-world data. Offered Winter.
Restriction(s): Enrollment is limited to Graduate level students.

CHE 7530 Materials Characterization and Computational Data Analysis for Engineers Cr. 3
Principles of data acquisition and analysis from a wide range of experimental measurements, with an emphasis on high-throughput and automated processing, data visualization, and effective communication. Data management and functional Python skills (no prior programming experience needed, though students with concerns should reach out to the instructor early). Experimental techniques covered in lessons and examples include microscopies, spectroscopies, thermal characterization, ellipsometry, rheology, and X-ray and neutron scattering and reflectivity. Offered Fall.
Restriction(s): Enrollment is limited to Graduate level students.
Equivalent: MSE 7530

CHE 7990 Directed Study Cr. 1-9
Library investigation of an approved project in chemical engineering. Independent study, conferences with supervisor and preparation of a comprehensive written and oral report. Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students.

CHE 8510 Graduate Co-op Experience Cr. 1-3
Presentation of oral and written reports to peer group describing co-op experience. Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students.

CHE 8996 Research Cr. 1-9
Library and laboratory investigation of an approved proposal for advanced research project. Conferences and periodic oral progress reports. Comprehensive report of entire project upon completion. Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 30 Credits

CHE 8997 Chemical Engineering Graduate Seminar Cr. 0.5
Advanced concepts in chemical engineering; presentation of research results. Must attend and present evidence of attending 30 hours of seminar over two-year period, and present one seminar. Offered Every Term.
Prerequisite: CHE 7200 with a minimum grade of C and CHE 7400 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

CHE 8999 Master's Thesis Research and Direction Cr. 1-8
Offered Every Term.
Restriction(s): Enrollment limited to students with a class of Candidate Masters; enrollment is limited to Graduate level students.
Repeatable for 8 Credits

CHE 9990 Pre-Doctoral Candidacy Research Cr. 1-8
Research in preparation for doctoral dissertation. Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 12 Credits

CHE 9991 Doctoral Candidate Status I: Dissertation Research and Direction Cr. 3-9
Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 9 Credits

CHE 9992 Doctoral Candidate Status II: Dissertation Research and Direction Cr. 1-18
Offered Every Term.
Prerequisite: CHE 9991 with a minimum grade of S
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 18 Credits

CHE 9993 Doctoral Candidate Status III: Dissertation Research and Direction Cr. 7.5
Offered Every Term.
Prerequisite: CHE 9992 with a minimum grade of S
Restriction(s): Enrollment is limited to Graduate level students.

CHE 9994 Doctoral Candidate Status IV: Dissertation Research and Direction Cr. 7.5
Offered Every Term.
Prerequisite: CHE 9993 with a minimum grade of S
Restriction(s): Enrollment is limited to Graduate level students.

CHE 9995 Candidate Maintenance Status: Doctoral Dissertation Research and Direction Cr. 0
Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 0 Credits