

CHEMICAL ENGINEERING (CHEN)

Courses

CHEN 1000 (3) Creative Technology

Delve into cutting-edge topics such as the science of climate change, biotechnology, biomedical devices, advanced materials, renewable energy, and environmental sustainability! This course will introduce undergraduate students to the most recent concepts in technology and how these concepts impact all aspects of life, including human health and the health of the planet.

Additional Information: Arts Sci Core Curr: Natural Science Non-Sequence
Arts Sci Gen Ed: Distribution-Natural Sciences

CHEN 1201 (4) General Chemistry for Engineers 1

Designed to meet the general chemistry requirement for some engineering students and serve as part one for students whose academic plans require advanced work in chemistry. Topics include components of matter, stoichiometry, electron configuration, chemical bonding, molecular shapes, covalent bonding, classes of reactions, thermochemistry, gases, atomic structure, organic compounds, intermolecular forces, and phase equilibria. Examples and problems illustrate the application of chemistry to engineering sub-disciplines. Department enforced prerequisites: High school Algebra, one year of high school Chemistry or CHEM 1021 (minimum grade C-).

Equivalent - Duplicate Degree Credit Not Granted: CHEN 1211, CHEM 1113, CHEM 1400 and MCEN 1024

Requisites: Restricted to College of Engineering (ENGRU) undergraduates and IUT On Track applicants only.

Recommended: Not recommended for students with grade below B- in CHEM 1021.

CHEN 1203 (2) General Chemistry for Engineers 2

Designed for students whose academic plans require advanced work in chemistry. Topics include kinetics, solubility/solubility equilibria, acid-bases, buffers and titrations, thermodynamics, and electrochemistry. Examples and problems illustrate the application of chemistry to engineering sub-disciplines. AP Chemistry credit not accepted in lieu of any of these prereq classes.

Equivalent - Duplicate Degree Credit Not Granted: CHEN 1211 or CHEM 1133 or CHEM 2100

Requisites: Requires prerequisite courses of CHEN 1201 or CHEM 1113 or MCEN 1024 (all minimum grade C-). Restricted to College of Engineering undergraduates (ENGRU) and IUT On Track applicants only.

Recommended: Corequisite CHEM 1221.

CHEN 1211 (4) Accelerated Chemistry for Engineers

One-semester lecture and recitation course designed for engineering students with more advanced chemistry backgrounds. Topics include stoichiometry; thermodynamics; gases, liquids, and solids; equilibrium; acids and bases; bonding concepts; kinetics; reactions; and materials science. Examples and problems illustrate the application of chemistry to engineering sub-disciplines. Department enforced prerequisite of 3, 4 or 5 on the AP Chemistry exam or equivalent IB scores or a passing score on the "Chemistry Readiness Exam for Engineers."

Equivalent - Duplicate Degree Credit Not Granted: CHEM 1113 or CHEM 1400 or CHEN 1201 or CHEN 1203 or MCEN 1024

Requisites: Restricted to College of Engineering (ENGRU) undergraduates and IUT On Track applicants only.

Recommended: Corequisite CHEM 1221.

CHEN 1300 (1) Introduction to Chemical and Biological Engineering

Meets for one lecture per week. Examines the different fields of chemical engineering and chemical & biological engineering including energy, materials, pharma, and biomedical; addresses how to be successful in college and engineering; and showcases some of the opportunities here at CU.

Requisites: Restricted to Chemical Engineering, Chemical Biological Engineering, Biological Engineering, and open option (XXEN) majors only with a maximum of 50 credit hours.

CHEN 1310 (3) Introduction to Engineering Computing

Introduces the use of computers in engineering problem solving, including elementary numerical methods. Teaches programming fundamentals, including data and algorithm structure, and modular programming. Software vehicles include Excel/Vba and Matlab. Formerly GEEN 1300 and COEN 1300.

Requisites: Requires prerequisite or corequisite course of APPM 1340 or 1345 or 1350 or GEEN 3830 or MATH 1300 (all minimum grade C-). Restricted to College of Engineering majors and IUT On Track applicants only

CHEN 1400 (3) Drugs, Driving and Dynamic Processes

Project-based course that applies the principles of chemistry, biology, mechanics and electronics to the production and application of sustainable commodities (fuels, drugs, chemicals, and energy). Examples include student-developed green vehicles, sustainable nutraceuticals, or renewable electrical generation.

Requisites: Restricted to Chemical Engineering (CHEN) and Chemical and Biological Engineering (CBEN), and open option (XXEN) majors only with a maximum of 70 credit hours.

CHEN 2120 (3) Chemical Engineering Material and Energy Balances

Provides a basic understanding of chemical engineering calculations involving material and energy balances around simple chemical processes.

Requisites: Requires prerequisite courses of CHEN 1211 or CHEN 1201 or CHEM 1400 or CHEM 1113 or MCEN 1024 (all min grade C-). Requires corequisite courses of CHEN 1310 (CHEN 1203 or CHEM 1133). Restricted to Coll of Engineering mjrs IUT On Track applicants onl

CHEN 2840 (1-4) Independent Study

Available to sophomores with approval of Department of Chemical Engineering. Subject arranged to fit needs of student.

Repeatable: Repeatable for up to 6.00 total credit hours.

CHEN 3010 (3) Applied Data Analysis

Teaches students to analyze and interpret data. Topics include engineering measurements, graphical presentation and numerical treatment of data, statistical inference, and regression analysis.

Requisites: Requires prerequisite course of CHEN 1310 and APPM 2360 or MATH 2130 and MATH 3430 (all minimum grade C-). Restricted to College of Engineering students only.

CHEN 3200 (3) Chemical Engineering Fluid Mechanics

Introduces fluid mechanics and momentum transfer, emphasizing the application of these principles to chemical engineering systems.

Equivalent - Duplicate Degree Credit Not Granted: CVEN 3313 and MCEN 3021

Requisites: Requires prereq courses of PHYS 1110 and (APPM 2350 or MATH 2400) and (CHEN 2120 or CVEN 2121 or GEEN 2851 or MCEN 2023) (all min grade C-). Requires prereq or coreq courses of APPM 2360 or (MATH 2130 and MATH 3430) (min grade C-). Restricted to ENGR mjr

CHEN 3210 (4) Chemical Engineering Heat and Mass Transfer

Examines conservation and transfer of mass and thermal energy. Focuses on conduction and convection of heat in the context of chemical processes and heat exchangers. Addresses radiation. Also studies mass transfer rate processes, including diffusion, microscopic material balances, and correlations for mass transfer coefficients.

Requisites: Requires prerequisite courses of (CHEN 3200 or MCEN 3021) and (APPM 2360 or MATH 3430) (minimum grade C-). Restricted to College of Engineering majors only

CHEN 3211 (1) Chemical Engineering Mass Transfer

Study of mass-transfer rate processes, including diffusion, convection, microscopic material balances, and correlations for mass-transfer coefficients. Requires department approval and a department-approved heat transfer course.

Requisites: Requires prerequisite course of either CHEN 3200 or MCEN 3021 (minimum grade C-). Restricted to College of Engineering (ENGRU) undergraduates only.

CHEN 3220 (3) Chemical Engineering Separations

Studies separation methods including distillation, absorption, extraction, and membranes, and graphical and computer-based solutions to separation problems. Applies mass transfer rate theory to packed and tray columns.

Requisites: Requires prerequisite courses of CHEN 3210 and CHEN 3320 and (CHEN 4521 or a prerequisite or corequisite of CHEM 4531) (all minimum grade C-). Restricted to College of Engineering majors only.

CHEN 3320 (3) Chemical Engineering Thermodynamics

Applies thermodynamic principles to nonideal systems, phase equilibrium, chemical equilibrium, power generation, refrigeration, and chemical processes.

Requisites: Requires prerequisite courses of CHEN 2120 and (CHEN 4521 or a prerequisite or corequisite of CHEM 4531) and (APPM 2360 or MATH 3430) (all minimum grade C-). Restricted to College of Engineering majors only

CHEN 3660 (3) Energy Fundamentals

Explains the most important energy technologies and systems; provides tools to analyze performance using science and engineering principles. This course will investigate important energy concepts from sources and extraction to utilization, storage and efficiency. Topics include fossil fuels, hydropower, renewable energy, biofuels, carbon capture and waste disposal.

Requisites: Requires prerequisite courses of CHEN 1201 or CHEN 1211 or CHEM 1113 or MCEN 1024 and PHYS 1110 and APPM 1360 or MATH 2300 (all minimum grade C-). Restricted to College of Engineering majors only.

CHEN 3840 (1-4) Independent Study

Available to juniors with approval of the Department of Chemical Engineering. Subject arranged to fit needs of the student.

Repeatable: Repeatable for up to 6.00 total credit hours.

Requisites: Restricted to College of Engineering (ENGRU) undergraduates only.

CHEN 3930 (6) Chemical Engineering Cooperative Education

Students enrolled in this course participate in a previously arranged, department-sponsored cooperative education program.

Requisites: Requires prerequisite course of CHEN 2120 (minimum grade C-). At least a 2.85 cumulative GPA is required. Restricted to College of Engineering majors only.

Recommended: Prerequisite 3.00 GPA or higher.

CHEN 4010 (2) Chemical Engineering Senior Thesis 1

Provides an opportunity for advanced students to conduct exploratory research in chemical engineering.

Requisites: Restricted to College of Engineering (ENGRU) undergraduates only.

CHEN 4020 (2) Chemical Engineering Senior Thesis 2

Continuation of CHEN 4010. This course and CHEN 4020 can substitute for CHEN 4130.

Requisites: Requires prerequisite course of CHEN 4010 (minimum grade C-). Restricted to College of Engineering students only.

CHEN 4090 (1) Undergraduate Seminar

Provides chemical engineering career and professional information, facilitates contact with faculty and industry representatives, and improves communication and leadership skills. Consists of a series of seminars and field trips and requires a research project involving a written and oral report.

Requisites: Restricted to Chemical (CHEN) Engineering or Chemical and Biological (CBEN) Engineering majors only.

CHEN 4130 (3) Chemical Engineering Laboratory

Involves planning and execution of chemical engineering experiments on mass transfer operations, separations, and chemical reactors. Interprets experimental data with theoretical principles and statistical analysis. Emphasizes communication with written memos, full reports, and oral presentations.

Requisites: Requires prerequisite courses of CHEN 3010 and CHEN 3220 and CHEN 3320 and CHEN 4330 (all minimum grade C-). Restricted to College of Engineering majors only.

CHEN 4330 (3) Kinetics and Reactor Design

Introduces chemical kinetics and chemical reactor design. Involves mass and energy balances for steady-state and transient reactor systems. Also covers residence time distribution, mass transfer, catalytic reactions, and multiple steady states in reactors.

Requisites: Requires prerequisite courses of CHEN 3320 and CHEN 3210 and (CHEN 4521 or CHEM 4531) (all minimum grade C-). Restricted to College of Engineering majors only.

CHEN 4440 (3) Chemical Engineering Materials

Introduces materials engineering, including properties of polymers, metals, ceramics, and semiconductors, especially as related to chemical engineering processes.

Requisites: Requires prerequisite courses of CHEN 3320 and CHEM 3311 (all minimum grade C-). Restricted to College of Engineering majors only.

CHEN 4450 (3) Polymer Chemistry

Introduces polymer science with a focus on polymer chemistry and polymerization reactions. Focuses on polymerization reaction engineering and how polymer properties depend on structure.

Equivalent - Duplicate Degree Credit Not Granted: CHEN 5450

Requisites: Requires prerequisite courses of CHEN 4830 or CHEN 4330 and CHEM 3311 (all minimum grade C-). Restricted to College of Engineering majors only.

CHEN 4460 (3) Polymer Engineering

Introductory polymer engineering course reviewing basic terminology and definitions; the properties and synthetic routes of important industrial polymers; and processing of polymers and their applications.

Equivalent - Duplicate Degree Credit Not Granted: CHEN 5460

Requisites: Requires prerequisite courses of CHEM 3311 and CHEN 3320 (all minimum grade C-). Restricted to College of Engineering majors only.

CHEN 4480 (3) Solar Cells and Optical Devices for Sustainable Buildings

This course assumes no background in electronic materials and explains how silicon and cutting-edge metal halide perovskite solar cells are designed, fabricated and characterized. Topics will include optics, band diagrams, wafer fabrication, most thin film deposition techniques, module design and economics. Other optical devices that can help the world rapidly reduce its carbon emissions, such as light-emitting diodes and energy saving windows with dynamic tinting, will also be covered.

Equivalent - Duplicate Degree Credit Not Granted: CHEN 5480

Recommended: Prerequisite a course in materials science (for example CHEN 4440), the physics of electromagnetism and optics at a very basic level.

CHEN 4490 (3) Electrochemical Engineering

This course discusses fundamentals and applications of electrochemical systems from an engineering perspective. Aspects of thermodynamics, reaction kinetics, and transport phenomena relevant to the description of electrode/electrolyte interfaces and charge transfer reactions are covered. Topics include cell equilibrium (Nernst equation), reactions rates within Butler-Volmer and Marcus theory, electrochemical double layer structure, ion transport (Poisson-Nernst-Planck equation), potential and current distributions in electrochemical cells, and experimental electroanalytical techniques. Applications include fuel cells, electrolyzers, batteries, sensors, and corrosion. Contact instructor to request to take prerequisites as corequisites.

Equivalent - Duplicate Degree Credit Not Granted: CHEN 5490

Requisites: Requires prerequisite courses of (CHEN 4330 or CHEN 4830) and PHYS 1120 (minimum grade C-). Restricted to College of Engineering (ENGRU) undergraduates only.

CHEN 4520 (3) Chemical Process Design

Studies applied chemical process design including equipment specification and economic evaluation.

Requisites: Requires prerequisite courses of CHEN 3010 and CHEN 3210 and CHEN 3220 and CHEN 4330 or CHEN 4830 (all minimum grade C-). Restricted to College of Engineering majors only.

CHEN 4521 (3) Physical Chemistry for Engineers

Examines the laws of classical thermodynamics followed by physical transformations of pure substances, the thermodynamics of simple mixtures and chemical equilibrium. Applies quantum theory to atomic and molecular structure. Presents the concepts and applications of statistical thermodynamics. Introduces rates of chemical reactions, reaction dynamics and catalysis.

Requisites: Requires prereq courses of APPM 2350 or MATH 2400 and CHEN 1211 or CHEN 1203 or CHEM 1133 (all min. grade C-). Requires a prereq or coreq course of APPM 2360 or MATH 2130 and MATH 3430 (min. grade C-). Restricted to College of Engineering majors only.

CHEN 4530 (2) Chemical Engineering Design Project

Provides a team-based capstone design experience for chemical engineering students. Projects are sponsored by industry and student design teams collaborate with industrial consultants. Projects consider chemical process and product design with emphasis on economic analysis. Deliverables include an oral mid-project design review, a final oral presentation and final written design report.

Requisites: Requires prerequisite course of CHEN 4520 (minimum grade C-). Restricted to College of Engineering majors only.

CHEN 4570 (4) Process Dynamics and Control

Examines principles of controls theory and controls application to chemical processes. Focuses on feedback, feedforward and distributed control systems. Laboratory sessions cover measurement fundamentals, signal transmission, dynamic testing, control system synthesis, and implementation and adjustment.

Requisites: Requires prerequisite courses of CHEN 3220 and CHEN 4330 or BIEN 4830 and PHYS 1120 and APPM 2360 or MATH 2130 and MATH 3430 (all minimum grade C-). Restricted to College of Engineering majors only.

CHEN 4630 (1) Intellectual Property Law and Engineering

Learn the fundamentals of the various types of intellectual property, obtain the ability to search the USPTO database for patents, learn the difference between provisional patents, utility patents and foreign patents and learn the timing requirements related to the filing of patents and public disclosure, use, and/or sale of an invention.

Equivalent - Duplicate Degree Credit Not Granted: CHEN 5630

Requisites: Restricted to students with 87-180 credits (Senior, Fifth Year Senior) College of Engineering majors only.

CHEN 4650 (3) Particle Technology

Aims to identify the important physical mechanisms occurring in processes involving particles, formulate and solve mathematical descriptions of such processes, and analyze experimental and theoretical results in both a qualitative and quantitative manner. Teaches students to apply this knowledge to the design of particulate systems. Conveys the breadth and depth of natural and industrial applications involving particulates.

Equivalent - Duplicate Degree Credit Not Granted: CHEN 5650

Requisites: Requires prerequisite courses of APPM 2360 or MATH 2130 and MATH 3430 and CHEN 3200 or MCEN 3021 (all minimum grade C-). Restricted to College of Engineering majors only.

CHEN 4831 (1) Biokinetics and Bioreactors Module

Study of biokinetics of enzyme reactions, cell growth and bioproduct formation. Design of batch, semi-batch and continuous bioreactors. Overview of biotechnology industry. Introduction to pharmacokinetics and drug delivery. Requires department approval and a department-approved kinetics and reactor design course.

Requisites: Requires prerequisite course CHEN 3210 (minimum grade C-). Restricted to College of Engineering (ENGRU) undergraduates only.

CHEN 4836 (3) Nanomaterials

Presents fundamental chemical and physical concepts that give rise to the unique optical, electronic and magnetic properties of nanoscale materials. Introduces important synthetic routes for producing nanomaterials, and interparticle forces governing colloidal behavior and self-assembly. Discusses current and potential applications in catalysis, biomedicine, renewable energy, and other fields.

Equivalent - Duplicate Degree Credit Not Granted: CHEN 5836

Requisites: Require prerequisite or corequisite of CHEN 3320 (minimum grade C-). Restricted to College of Engineering students only.

CHEN 4838 (1-3) Special Topics in Chemical Engineering

Examines a special topic in Chemical Engineering.

Repeatable: Repeatable for up to 6.00 total credit hours. Allows multiple enrollment in term.

Requisites: Restricted to College of Engineering (ENGRU) undergraduates only.

CHEN 4840 (1-4) Independent Study

Available to seniors with approval of chemical engineering department. Subject arranged to fit needs of student.

Repeatable: Repeatable for up to 6.00 total credit hours. Allows multiple enrollment in term.

Requisites: Restricted to students with 87-180 credits (Senior, Fifth Year Senior) College of Engineering majors only.

CHEN 5090 (1) Seminar in Chemical Engineering

Required of all chemical engineering graduate students. Includes reports on research activities and on special current topics.

Requisites: Restricted to graduate students only.

CHEN 5128 (3) Applied Statistics In Research and Development

Students learn current and emerging statistical methods that are appropriate to experimentation in research and development activities. Statistical design of experiments and model fitting is emphasized. Department enforced prereq.: one introductory probability/statistics course.

CHEN 5150 (3) Biomolecular Kinetics, Transport, and Thermodynamics

Required for the Biological Engineering PhD. This course covers aspects of kinetics, transport, and thermodynamics as they relate to interactions between biomolecules and cells. These core subjects will be introduced within concepts common to cell biology, protein/genetic engineering, and signaling, among others. Undergraduate enrollment with instructor consent only.

Recommended: Prerequisites Introductory biology and/or biochemistry, linear algebra, differential equations, thermodynamics, organic chemistry.

CHEN 5160 (3) Systems Analysis of Cells and Tissues

Required for the Biological Engineering PhD. This course explores how to describe signaling and regulation networks present at the cell and tissue level. Topics include gene expression, stem cell differentiation, homeostasis, and others.

Recommended: Prerequisite prior experience in introductory biology and/or biochemistry, linear algebra, differential equations, thermodynamics, and organic chemistry.

CHEN 5210 (4) Transport Phenomena

Considers continuum mechanics, emphasizing fundamental relationships for fluid mechanics and heat and mass transfer and their applications to engineering problems. Department enforced prerequisites: undergraduate courses in fluid mechanics, heat transfer, and differential equations.

Requisites: Restricted to students with 87-180 credits (Seniors) or graduate students only.

CHEN 5360 (3) Catalysis and Kinetics

Studies principles of chemical kinetics and catalytic reactions, emphasizing heterogeneous catalysis.

Requisites: Requires corequisite course of CHEN 4330. Restricted to Chemistry (CHEM) or Chemical Engineering (CHEN) graduate students only.

CHEN 5370 (3) Intermediate Chemical Engineering Thermodynamics

Reviews fundamentals of thermodynamics, application to pure fluids and mixtures, and physical equilibrium and changes of state. Examines the equation of state and computation of fluid properties for pure fluids, mixtures and solutions. Also looks at relations between thermodynamics and statistical mechanics. Department enforced prerequisite: an undergraduate course in chemical thermodynamics.

Requisites: Restricted to graduate students only.

CHEN 5390 (3) Chemical Reactor Engineering

Studies ideal and nonideal chemical reactors, including unsteady state behavior, mixing effects, reactor stability, residence time distribution and diffusion effects. Department enforced prerequisite: undergraduate course in chemical reactor design/kinetics.

Requisites: Restricted to graduate students only.

CHEN 5420 (3) Physical Chemistry and Fluid Mechanics of Interfaces

Covers thermodynamics of interfaces and surface tension measurement; adsorption at liquid-gas, liquid-liquid, and solid-gas interfaces; monolayers; conservation equations for a fluid interface; rheology of interfaces; surface tension driven flows; contact angle and wettability; and double layer phenomena.

Requisites: Requires prerequisite course of CHEN 3200 (minimum grade D-).

CHEN 5440 (3-4) Design of Materials

The course content includes introduction and study of important concepts in solid state physics (particularly those relevant for design of materials); origin, characterization and design of mechanical, electronic, optical, magnetic, thermal and electrochemical properties of materials; design of bulk and nanostructured composites; introduction to polymers and soft materials; fundamentals of colloids and interfaces; and nanoscale chemistry and physics for design or desired material properties.

Grading Basis: Letter Grade

CHEN 5450 (3) Polymer Chemistry

Introduces polymer science with a focus on polymer chemistry and polymerization reactions. Focuses on polymerization reaction engineering and how polymer properties depend on structure.

Equivalent - Duplicate Degree Credit Not Granted: CHEN 4450

Requisites: Restricted to graduate students only.

CHEN 5460 (3) Polymer Engineering

Introductory polymer engineering course reviewing basic terminology and definitions; the properties and synthetic routes of important industrial polymers; and processing of polymers and their applications.

Equivalent - Duplicate Degree Credit Not Granted: CHEN 4460

Requisites: Restricted to graduate students only.

CHEN 5470 (3) Functional Materials Chemistry

The synthesis, organization, and processing of materials can enable functional performance. Curriculum will overview the synthesis and design of functional organic and inorganic materials. A particular emphasis will be placed on structure-performance correlations between chemistry and materials organization. Topical foci will include polymers, biomaterials, and materials for energy.

Recommended: Prerequisite Introductory course(s) in materials or organic chemistry.

CHEN 5480 (3) Solar Cells and Optical Devices for Sustainable Buildings

This course assumes no background in electronic materials and explains how silicon and cutting-edge metal halide perovskite solar cells are designed, fabricated and characterized. Topics will include optics, band diagrams, wafer fabrication, most thin film deposition techniques, module design and economics. Other optical devices that can help the world rapidly reduce its carbon emissions, such as light-emitting diodes and energy saving windows with dynamic tinting, will also be covered.

Equivalent - Duplicate Degree Credit Not Granted: CHEN 4480

Requisites: Restricted to graduate students only.

Recommended: Prerequisite a course in materials science (for example CHEN 4440), the physics of electromagnetism and optics at a very basic level.

CHEN 5490 (3) Electrochemical Engineering

This course discusses fundamentals and applications of electrochemical systems from an engineering perspective. Aspects of thermodynamics, reaction kinetics, and transport phenomena relevant to the description of electrode/electrolyte interfaces and charge transfer reactions are covered. Topics include cell equilibrium (Nernst equation), reactions rates within Butler-Volmer and Marcus theory, electrochemical double layer structure, ion transport (Poisson-Nernst-Planck equation), potential and current distributions in electrochemical cells, and experimental electroanalytical techniques. Applications include fuel cells, electrolyzers, batteries, sensors, and corrosion. Contact instructor to request to take prerequisites as corequisites.

Equivalent - Duplicate Degree Credit Not Granted: CHEN 4490

Requisites: Requires prerequisite courses of (CHEN 4330 or CHEN 4830) and PHYS 1120 (minimum grade D-). Restricted to graduate students only.

Grading Basis: Letter Grade

CHEN 5630 (1) Intellectual Property Law and Engineering

Learn the fundamentals of the various types of intellectual property, obtain the ability to search the USPTO database for patents, learn the difference between provisional patents, utility patents and foreign patents and learn the timing requirements related to the filing of patents and public disclosure, use, and/or sale of an invention.

Equivalent - Duplicate Degree Credit Not Granted: CHEN 4630

Requisites: Restricted to graduate students only.

CHEN 5650 (3) Particle Technology

Aims to identify the important physical mechanisms occurring in processes involving particles, formulate and solve mathematical descriptions of such processes, and analyze experimental and theoretical results in both a qualitative and quantitative manner. Teaches students to apply this knowledge to the design of particulate systems. Conveys the breadth and depth of natural and industrial applications involving particulates. Extra work required for graduate course.

Equivalent - Duplicate Degree Credit Not Granted: CHEN 4650

Requisites: Restricted to graduate students only.

CHEN 5670 (3) Environmental Separations

Lect. Covers traditional, as well as new, chemical separations processes that have environmental applications. Includes chemically benign processing (pollution prevention) as well as approaches to address existing pollution problems.

CHEN 5730 (1) Mathematical Methods Short Course for Chemical Engineers

Determine and apply appropriate analytical methods, which may include linear and nonlinear algebraic equations, ordinary differential equations and partial differential equations, to solve an array of chemical engineering problems. Identify and interpret the differences between model predictions and experimental results.

Grading Basis: Letter Grade

CHEN 5740 (3) Analytical Methods in Chemical Engineering

Presents applied analytical and numerical mathematical methods in the context of chemical engineering problems. Topics include modeling techniques, algebraic equations, and ordinary and partial differential equations. Department enforced requisite: working knowledge of computing, calculus, differential equations, linear algebra, and vector operations; and undergraduate courses in physics, fluid mechanics, heat transfer, and reaction engineering.

Requisites: Restricted to students with 87-180 credits (Seniors) or graduate students only.

CHEN 5750 (3) Numerical Methods in Chemical Engineering

Covers numerical methods for solving ordinary differential, partial differential, and integral equations. These principles are employed to develop, test, and assess computer programs for solving problems of interest to chemical engineers.

Requisites: Restricted to graduate students only.

CHEN 5800 (3) Bioprocess Engineering

Reviews the recent developments in the fields of microbiology, molecular genetics, and genetic engineering that are of commercial value and benefit to mankind. Covers engineering implementation of such biological processes.

CHEN 5805 (3) Biological Interactions to Biomaterials

Covers major classes of materials used in medical applications. Provide an in-depth view of advanced biomaterial concepts with a focus on biological interactions with materials that relate to protein and cell interactions, the innate and acquired immune response, blood interactions and infection.

Requisites: Restricted to graduate students only.

CHEN 5830 (1) Introduction to Modern Biotechnology

Introduces students to the biotechnology enterprise. Topics include the biotechnology industry and profession, the various academic disciplines of biotechnology, intellectual property, financing, and ethics.

CHEN 5831 (2) Biotechnology Case Studies

Capstone course required of all graduate students in the interdisciplinary graduate biotechnology certificate program. Reviews molecular genetics, product synthesis and purification, economics, intellectual property, and business planning. Working in teams, students present a biotechnology product plan.

Requisites: Requires prerequisite course of CHEN 5830 (minimum grade D-).

CHEN 5835 (3) Colloids and Interfaces

Provides a deep exploration of the fundamental principles of colloid and interface science and of related applications. Core topics include fundamental equations of interfacial science, capillary phenomena, interfacial thermodynamics interfaces, molecular monolayers, electrical surface properties, and interfacial forces. Advanced topics include wetting phenomena, adsorption isotherms, dynamic interfacial behavior, surface modification, tribology, surfactant self-assembly, and foams/emulsions among others.

Requisites: Requires prerequisite course of CHEN 3320 (minimum grade C-).

CHEN 5836 (3) Nanomaterials

Presents fundamental chemical and physical concepts that give rise to the unique optical, electronic and magnetic properties of nanoscale materials. Introduces important synthetic routes for producing nanomaterials, and interparticle forces governing colloidal behavior and self-assembly. Discusses current and potential applications in catalysis, biomedicine, renewable energy, and other fields.

Equivalent - Duplicate Degree Credit Not Granted: CHEN 4836

Requisites: Restricted to graduate students only.

CHEN 5838 (1-3) Special Topics in Chemical Engineering

Graduate-selected topics courses offered upon demand.

Repeatable: Repeatable for up to 6.00 total credit hours. Allows multiple enrollment in term.

Requisites: Restricted to graduate students only.

CHEN 5840 (1-4) Independent Study

Allows multiple enrollment in term.

Repeatable: Repeatable for up to 7.00 total credit hours. Allows multiple enrollment in term.

Requisites: Restricted to graduate students only.

CHEN 5900 (3) Pharmaceutical Biotechnology

Incorporates biochemistry, pharmaceutical science, and engineering for application in the pharmaceutical industry. Emphasizes microscale mechanisms affecting drug delivery, bioavailability, and stability. Specific topics include thermodynamics of macromolecular conformational stability, crystallization kinetics, interfacial phenomena, and industrial protein folding.

Requisites: Restricted to graduate students only.

CHEN 5919 (1-5) Special Topics in CHBE

Repeatable: Repeatable for up to 5.00 total credit hours.

Requisites: Restricted to graduate students only.

CHEN 5930 (1-3) Professional Internship

This class provides a structure for CHEN and BIEN graduate students to receive academic credit for participating in internship experiences with industry partners that have an academic component consistent with graduate-level education in the engineering arts and sciences.

Participation in this class requires an internship agreement between the student and the employment (industry) partner, detailing the academic goals of the internship experience. Instructor participation will include facilitation of mid-term and final assessment of student performance as well as additional educational opportunities during the internship period. May be taken during any term following initial enrollment and participation in CHEN or BIEN graduate programs.

Requisites: Restricted to graduate students only.

CHEN 6210 (3) Microhydrodynamics of Suspensions and Colloids

Focuses on fluid mechanics and colloid science of suspensions of particles, cells, and drops. Covers fundamentals, applications, and research frontiers.

Requisites: Requires prerequisite course of CHEN 5210 (minimum grade D-).

CHEN 6820 (3) Biochemical Engineering Fundamentals

Covers design and operation of fermentation processes, microbial and enzyme kinetics, multiple substrate and multiple species of fermentation, regulation of enzyme activity, energetics of cellular growth, immobilized enzyme and cell reactors, and transport phenomena in microbial systems and downstream processing.

Requisites: Restricted to Chemistry (CHEM), Chemical Engineering (CHEN), Biological Engineering (BIEN), or Biological Sciences (MCDB) graduate students only.

CHEN 6940 (1) Master's Candidate for Degree

Registration intended for students preparing for a thesis defense, final examination, culminating activity, or completion of degree.

CHEN 6950 (1-6) Master's Thesis**CHEN 8990 (1-10) Doctoral Dissertation**