Chemical and Biomolecular Engineering

Overview

The Department of Chemical and Biomolecular Engineering (CBE) provides the opportunity for undergraduate and graduate students to obtain a thorough fundamental knowledge of all fields in chemical and biomolecular engineering.

In broad terms, research conducted in the department can be divided into the following areas: catalysis and reaction engineering; electrochemical engineering; polymers and complex fluids; microsystems technology and microelectronics; molecular simulations and theory; interfacial engineering; biochemical and bioprocess engineering; biomedical engineering; and synthetic biology.

Undergraduate Programs

Chemical Engineering (http://guide.berkeley.edu/undergraduate/degree-programs/chemical-engineering): BS, Minor
Chemical Engineering/Materials Science and Engineering (http://guide.berkeley.edu/undergraduate/degree-programs/chemical-engineering-materials-science-joint-major): BS (Joint Major offered in cooperation with the College of Engineering)
Chemical Engineering/Nuclear Engineering (http://guide.berkeley.edu/undergraduate/degree-programs/chemical-engineering-nuclear-joint-major): BS (Joint Major offered in cooperation with the College of Engineering)

Graduate Programs

Chemical and Biomolecular Engineering (http://guide.berkeley.edu/graduate/degree-programs/chemical-biomolecular-engineering): MS Professional Masters (Product Development Program), MS and PhD

Chemical and Biomolecular Engineering

Expand all course descriptions [+ ] Collapse all course descriptions [-]

CHM ENG 24 Freshman Seminars 1 Unit
Terms offered: Spring 2020, Spring 2019, Spring 2015
The Berkeley Seminar Program has been designed to provide new students with the opportunity to explore an intellectual topic with a faculty member in a small-seminar setting. Berkeley Seminars are offered in all campus departments, and topics vary from department to department and semester to semester.
Freshman Seminars: Read More [+]

Rules & Requirements

Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 1 hour of seminar per week

Additional Details

Subject/Course Level: Chemical & Biomolecular Engineering/Undergraduate

Grading/Final exam status: The grading option will be decided by the instructor when the class is offered. Final exam required.

Freshman Seminars: Read Less [-]

CHM ENG 40 Introduction to Chemical Engineering Design 2 Units
Terms offered: Spring 2020, Fall 2019, Spring 2019
Design and analysis of processes involving chemical change. Strategies for design, such as creative thinking and (re)definition of the design goal. Methods for analyzing designs, such as mathematical modeling, empirical analysis by graphics, and dynamic scaling by dimensional analysis. Design choices in light of process efficiency, product quality, economics, safety, and environmental issues.

Introduction to Chemical Engineering Design: Read More [+]

Rules & Requirements

Prerequisites: Math 1B OR Chem 4A

Hours & Format

Fall and/or spring: 15 weeks - 1 hour of lecture and 1.5 hours of discussion per week

Additional Details

Subject/Course Level: Chemical & Biomolecular Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Introduction to Chemical Engineering Design: Read Less [-]
CHM ENG 84 Sophomore Seminar 1 or 2 Units
Terms offered: Spring 2013, Spring 2012, Spring 2010
Sophomore seminars are small interactive courses offered by faculty members in departments all across the campus. Sophomore seminars offer opportunity for close, regular intellectual contact between faculty members and students in the crucial second year. The topics vary from department to department and semester to semester. Enrollment limited to 15 sophomores.
Sophomore Seminar: Read More [+]

Rules & Requirements

Prerequisites: At discretion of instructor
Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring:
5 weeks - 3-6 hours of seminar per week
10 weeks - 1.5-3 hours of seminar per week
15 weeks - 1-2 hours of seminar per week

Summer:
6 weeks - 2.5-5 hours of seminar per week
8 weeks - 2-4 hours of seminar per week

Additional Details

Subject/Course Level: Chemical & Biomolecular Engineering/Undergraduate
Grading/Final exam status: The grading option will be decided by the instructor when the class is offered. Final exam required.

Sophomore Seminar: Read Less [-]

CHM ENG 90 Science and Engineering of Sustainable Energy 3 Units
Terms offered: Spring 2020, Spring 2019, Spring 2018
An introduction is given to the science and technologies of producing electricity and transportation fuels from renewable energy resources (biomass, geothermal, solar, wind, and wave). Students will be introduced to quantitative calculations and comparisons of energy technologies together with the economic and political factors affecting the transition from nonrenewable to sustainable energy resources. Mass and energy balances are used to analyze the conversion of energy resources.
Science and Engineering of Sustainable Energy: Read More [+]

Rules & Requirements

Prerequisites: Chemistry 1A or 4A

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Chemical & Biomolecular Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructors: Bell, Segalman

Science and Engineering of Sustainable Energy: Read Less [-]

CHM ENG 98 Directed Group Studies for Lower Division Undergraduates 1 - 3 Units
Terms offered: Spring 2020, Fall 2019, Spring 2019
Supervised research on a specific topic.
Directed Group Studies for Lower Division Undergraduates: Read More [+]

Rules & Requirements

Prerequisites: Consent of instructor
Credit Restrictions: Enrollment is restricted; see the Introduction to Courses and Curricula section of this catalog.
Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 1-3 hours of directed group study per week

Additional Details

Subject/Course Level: Chemical & Biomolecular Engineering/Undergraduate
Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

Directed Group Studies for Lower Division Undergraduates: Read Less [-]
Chemical and Biomolecular Engineering

CHM ENG 98W Directed Group Study 1 Unit
Terms offered: Fall 2015
Directed group study consisting of supplementary problem sets, review sessions, and discussions related to chemical engineering. Topics vary with instructor.

Rules & Requirements

Prerequisites: This Chemical Engineering 98W is planned for students who are concurrently enrolled in Chemical Engineering 140

Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of independent study per week

Additional Details

Subject/Course Level: Chemical & Biomolecular Engineering/Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

Directed Group Study: Read Less [-]

CHM ENG 140 Introduction to Chemical Process Analysis 4 Units
Terms offered: Spring 2020, Fall 2019, Spring 2019
Material and energy balances applied to chemical process systems. Determination of thermodynamic properties needed for such calculations. Sources of data. Calculation procedures.

Rules & Requirements

Prerequisites: Chemical Engineering 40 and Chemistry 4B (may be taken concurrently) or Chemistry 1B; and Physics 7B (may be taken concurrently)

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Chemical & Biomolecular Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Introduction to Chemical Process Analysis: Read Less [-]

CHM ENG 141 Chemical Engineering Thermodynamics 4 Units
Terms offered: Spring 2020, Fall 2019, Spring 2019

Rules & Requirements

Prerequisites: 140 with a grade of C- or higher; Engineering 7, which may be taken concurrently

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Chemical & Biomolecular Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Chemical Engineering Thermodynamics: Read Less [-]

CHM ENG 142 Chemical Kinetics and Reaction Engineering 4 Units
Terms offered: Spring 2020, Fall 2019, Fall 2018
Analysis and prediction of rates of chemical conversion in flow and nonflow processes involving homogeneous and heterogeneous systems.

Rules & Requirements

Prerequisites: 141 with a grade of C- or higher; 150B, which may be taken concurrently

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Chemical & Biomolecular Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Chemical Kinetics and Reaction Engineering: Read Less [-]
CHM ENG 143 Computational Methods in Chemical Engineering 4 Units
Terms offered: Spring 2020, Spring 2019, Spring 2016
The purpose of Chemical Engineering Modeling and Computations in Chemical Engineering is to teach students the methodologies used in setting up mathematical models of simple chemical processes and operations, and the numerical techniques used to simulate them. Included are techniques to obtain physical properties of mixtures/solutions using equations of state. This is followed by simple processes such as vapor liquid equilibrium, separation operations such as distillation, heat transfer, and chemical reactions in ideal reactors such as stirred tank and plug flow. Later on, real chemical process equipment and processes are modeled and simulated, using many of the techniques learned earlier. Programming languages such as Matlab and...

Objectives & Outcomes
Course Objectives: The focus of this course is on developing insights into chemical processes and operations through the use of modeling and computations. This is not a programming course. The instructors will provide introduction to the use of Aspen and the other codes, but the majority of the learning will be through the active use of these programs by the students in solving assigned problems.

Student Learning Outcomes: The course will be consistent with the overall objectives of the Chemical Engineering curriculum as outlined in the ABET guidelines.

Rules & Requirements
Prerequisites: E7 and CHM ENG 140

CHM ENG 150A Transport Processes 4 Units
Terms offered: Spring 2020, Fall 2019, Spring 2019
Principles of fluid mechanics and heat transfer with application to chemical processes. Laminar and turbulent flow in pipes and around submerged objects. Flow measurement. Heat conduction and convection; heat transfer coefficients.

Rules & Requirements
Prerequisites: 140 with a grade of C- or higher; Math 54, which may be taken concurrently

CHM ENG 150B Transport and Separation Processes 4 Units
Terms offered: Spring 2020, Fall 2019, Fall 2018
Principles of mass transfer with application to chemical processes. Diffusion and convection. Simultaneous heat and mass transfer; mass transfer coefficients. Design of staged and continuous separations processes.

Rules & Requirements
Prerequisites: Chemical and Biomolecular Engineering 141 with a grade of C- or higher; Chemical and Biomolecular Engineering 150A with a grade of C- or higher; Engineering 7

Subject/Course Level: Chemical & Biomolecular Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
**CHM ENG 154 Chemical Engineering Laboratory 4 Units**

Terms offered: Spring 2020, Fall 2019, Spring 2019

Experiments in physical measurements, fluid mechanics, heat and mass transfer, kinetics, and separation processes. Emphasis on investigation of basic relationships important in engineering. Experimental design, analysis of results, and preparation of engineering reports are stressed.

Chemical Engineering Laboratory: Read More [+]

**Rules & Requirements**

**Prerequisites:** Chemical and Biomolecular Engineering 141, 142, and 150B

**Hours & Format**

**Fall and/or spring:** 15 weeks - 1 hour of lecture and 8 hours of laboratory per week

**Summer:** 8 weeks - 2 hours of lecture and 16 hours of laboratory per week

**Additional Details**

**Subject/Course Level:** Chemical & Biomolecular Engineering/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

Chemical Engineering Laboratory: Read Less [-]

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**CHM ENG 160 Chemical Process Design 4 Units**

Terms offered: Spring 2020, Fall 2019, Spring 2019

Design principles of chemical process equipment. Design of integrated chemical processes with emphasis upon economic considerations.

Chemical Process Design: Read More [+]

**Rules & Requirements**

**Prerequisites:** Chemical and Biomolecular Engineering 142, 150B, and 154. 154 can be taken concurrently

**Hours & Format**

**Fall and/or spring:** 15 weeks - 3 hours of lecture and 3 hours of laboratory per week

**Summer:** 8 weeks - 6 hours of lecture and 6 hours of laboratory per week

**Additional Details**

**Subject/Course Level:** Chemical & Biomolecular Engineering/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

Chemical Process Design: Read Less [-]

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**CHM ENG 161S Industrial Chemical Process Design 6 Units**

Terms offered: Prior to 2007

Design of chemical processes and equipment, with an emphasis on industry-sponsored and/or industry-tailored processes

Industrial Chemical Process Design: Read More [+]

**Objectives & Outcomes**

**Course Objectives:** Teach students the strategies used in the design of chemical processes through an authentic industrial project.

**Student Learning Outcomes:**
- Develop an ability to function on multi-disciplinary teams.
- Develop the ability to design an integrated chemical engineering-based process to meet stated objectives within realistic constraints.
- Establish proficiency in the design process and project management fundamentals.
- Gain an understanding of professional and ethical responsibilities.

**Rules & Requirements**

**Prerequisites:** Prerequisites: Chemical and Biomolecular Engineering 142, 150B, and 154

**Hours & Format**

**Summer:** 8 weeks - 6 hours of lecture and 6 hours of discussion per week

**Additional Details**

**Subject/Course Level:** Chemical & Biomolecular Engineering/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

Instructors: Bryan, Sciamanna

Industrial Chemical Process Design: Read Less [-]

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**CHM ENG 162 Dynamics and Control of Chemical Processes 4 Units**

Terms offered: Spring 2020, Fall 2019, Spring 2019

Analysis of the dynamic behavior of chemical processes and methods and theory of their control. Implementation of computer control systems on process simulations.

Dynamics and Control of Chemical Processes: Read More [+]

**Rules & Requirements**

**Prerequisites:** Chemical and Biomolecular Engineering 142 and 150B; Mathematics 53 and 54

**Hours & Format**

**Fall and/or spring:** 15 weeks - 3 hours of lecture and 1 hour of laboratory per week

**Additional Details**

**Subject/Course Level:** Chemical & Biomolecular Engineering/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

Dynamics and Control of Chemical Processes: Read Less [-]
CHM ENG 170A Biochemical Engineering 3 Units
Terms offered: Fall 2019, Fall 2018, Fall 2016
This course intends to introduce chemical engineers to the basic concepts of biochemical engineering. The course focuses on the use of chemical engineering skills and principles in the analysis and design of biologically-based processes. The main emphasis will be on biochemical kinetics, heat and mass transfer, thermodynamics, and transport phenomena as they apply to enzyme catalysis, microbial growth and metabolism, fermentation and bioreactor design, product recovery and downstream processing. Fundamental topics in biological sciences will be introduced as necessary throughout the course.

Biochemical Engineering: Read More [+]

Rules & Requirements
Prerequisites: Chemical and Biomolecular Engineering 142, 150B, or consent of instructor; Biology 1A

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: Clark

Biochemical Engineering: Read Less [-]

CHM ENG 170B Biochemical Engineering 3 Units
Terms offered: Spring 2020, Spring 2019, Spring 2014
The second of a two-semester sequence intended to introduce chemical engineers to the basic concepts of biochemical engineering. The course focuses on the use of chemical engineering skills and principles in the analysis and design of biologically-based processes. The emphasis will be on biochemical kinetics, protein engineering, cell growth and metabolism, bioreactor design, downstream processing, pharmacokinetics, drug delivery, and ethics.

Biochemical Engineering: Read More [+]

Rules & Requirements
Prerequisites: 170A: Chemistry 135 or Molecular and Cell Biology 102, which may be taken concurrently

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: Clark

Formerly known as: 170

Biochemical Engineering: Read Less [-]

CHM ENG C170L Biochemical Engineering Laboratory 3 Units
Terms offered: Spring 2020, Spring 2019, Fall 2018, Spring 2014, Spring 2013
Laboratory techniques for the cultivation of microorganisms in batch and continuous reactions. Enzymatic conversion processes. Recovery of biological products.

Biochemical Engineering Laboratory: Read More [+]

Rules & Requirements
Prerequisites: Chemical Engineering 170A (may be taken concurrently) or consent of instructor

Hours & Format
Fall and/or spring: 15 weeks - 7 hours of laboratory and 1 hour of lecture per week

Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Also listed as: CHEM C170L

Biochemical Engineering Laboratory: Read Less [-]
CHM ENG 171 Transport Phenomena 3 Units
Terms offered: Fall 2018, Spring 2011, Spring 2009
Study of momentum, energy, and mass transfer in laminar and turbulent flow.
Transport Phenomena: Read More [+]

Rules & Requirements
Prerequisites: 150B

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Transport Phenomena: Read Less [-]

CHM ENG 176 Principles of Electrochemical Processes 3 Units
Terms offered: Spring 2019, Spring 2018, Fall 2016
Principles and application of electrochemical equilibria, kinetics, and transport processes. Technical electrolysis and electrochemical energy conversion.
Principles of Electrochemical Processes: Read More [+]

Rules & Requirements
Prerequisites: Chemical and Biomolecular Engineering 141, 142, and 150B

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Principles of Electrochemical Processes: Read Less [-]

CHM ENG C178 Polymer Science and Technology 3 Units
An interdisciplinary course on the synthesis, characterization, and properties of polymer materials. Emphasis on the molecular origin of properties of polymeric materials and technological applications. Topics include single molecule properties, polymer mixtures and solutions, melts, glasses, elastomers, and crystals. Experiments in polymer synthesis, characterization, and physical properties.
Polymer Science and Technology: Read More [+]

Rules & Requirements
Prerequisites: Junior standing

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Also listed as: CHEM C178
Polymer Science and Technology: Read Less [-]

CHM ENG 179 Process Technology of Solid-State Materials Devices 3 Units
Terms offered: Fall 2019, Fall 2018, Fall 2017
Chemical processing and properties of solid-state materials. Crystal growth and purification. Thin film technology. Application of chemical processing to the manufacture of semiconductors and solid-state devices.
Process Technology of Solid-State Materials Devices: Read More [+]

Rules & Requirements
Prerequisites: Engineering 45; one course in electronic circuits recommended; senior standing

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Process Technology of Solid-State Materials Devices: Read Less [-]
CHM ENG 180 Chemical Engineering Economics 3 Units
Terms offered: Fall 2019, Spring 2019, Fall 2017
Optimal design of chemical processes and unit operations, emphasizing the interactions between technical and economic considerations. Analysis of process risks. Chemical and biomolecular process design in the presence of uncertainties. Interest rate determinants and their effects on chemical process feasibility and choices. Relationships between structure and behavior of firms in the chemical processing industries. Multivariable input-output analyses.  
Chemical Engineering Economics: Read More [+]

Rules & Requirements
Prerequisites: Chemical and Biomolecular Engineering 142 and 150B. Consent of instructor

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Chemical Engineering Economics: Read Less [-]

CHM ENG 182 Nanoscience and Engineering Biotechnology 3 Units
Terms offered: Spring 2020, Fall 2018
This nanoscale science and biomolecular engineering course will cover emerging topics in applied biotechnology and nanotechnology. Topics include enzyme kinetics, enzyme inhibition, recombinant protein generation, cell culture, genome editing, drug design, nanoparticle-based gene and drug delivery, fluorescence imaging, and sensors. The course will also probe the interface of biology with nanomaterials, and standard microscopic techniques to image biological structures and nanoscale materials.
Nanoscience and Engineering Biotechnology: Read More [+]

Rules & Requirements
Prerequisites: Bio 1A or BioE 11 and Physics 7A

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Nanoscience and Engineering Biotechnology: Read Less [-]

CHM ENG H193 Senior Honors Thesis 3 Units
Terms offered: Spring 2016, Fall 2015, Spring 2015
A senior honors thesis is written in consultation with the student's faculty research advisor. This is a required course for students wishing to graduate with honors in Chemical Engineering.
Senior Honors Thesis: Read More [+]

Rules & Requirements
Prerequisites: Senior standing, approval of faculty research advisor, overall GPA of 3.4 or higher

Hours & Format
Fall and/or spring: 15 weeks - 9 hours of independent study per week

Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Undergraduate
Grading/Final exam status: Letter grade. Alternative to final exam.
Senior Honors Thesis: Read Less [-]

CHM ENG H194 Research for Advanced Undergraduates 2 - 4 Units
Terms offered: Spring 2020, Spring 2019, Summer 2016 10 Week Session
Original research under direction of one of the members of the staff.
Research for Advanced Undergraduates: Read More [+]

Rules & Requirements
Prerequisites: Minimum GPA of 3.4 overall at Berkeley and consent of instructor
Repeat rules: Course may be repeated for credit without restriction.

Hours & Format
Fall and/or spring: 15 weeks - 0 hours of independent study per week
Summer:
6 weeks - 1-5 hours of independent study per week
8 weeks - 1-4 hours of independent study per week

Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam not required.
Research for Advanced Undergraduates: Read Less [-]
**CHM ENG 195 Special Topics 2 - 4 Units**
Terms offered: Fall 2019, Fall 2018, Fall 2017
Lectures and/or tutorial instruction on special topics. Please refer to the Notes section in the Academic Guide for the current course description.
Special Topics: Read More [+]

**Rules & Requirements**

Prerequisites: Consent of instructor

Repeat rules: Course may be repeated for credit without restriction.

**Hours & Format**

Fall and/or spring: 15 weeks - 2-4 hours of independent study per week

**Additional Details**

Subject/Course Level: Chemical & Biomolecular Engineering/ Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Special Topics: Read Less [-]

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**CHM ENG C195A The Berkeley Lectures on Energy: Energy from Biomass 3 Units**
Terms offered: Fall 2015, Fall 2014, Fall 2013
After an introduction to the different aspects of our global energy consumption, the course will focus on the role of biomass. The course will illustrate how the global scale of energy guides the biomass research. Emphasis will be placed on the integration of the biological aspects (crop selection, harvesting, storage and distribution, and chemical composition of biomass) with the chemical aspects to convert biomass to energy. The course aims to engage students in state-of-the-art research.
The Berkeley Lectures on Energy: Energy from Biomass: Read More [+]

**Rules & Requirements**

Prerequisites: Chemistry 1B or Chemistry 4B, Mathematics 1B, Biology 1A

Repeat rules: Course may be repeated for credit under special circumstances: Repeatable when topic changes with consent of instructor.

**Hours & Format**

Fall and/or spring: 15 weeks - 3 hours of lecture per week

**Additional Details**

Subject/Course Level: Chemical & Biomolecular Engineering/ Undergraduate

Grading/Final exam status: Letter grade. Final exam not required.

Special Laboratory Study: Read Less [-]

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**CHM ENG 196 Special Laboratory Study 2 - 4 Units**
Terms offered: Spring 2020, Spring 2019, Spring 2016
Special laboratory or computational work under direction of one of the members of the staff.
Special Laboratory Study: Read More [+]

**Rules & Requirements**

Prerequisites: Consent of instructor

Repeat rules: Course may be repeated for credit without restriction.

**Hours & Format**

Fall and/or spring: 15 weeks - 2-3 hours of independent study per week

Summer:
6 weeks - 5-8 hours of independent study per week
8 weeks - 3.5-6 hours of independent study per week
10 weeks - 3-4.5 hours of independent study per week

**Additional Details**

Subject/Course Level: Chemical & Biomolecular Engineering/ Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

**Instructor:** Strauss

Field Study in Chemical Engineering: Read Less [-]
CHM ENG 198 Directed Group Study for Undergraduates 1 - 3 Units
Terms offered: Spring 2020, Fall 2019, Spring 2019
Supervised research on a specific topic. Enrollment is restricted; see Introduction to Courses and Curricula section in the General Catalog.

Rules & Requirements

Prerequisites: Completion of 60 units of undergraduate study and in good academic standing

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 1-3 hours of lecture per week
Summer: 6 weeks - 2.5-7.5 hours of lecture per week

Additional Details

Subject/Course Level: Chemical & Biomolecular Engineering/Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

CHM ENG 199 Supervised Independent Study and Research 1 - 4 Units
Terms offered: Spring 2016, Fall 2015, Spring 2015
Supervised Independent Study and Research: Read More [+]

Rules & Requirements

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 1-4 hours of independent study per week
Summer:
6 weeks - 2.5-10 hours of independent study per week
8 weeks - 1.5-7.5 hours of independent study per week
10 weeks - 1.5-6 hours of independent study per week

Additional Details

Subject/Course Level: Chemical & Biomolecular Engineering/Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

CHM ENG 230 Mathematical Methods in Chemical Engineering 3 Units
Terms offered: Fall 2018, Fall 2017, Fall 2014

The course aims to introduce a variety of mathematical and computational methods useful in solving research problems pertaining to chemical and biomolecular systems. The course covers a wide range of topics from linear algebra and matrices, differential equations, and stochastic methods. Even though the focus is primarily on analytical methods, most of the concepts will be demonstrated with computations and applications. The goal of the course is to ensure that the students are aware of a wide range of computational methods that can be useful in their research and to provide the students with sufficient background in applied mathematics that can be useful in reading the science and engineering literature.

Mathematical Methods in Chemical Engineering: Read More [+]

Rules & Requirements

Prerequisites: Math 53 and 54 or equivalent; open to seniors with consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Chemical & Biomolecular Engineering/Graduate

Grading: Letter grade.

CHM ENG 240 Thermodynamics for Chemical Product and Process Design 3 Units
Terms offered: Fall 2019, Fall 2018, Fall 2017

Topics covered include molecular thermodynamics of pure substances and mixtures, interfacial thermodynamics, statistical mechanics, and computer simulations.

Thermodynamics for Chemical Product and Process Design: Read More [+]

Rules & Requirements

Prerequisites: Math 53 and 54 or equivalent; 141 or equivalent; open to seniors with consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Chemical & Biomolecular Engineering/Graduate

Grading: Letter grade.
CHM ENG 244 Kinetics and Reaction Engineering 3 Units
Terms offered: Fall 2019, Fall 2018, Fall 2017
Molecular processes in chemical systems, kinetics and catalysis. Interaction of mass and heat transfer in chemical processes. Performance of systems with chemical reactors. 
Kinetics and Reaction Engineering: Read More [+]

Rules & Requirements
Prerequisites: 142 or equivalent; open to seniors with consent of instructor

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Chemical & Biomolecular Engineering/Graduate
Grading: Letter grade.

Kinetics and Reaction Engineering: Read Less [-]

CHM ENG 245 Catalysis 3 Units
Terms offered: Spring 2019, Spring 2018, Spring 2016
Adsorption and kinetics of surface reactions; catalyst preparation and characterization; poisoning, selectivity, and empirical activity patterns in catalysis; surface chemistry, catalytic mechanisms and modern experimental techniques in catalytic research; descriptive examples of industrial catalytic systems. 
Catalysis: Read More [+]

Rules & Requirements
Prerequisites: 244 or Chemistry 223, or consent of instructor

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Chemical & Biomolecular Engineering/Graduate
Grading: Letter grade.

Catalysis: Read Less [-]

CHM ENG 246 Principles of Electrochemical Engineering 3 Units
Terms offered: Spring 2012, Fall 2010, Fall 2009
Electrode processes in electrolysis and in galvanic cells. Charge and mass transfer in ionic media. Criteria of scale-up. 
Principles of Electrochemical Engineering: Read More [+]

Rules & Requirements
Prerequisites: Graduate standing or consent of instructor

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Chemical & Biomolecular Engineering/Graduate
Grading: Letter grade.

Principles of Electrochemical Engineering: Read Less [-]

CHM ENG 248 Applied Surface and Colloid Chemistry 3 Units
Terms offered: Spring 2020, Spring 2014, Spring 2012
Principles of surface and colloid chemistry with current applications; surface thermodynamics, wetting, adsorption from solution, disperse systems, association colloids, interacting electrical double layers and colloid stability, kinetics of coagulation, and electrokinetics. 
Applied Surface and Colloid Chemistry: Read More [+]

Rules & Requirements
Prerequisites: Graduate standing or consent of instructor

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Chemical & Biomolecular Engineering/Graduate
Grading: Letter grade.

Applied Surface and Colloid Chemistry: Read Less [-]
CHM ENG 250 Transport Processes 3 Units
Terms offered: Fall 2019, Fall 2018, Fall 2017
Basic differential relations of mass, momentum, and energy including creeping, laminar, and turbulent flow, boundary layers, convective-diffusion in heat and mass transfer, and simultaneous multicomponent mass and energy transport. Analytic mathematical solution of the equations of change using classical techniques including: separation of variables, similarity solutions, and Laplace and Fourier transforms.

Rules & Requirements
Prerequisites: Chemical & Biomolecular Engineering 150A, 150B; Mathematics 53 and 54, or equivalent; open to seniors with consent of instructor

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Graduate
Grading: Letter grade.

CHM ENG 256 Advanced Transport Phenomena 3 Units
Terms offered: Fall 2018, Fall 2016, Spring 2009
Formulation and rigorous analysis of the laws governing the transport of momentum, heat, and mass, with special emphasis on chemical engineering applications. Detailed investigation of laminar flows complemented by treatments of turbulent flow systems and hydrodynamic stability.

Advanced Transport Phenomena: Read More [+]

Rules & Requirements
Prerequisites: 230

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

CHM ENG C268 Physicochemical Hydrodynamics 3 Units
Terms offered: Spring 2017, Fall 2013, Fall 2011, Spring 2011

Physicochemical Hydrodynamics: Read More [+]

Rules & Requirements
Prerequisites: A first graduate course in fluid mechanics such as 260A-260B

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Graduate
Grading: Letter grade.

Instructor: Morris
Also listed as: MEC ENG C268

CHM ENG C270 Protein Engineering 3 Units
Terms offered: Fall 2015, Fall 2014, Fall 2010
An in-depth study of the current methods used to design and engineer proteins. Emphasis on how strategies can be applied in the laboratory. Relevant case studies presented to illustrate method variations and applications. Intended for graduate students.

Protein Engineering: Read More [+]

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Graduate
Grading: Letter grade.

Instructor: Tullman-Ercek
Also listed as: BIO ENG C219

Protein Engineering: Read Less [-]
CHM ENG 274 Biomolecular Engineering 3 Units
Terms offered: Spring 2020, Spring 2019, Spring 2018
Biomolecular Engineering: Read More [+]

Rules & Requirements
Prerequisites: Graduate standing or consent of instructor

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Graduate
Grading: Letter grade.

Biomolecular Engineering: Read Less [-]

CHM ENG 293C Curricular Practical Training Internship 0.0 Units
Terms offered: Prior to 2007
This is an independent study course for international students doing internships under the Curricular Practical Training program.
Curricular Practical Training Internship: Read More [+]

Rules & Requirements
Repeat rules: Course may be repeated for credit without restriction.

Hours & Format
Summer: 8 weeks - 0 hours of independent study per week

Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Graduate
Grading: Offered for satisfactory/unsatisfactory grade only.
Curricular Practical Training Internship: Read Less [-]

CHM ENG C294A Mechanics and Physics of Lipid Bilayers 3 Units
Terms offered: Fall 2017
Lipid bilayers constitute the membrane that encloses every animal cell and many of its interior structures, including the nuclear envelope, the organelles and the endoplasmic reticulum. This is a unique course devoted to modern developments in this exceptionally active field of research, ranging from models based on continuum theory to recent developments based on statistical mechanics.
Mechanics and Physics of Lipid Bilayers: Read More [+]

Objectives & Outcomes
Student Learning Outcomes: To expose students to advanced current work on the mechanics and physics of lipid bilayers (a very active field of current research relevant to biomechanics and biophysics)

Rules & Requirements
Prerequisites: Mechanical Engineering 185 or equivalent

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Graduate
Grading: Letter grade.
Instructor: Steigmann
Also listed as: MEC ENG C285E
Mechanics and Physics of Lipid Bilayers: Read Less [-]

CHM ENG 295B Special Topics in Chemical Engineering: Electrochemical, Hydrodynamic, and Interfacial Phenomena 2 Units
Terms offered: Fall 2011, Spring 2011, Fall 2010
Current and advanced study in chemical engineering, primarily for advanced graduate students.
Special Topics in Chemical Engineering: Electrochemical, Hydrodynamic, and Interfacial Phenomena: Read More [+]

Rules & Requirements
Prerequisites: Open to properly qualified graduate students
Repeat rules: Course may be repeated for credit without restriction.

Hours & Format
Fall and/or spring: 15 weeks - 2 hours of lecture per week

Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Graduate
Grading: Letter grade.
Special Topics in Chemical Engineering: Electrochemical, Hydrodynamic, and Interfacial Phenomena: Read Less [-]
CHM ENG 295K Design of Functional Interfaces 3 Units
Terms offered: Spring 2011, Spring 2005, Fall 2004
This course introduces students to the concepts and techniques involved in the design and physical characterization of advanced functional materials consisting of well-defined interfaces. Throughout the course, principles of supramolecular chemistry on solid surfaces are applied to functional systems. Materials with different connectivity and structure at the active site are compared for development of understanding. Specific topics include catalysis, separations, encapsulation, and biomedicine.
Design of Functional Interfaces: Read More [+]
Rules & Requirements

Prerequisites: Graduate standing

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Graduate
Grading: Letter grade.
Instructor: Katz

Design of Functional Interfaces: Read Less [-]

CHM ENG 295N Polymer Physics 3 Units
Terms offered: Spring 2015, Spring 2010, Spring 2008
This course, which is based on Gert Strobl's book addresses the origin of some of the important physical properties of polymer liquids and solids. This includes phase transitions, crystallization, morphology of multiphase polymer systems, mechanical properties, response to mechanical and electric fields, and fracture. When possible, we will develop quantitative molecular models that predict macroscopic behavior. The course will address experimental data obtained by microscopy, light and neutron scattering, rheology, and dielectric relaxation.
Polymer Physics: Read More [+]
Rules & Requirements

Prerequisites: 230 and 240

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Graduate
Grading: Letter grade.
Instructor: Alexander

Polymer Physics: Read Less [-]
CHM ENG 295Q Special Topics in Chemical Engineering: Advanced Topics in New Product Development 3 Units
Terms offered: Spring 2020, Spring 2019, Spring 2018
This course is a part of the product development initiative sponsored by the department of chemical engineering. The course builds on the coverage in 295P of real-life practices of translating scientific discovery into commercial products. We will cover a wide range of advanced product development concepts including technology road maps, decision analysis, six sigma, product portfolio optimization, and best practices for field project management.
Special Topics in Chemical Engineering: Advanced Topics in New Product Development: Read More [+]

Rules & Requirements
Prerequisites: Graduate standing or consent of instructor. 295P recommended

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Graduate
Grading: Letter grade.
Instructor: Alexander

Special Topics in Chemical Engineering: Advanced Topics in New Product Development: Read Less [-]

CHM ENG C295A The Berkeley Lectures on Energy: Energy from Biomass 3 Units
Terms offered: Fall 2015, Fall 2014, Fall 2013
After an introduction to the different aspects of our global energy consumption, the course will focus on the role of biomass. The course will illustrate how the global scale of energy guides the biomass research. Emphasis will be places on the integration of the biological aspects (crop selection, harvesting, storage, and distribution, and chemical composition of biomass) with the chemical aspects to convert biomass to energy. The course aims to engage students in state-of-art research.
The Berkeley Lectures on Energy: Energy from Biomass: Read More [+]

Rules & Requirements
Prerequisites: Biology 1A; Chemistry 1B or 4B, Mathematics 1B
Repeat rules: Course may be repeated for credit under special circumstances: Repeatable when topic changes with consent of instructor.

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Graduate
Grading: Letter grade.
Instructors: Bell, Blanch, Clark, Smit, C. Somerville
Also listed as: BIO ENG C281/CHEM C238/PLANTBI C224
The Berkeley Lectures on Energy: Energy from Biomass: Read Less [-]
CHM ENG C295L Implications and Applications of Synthetic Biology 3 Units
Terms offered: Spring 2007
Explore strategies for maximizing the economic and societal benefits of synthetic biology and minimizing the risks; create "seedlings" for future research projects in synthetic biology at UC Berkeley; increase multidisciplinary collaborations at UC Berkeley on synthetic biology; and introduce students to a wide perspective of SB projects and innovators as well as policy, legal, and ethical experts.

Prerequisites: Consent of instructor
Hours & Format
Fall and/or spring: 15 weeks - 2 hours of lecture and 1 hour of discussion per week
Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Graduate
Grading: Letter grade.
Instructors: Arkin, Keasling
Also listed as: BIO ENG C230

Implications and Applications of Synthetic Biology: Read More [+]
Rules & Requirements
Prerequisites: Consent of instructor
Hours & Format
Fall and/or spring: 15 weeks - 2 hours of lecture and 1 hour of discussion per week
Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Graduate
Grading: Letter grade.
Instructors: Arkin, Keasling
Also listed as: BIO ENG C230

Implications and Applications of Synthetic Biology: Read Less [-]
CHM ENG C295R Applied Spectroscopy 3 Units
Terms offered: Spring 2009, Spring 2007, Spring 2002
After a brief review of quantum mechanics and semi-classical theories for the interaction of radiation with matter, this course will survey the various spectroscopies associated with the electromagnetic spectrum, from gamma rays to radio waves. Special emphasis is placed on application to research problems in applied and engineering sciences. Graduate researchers interested in systematic in situ process characterization, analysis, or discovery are best served by this course.
Prerequisites: Graduate standing in engineering, physics, chemistry, or chemical engineering; courses: quantum mechanics, linear vector space theory
Rules & Requirements
Prerequisites: Graduate standing in engineering, physics, chemistry, or chemical engineering; courses: quantum mechanics, linear vector space theory
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week
Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Graduate
Grading: Letter grade.
Instructor: Reimer
Also listed as: AST C295R
Applied Spectroscopy: Read Less [-]

CHM ENG C295Z Energy Solutions: Carbon Capture and Sequestration 3 Units
After a brief overview of the chemistry of carbon dioxide in the land, ocean, and atmosphere, the course will survey the capture and sequestration of CO2 from anthropogenic sources. Emphasis will be placed on the integration of materials synthesis and unit operation design, including the chemistry and engineering aspects of sequestration. The course primarily addresses scientific and engineering challenges and aims to engage students in state-of-the-art research in global energy challenges.
Rules & Requirements
Prerequisites: Chemistry 4B or 1B, Mathematics 1B, and Physics 7B, or equivalents
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week
Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Graduate
Grading: Letter grade.
Instructors: Bourg, DePaolo, Long, Reimer, Smit
Also listed as: CHEM C236/EPS C295Z
Energy Solutions: Carbon Capture and Sequestration: Read Less [-]

CHM ENG 296 Special Study for Graduate Students in Chemical Engineering 1 - 6 Units
Terms offered: Spring 2016, Fall 2015, Spring 2015
Special laboratory and theoretical studies.
Rules & Requirements
Prerequisites: Consent of instructor
Repeat rules: Course may be repeated for credit without restriction.
Hours & Format
Fall and/or spring: 15 weeks - 0 hours of independent study per week
Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Graduate
Grading: The grading option will be decided by the instructor when the class is offered.
Special Study for Graduate Students in Chemical Engineering: Read Less [-]
CHM ENG 298 Seminar in Chemical Engineering 1 Unit
Terms offered: Spring 2016, Fall 2015, Spring 2015
Lectures, reports, and discussions on current research in chemical engineering. Sections are operated independently and directed toward different topics.
Seminar in Chemical Engineering: Read More [+]
Rules & Requirements
Prerequisites: Open to properly qualified graduate students with consent of instructor
Repeat rules: Course may be repeated for credit without restriction.
Hours & Format
Fall and/or spring: 15 weeks - 2 hours of seminar per week
Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Graduate
Grading: Offered for satisfactory/unsatisfactory grade only.
Seminar in Chemical Engineering: Read Less [-]

CHM ENG 298C Colloquium in Chemical Engineering 1 - 2 Units
Terms offered: Spring 2020, Fall 2019, Spring 2019
Lectures, reports, and discussions on current research in chemical engineering.
Colloquium in Chemical Engineering: Read More [+]
Rules & Requirements
Prerequisites: Open to properly qualified graduate students with consent of instructor
Repeat rules: Course may be repeated for credit without restriction.
Hours & Format
Fall and/or spring: 15 weeks - 2-3 hours of colloquium per week
Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Graduate
Grading: Offered for satisfactory/unsatisfactory grade only.
Colloquium in Chemical Engineering: Read Less [-]

CHM ENG 299 Research in Chemical Engineering 1 - 12 Units
Terms offered: Spring 2020, Fall 2019, Spring 2019
Research.
Research in Chemical Engineering: Read More [+]
Rules & Requirements
Prerequisites: Consent of instructor
Repeat rules: Course may be repeated for credit without restriction.
Hours & Format
Fall and/or spring: 15 weeks - 1-12 hours of independent study per week
Summer:
6 weeks - 2.5-30 hours of independent study per week
8 weeks - 1.5-22.5 hours of independent study per week
10 weeks - 1.5-18 hours of independent study per week
Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Graduate
Grading: Offered for satisfactory/unsatisfactory grade only.
Research in Chemical Engineering: Read Less [-]

CHM ENG 300 Professional Preparation: Supervised Teaching of Chemical Engineering 2 Units
Terms offered: Spring 2020, Spring 2019, Spring 2016
Discussion, problem review and development, guidance of large scale laboratory experiments, course development, supervised practice teaching.
Professional Preparation: Supervised Teaching of Chemical Engineering: Read More [+]
Rules & Requirements
Prerequisites: Graduate standing, appointment as a Graduate Student Instructor, or consent of instructor
Repeat rules: Course may be repeated for credit without restriction.
Hours & Format
Fall and/or spring: 15 weeks - 0 hours of independent study per week
Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Professional course for teachers or prospective teachers
Grading: Offered for satisfactory/unsatisfactory grade only.
Professional Preparation: Supervised Teaching of Chemical Engineering: Read Less [-]
CHM ENG 375 Professional Preparation: Supervised Teaching of Chemical Engineering 2 Units
Terms offered: Fall 2019, Fall 2018, Fall 2015
Discussion, problem review and development, guidance of large scale laboratory experiments, course development, supervised practice teaching.
Professional Preparation: Supervised Teaching of Chemical Engineering: Read More [+]

Rules & Requirements

Prerequisites: Graduate standing, appointment as a Graduate Student Instructor, or consent of instructor
Repeat rules: Course may be repeated for credit without restriction.

Hours & Format
Fall and/or spring: 15 weeks - 0 hours of independent study per week

Additional Details

Subject/Course Level: Chemical & Biomolecular Engineering/ Professional course for teachers or prospective teachers
Grading: Offered for satisfactory/unsatisfactory grade only.

CHM ENG 602 Individual Studies for Graduate Students 1 - 8 Units
Terms offered: Fall 2019, Spring 2019, Fall 2018
Individual study in consultation with the major field adviser for qualified students to prepare themselves for the various examinations required of candidates for the Ph.D.
Individual Studies for Graduate Students: Read More [+]

Rules & Requirements

Prerequisites: Graduate standing in Ph.D. program
Credit Restrictions: Course does not satisfy unit or residence requirements for doctoral degree.
Repeat rules: Course may be repeated for credit without restriction.

Hours & Format
Fall and/or spring: 15 weeks - 0 hours of independent study per week
Summer:
6 weeks - 1-5 hours of independent study per week
8 weeks - 1-4 hours of independent study per week

Additional Details

Subject/Course Level: Chemical & Biomolecular Engineering/Graduate examination preparation
Grading: Offered for satisfactory/unsatisfactory grade only.