Chemical Engineering/ Materials Science and Engineering Joint Major

Bachelor of Science (BS)

The joint major programs are designed for students who wish to undertake study in two areas of engineering in order to qualify for employment in either field or for positions in which competence in two fields is required. The joint majors contain comparable proportions of coursework in both major fields. While they require slightly increased course loads, they can be completed in four years. Both majors are shown on the student's transcript of record. Students in this joint major program are concurrently enrolled in both the College of Engineering and the College of Chemistry, but their college of residence will be Chemistry.

Many of the engineering problems facing the nation in the next decades will require solution by engineers who have training in both chemical process engineering and materials engineering. Three typical examples are coal gasification and liquefaction, extraction of metals from low-grade ores and wastes, and environmental control of metallurgical processes.

Admission to the Joint Major

Admission to the joint major programs is open to transfer students but closed to freshmen. Continuing students may petition for a change to a joint major program after their first year. For further details regarding how to declare the joint major, please contact the College of Chemistry.

Other Joint Major Offered with the College of Engineering

Chemical Engineering/Nuclear Engineering (http://guide.berkeley.edu/archive/2014-15/undergraduate/degree-programs/chemical-engineering-nuclear-joint-major)

In addition to the University, campus, and college requirements, listed on the College Requirements tab, students must fulfill the below requirements specific to their major program.

General Guidelines

1. A minimum grade point average (GPA) of 2.0 must be maintained in all courses undertaken at UC Berkeley, including those from UC Summer Sessions, UC Education Abroad Program, UC Berkeley in Washington Program, and XB courses from University Extension.
2. A minimum GPA of 2.0 in all courses taken in the college is required in order to advance and continue in the upper-division.
3. A minimum GPA of 2.0 in all upper-division courses taken at the University is required to satisfy major requirements.
4. Students in the College of Chemistry who receive a grade of D+ or lower in a Chemical and Biomolecular Engineering or Chemistry course for which a grade of C- or higher is required must repeat the course at UC Berkeley.

For information regarding grade requirements in specific courses, please see the notes sections below.

For information regarding residence requirements and unit requirements, please see the College Requirements tab.

Lower-division Requirements

MATH 1A	Calculus	4
MATH 1B	Calculus	4
MATH 53	Multivariable Calculus	4
MATH 54	Linear Algebra and Differential Equations	4
CHEM 1A & 1AL	General Chemistry and General Chemistry Laboratory	4
or CHEM 4A	General Chemistry and Quantitative Analysis	
CHEM 1B	General Chemistry	4
or CHEM 4B	General Chemistry and Quantitative Analysis	
BIOLOGY 1A	General Biology Lecture	3
PHYSICS 7A	Physics for Scientists and Engineers	4
PHYSICS 7B	Physics for Scientists and Engineers	4
PHYSICS 7C	Physics for Scientists and Engineers	4
ENGIN 7	Introduction to Computer Programming for Scientists and Engineers	4
EL ENG 40	Introduction to Microelectronic Circuits	4
ENGIN 45	Properties of Materials	3

Upper-division Requirements

CHEM 112A	Organic Chemistry	5
CHEM 120A	Physical Chemistry	3
or PHYSICS 137A	Quantum Mechanics	
CHM ENG 140	Introduction to Chemical Process Analysis	4
CHM ENG 141	Chemical Engineering Thermodynamics	4
CHM ENG 142	Chemical Kinetics and Reaction Engineering	4
CHM ENG 150A	Transport Processes	4
CHM ENG 150B	Transport and Separation Processes	4
CHM ENG 154	Chemical Engineering Laboratory	4
CHM ENG 160	Chemical Process Design	4
CHM ENG 162	Dynamics and Control of Chemical Processes	4
CHM ENG 185	Technical Communication for Chemical Engineers	3
EL ENG 100	Electronic Techniques for Engineering	4
MAT SCI 102	Bonding, Crystallography, and Crystal Defects	3
MAT SCI 103	Phase Transformations and Kinetics	3
MAT SCI 120	Materials Production	3
MAT SCI 130	Experimental Materials Science and Design	3
Materials Science Electives: Two courses		
Choose one course from the following:		
MAT SCI 104	Materials Characterization	
MAT SCI 111	Properties of Electronic Materials	
MAT SCI 112	Corrosion (Chemical Properties)	
MAT SCI 113	Mechanical Behavior of Engineering Materials	
MAT SCI 117	Properties of Dielectric and Magnetic Materials	
MAT SCI C118	Biological Performance of Materials	
MAT SCI 151	Polymeric Materials	
Select one course from the following:		
MAT SCI 121	Metals Processing	
MAT SCI 122	Ceramic Processing	

MAT SCI 123	Semiconductor Processing
MAT SCI 125	Thin-Film Materials Science

Undergraduate students in the College of Chemistry must fulfill the following requirements in addition to those required by the major program.

For detailed lists of courses that fulfill college requirements, please see the College of Chemistry (http://guide.berkeley.edu/archive/2014-15/undergraduate/colleges-schools/chemistry/#collegerequirementstext) page in this bulletin.

Entry Level Writing

All students who will enter the University of California as freshmen must demonstrate their command of the English language by fulfilling the Entry Level Writing Requirement. Fulfillment of this requirement is also a prerequisite to enrollment in all reading and composition courses at UC Berkeley.

American History and American Institutions

The American History and Institutions requirements are based on the principle that a U.S. resident graduated from an American university should have an understanding of the history and governmental institutions of the United States.

American Cultures

American Cultures is the one requirement that all undergraduate students at Cal need to take and pass in order to graduate. The requirement offers an exciting intellectual environment centered on the study of race, ethnicity and culture of the United States. AC courses offer students opportunities to be part of research-led, highly accomplished teaching environments, grappling with the complexity of American Culture.

Foreign Language

Applies to Chemistry and Chemical Biology majors only.

The Foreign Language requirement may be satisfied with one foreign language, in one of the following ways:

- By completing in high school the third year of one foreign language with minimum grades of C-.
- By completing at Berkeley the second semester of a sequence of courses in one foreign language, or the equivalent at another institution. Only foreign language courses that include reading and composition as well as conversation are accepted in satisfaction of this requirement. Foreign language courses may be taken on a Pass/No Pass basis.
- By demonstrating equivalent knowledge of a foreign language through examination, including a College Entrance Examination Board (CEEB) Advanced Placement Examination with a score of 3 or higher (if taken before admission to college), an SAT II: Subject Test with a score of 590 or higher, or a proficiency examination offered by some departments at Berkeley or at another campus of the University of California.

Reading and Composition

In order to provide a solid foundation in reading, writing and critical thinking the College requires lower division work in composition.

- Chemical Engineering majors – A-level R&C course (e.g., English R1A) by end of freshman year
- Chemical Biology and Chemistry majors – A- and B-level courses by end of sophomore year

Breadth Elective Requirement – Chemistry & Chemical Biology majors

- 15 units total; includes Reading & Composition (R1A + R1B) and American Cultures courses
- Remaining units must come from the College of Chemistry's list of acceptable Humanities and Social Science courses (Group II)
- Breadth elective courses may be taken on a Pass/No Pass basis (excluding R&C)
- AP, IB, and GCE A-level exam credit may be used to satisfy the breadth requirement

Breadth Elective Requirement – Chemical Engineering major

- 19 unit total; includes Reading & Composition (R1A only) and American Cultures courses
- Breadth Series requirement: As part of the 19 units, students must complete two courses, at least one being upper division, in the same or very closely allied humanities or social science department(s). AP credit may be used to satisfy the lower division aspect of the requirement.
- Breadth Series courses and all remaining units must come from the College of Chemistry's list of acceptable Humanities and Social Science courses (Group II)
- Breadth elective courses may be taken on a Pass/No Pass basis (excluding R&C)
- AP, IB, and GCE A-level exam credit may be used to satisfy the breadth requirement

Class Schedule Requirements

Minimum units per semester

Maximum units per semester – 19.5

12 units of course work each semester must satisfy degree requirements.

Chemical engineering freshmen and Chemistry majors are required to enroll in a minimum of one chemistry course each semester.

After the freshman year, Chemical Engineering majors must enroll in a minimum of one chemical and biomolecular engineering course each semester.

Semester Limit

- Students who entered as freshmen – 8 semesters

- Chemistry & Chemical Biology majors who entered as transfer students – 4 semesters
- Chemical Engineering majors who entered as transfer students – 5 semester

Summer sessions are excluded when determining the limit on semesters. Students who wish to delay graduation to complete a minor, a double major, or simultaneous degrees must request approval for delay of graduation before what would normally be their final two semesters. The College of Chemistry does not have a rule regarding maximum units that a student can accumulate.

Senior Residence

After 90 units toward the bachelor's degree have been completed, at least 24 of the remaining units must be completed in residence in the College of Chemistry, in at least two semesters (the semester in which the 90 units are exceeded, plus at least one additional semester).

To count as a semester of residence for this requirement, a program must include at least 4 units of successfully completed courses. A summer session can be credited as a semester in residence if this minimum unit requirement is satisfied.

Juniors and seniors who participate in the UC Education Abroad Program (EAP) for a full year#may meet a modified senior residence requirement. After 60 units toward the bachelor's degree have been completed, at least 24 (excluding EAP) of the remaining units must be completed in residence in the College of Chemistry, in at least two semesters. At least 12 of the 24 units must be completed after the student has already completed 90 units. Undergraduate Dean's approval for the modified senior residence requirement must be obtained before enrollment in the Education Abroad Program.

Minimum Total Units

A student must successfully complete at least 120 semester units in order to graduate.

Minimum Academic Requirements

Grades

A student must earn at least a C average (2.0 GPA) in all courses undertaken at UC, including those from UC Summer Sessions, UC Education Abroad Program, and UC Berkeley Washington Program, as well as XB courses from University Extension.

Minimum Course Grade Requirements

Students in the College of Chemistry who receive a grade of D+ or lower in a chemical and biomolecular engineering or chemistry course for which a grade of C- or higher is required must repeat the course at Berkeley.

Students in the College of Chemistry must achieve:

- C- or higher in CHEM 4A (http://guide.berkeley.edu/search/?P=CHEM%204A) General Chemistry and Quantitative Analysis before taking CHEM 4B (http://guide.berkeley.edu/search/?P=CHEM%204B) General Chemistry and Quantitative Analysis
- C- or higher in CHEM 4B (http://guide.berkeley.edu/search/?P=CHEM%204B) General Chemistry and Quantitative Analysis before taking more advanced courses
- C- or higher in CHEM 112A (http://guide.berkeley.edu/search/?P=CHEM%20112A) Organic Chemistry before taking CHEM 112B (http://guide.berkeley.edu/search/?P=CHEM%20112B) Organic Chemistry GPA of at least 2.0 in all courses taken in the college in order to advance to and continue in the upper division

Chemistry or chemical biology majors must also achieve:

- C- or higher in CHEM 120A (http://guide.berkeley.edu/search/?P=CHEM%20120A) Physical Chemistry and CHEM 120B (http://guide.berkeley.edu/search/?P=CHEM%20120B) Physical Chemistry if taken before CHEM 125 (http://guide.berkeley.edu/search/?P=CHEM%20125) Physical Chemistry Laboratory or CHEM C182 (http://guide.berkeley.edu/search/?P=CHEM%20C182) Atmospheric Chemistry and Physics Laboratory
- 2.0 GPA in all upper division courses taken at the University to satisfy major requirements

Chemical engineering students must also achieve:

- C- or higher in Chemical and Biomolecular Engineering (CBE) 140 before taking any other CBE courses
- C- or higher in CHM ENG 150A (http://guide.berkeley.edu/search/?P=CHM%20ENG%20150A) Transport Processes to be eligible to take any other course in the 150 series
- 2.0 GPA in all upper division courses taken at the University to satisfy major requirements

Chemical engineering students who do not achieve a grade of C- or higher in CHM ENG 140 (http://guide.berkeley.edu/search/?P=CHM%20ENG%20140) Introduction to Chemical Process Analysis on their first attempt are advised to change to another major. If the course is not passed with a grade of C- or higher on the second attempt, continuation in the Chemical Engineering program is normally not allowed.

Minimum Progress

To make normal progress toward a degree, undergraduates must successfully complete 30 units of coursework each year. The continued enrollment of students who do not maintain normal progress will be subject to the approval of the Undergraduate Dean. To achieve minimum academic progress, the student must meet two criteria:

1. Completed no fewer units than 15 multiplied by the number of semesters, less one, in which the student has been enrolled at Berkeley. Summer sessions do not count as semesters for this purpose.
2. A student's class schedule must contain at least 13 units in any term, unless otherwise authorized by the staff adviser or the Undergraduate Dean.

For more detailed information regarding the courses listed below (e.g., elective information, GPA requirements, etc.), please see the Major Requirements tab.

				Freshman
Fall	**Units**	**Spring**		**Units**
MATH 1A	4	PHYSICS 7A		4
English R1A or equivalent	4	ENGIN 7		4

Breadth Elective		3	CHEM 4B or 1B	4
CHEM 4A or 1A ***and*** 1AL		4	MATH 1B	4
		15		**16**
				Sophomore
	Fall	**Units**	**Spring**	**Units**
PHYSICS 7B		4	MATH 54	4
CHEM 112A		5	PHYSICS 7C	4
MATH 53		4	BIOLOGY 1A	3
CHM ENG 140		4	CHM ENG 141	4
			CHM ENG 150A	4
		17		**19**
				Junior
	Fall	**Units**	**Spring**	**Units**
ENGIN 45		3	EL ENG 40	4
MAT SCI 102[1]		3	Materials Science Elective	3
CHEM 120A or PHYSICS 137A		3-4	CHM ENG 185	3
CHM ENG 142		4	Breadth Elective	3
CHM ENG 150B		4	MAT SCI 103	3
		17-18		**16**
				Senior
	Fall	**Units**	**Spring**	**Units**
Materials Science Elective		3-4	CHM ENG 160	4
MAT SCI 120		3	CHM ENG 162	4
MAT SCI 130		3	Breadth Electives	6
CHM ENG 154		4		
Breadth Elective		3		
		16-17		**14**

Total Units: 130-132

[1] Permission is required from the instructor of MAT SCI 120 to take ENGIN 45 concurrently.

Chemical Engineering/Materials Science and Engineering

CHM ENG 24 Freshman Seminars 1 Unit
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.
Rules & Requirements

Repeat rules: Course may be repeated for credit as topic varies. 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.

CHM ENG 40 Introduction to Chemical Engineering Design 2 Units
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.
Rules & Requirements

Prerequisites: Mathematics 1A, which may be taken concurrently

Hours & Format

Fall and/or spring: 15 weeks - 1.5 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.

CHM ENG 84 Sophomore Seminar 1 or 2 Units
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.
Rules & Requirements

Prerequisites: At discretion of instructor

Repeat rules: Course may be repeated for credit as topic varies. 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 - 1.5-3.5 hours of seminar and 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.

CHM ENG 90 Science and Engineering of Sustainable Energy 3 Units
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 comparisions 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.
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

CHM ENG 98 Directed Group Studies for Lower Division Undergraduates 1 - 3 Units
Supervised research on a specific topic.
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. Course may be repeated for credit when topic changes.

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.

CHM ENG 98W Directed Group Study 1 Unit
Directed group study consisting of supplementary problem sets, review sessions, and discussions related to chemical engineering. Topics vary with instructor.
Rules & Requirements

Prerequisites: This 98W is planned for students who are concurrently enrolled in CHM ENG 140

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

Hours & Format

Fall and/or spring: 15 weeks - 1 hour 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 140 Introduction to Chemical Process Analysis 4 Units
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: Chemistry 4B or 1B with a grade of C- or better; 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.

CHM ENG 141 Chemical Engineering Thermodynamics 4 Units
Thermodynamic behavior of pure substances and mixtures. Properties of solutions, phase equilibria. Thermodynamic cycles. Chemical equilibria for homogeneous and heterogeneous systems.
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.

CHM ENG 142 Chemical Kinetics and Reaction Engineering 4 Units
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.

CHM ENG 150A Transport Processes 4 Units
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

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.

CHM ENG 150B Transport and Separation Processes 4 Units
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

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.

CHM ENG 154 Chemical Engineering Laboratory 4 Units
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.
Rules & Requirements

Prerequisites: Chemical and Biomolecular Engineering 141, 142, 150B, and 185

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.

CHM ENG 160 Chemical Process Design 4 Units
Design principles of chemical process equipment. Design of integrated chemical processes with emphasis upon economic considerations.
Rules & Requirements

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

Hours & Format

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

Summer: 8 weeks - 6 hours of lecture, 2 hours of discussion, 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.

CHM ENG 161S Industrial Chemical Process Design 6 Units
Design of chemical processes and equipment, with an emphasis on industry-sponsored and/or industry-tailored processes
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

CHM ENG 162 Dynamics and Control of Chemical Processes 4 Units
Analysis of the dynamic behavior of chemical processes and methods and theory of their control. Implementation of computer control systems on process simulations.
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.

CHM ENG 170A Biochemical Engineering 3 Units
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.
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 per week

Additional Details

Subject/Course Level: Chemical & Biomolecular Engineering/ Undergraduate

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

Instructor: Clark

CHM ENG 170B Biochemical Engineering 3 Units
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.
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 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

CHM ENG C170L Biochemical Engineering Laboratory 3 Units
Laboratory techniques for the cultivation of microorganisms in batch and continuous reactions. Enzymatic conversion processes. Recovery of biological products.
Rules & Requirements

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

Hours & Format

Fall and/or spring: 15 weeks - 6 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

CHM ENG 171 Transport Phenomena 3 Units
Study of momentum, energy, and mass transfer in laminar and turbulent flow.
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.

CHM ENG 176 Principles of Electrochemical Processes 3 Units
Principles and application of electrochemical equilibria, kinetics, and transport processes. Technical electrolysis and electrochemical energy conversion.
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.

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.
Rules & Requirements

Prerequisites: Junior standing

Hours & Format

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

Additional Details

Subject/Course Level: Chemical & Biomolecular Engineering/ Undergraduate

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

Instructor: Segalman

Also listed as: CHEM C178

CHM ENG 179 Process Technology of Solid-State Materials Devices 3 Units
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.
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.

CHM ENG 180 Chemical Engineering Economics 3 Units
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.
Rules & Requirements

Prerequisites: Chemical and Biomolecular Engineering 142 and 150B, both of which may be taken concurrently. 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.

CHM ENG 185 Technical Communication for Chemical Engineers 3 Units
Development of technical writing and oral presentation skills in formats commonly used by chemical engineers.
Rules & Requirements

Prerequisites: 140; ENGLISH R1A or equivalent; consent of instructor

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

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.

CHM ENG H193 Senior Honors Thesis 3 Units
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.
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.

CHM ENG H194 Research for Advanced Undergraduates 2 - 4 Units
Original research under direction of one of the members of the staff.
Rules & Requirements

Prerequisites: Minimum GPA of 3.4 overall at Berkeley and consent of instructor

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

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.

CHM ENG 195 Special Topics 2 - 4 Units
Lectures and/or tutorial instruction on special topics.
Rules & Requirements

Prerequisites: Consent of instructor

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

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.

CHM ENG C195A The Berkeley Lectures on Energy: Energy from Biomass 3 Units
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.
Rules & Requirements

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

Repeat rules: 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 required.

Instructors: Bell, Blanch, Clark, Smit, C. Somerville

Also listed as: BIO ENG C181/CHEM C138/PLANTBI C124

CHM ENG 196 Special Laboratory Study 2 - 4 Units
Special laboratory or computational work under direction of one of the members of the staff.
Rules & Requirements

Prerequisites: Consent of instructor

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

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: Letter grade. Final exam not required.

CHM ENG 197 Field Study in Chemical Engineering 1 - 4 Units
Supervised experience in off-campus organizations relevant to specific aspects and applications of chemical engineering. Written report required at the end of the term. Course does not satisfy unit or residence requirements for the bachelor's degree.
Rules & Requirements

Prerequisites: Upper division standing and consent of instructor

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

Hours & Format

Fall and/or spring: 15 weeks - 1-4 hours of fieldwork per week

Summer:
6 weeks - 2.5-10 hours of fieldwork per week
8 weeks - 1.5-7.5 hours of fieldwork per week
10 weeks - 1.5-6 hours of fieldwork 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

CHM ENG 198 Directed Group Study for Undergraduates 1 - 3 Units
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. Course may be repeated for credit when topic changes.

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
Rules & Requirements

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

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.