CHEMICAL ENGINEERING (CH E)

Courses primarily for undergraduates:

**CH E 104: Chemical Engineering Learning Community**
Cr. R. F.  
*Prereq: Enrollment in Chemical Engineering Learning Team*  
(1-0) Curriculum in career planning and academic course support for Freshmen learning team.

**CH E 160: Chemical Engineering Problems with Computer Applications Laboratory**
(2-2) Cr. 3. F.S.  
*Prereq: MATH 143 or satisfactory scores on mathematics placement examinations; credit or enrollment in MATH 165*  

**CH E 202: Chemical Engineering Seminar**
(1-0) Cr. 1. F.  
*Prereq: Sophomore classification in chemical engineering; credit or enrollment in CH E 210.*  
Professionalism in the context of the engineering/technical workplace. Introduction to chemical engineering career opportunities. Process and workplace safety. Development and demonstration of key workplace competencies: teamwork, professionalism and ethical responsibility, ability to engage in life-long learning, and knowledge of contemporary issues. Resumes; professional portfolios; preparation for internship experiences.

**CH E 204: Chemical Engineering Continuing Learning Community**
Cr. R.  
*Prereq: Corequisite-enrollment in Chemical Engineering Learning Team*  
Curriculum and career planning, academic course support for learning community.

**CH E 205: Chemical Engineering Progress Assessment**
Cr. R. F.S.  
*Prereq: CHEM 178, MATH 166; credit or enrollment in CH E 160, CH E 210*  
Assessment of proficiency in general chemistry, calculus (including infinite series and applications of derivatives and integrals), and material balances, and an ability to use the principles of science and mathematics to identify, formulate, and solve engineering problems. Offered on a satisfactory-fail basis only.

**CH E 210: Material and Energy Balances**  
(3-0) Cr. 3. F.S.  
*Prereq: Chem 178, Math 166, CH E 160*  
Introduction to chemical processes. Physical behavior of gases, liquids, and solids. Application of material and energy balances to chemical engineering equipment and processes.

**CH E 220: Introduction to Biomedical Engineering**  
(Cross-listed with B M E). (3-0) Cr. 3. S.  
*Prereq: BIOL 212, ENGR 160 or equiv, MATH 166, CHEM 167 or CHEM 178, PHYS 222*  
Engineering analysis of basic biology and engineering problems associated with living systems and health care delivery. The course will illustrate biomedical engineering applications in such areas as: biotechnology, biomechanics, biomaterials and tissue engineering, and biosignal and image processing, and will introduce the basic life sciences and engineering concepts associated with these topics.

**CH E 310: Computational Methods in Chemical Engineering**  
(3-0) Cr. 3. F.S.  
*Prereq: CH E 160, CH E 205, CH E 210, MATH 265*  
Numerical methods for solving systems of linear and nonlinear equations, ordinary differential equations, numerical differentiation and integration, and nonlinear regression using chemical engineering examples.

**CH E 325: Chemical Engineering Laboratory I**  
(0-4) Cr. 2. F.S.  
*Prereq: CH E 357, CH E 381; credit or enrollment in CH E 382; credit or enrollment in ENGL 314 or ENGL 309 or ENGL 312 or JL MC 347*  
Experiments covering fundamental material and energy balances, momentum and energy transport operations, and thermodynamics. Computer applications.

**CH E 356: Transport Phenomena I**  
(3-0) Cr. 3. F.S.  
*Prereq: CH E 205, CH E 210, PHYS 221, credit or enrollment in MATH 267*  
Momentum and mechanical energy balances. Incompressible and compressible fluid flow. Applications to fluid drag, piping system design, filtration, packed beds and settling.

**CH E 357: Transport Phenomena II**  
(3-0) Cr. 3. F.S.  
*Prereq: Credit or enrollment in CH E 310; CH E 356*  
Conduction and diffusion, convective heat and mass transfer, boiling and condensation, radiation, and design of heat exchange equipment. Introduction to diffusion.
CH E 358: Separations
(3-0) Cr. 3. F.S.
Prereq: CH E 310, CH E 357
Diffusion and mass transfer in fluids. Analysis and design of continuous contacting and multistage separation processes. Binary and multicomponent distillation, absorption, extraction, evaporation, membrane processes, and simultaneous heat and mass transfer.

CH E 381: Chemical Engineering Thermodynamics
(3-0) Cr. 3. F.S.
Prereq: Credit or enrollment in CH E 310, MATH 267, PHYS 222, CHEM 325
Application of thermodynamic principles to chemical engineering problems. Thermodynamic properties of fluids, phase equilibria, and chemical reaction equilibria.

CH E 382: Chemical Reaction Engineering
(3-0) Cr. 3. F.S.
Prereq: CH E 310; CH E 381, credit or enrollment in CH E 357
Kinetics of chemical reactions. Design of homogeneous and heterogeneous chemical reactors.

CH E 391: Foreign Study Orientation
(3-0) Cr. 3. S.
Prereq: CH E 357 and CH E 381
Offered on a satisfactory-fail basis only. Credit for graduation allowable only upon completion of CH E 392.
Meets International Perspectives Requirement.

CH E 392: Foreign Study Program
Cr. 4. SS.
Prereq: CH E 391
Study of chemical engineering including laboratories and lectures at collaborating international universities. Comparative study of U.S. and international manufacturing facilities. Expenses required.
Meets International Perspectives Requirement.

CH E 396: Summer Internship
Cr. R. Repeatable. SS.
Prereq: Permission of department and Engineering Career Services
Professional work period of at least 10 weeks during the summer.
Students must register for this course prior to commencing work. Offered on a satisfactory-fail basis only.

CH E 398: Cooperative Education
Cr. R. Repeatable. F.S.
Prereq: Permission of department and Engineering Career Services
Professional work period. One semester per academic or calendar year. Students must register for this course before commencing work. Offered on a satisfactory-fail basis only.

CH E 406: Environmental Chemodynamics
(Dual-listed with CH E 506). (3-0) Cr. 3.
Prereq: CH E 318, credit or enrollment in CH E 358
Examines the mechanisms and rates of chemical transport across air, water, and soil interfaces. Applications of transport and thermodynamic fundamentals to movement of chemicals in the environment.

CH E 408: Surface and Colloid Chemistry
(Dual-listed with CH E 508). (3-0) Cr. 3.
Prereq: CH E 381 or equivalent
Examines the factors underlying interfacial phenomena, with an emphasis on the thermodynamics of surfaces, structural aspects, and electrical phenomena. Application areas include emulsification, foaming, detergency, sedimentation, fluidization, nucleation, wetting, adhesion, flotation, and electrophoresis.

CH E 415: Biochemical Engineering
(Dual-listed with CH E 515). (3-0) Cr. 3.
Prereq: CH E 357, CH E 382 recommended, CHEM 331
Application of basic chemical engineering principles in biochemical and biological process industries such as enzyme technology and fermentation.

CH E 420: Chemical Process Safety
(3-0) Cr. 3. F.S.
Prereq: CH E 357, CH E 381; junior classification
Application of transport phenomena, thermodynamics, and chemical kinetics to the study of safety, health, and loss prevention. Government regulations, industrial hygiene, relief sizing, runaway reactions, toxic release, and dispersion models will be used. Fires, explosions, risk assessment, hazard identification, case studies, accident investigations, and design considerations will be studied.

CH E 421: Process Control
(3-0) Cr. 3. F.S.
Prereq: CH E 358, CH E 382, Math 267
Control of industrial chemical processes. Device applications and limitations. Dynamics of chemical process components and process control systems.

CH E 426: Chemical Engineering Laboratory II
(0-4) Cr. 2. F.S.
Prereq: CH E 325, CH E 358, CH E 382
Experiments in heat and mass transfer, staged operations, chemical reactor performance, unit processes. Computer applications. Only one of CH E 426 or 427 may count toward graduation.
CH E 427: Biological Engineering Laboratory  
(0-4) Cr. 2. S.  
**Prereq:** CH E 325, CH E 358, CH E 382; BBMB 301 or BBMB 404  
Experiments on biological applications in chemical engineering. Only one of CH E 426 or CH E 427 may count toward graduation.

CH E 430: Process and Plant Design  
(2-4) Cr. 4. F.S.  
**Prereq:** CH E 358, CH E 382  
Synthesis of chemical engineering processes, equipment and plants. Cost estimation and feasibility analysis.

CH E 440: Biomedical Applications of Chemical Engineering  
(Dual-listed with CH E 540). (Cross-listed with B M E). (3-0) Cr. 3.  
**Prereq:** CH E 210, MATH 266, PHYS 222  
Applications of material and energy balances, transport phenomena, chemical reaction engineering, and thermodynamics to problems in biomedical engineering and applied physiology; survey of biomedical engineering; biomaterials; biomedical imaging.

CH E 447: Polymers and Polymer Engineering  
(Dual-listed with CH E 547). (3-0) Cr. 3.  
**Prereq:** CH E 382 and CHEM 331 or MAT E 351  
Chemistry of polymers, addition and condensation polymerization. Physical and mechanical properties, polymer rheology, production methods. Applications of polymers in the chemical industry.

CH E 490: Undergraduate Research/Independent Study  
(0-18) Cr. 1-6. Repeatable, maximum of 6 credits.  
**Prereq:** Permission of Department  
Investigation of topics of special interest to student and faculty with a final written report or presentation. Election of course and topic must be approved in advance by Department with completion of Study Proposal. No more than 6 credits of ChE 490 may be counted towards technical electives.

CH E 490H: Undergraduate Research/Independent Study, Honors  
(0-18) Cr. 1-6. Repeatable, maximum of 6 credits.  
**Prereq:** Permission of Department  
Investigation of topics of special interest to student and faculty with a final written report or presentation. Election of course and topic must be approved in advance by Department with completion of Study Proposal. No more than 6 credits of ChE 490 may be counted towards technical electives.

Courses primarily for graduate students, open to qualified undergraduates:

CH E 506: Environmental Chemodynamics  
(Dual-listed with CH E 406). (3-0) Cr. 3.  
**Prereq:** CH E 381, credit or enrollment in CH E 358  
Examines the mechanisms and rates of chemical transport across air, water, and soil interfaces. Applications of transport and thermodynamic fundamentals to movement of chemicals in the environment.

CH E 508: Surface and Colloid Chemistry  
(Dual-listed with CH E 408). (3-0) Cr. 3.  
**Prereq:** CH E 381 or equivalent  
Examines the factors underlying interfacial phenomena, with an emphasis on the thermodynamics of surfaces, structural aspects, and electrical phenomena. Application areas include emulsification, foaming, detergency, sedimentation, fluidization, nucleation, wetting, adhesion, flotation, and electrophoresis.

CH E 515: Biochemical Engineering  
(Dual-listed with CH E 415). (3-0) Cr. 3.  
**Prereq:** CH E 357, CH E 382 recommended, CHEM 331  
Application of basic chemical engineering principles in biochemical and biological process industries such as enzyme technology and fermentation.

CH E 540: Biomedical Applications of Chemical Engineering  
(Dual-listed with CH E 440). (3-0) Cr. 3.  
**Prereq:** CH E 210, MATH 266, PHYS 222  
Applications of material and energy balances, transport phenomena, chemical reaction engineering, and thermodynamics to problems in biomedical engineering and applied physiology; survey of biomedical engineering; biomaterials; biomedical imaging.

CH E 542: Polymeric Biomaterials  
(3-0) Cr. 3.  
**Prereq:** CHEM 331 or a polymers class  
Polymeric biomaterials, overview of biomaterial requirements, different classes of polymers used as biomaterials, specific bioapplications of polymers.

CH E 545: Analytical and Numerical Methods  
(3-0) Cr. 3. F.  
**Prereq:** CH E 358, MATH 267  
Analysis of equipment and processes by analytic and/or numerical solution of descriptive differential equations. Operational and series techniques, boundary value problems, numerical interpolation and approximation, integration techniques.
CH E 547: Polymers and Polymer Engineering
(Dual-listed with CH E 447). (3-0) Cr. 3.
Prereq: CH E 382 and CHEM 331 or MAT E 351
Chemistry of polymers, addition and condensation polymerization. Physical and mechanical properties, polymer rheology, production methods. Applications of polymers in the chemical industry.

CH E 554: Integrated Transport Phenomena
(4-0) Cr. 4. F.
Prereq: CH E 357, CH E 381, Math 267, credit or enrollment in CH E 545
Conservation equations governing diffusive and convective transport of momentum, thermal energy and chemical species. Transport during laminar flow in conduits, boundary layer flow, creeping flow. Heat and mass transport coupled with chemical reactions and phase change. Scaling and approximation methods for mathematical solution of transport models. Diffusive fluxes; conservation equations for heat and mass transfer; scaling and approximation techniques; fundamentals of fluid mechanics; unidirectional flow; creeping flow; laminar flow at high Reynolds number; forced-convection heat and mass transfer in confined and unconfined laminar flows.

CH E 562: Bioseparations
(3-0) Cr. 3.
Prereq: CH E 357 or advanced standing in a science major
Principles and techniques for separation and recovery of biologically-produced molecules, especially proteins. Relationship between the chemistry of biological molecules and efficient separation and preservation of biological activity. Includes centrifugation and filtration, membrane processing, extraction, precipitation and crystallization, chromatography, and electrophoresis.

CH E 572: Turbulence
(Cross-listed with AER E). (3-0) Cr. 3.
Prereq: AER E 541 or M E 538

CH E 583: Advanced Thermodynamics
(3-0) Cr. 3. F.
Prereq: CH E 381
Application of thermodynamic principles to chemical engineering problems. Thermodynamic properties of non-ideal fluids and solutions; phase and chemical-reaction equilibria/stability.

CH E 587: Advanced Chemical Reactor Design
(3-0) Cr. 3. S.
Prereq: CH E 382
Analysis of complex reactions and kinetics. Fixed bed, fluidized bed, and other industrial reactors. Analysis and design of non-ideal flow mixing, and residence times. Heterogeneous reactors.

CH E 590: Independent Study
Cr. 2-6. Repeatable.
Investigation of an approved topic on an individual basis.

CH E 595: Special Topics
Cr. 2-3. Repeatable.

CH E 595A: Special Topics: Separations
Cr. 2-3. Repeatable.

CH E 595B: Special Topics: Advanced Control Theory
Cr. 2-3. Repeatable.

CH E 595C: Special Topics: Crystallization
Cr. 2-3. Repeatable.

CH E 595D: Special Topics: Thermodynamics
Cr. 2-3. Repeatable.

CH E 595E: Special Topics: Protein Engineering/Bioseparations
Cr. 2-3. Repeatable.

CH E 595F: Special Topics: Biological Engineering
Cr. 2-3. Repeatable.

CH E 595G: Special Topics: Materials and Biomaterials
Cr. 2-3. Repeatable.

CH E 595H: Special Topics: Surfaces
Cr. 2-3. Repeatable.

CH E 595I: Special Topics: Combinatorial Design
Cr. 2-3. Repeatable.

CH E 599: Creative Component
Cr. arr. Repeatable.

Courses for graduate students:

CH E 601: Seminar
Cr. R. Repeatable. F.S.
Offered on a satisfactory-fail basis only.
CH E 625: Metabolic Engineering
(3-0) Cr. 3.
Prereq: CH E 382, CHEM 331
Principles of metabolic engineering. Emphasis on emerging examples in biorenewables and plant metabolic engineering. Overview of biochemical pathways, determination of flux distributions by stoichiometric and labeling techniques; kinetics and thermodynamics of metabolic networks; metabolic control analysis; genetic engineering for overexpression, deregulation, or inhibition of enzymes; directed evolution; application of bioinformatics, genomics, and proteomics.

CH E 632: Multiphase Flow
(Cross-listed with M E). (3-0) Cr. 3. Alt. S., offered odd-numbered years.
Prereq: M E 538
Single particle, mutliparticle and two-phase fluid flow phenomena (gas-solid, liquid-solid and gas-liquid mixtures); particle interactions, transport phenomena, wall effects; bubbles, equations of multiphase flow. Dense phase (fluidized and packed beds) and ducted flows; momentum, heat and mass transfer. Computer solutions.

CH E 642: Principles and Applications of Molecular Simulation
(3-0) Cr. 3.
Prereq: CH E 545

CH E 652: Advanced Transport
(3-0) Cr. 3.
Prereq: CH E 552 and CH E 553
Advanced topics in momentum transport, fluid mechanics, and mass transport including study of recent literature.

CH E 688: Catalysis and Catalytic Processes
(Cross-listed with BR C). (3-0) Cr. 3.
Prereq: CH E 382
Principles and applications of heterogeneous and homogeneous catalysis. Adsorption. Reaction kinetics and mass transfer effects. Catalyst characterization. Industrial catalytic processes.

CH E 692: Independent Study
Cr. 2-6. Repeatable.
Investigation of an approved topic on an individual basis. Election of course and topic must be approved in advance by Program of Study Committee.

CH E 695: Advanced Topics
Cr. arr. Repeatable.

CH E 695A: Advanced Topics: Separations
Cr. arr. Repeatable.

CH E 695B: Advanced Topics: Advanced Statistical Modeling and Control
Cr. arr. Repeatable.

CH E 695C: Advanced Topics: Crystallization
Cr. arr. Repeatable.

CH E 695D: Advanced Topics: Thermodynamics
Cr. arr. Repeatable.

CH E 695E: Advanced Topics: Protein Engineering/Bioseparations
Cr. arr. Repeatable.

CH E 695F: Advanced Topics: Biological Engineering
Cr. arr. Repeatable.

CH E 695G: Advanced Topics: Materials and Biomaterials
Cr. arr. Repeatable.

CH E 695H: Advanced Topics: Surfaces
Cr. arr. Repeatable.

CH E 695I: Advanced Topics: Combinatorial Design
Cr. arr. Repeatable.

CH E 695J: Advanced Topics: Polymeric and Nanostructured Materials
Cr. arr. Repeatable.

CH E 695K: Advanced Topics: Biomaterials and Tissue Engineering
Cr. arr. Repeatable.

CH E 695L: Advanced Topics: Catalysis, Reaction Engineering, and Renewable Energy
Cr. arr. Repeatable.

CH E 697: Engineering Internship
Cr. R. Repeatable. F.S.SS.
Prereq: Permission of major professor, graduate classification
One semester and one summer maximum per academic year professional work period.

CH E 698: Chemical Engineering Teaching Practicum
(1-0) Cr. 1. F.
Prereq: Graduate student classification and permission of instructor
Discussions intended to foster the development of graduate students as teaching assistants and future chemical engineering instructors. Topics include classroom and laboratory instruction, grading, and developing a teaching philosophy. Offered on a satisfactory-fail basis only.
CH E 698A: Chemical Engineering Teaching Practicum: Teaching Practicum
(1-0) Cr. 1. F.
Prereq: Graduate student classification and permission of instructor
Discussions intended to foster the development of graduate students as teaching assistants and future chemical engineering instructors. Topics include classroom and laboratory instruction, grading, and developing a teaching philosophy. Offered on a satisfactory-fail basis only.

CH E 698B: Chemical Engineering Teaching Practicum: Teaching Experience
(1-0) Cr. 1. Repeatable. F.S.S.
Prereq: CH E 698A
Participation in the instruction of a CH E course under the mentorship of a CBE faculty member. Typical activities may include lecture preparation and delivery, laboratory instruction, design of assessments, problem-solving sessions, office hours, and grading. Offered on a satisfactory-fail basis only.

CH E 699: Research
Cr. arr. Repeatable.