

# 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/2017-18/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 or CHEM 4A	General Chemistry and General Chemistry Laboratory General Chemistry and Quantitative Analysis	4
CHEM 1B or CHEM 4B	General Chemistry General Chemistry and Quantitative Analysis	4
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
CHEM 12A	Organic Chemistry	5
MAT SCI 45	Properties of Materials	3
MAT SCI 45L	Properties of Materials Laboratory	1

## Upper Division Requirements

CHEM 120A or PHYSICS 137A	Physical Chemistry Quantum Mechanics	3
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
MAT SCI 102	Bonding, Crystallography, and Crystal Defects	3
MAT SCI 103	Phase Transformations and Kinetics	3
MAT SCI 112	Corrosion (Chemical Properties)	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 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	ELECTRONIC MATERIALS 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/2017-18/undergraduate/colleges-schools/chemistry/#collegerequirementstext>) page in this Guide.

## 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 US 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

## Humanities and Social Sciences Breadth 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 lists of approved humanities and social science courses
- Breadth 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

## Humanities and Social Sciences Breadth Requirement – Chemical Engineering major

- 22 units total; includes Reading & Composition (R1A only) and American Cultures courses
- Breadth Series requirement: As part of the 22 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 lists of approved humanities and social science courses
- Breadth 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 – 13

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 and Joint majors who entered as transfer students – 5 semesters

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>) before taking CHEM 4B (<http://guide.berkeley.edu/search/?P=CHEM%204B>)
- C- or higher in CHEM 4B (<http://guide.berkeley.edu/search/?P=CHEM%204B>) before taking more advanced courses
- C- or higher in CHEM 12A (<http://guide.berkeley.edu/search/?P=CHEM%2012A>) before taking CHEM 12B (<http://guide.berkeley.edu/search/?P=CHEM%2012B>)
- 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>) and CHEM 120B (<http://guide.berkeley.edu/search/?P=CHEM%20120B>) if taken before CHEM 125 (<http://guide.berkeley.edu/search/?P=CHEM%20125>) or CHEM C182 (<http://guide.berkeley.edu/search/?P=CHEM%20C182>)
- 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>) 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>) 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.

## University of California Requirements

Entry Level Writing (<http://guide.berkeley.edu/archive/2017-18/undergraduate/colleges-schools/natural-resources/entry-level-writing-requirement>)

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 (<http://guide.berkeley.edu/archive/2017-18/undergraduate/colleges-schools/natural-resources/american-history-institutions-requirement>)

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.

## Campus Requirement

American Cultures (<http://guide.berkeley.edu/archive/2017-18/undergraduate/colleges-schools/natural-resources/american-cultures-requirement>)

American Cultures (AC) is the one requirement that all undergraduate students at UC Berkeley 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 in 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.

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 <b>and</b> 1AL		4	MATH 1B	4
		15		16
Sophomore				
	Fall	Units	Spring	Units
PHYSICS 7B		4	MATH 54	4
CHEM 12A		5	PHYSICS 7C	4
MATH 53		4	BIOLOGY 1A	3
CHM ENG 140		4	CHM ENG 14 <sup>1</sup>	4
			CHM ENG 150A	4
		17		19
Junior				
	Fall	Units	Spring	Units
MAT SCI 102 <sup>1</sup>		3	Materials Science Elective	3
CHEM 120A or PHYSICS 137A		3-4	Breadth Elective <sup>2</sup>	9
CHM ENG 142		4	MAT SCI 103	3
CHM ENG 150B		4		
MAT SCI 45		3		
MAT SCI 45L		1		
		18-19		15
Senior				
	Fall	Units	Spring	Units
Materials Science Elective		3-4	CHM ENG 160	4
MAT SCI 120		3	CHM ENG 16 <sup>1</sup>	4
MAT SCI 130		3	Breadth Electives	3
CHM ENG 154		4	MAT SCI 112	3
Breadth Elective		3		
		16-17		14
<b>Total Units: 130-132</b>				

<sup>1</sup> Permission is required from the instructor of MAT SCI 102 to take ENGIN 45/ENGIN 45L concurrently with MAT SCI 102.

<sup>2</sup> Up to 3 units of breadth elective can be fulfilled by CHM ENG 185.

## Chemical Engineering/Materials Science and Engineering

### CHM ENG 24 Freshman Seminars 1 Unit

Terms offered: Spring 2015, Fall 2014, Spring 2014

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. 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: Fall 2018, Fall 2017, Fall 2016

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. 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 2018, Spring 2016, Spring 2015

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: Fall 2018, Spring 2018, Fall 2017

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 [-]



**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.

Directed Group Study: Read More [\[+\]](#)

**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. 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: Fall 2018, Fall 2017, Fall 2016

Material and energy balances applied to chemical process systems. Determination of thermodynamic properties needed for such calculations. Sources of data. Calculation procedures.

Introduction to Chemical Process Analysis: Read More [\[+\]](#)

**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.

Introduction to Chemical Process Analysis: Read Less [\[-\]](#)

**CHM ENG 141 Chemical Engineering Thermodynamics 4 Units**

Terms offered: Spring 2018, Spring 2016, Spring 2015

Thermodynamic behavior of pure substances and mixtures. Properties of solutions, phase equilibria. Thermodynamic cycles. Chemical equilibria for homogeneous and heterogeneous systems.

Chemical Engineering Thermodynamics: Read More [\[+\]](#)

**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: Fall 2018, Fall 2017, Fall 2016

Analysis and prediction of rates of chemical conversion in flow and nonflow processes involving homogeneous and heterogeneous systems. Chemical Kinetics and Reaction Engineering: Read More [\[+\]](#)

**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 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... Computational Methods in Chemical Engineering: Read More [+]

### 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

### 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. Alternative to final exam.

Computational Methods in Chemical Engineering: Read Less [-]

## CHM ENG 150A Transport Processes 4 Units

Terms offered: Spring 2018, Spring 2016, Spring 2015

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.

Transport Processes: Read More [+]

### 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.

Transport Processes: Read Less [-]

## CHM ENG 150B Transport and Separation Processes 4 Units

Terms offered: Fall 2018, Fall 2017, Fall 2016

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.

Transport and Separation Processes: Read More [+]

### 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

**Summer:** 8 weeks - 6 hours of lecture and 2 hours of discussion per week

### Additional Details

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

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

Transport and Separation Processes: Read Less [-]

## CHM ENG 154 Chemical Engineering Laboratory 4 Units

Terms offered: Fall 2018, Spring 2018, Fall 2017

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 [\[-\]](#)

## CHM ENG 160 Chemical Process Design 4 Units

Terms offered: Fall 2018, Summer 2018 8 Week Session, Spring 2018  
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 [\[-\]](#)

## 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 [\[-\]](#)

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

Terms offered: Fall 2018, Spring 2018, Fall 2017

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 2018, Fall 2016, Spring 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 2014, Spring 2013, Spring 2012

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 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: Fall 2018, Spring 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 2018, Fall 2016, Fall 2014

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**

Terms offered: Spring 2018, Fall 2016, Spring 2016, Spring 2015

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 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

Polymer Science and Technology: Read Less [-]

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

Terms offered: Fall 2018, Fall 2017, Fall 2016

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 2017, Fall 2016, Fall 2015

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 [a+]

### 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: 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 [a+]

### 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.

**Instructor:** Landry

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 [a+]

### 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: Summer 2016 10 Week Session, Spring 2016, Fall 2015

Original research under direction of one of the members of the staff.

Research for Advanced Undergraduates: Read More [a+]

### 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 2018, Fall 2017, Spring 2016

Fall 2017's Special Topic: Nanoscience and Engineering Biotechnology

This nanoscale science and biomolecular engineering course will cover emerging topics in applied biotechnology. Topics include bioanalytical chemistry, recombinant protein generation and purification, cell culture, immunology, nanomaterials in biology, bio-toxicity, and biomolecular sensors. The scope of the course will also probe the interface of biology with nanomaterials, and standard microscopic and spectroscopic techniques to image both biological structures and nanoscale materials. 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 [-]

**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. 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

The Berkeley Lectures on Energy: Energy from Biomass: Read Less [-]

## CHM ENG 196 Special Laboratory Study 2 - 4 Units

Terms offered: Spring 2016, Fall 2015, Spring 2015

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:** Letter grade. Final exam not required.

Special Laboratory Study: Read Less [\[-\]](#)

## CHM ENG 197 Field Study in Chemical Engineering 1 - 4 Units

Terms offered: Spring 2016, Fall 2015, Spring 2015

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.

Field Study in Chemical Engineering: Read More [\[+\]](#)

### Rules & Requirements

**Prerequisites:** Upper division standing and consent of instructor

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

### 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

Field Study in Chemical Engineering: Read Less [\[-\]](#)

## CHM ENG 198 Directed Group Study for Undergraduates 1 - 3 Units

Terms offered: Fall 2018, Spring 2018, Fall 2017

Supervised research on a specific topic. Enrollment is restricted; see Introduction to Courses and Curricula section in the General Catalog.

Directed Group Study for Undergraduates: Read More [\[+\]](#)

### 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.

Directed Group Study for Undergraduates: Read Less [\[-\]](#)

## 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.

Supervised Independent Study and Research: Read Less [\[-\]](#)



## Materials Science and Engineering

### MAT SCI 24 Freshman Seminar 1 Unit

Terms offered: Spring 2018, Spring 2017, Spring 2016

The Freshman 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. Freshman seminars are offered in all campus departments, and topics vary from department to department and semester to semester. Enrollment limited to 20 freshmen.

Freshman Seminar: Read More [+]

#### Hours & Format

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

#### Additional Details

**Subject/Course Level:** Materials Science and Engineering/  
Undergraduate

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

Freshman Seminar: Read Less [-]

### MAT SCI 45 Properties of Materials 3 Units

Terms offered: Fall 2018, Spring 2018, Fall 2017

Application of basic principles of physics and chemistry to the engineering properties of materials. Special emphasis devoted to relation between microstructure and the mechanical properties of metals, concrete, polymers, and ceramics, and the electrical properties of semiconducting materials. Sponsoring Department: Materials Science and Engineering  
Properties of Materials: Read More [+]

#### Rules & Requirements

**Prerequisites:** Physics 7A (may be taken concurrently)

**Credit Restrictions:** Students will receive no credit for MSE 45 after taking E45

#### Hours & Format

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

#### Additional Details

**Subject/Course Level:** Materials Science and Engineering/  
Undergraduate

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

**Instructors:** Martin, Messersmith

Bonding, Crystallography, and Crystal Defects: Read Less [-]

### MAT SCI 45L Properties of Materials Laboratory 1 Unit

Terms offered: Fall 2018, Spring 2018, Fall 2017

This course presents laboratory applications of the basic principles introduced in the lecture-based course MSE45 – Properties of Materials. Properties of Materials Laboratory: Read More [+]

#### Rules & Requirements

**Credit Restrictions:** Students will receive no credit for MSE 45L after taking E45L

#### Hours & Format

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

#### Additional Details

**Subject/Course Level:** Materials Science and Engineering/  
Undergraduate

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

**Instructors:** Martin, Messersmith

Properties of Materials Laboratory: Read Less [-]

### MAT SCI 102 Bonding, Crystallography, and Crystal Defects 3 Units

Terms offered: Fall 2018, Fall 2017, Fall 2016

Bonding in solids; classification of metals, semiconductors, and insulators; crystal systems; point, line, and planar defects in crystals; examples of crystallographic and defect analysis in engineering materials; relationship to physical and mechanical properties.

Bonding, Crystallography, and Crystal Defects: Read More [+]

#### Rules & Requirements

**Prerequisites:** Engineering 45

#### Hours & Format

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

#### Additional Details

**Subject/Course Level:** Materials Science and Engineering/  
Undergraduate

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

**Instructor:** Chrzan

Bonding, Crystallography, and Crystal Defects: Read Less [-]

## MAT SCI 103 Phase Transformations and Kinetics 3 Units

Terms offered: Spring 2018, Spring 2017, Spring 2016

The nature, mechanisms, and kinetics of phase transformations and microstructural changes in the solid state. Atom diffusion in solids. Phase transformations through the nucleation and growth of new matrix or precipitate phases. Martensitic transformations, spinodal decomposition. The use of phase transformations to control microstructure.

Phase Transformations and Kinetics: Read More [+]

### Rules & Requirements

**Prerequisites:** 102 and Engineering 115

### Hours & Format

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

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/ Undergraduate

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

Phase Transformations and Kinetics: Read Less [-]

## MAT SCI 104 Materials Characterization 4 Units

Terms offered: Spring 2018, Spring 2017, Spring 2016

Physical and chemical characterization of materials: Diffraction, imaging, and spectroscopy using optical, electron, and X-ray methods for bulk and surface analysis. Measurement of mechanical and physical properties. Project laboratory focusing on mechanical, chemical, electrical, and magnetic properties of materials, and materials characterization. Field trips.

Materials Characterization: Read More [+]

### Rules & Requirements

**Prerequisites:** 102

### Hours & Format

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

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/ Undergraduate

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

**Instructor:** Gronskey

Materials Characterization: Read Less [-]

## MAT SCI 111 Properties of Electronic Materials 4 Units

Terms offered: Spring 2018, Spring 2017, Spring 2016

Introduction to the physical principles underlying the electric properties of modern solids with emphasis on semiconductors; control of defects and impurities through physical purification, bulk and thin film crystal growth and doping processes, materials basis of electronic and optoelectronic devices (diodes, transistors, semiconductor lasers) and optical fibers; properties of metal and oxide superconductors and their applications.

Properties of Electronic Materials: Read More [+]

### Rules & Requirements

**Prerequisites:** Physics 7A-7B-7C or Physics 7A-7B and consent of instructor

### Hours & Format

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

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/ Undergraduate

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

**Instructors:** Dubon, Wu, Yao

Properties of Electronic Materials: Read Less [-]

## MAT SCI 112 Corrosion (Chemical Properties) 3 Units

Terms offered: Spring 2018, Spring 2017, Spring 2016

Electrochemical theory of corrosion. Mechanisms and rates in relation to physiochemical and metallurgical factors. Stress corrosion and mechanical influences on corrosion. Corrosion protection by design, inhibition, cathodic protection, and coatings.

Corrosion (Chemical Properties): Read More [+]

### Rules & Requirements

**Prerequisites:** Engineering 45 and Engineering 115

### Hours & Format

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

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/ Undergraduate

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

**Instructor:** Devine

Corrosion (Chemical Properties): Read Less [-]

## **MAT SCI 113 Mechanical Behavior of Engineering Materials 3 Units**

Terms offered: Fall 2018, Fall 2017, Fall 2016

This course covers elastic and plastic deformation under static and dynamic loads. Prediction and prevention of failure by yielding, fracture, fatigue, wear and environmental factors are addressed. Design issues pertaining to materials selection for load bearing applications are discussed. Case studies of engineering failures are presented. Topics include engineering materials, structure-property relationships, materials selection for design, mechanical behavior of polymers and design of plastic components, complex states of stress and strain, elastic deformation and multiaxial loading, plastic deformation and yield criteria, dislocation plasticity and strengthening mechanisms, creep, effects of stress concentrations, fracture, fatigue, and contact stresses.

Mechanical Behavior of Engineering Materials: Read More [\[+\]](#)

### **Rules & Requirements**

**Prerequisites:** C30/Mechanical Engineering C85 and Engineering 45

**Credit Restrictions:** Students will receive no credit for 113 after taking C113 or Mechanical Engineering C124. Deficiency in C113 or Mechanical Engineering C124 maybe removed by taking 113.

### **Hours & Format**

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

### **Additional Details**

**Subject/Course Level:** Materials Science and Engineering/ Undergraduate

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

**Instructor:** Ritchie

Mechanical Behavior of Engineering Materials: Read Less [\[-\]](#)

## **MAT SCI 117 Properties of Dielectric and Magnetic Materials 3 Units**

Terms offered: Spring 2017, Spring 2011, Fall 2010

Introduction to the physical principles underlying the dielectric and magnetic properties of solids. Processing-microstructure-property relationships of dielectric materials, including piezoelectric, pyroelectric, and ferroelectric oxides, and of magnetic materials, including hard- and soft ferromagnets, ferrites and magneto-optic and -resistive materials. The course also covers the properties of grain boundary devices (including varistors) as well as ion-conducting and mixed conducting materials for applications in various devices such as sensors, fuel cells, and electric batteries.

Properties of Dielectric and Magnetic Materials: Read More [\[+\]](#)

### **Rules & Requirements**

**Prerequisites:** Physics 7A-7B-7C or Physics 7A-7B and consent of instructor; 111 is recommended

### **Hours & Format**

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

### **Additional Details**

**Subject/Course Level:** Materials Science and Engineering/ Undergraduate

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

Properties of Dielectric and Magnetic Materials: Read Less [\[-\]](#)

## MAT SCI C118 Biological Performance of Materials 4 Units

Terms offered: Fall 2018, Fall 2017, Fall 2015

This course is intended to give students the opportunity to expand their knowledge of topics related to biomedical materials selection and design. Structure-property relationships of biomedical materials and their interaction with biological systems will be addressed. Applications of the concepts developed include blood-materials compatibility, biomimetic materials, hard and soft tissue-materials interactions, drug delivery, tissue engineering, and biotechnology.

Biological Performance of Materials: [Read More](#) [+]

### Objectives Outcomes

**Course Objectives:** The course is separated into four parts spanning the principles of synthetic materials and surfaces, principles of biological materials, biological performance of materials and devices, and state-of-the-art materials design. Students are required to attend class and master the material therein. In addition, readings from the clinical, life and materials science literature are assigned. Students are encouraged to seek out additional reference material to complement the readings assigned. A mid-term examination is given on basic principles (parts 1 and 2 of the outline). A comprehensive final examination is given as well. The purpose of this course is to introduce students to problems associated with the selection and function of biomaterials. Through class lectures and readings in both the physical and life science literature, students will gain broad knowledge of the criteria used to select biomaterials, especially in devices where the material-tissue or material-solution interface dominates performance. Materials used in devices for medicine, dentistry, tissue engineering, drug delivery, and the biotechnology industry will be addressed.

This course also has a significant design component (~35%). Students will form small teams (five or less) and undertake a semester-long design project related to the subject matter of the course. The project includes the preparation of a paper and a 20 minute oral presentation critically analyzing a current material-tissue or material-solution problem. Students will be expected to design improvements to materials and devices to overcome the problems identified in class with existing materials.

**Student Learning Outcomes:** Apply math, science & engineering principles to the understanding of soft materials, surface chemistry, DLVO theory, protein adsorption kinetics, viscoelasticity, mass diffusion, and molecular (i.e., drug) delivery kinetics.

- Design experiments and analyze data from the literature in the context of the class design project.

Apply core concepts in materials science to solve engineering problems related to the selection biomaterials, especially in devices where the material-tissue or material-solution interface dominates performance.

Develop an understanding of the social, safety and medical consequences of biomaterial use and regulatory issues associated with the selection of biomaterials in the context of the silicone breast implant controversy and subsequent biomaterials crisis.

Work independently and function on a team, and develop solid communication skills (oral, graphic & written) through the class design project.

- Understanding of the origin of surface forces and interfacial free energy, and how they contribute to the development of the biomaterial interface and ultimately biomaterial performance.

### Rules & Requirements

**Prerequisites:** Engin 45; BioE 103 or equivalent; BioE 102 and BioE 104 recommended

### Hours & Format

## MAT SCI 120 Materials Production 3 Units

Terms offered: Fall 2018, Fall 2017, Fall 2016

Economic and technological significance of metals and other materials. Elementary geology (composition of lithosphere, mineralization). Short survey of mining and mineral processing techniques. Review of chemical thermodynamics and reaction kinetics. Principles of process engineering including material, heat, and mechanical energy balances. Elementary heat transfer, fluid flow, and mass transfer. Electrolytic production and refining of metals. Vapor techniques for production of metals and coatings.

Materials Production: [Read More](#) [+]

### Rules & Requirements

**Prerequisites:** Engineering 115, Mechanical Engineering 40, Chemical Engineering 141, Chemistry 120B or equivalent thermodynamics course

### Hours & Format

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

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/ Undergraduate

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

Materials Production: [Read Less](#) [-]

## MAT SCI 121 Metals Processing 3 Units

Terms offered: Spring 2015, Spring 2014, Spring 2013

The principles of metals processing with emphasis on the use of processing to establish microstructures which impart desirable engineering properties. The techniques discussed include solidification, thermal and mechanical processing, powder processing, welding and joining, and surface treatments.

Metals Processing: [Read More](#) [+]

### Rules & Requirements

**Prerequisites:** Engineering 45

### Hours & Format

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

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/ Undergraduate

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

**Instructor:** Gronsky

Metals Processing: [Read Less](#) [-]

**MAT SCI 122 Ceramic Processing 3 Units**

Terms offered: Fall 2012, Fall 2011, Fall 2010

Powder fabrication by grinding and chemical methods, rheological behavior of powder-fluid suspensions, forming methods, drying, sintering, and grain growth. Relation of processing steps to microstructure development.

Ceramic Processing: Read More [a]

**Rules & Requirements**

**Prerequisites:** Engineering 45, 115

**Hours & Format**

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

**Additional Details**

**Subject/Course Level:** Materials Science and Engineering/ Undergraduate

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

Ceramic Processing: Read Less [-]

**MAT SCI 123 ELECTRONIC MATERIALS PROCESSING 4 Units**

Terms offered: Fall 2018, Fall 2017, Fall 2016

This 4-unit course starts with a brief review of the fundamentals of solid-state physics including bands and defects in semiconductors and oxides, and then moves to bulk semiconductor crystals growth and processing including doping, diffusion and implantation, and then to thin film deposition and processing methods, and finishes with a discussion of materials analysis and characterization. Recent advances in nanomaterials research will also be introduced.

ELECTRONIC MATERIALS PROCESSING: Read More [a]

**Objectives Outcomes**

**Course Objectives:** To prepare students a) for work in semiconductor processing facilities and b) for graduate studies related to thin film processing and relevant materials science topics.

To present the relevant materials science issues in semiconductor and oxide processing

To provide an introduction into the principles of thin film processing and related technologies.

**Student Learning Outcomes:** Basic knowledge of gas kinetics and vacuum technology, including ideal gas, gas transport theory, definition, creation and measurement of vacuum.

Knowledge of electrical and optical properties of thin films.

Knowledge of the formation of p-n junction to explain the diode operation and its I-V characteristics. Understanding of the mechanisms of Hall Effect, transport, and C-V measurements, so that can calculate carrier concentration, mobility and conductivity given raw experimental data. The ability to describe major growth techniques of bulk, thin film, and nanostructured semiconductors, with particular emphasis on thin film deposition technologies, including evaporation, sputtering, chemical vapor deposition and epitaxial growths.

To have basic knowledge of doping, purification, oxidation, gettering, diffusion, implantation, metallization, lithography and etching in semiconductor processing.

To have basic knowledge of electronic material characterization methods: x-ray diffraction, SEM and TEM, EDX, Auger, STM and AFM, Rutherford Back Scattering and SIMS, as well as optical methods including photoluminescence, absorption and Raman scattering.

To understand the concepts of bands, bandgap, to distinguish direct and indirect bandgap semiconductors. Understanding of free electron and hole doping of semiconductors to determine Fermi level position.

To understand the effect of defects in semiconductors, so that can describe their electronic and optical behaviors, and the methods to eliminate and control them in semiconductors.

**Rules & Requirements**

**Prerequisites:** MSE 111 or Physics 7C or consent of instructor

**Hours & Format**

**Fall and/or spring:** 15 weeks - 4 hours of lecture per week

**Additional Details**

**Subject/Course Level:** Materials Science and Engineering/ Undergraduate

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

**Instructors:** Wu, Yao

ELECTRONIC MATERIALS PROCESSING: Read Less [-]



## MAT SCI 125 Thin-Film Materials Science 3 Units

Terms offered: Spring 2016, Spring 2015, Fall 2014

Deposition, processing, and characterization of thin films and their technological applications. Physical and chemical vapor deposition methods. Thin-film nucleation and growth. Thermal and ion processing. Microstructural development in epitaxial, polycrystalline, and amorphous films. Thin-film characterization techniques. Applications in information storage, integrated circuits, and optoelectronic devices. Laboratory demonstrations.

Thin-Film Materials Science: Read More [ + ]

### Rules & Requirements

**Prerequisites:** Upper division or graduate standing in engineering, physics, chemistry, and chemical engineering; Engineering 45 required; 111 or Physics 141A recommended

### Hours & Format

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

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/ Undergraduate

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

**Instructor:** Dubon

Thin-Film Materials Science: Read Less [ - ]

## MAT SCI 130 Experimental Materials Science and Design 3 Units

Terms offered: Fall 2018, Fall 2017, Fall 2016

This course provides a culminating experience for students approaching completion of the materials science and engineering curriculum. Laboratory experiments are undertaken in a variety of areas from the investigations on semiconductor materials to corrosion science and elucidate the relationships among structure, processing, properties, and performance. The principles of materials selection in engineering design are reviewed.

Experimental Materials Science and Design: Read More [ + ]

### Rules & Requirements

**Prerequisites:** Senior standing or consent of instructor

### Hours & Format

**Fall and/or spring:** 15 weeks - 2 hours of lecture and 3 hours of laboratory per week

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/ Undergraduate

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

Experimental Materials Science and Design: Read Less [ - ]

## MAT SCI 136 Materials in Energy Technologies 4 Units

Terms offered: Fall 2017, Fall 2015, Fall 2011

In many, if not all, technologies, it is materials that play a crucial, enabling role. This course examines potentially sustainable technologies, and the materials properties that enable them. The science at the basis of selected energy technologies are examined and considered in case studies.

Materials in Energy Technologies: Read More [ + ]

### Rules & Requirements

**Prerequisites:** Junior or above standing in Materials Science and Engineering or related field

### Hours & Format

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

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/ Undergraduate

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

**Formerly known as:** Materials Science and Engineering 126

Materials in Energy Technologies: Read Less [ - ]

## MAT SCI 140 Nanomaterials for Scientists and Engineers 3 Units

Terms offered: Spring 2015, Spring 2013, Spring 2012

This course introduces the fundamental principles needed to understand the behavior of materials at the nanometer length scale and the different classes of nanomaterials with applications ranging from information technology to biotechnology. Topics include introduction to different classes of nanomaterials, synthesis and characterization of nanomaterials, and the electronic, magnetic, optical, and mechanical properties of nanomaterials.

Nanomaterials for Scientists and Engineers: Read More [ + ]

### Rules & Requirements

**Prerequisites:** 102 or equivalent recommended; Physics 7C and Engineering 45 required

### Hours & Format

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

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/ Undergraduate

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

**Instructor:** Minor

Nanomaterials for Scientists and Engineers: Read Less [ - ]

## MAT SCI C150 Introduction to Materials Chemistry 3 Units

Terms offered: Spring 2018, Spring 2017, Spring 2015, Spring 2014, Spring 2012

The application of basic chemical principles to problems in materials discovery, design, and characterization will be discussed. Topics covered will include inorganic solids, nanoscale materials, polymers, and biological materials, with specific focus on the ways in which atomic-level interactions dictate the bulk properties of matter.

Introduction to Materials Chemistry: Read More [+]

### Rules & Requirements

**Prerequisites:** 104A; 104B is recommended

### Hours & Format

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

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/ Undergraduate

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

**Also listed as:** CHEM C150

Introduction to Materials Chemistry: Read Less [-]

## MAT SCI 151 Polymeric Materials 3 Units

Terms offered: Spring 2018, Spring 2017, Spring 2016

This course is designed for upper division undergraduate and graduate students to gain a fundamental understanding of the science of polymeric materials. Beginning with a treatment of ideal polymeric chain conformations, it develops the thermodynamics of polymer blends and solutions, the modeling of polymer networks and gels, the dynamics of polymer chains, and the morphologies of thin films and other dimensionally-restricted structures relevant to nanotechnology.

Polymeric Materials: Read More [+]

### Rules & Requirements

**Prerequisites:** Chemistry 1A or Engineering 5. 103 is recommended

### Hours & Format

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

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/ Undergraduate

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

**Instructor:** Xu

Polymeric Materials: Read Less [-]

## MAT SCI H194 Honors Undergraduate Research 1 - 4 Units

Terms offered: Fall 2016, Spring 2016, Fall 2015

Students who have completed a satisfactory number of advanced courses with a grade-point average of 3.3 or higher may pursue original research under the direction of one of the members of the staff. A maximum of 3 units of H194 may be used to fulfill technical elective requirements in the Materials Science and Engineering program or double majors (unlike 198 or 199, which do not satisfy technical elective requirements). Final report required.

Honors Undergraduate Research: Read More [+]

### Rules & Requirements

**Prerequisites:** Upper division technical GPA of 3.3 or higher and consent of instructor and adviser

**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:** 8 weeks - 1.5-7.5 hours of independent study per week

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/ Undergraduate

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

Honors Undergraduate Research: Read Less [-]

## MAT SCI 195 Special Topics for Advanced Undergraduates 1 Unit

Terms offered: Spring 2012, Spring 2011, Spring 2010

Group study of special topics in materials science and engineering. Selection of topics for further study of underlying concepts and relevant literature, in consultation with appropriate faculty members.

Special Topics for Advanced Undergraduates: Read More [+]

### Rules & Requirements

**Prerequisites:** Upper division standing and good academic standing. (2.0 gpa and above)

### Hours & Format

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

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/ Undergraduate

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

Special Topics for Advanced Undergraduates: Read Less [-]

## **MAT SCI 198 Directed Group Studies for Advanced Undergraduates 1 - 4 Units**

Terms offered: Fall 2018, Spring 2016, Fall 2015

Group studies of selected topics.

Directed Group Studies for Advanced Undergraduates: [Read More](#) [+]

### **Rules & Requirements**

**Prerequisites:** Upper division standing in Engineering

### **Hours & Format**

**Fall and/or spring:** 15 weeks - 1-4 hours of directed group study per week

### **Additional Details**

**Subject/Course Level:** Materials Science and Engineering/  
Undergraduate

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

Directed Group Studies for Advanced Undergraduates: [Read Less](#) [-]

## **MAT SCI 199 Supervised Independent Study 1 - 4 Units**

Terms offered: Fall 2016, Spring 2016, Fall 2015

Supervised independent study. Enrollment restrictions apply; see the Introduction to Courses and Curricula section of this catalog.

Supervised Independent Study: [Read More](#) [+]

### **Rules & Requirements**

**Prerequisites:** Consent of instructor and major adviser

**Credit Restrictions:** Course may be repeated for a maximum of four units per semester.

**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 - 1-5 hours of independent study per week

8 weeks - 1-4 hours of independent study per week

### **Additional Details**

**Subject/Course Level:** Materials Science and Engineering/  
Undergraduate

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

Supervised Independent Study: [Read Less](#) [-]