

# CHEMICAL ENGINEERING (CH E)

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## **Any experimental courses offered by CH E can be found at:**

registrar.iastate.edu/faculty-staff/courses/explistsings/ (<http://www.registrar.iastate.edu/faculty-staff/courses/explistsings/>)

## **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*

Formulation and solution of engineering problems. Significant figures. Use of SI units. Graphing and curve-fitting. Flowcharting. Introduction to material balances, engineering economics, and design. Use of spreadsheet programs to solve and present engineering problems. Solution of engineering problems using computer programming languages. Chemical Engineering examples. Only one of ENGR 160, A B E 160, AER E 160, CH E 160, C E 160, CPR E 160, E E 185, I E 148, M E 160 and S E 185 may count towards graduation.

### **CH E 202: Chemical Engineering Seminar**

(1-0) Cr. 1. F.

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. Restricted to CHE majors.

### **CH E 204: Chemical Engineering Continuing Learning Community**

Cr. R.

*Prereq: 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*

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 177, PHYS 232*

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 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: 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, CH E 381*

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: CH E 202, MATH 267, PHYS 232, CHEM 325; credit or enrollment in CH E 310, PHYS 232L*

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, CH E 381; credit or enrollment in ENGL 314 or ENGL 309 or ENGL 312 or JL MC 347*

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 358, CH E 382, 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: CHE 357, CH E 381*

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*

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 410: Electrochemical Engineering**

(Dual-listed with CH E 510). (3-0) Cr. 3. F.

*Prereq: CH E 357, CH E 381, CH E 382*

Electrochemical engineering principles in thermodynamics, electrode kinetics, charge and mass transport; modeling and simulation; electrocatalysis; electrochemical reactions; applications of electrochemical engineering in fuel cells, batteries and electrolyzers.

**CH E 415: Biochemical Engineering**

(Dual-listed with CH E 515). (3-0) Cr. 3.

*Prereq: CH E 357, CHEM 331; BBMB 301 or BBMB 303 or BBMB 404*

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*

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 303 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 or CH E 220, MATH 266 or MATH 267, PHYS 232*

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: CHEM 331; CH E 382 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: CHE 357, CH E 381*

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*

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 510: Electrochemical Engineering**

(Dual-listed with CH E 410). (3-0) Cr. 3. F.

*Prereq: CH E 357, CH E 381, CH E 382*

Electrochemical engineering principles in thermodynamics, electrode kinetics, charge and mass transport; modeling and simulation; electrocatalysis; electrochemical reactions; applications of electrochemical engineering in fuel cells, batteries and electrolyzers.

**CH E 515: Biochemical Engineering**

(Dual-listed with CH E 415). (3-0) Cr. 3.

*Prereq: CH E 357, CHEM 331; BBMB 301 or BBMB 303 or BBMB 404*

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 or CH E 220, MATH 266 or MATH 267, PHYS 232*

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: CHEM 331; CH E 382 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*

Qualitative features of turbulence. Statistical representation of turbulent velocity fields: averages, moments, correlations, length and time scales and the energy cascade. Averaged equations of motion, closure requirements, Reynolds averaged models. Homogeneous shear flows, free shear flows, boundary layers. Numerical simulation of turbulence: DNS, LES, DES.

**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 even-numbered years.

*Prereq: M E 538*

Single particle, multiparticle 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*

Principles of statistical physics. General features of molecular simulations including Monte Carlo (MC) methods, molecular mechanics (MM), and molecular dynamics (MD). Overview of intermolecular and interatomic potentials. Evaluation of phase equilibria, free energies, and surface/interfacial properties. Coarse-grained methods.

**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.S.SS.

*Prereq: Graduate student classification and permission of instructor*

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.SS.

*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.

Advanced topic for thesis/dissertation.