

## Chemical Engineering

### CM 2110 - Fund of Chem Engg 1

Application of chemical engineering fundamentals to the design and analysis of chemical processes. Mass balances, energy balances, and fundamentals concepts are applied. Introduces use of Process Flowsheet Simulation Software.

**Credits:** 3.0

**Lec-Rec-Lab:** (3-0-0)

**Semesters Offered:** Fall, Summer

**Pre-Requisite(s):** CH 1100 or CH 1110 or CH 1112 or (CH 1150 and CH 1151)

### CM 2120 - Fund of Chem Engg 2

Application of mass and energy balances to common chemical engineering operations. Mass balances, energy balances, and fundamental concepts are applied to flow in piping systems, pumps, compressors and stagewise separations (distillation, absorption/desorption, and extraction). Advanced use of Process Flowsheet Simulations software.

**Credits:** 3.0

**Lec-Rec-Lab:** (3-0-0)

**Semesters Offered:** Spring, Summer

**Pre-Requisite(s):** CM 2110

### CM 2200 - Intro Minerals and Materials

Fundamentals of minerals processing, raw materials production, and extractive metallurgy, including primary metals production.

**Credits:** 3.0

**Lec-Rec-Lab:** (3-0-0)

**Semesters Offered:** Fall

### CM 3110 - Transport/Unit Operations 1

Develop an understanding of the processes of momentum transfer (fluid mechanics) and heat transfer. Presents the basic equations of microscopic momentum and heat transfer, along with macroscopic transport equations that can be used in engineering analysis.

**Credits:** 3.0

**Lec-Rec-Lab:** (3-0-0)

**Semesters Offered:** Fall, Spring

**Pre-Requisite(s):** CM 2120 and (MA 3520 or MA 3521 or MA 3530 or MA 3560) and PH 2200

### CM 3120 - Transport/Unit Operations 2

Mass transfer fundamentals applied to unit operations. Topics include Fick's Law, continuity equation with reaction and mass transfer coefficients. Transient heat transfer and numerical solution are covered. Applications include absorption, distillation, extraction, adsorption, and membrane separations.

**Credits:** 3.0

**Lec-Rec-Lab:** (3-0-0)

**Semesters Offered:** Spring

**Restrictions:** Must be enrolled in one of the following Major(s): Chemical Engineering

**Pre-Requisite(s):** CM 3110 and (MA 3520 or MA 3521 or MA 3530 or MA 3560)

### CM 3215 - Fundamentals of Chemical Engineering Laboratory

This course will be an introduction to basic laboratory methods and instrumentation used in the measurement of fluid flow, heat transfer, and mass transfer. Topics to be covered include methods of statistical data analysis, experimental design, principles of measurement and instrumentation, and presentation of data.

**Credits:** 2.0

**Lec-Rec-Lab:** (1-0-3)

**Semesters Offered:** Fall, Spring

**Restrictions:** Must be enrolled in one of the following Major(s): Chemical Engineering

**Pre-Requisite(s):** CM 2120(C) and CM 3110(C) and (MA 3520 or MA 3521 or MA 3530 or MA 3560)

### CM 3230 - Thermodynamics for Chemical Engineers

First and second law applied to closed and open systems. Topics include energy conversion, power cycles, entropy and enthalpy calculations on engineering systems; property estimation for non-ideal vapors, liquids, and other substances, non-ideal multicomponent equilibria, chemical reaction equilibria.

**Credits:** 4.0

**Lec-Rec-Lab:** (4-0-0)

**Semesters Offered:** Fall, Spring

**Pre-Requisite(s):** CH 3510 and MA 3160 and (MA 3520(C) or MA 3521(C) or MA 3530(C) or MA 3560(C))

### CM 3310 - Process Control

Covers methods of analyzing the transient behavior of chemical processing systems. Develops methods of analyzing systems and system components along with the special mathematical techniques needed. These concepts are then applied to illustrate mathematical modeling of large-scale chemical processing systems.

**Credits:** 3.0

**Lec-Rec-Lab:** (2-0-2)

**Semesters Offered:** Spring

**Pre-Requisite(s):** (MA 3520 or MA 3521 or MA 3530 or MA 3560) and PH 2200

### CM 3410 - Tech Comm for Chem Engg

Study of the purposes, genres, and applications of technical communication in chemical engineering professions, including written, oral, visual, and graphic communication. Assignments may include memos, progress reports, procedures, memo and formal reports, research citations, and job-seeking requirements. Emphasizes organization, support, coherence, usefulness, ethics, and professionalism.

**Credits:** 3.0

**Lec-Rec-Lab:** (3-0-0)

**Semesters Offered:** Fall, Spring, Summer

**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore, Senior

**Pre-Requisite(s):** UN 2001 and UN 2002

### CM 3450 - Computer-Aided Problem Solving in Chemical Engineering

The use of modern software packages in chemical engineering. Packages include spreadsheet, symbolic manipulator, chemical process calculator, statistical and modeling software. Course develops knowledge and skills in using computer tools that will complement chemical engineering courses and practice.

**Credits:** 3.0

**Lec-Rec-Lab:** (0-0-6)

**Semesters Offered:** Fall - Offered alternate years beginning with the 2008-2009 academic year

**Pre-Requisite(s):** CM 2110(C) and MA 2160

### CM 3510 - Chemical Reaction Engineering

A study of chemical reaction engineering including design and analysis of chemical reactors, the fundamentals of chemical kinetics, and analysis of reaction rate data.

**Credits:** 3.0

**Lec-Rec-Lab:** (3-0-0)

**Semesters Offered:** Spring

**Pre-Requisite(s):** CM 3110 and CM 3230(C) and (MA 3520 or MA 3521 or MA 3530 or MA 3560)

### CM 3820 - Sampling Statistics and Instrumentation

Solids sampling theory, practice, and instrumentation for process streams. Statistics/probability as they apply to representative samples from bulklots. Minimization of errors, proper design of sample collection apparatus, statistical design and analysis, and measurements of temperature, flow rate will be covered.

**Credits:** 3.0

**Lec-Rec-Lab:** (2-0-1)

**Semesters Offered:** Spring - Offered alternate years beginning with the 2006-2007 academic year

### CM 3974 - Fuel Cell Fundamentals

This course provides an introduction to fuel cells and fuel cell systems. Topics include an overview of fuel-cell construction, fuel-cell chemistry, fuel-cell losses and efficiency, and integrating fuel cells into vehicles.

**Credits:** 1.0

**Lec-Rec-Lab:** (1-0-0)

**Semesters Offered:** Fall, Spring

**Pre-Requisite(s):** CH 1100 or CH 1110 or CH 1112 or (CH 1150 and CH 1151)

### CM 3977 - Fundamentals of Hydrogen as an Energy Carrier

This course provides an overview of traditional and alternative energy sources, with particular emphasis on hydrogen energy. Discussion of energy production and sources; electric and hydrogen vehicles; production, distribution, and policy of hydrogen, and the hydrogen economy.

**Credits:** 1.0

**Lec-Rec-Lab:** (1-0-0)

**Semesters Offered:** Fall

**Restrictions:** May not be enrolled in one of the following Class(es): Freshman

**Pre-Requisite(s):** CH 1100 or CH 1110 or CH 1112 or (CH 1150 and CH 1151) and PH 2200

**CM 3978 - Hydrogen Measurements Lab**

This course provides an introduction to basic experiments and measurements that relate to hydrogen and hydrogen powered fuel cells. Includes chemical and electrical safety, fuel cell operation and introduction to fuel cell integration into practical applications.

**Credits:** 1.0

**Lec-Rec-Lab:** (0-0-2)

**Semesters Offered:** Spring

**Restrictions:** May not be enrolled in one of the following Class(es): Freshman

**Pre-Requisite(s):** CH 1100 or CH 1110 or (CH 1150 and CH 1151) and PH 2200

**CM 4000 - Chemical Engineering Research**

Student undertakes a problem in some phase of chemical engineering, reviews the literature, obtains experimental data, and submits a report.

**Credits:** variable to 3.0; Repeatable to a Max of 9

**Semesters Offered:** Fall, Spring, Summer

**Restrictions:** Permission of instructor required

**CM 4110 - Unit Operations Laboratory**

Provides a rigorous introduction to experiments focused in the unit operations of fluid mechanics, heat transfer, mass transfer, and chemical reaction engineering.

**Credits:** 3.0

**Lec-Rec-Lab:** (0-1-6)

**Semesters Offered:** Fall

**Pre-Requisite(s):** CM 3120 and CM 3215 and CM 3230 and CM 3410 and CM 3510 and CM 4310(C)

**CM 4120 - Chemical Plant Operations Lab**

A capstone laboratory course focused on chemical manufacturing processes from the perspective of manufacturing excellence. Lecture material includes equality management, the application of statistical process control, and current trends in quality manufacturing. Experimental reinforcement of these concepts occurs in the department's pilot plants.

**Credits:** 3.0

**Lec-Rec-Lab:** (0-1-6)

**Semesters Offered:** Spring

**Pre-Requisite(s):** CM 3215 and CM 4110

**CM 4125 - Bioprocess Engineering Laboratory**

An integrated biological process laboratory experience, including fermentation with downstream bioseparation, for the production of a purified product of potential commercial interest. Features process measurement-analysis-improvement, metabolic pathway analysis, quality assurance, and safety.

**Credits:** 1.0

**Lec-Rec-Lab:** (0-0-3)

**Semesters Offered:** Spring - Offered alternate years beginning with the 2005-2006 academic year

**Pre-Requisite(s):** CM 4710(C) or BL 3210 or BL 3310

**CM 4310 - Chemical Process Safety/Env**

A study of the technical fundamentals of chemical process safety and designing for the environment. Includes toxicology, industrial hygiene, source models, fires and explosions, relief systems, hazard identification, risk assessment, environmental fate and transport, hazardous waste generation, pollution prevention, and regulatory requirements.

**Credits:** 3.0

**Lec-Rec-Lab:** (3-0-0)

**Semesters Offered:** Fall

**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

**Pre-Requisite(s):** CM 3120 and CM 3230

**CM 4450 - Computational Methods in Chemical Engineering**

Computational methods for solution of chemical engineering problems in transport phenomena, reaction kinetics, and dynamical systems. Topics include general numerical methods and solution to ordinary and partial differential equations. Advanced use of MATLAB and Comsol Multiphysics software.

**Credits:** 2.0

**Lec-Rec-Lab:** (1-0-1)

**Semesters Offered:** Fall - Offered alternate years beginning with the 2008-2009 academic year

**Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore

**Pre-Requisite(s):** CM 3110(C) and (MA 3520 or MA 3521 or MA 3530 or MA 3560)

**CM 4500 - Particle Technology**

Fundamentals of particle processing, characterization, and separation. Topics include fine particle synthesis; mineral processing; automobile recycling; contaminated soils; recyclable materials such as batteries and tires; and sludges. Also covers zeta potential, particulate surface chemistry, flocculation, and dispersion.

**Credits:** 4.0

**Lec-Rec-Lab:** (3-0-3)

**Semesters Offered:** Fall, Spring - Offered alternate years beginning with the 2005-2006 academic year

**CM 4550 - Industrial Chemical Production**

Integration of chemical engineering and chemistry as practiced in modern industry. Engineering of chemical reactions and processes for commodity chemicals, petroleum-based fuels, petrochemicals, intermediates, specialty chemicals, pharmaceuticals, and engineered materials. Environmental strategies for waste minimization and pollution prevention.

**Credits:** 3.0

**Lec-Rec-Lab:** (3-0-0)

**Semesters Offered:** On Demand

**Pre-Requisite(s):** (CH 2400 or CH 2410) and CM 3510(C)

**CM 4610 - Introduction to Polymer Science**

Introductory study of the properties of polymers. Includes structure and characterization of polymers in the solid state, in solution, and as melts. Topics include viscoelasticity, rubbery elasticity, rheology and polymer processing. Applications discussed include coatings, adhesives, and composites.

**Credits:** 3.0

**Lec-Rec-Lab:** (3-0-0)

**Semesters Offered:** Fall

**Pre-Requisite(s):** CH 1120 or CH 1122 or (CH 1160 and CH 1161)

**CM 4620 - Polymer Chemistry**

Study of polymer chemistry dealing with the mechanisms of polymerization and copolymerization. Study of the chemistry of polymers, including polymer modification and degradation. Topics include methods of measuring and predicting the path of degradation and stabilization.

**Credits:** 3.0

**Lec-Rec-Lab:** (3-0-0)

**Semesters Offered:** Fall, Spring

**Pre-Requisite(s):** CH 2400 or CH 2420

**CM 4631 - Polymer Science Laboratory**

Students undertake experiments covering aspects of polymer characterization, processing, and recycling. Also included are experiments in applications such as coatings, adhesives, and composites.

**Credits:** 2.0

**Lec-Rec-Lab:** (0-1-3)

**Semesters Offered:** Fall - Offered alternate years beginning with the 2008-2009 academic year

**Pre-Requisite(s):** CM 4610(C)

**CM 4650 - Polymer Rheology**

A systematic development of the principles and applications of the science of rheology. Reviews vector and tensor mathematics and Newtonian fluid dynamics. Develops the physical and mathematical nature of stress and deformations in materials. Covers the use of theory and application of rheological equations of state.

**Credits:** 3.0

**Lec-Rec-Lab:** (3-0-0)

**Semesters Offered:** Spring

**Pre-Requisite(s):** (CM 3110 or MEEM 3210 or ENG 3200 or MY 3110 or CE 3600) and (MA 3520 or MA 3521 or MA 3530 or MA 3560)

**CM 4655 - Polymer Rheology Laboratory**

Basic techniques for acquisition of shear rheological data in torsional shear (cone-and-plate and parallel-plate) and capillary shear will be taught. Also covered will be sample preparation and handling techniques for polymers.

**Credits:** 1.0

**Lec-Rec-Lab:** (0-0-3)

**Semesters Offered:** Fall

**Restrictions:** Permission of instructor required; May not be enrolled in one of the following Class(es): Freshman, Sophomore

**Pre-Requisite(s):** CM 4610(C) or CH 4610(C) or CM 4650(C)

**CM 4710 - Biochemical Processes**

Presents an introduction to fundamental and applied aspects of industrial biochemical processing. Topics include cell structure and composition, enzymes and their use in industry, metabolism, bioreactor analysis and design, bioseparations for product recovery, industrial application, genetic engineering concepts, and applications.

**Credits:** 3.0

**Lec-Rec-Lab:** (3-0-0)

**Semesters Offered:** Fall - Offered alternate years beginning with the 2005-2006 academic year

**Restrictions:** May not be enrolled in one of the following Class(es):

Freshman, Sophomore

**Pre-Requisite(s):** CM 3110(C)

**CM 4740 - Hydrometallurgy/Pyrometallurgy**

Extracting metal from ores by aqueous chemical techniques. The unit processes and unit operations in the dissolution, solubility, aqueous chemistry, concentrating and purifying metal-bearing solutions, and recovery of metals by precipitation and electrolytic processing will be discussed.

**Credits:** 4.0

**Lec-Rec-Lab:** (4-0-0)

**Semesters Offered:** Spring - Offered alternate years beginning with the 2007-2008 academic year

**Restrictions:** May not be enrolled in one of the following Class(es):

Freshman, Sophomore

**Pre-Requisite(s):** CH 1120 or CH 1122 or (CH 1160 and CH 1161)

**CM 4855 - CM Process Analysis & Design I**

Technical and economic evaluation of chemical processes and operations. Applies material and energy balances, flowsheets, energy utilization, and optimization to process systems. Requires use of cost estimating and economic evaluation techniques. The optimization project requires a series of memoranda progress reports, a formal final report, and an oral presentation.

**Credits:** 3.0

**Lec-Rec-Lab:** (2-0-3)

**Semesters Offered:** Fall

**Pre-Requisite(s):** CM 3120 and CM 3230 and CM 3410

**CM 4860 - CM Process Analysis & Design 2**

Applies technical and economical techniques to the development of a chemical process into an optimized design. Uses process synthesis techniques and market research to develop a conceptual design for a proposed new venture. The AIChE National Design Problem is required of each student as a capstone experience.

**Credits:** 2.0

**Lec-Rec-Lab:** (2-0-0)

**Semesters Offered:** Spring

**Pre-Requisite(s):** CM 4855

**CM 4861 - CM Design Laboratory 2**

Discusses open-ended problems in chemical engineering design.

**Credits:** 1.0

**Lec-Rec-Lab:** (0-0-3)

**Semesters Offered:** Spring

**Pre-Requisite(s):** CM 4860(C)

**CM 4900 - Interdisciplinary Design 1**

Focuses on an interdisciplinary chemical engineering design project. (Senior project ready as defined by major substitutes for prerequisites)

**Credits:** 3.0

**Lec-Rec-Lab:** (0-3-0)

**Semesters Offered:** Fall

**Restrictions:** Permission of department required; May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

**CM 4910 - Interdisciplinary Design 2**

Focuses on an interdisciplinary chemical engineering design project. (Senior project ready as defined by major substitutes for prerequisites)

**Credits:** 3.0

**Lec-Rec-Lab:** (0-3-0)

**Semesters Offered:** Spring

**Restrictions:** Permission of department required; May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior

**CM 4990 - Special Topics in CM**

Covers chemical engineering topics not included in regular courses, which may include biochemical engineering, design of biochemical reactions, composite materials, and numerical analysis of transport processes.

**Credits:** variable to 3.0; Repeatable to a Max of 12

**Semesters Offered:** On Demand

**Restrictions:** Permission of instructor required