Chemical Engineering

Bachelor of Science (BS)
The College of Chemistry offers a major in Chemical Engineering leading to the Bachelor of Science (BS) degree, through the Department of Chemical and Biomolecular Engineering. The program equips the student for professional work in development, design, and operation of chemical processes and of process equipment. Students with high scholastic attainment are well prepared to enter graduate programs. The curriculum is accredited by ABET (http://www.abet.org).

Admission to the Major
For information on admission to the major, please see the College of Chemistry Admissions tab (http://guide.berkeley.edu/undergraduate/colleges-schools/chemistry/#admissionstext) in this Guide.

Minor Program
The Department of Chemical and Biomolecular Engineering offers an undergraduate minor in Chemical Engineering. For information regarding how to declare the minor, please contact the department. Please be sure to consult with your college or school for information on rules regarding overlap of courses between majors and minors.

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

In addition to the University, campus, and college requirements, listed in 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.

Please note, the Academic Guide is updated only once a year. For the most current information on requirements please a look at the College of Chemistry website (https://chemistry.berkeley.edu/ugrad/degrees/cheme).

Lower Division Requirements

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<thead>
<tr>
<th>Course</th>
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<td>General Chemistry and Quantitative Analysis</td>
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<td>General Chemistry and Quantitative Analysis</td>
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<tr>
<td>CHEM 12A</td>
<td>Organic Chemistry</td>
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<tr>
<td>CHM ENG 40</td>
<td>Introduction to Chemical Engineering Design</td>
<td>2</td>
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<tr>
<td>ENGIN 7</td>
<td>Introduction to Computer Programming for Scientists and Engineers</td>
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<tr>
<td>MATH 1A</td>
<td>Calculus</td>
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<td>Calculus</td>
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<tr>
<td>MATH 53</td>
<td>Multivariable Calculus</td>
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<tr>
<td>MATH 54</td>
<td>Linear Algebra and Differential Equations</td>
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<td>PHYSICS 7A</td>
<td>Physics for Scientists and Engineers</td>
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<td>PHYSICS 7B</td>
<td>Physics for Scientists and Engineers</td>
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<tr>
<td>BIOLOGY 1A</td>
<td>General Biology Lecture</td>
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<tr>
<td>or BIO ENG 11</td>
<td>Engineering Molecules 1</td>
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</table>

Notes
1. Students should take CHEM 4A and CHEM 4B during their freshman year, and CHEM 12A and CHEM 12B during their sophomore year.
2. A grade of C- or better is required in CHEM 4A before taking CHEM 4B, in CHEM 4B before taking more advanced courses, and in CHEM 12A before taking CHEM 12B.
3. Students in the Biotechnology concentration are required to take MCELLBI 102 or CHEM 135 in place of BIOLOGY 1A (even with a score of 4 or 5 on the AP Bio test).

Upper Division Requirements

<table>
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<tr>
<th>Course</th>
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<td>CHEM 120A</td>
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<td>or PHYSICS 137A Quantum Mechanics</td>
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<td>CHM ENG 140</td>
<td>Introduction to Chemical Process Analysis</td>
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<td>CHM ENG 141</td>
<td>Chemical Engineering Thermodynamics</td>
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<td>CHM ENG 142</td>
<td>Chemical Kinetics and Reaction Engineering</td>
<td>4</td>
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<tr>
<td>CHM ENG 150A</td>
<td>Transport Processes</td>
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<tr>
<td>CHM ENG 150B</td>
<td>Transport and Separation Processes</td>
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<tr>
<td>CHM ENG 154</td>
<td>Chemical Engineering Laboratory</td>
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<tr>
<td>CHM ENG 160</td>
<td>Chemical Process Design</td>
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</table>
Requirements for the open elective program: Students who do not choose a concentration must complete the following:

- **Open Elective Program**: 12 units (see below for details)
- Concentration (see below for details)

1 Effective Fall 2017, MSE 45/L is replacing E 45/L. MSE 45L is not required if the student took E 45 during spring 2016 or earlier. However, these students must complete 4 units of engineering elective instead of 3.

2 A course used toward satisfaction of the open elective program or a concentration cannot also be used toward satisfaction of another college or major requirement. A maximum of 6 units of research can be applied toward electives.

### Open Elective Program

Students who do not choose a concentration must complete the following requirements for the open elective program:

- One science elective, selected from physical and biological sciences electives list (see below) 3 units
- **CBE elective**: 3 units
- Engineering electives, selected from the engineering electives list 6 units

1 CHM ENG 196 may not be used to fulfill this elective requirement.

2 Other engineering courses may be approved by the CBE Department.

### Physical and Biological Sciences Electives List

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
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<tr>
<td>ANTHRO 1</td>
<td>Introduction to Biological Anthropology</td>
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<tr>
<td>ANTHRO C100</td>
<td>Human Paleontology</td>
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<tr>
<td>ANTHRO C103</td>
<td>Introduction to Human Osteology</td>
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<td>ANTHRO 107</td>
<td>Evolution of the Human Brain</td>
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<td>ANTHRO 134</td>
<td>Analysis of the Archaeological Record</td>
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<td>ANTHRO 135</td>
<td>Paleoenvironbology: Archaeological Methods and Laboratory Techniques</td>
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<td>ASTRON 3</td>
<td>Introduction to Modern Cosmology</td>
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<td>ASTRON 7A</td>
<td>Introduction to Astrophysics</td>
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<tr>
<td>ASTRON 7B</td>
<td>Introduction to Astrophysics</td>
<td>4</td>
</tr>
<tr>
<td>ASTRON 10</td>
<td>Introduction to General Astronomy</td>
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<tr>
<td>ASTRON C10</td>
<td>Introduction to General Astronomy</td>
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<tr>
<td>ASTRON C12</td>
<td>The Planets</td>
<td>3</td>
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<td>ASTRON C162</td>
<td>Planetary Astrophysics</td>
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<td>BIOLOGY 1B</td>
<td>General Biology Lecture and Laboratory</td>
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<td>CHEM 12B</td>
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<td>CHEM 103</td>
<td>Inorganic Chemistry in Living Systems</td>
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<td>CHEM 104A</td>
<td>Advanced Inorganic Chemistry</td>
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<td>CHEM 105</td>
<td>Instrumental Methods in Analytical Chemistry</td>
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<td>Inorganic Synthesis and Reactions</td>
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<td>Advanced Mechanistic Organic Chemistry</td>
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<td>CHEM 114</td>
<td>Advanced Synthetic Organic Chemistry</td>
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<td>CHEM 115</td>
<td>Organic Chemistry--Advanced Laboratory Methods</td>
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<td>CHEM 120B</td>
<td>Physical Chemistry</td>
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<td>CHEM 122</td>
<td>Quantum Mechanics and Spectroscopy</td>
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<td>CHEM 125</td>
<td>Physical Chemistry Laboratory</td>
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<td>Biophysical Chemistry: Physical Principles and the Molecules of Life</td>
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<td>Nuclear Chemistry</td>
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<td>Radiocative Methods in Nuclear Technology and Forensics</td>
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<td>Introduction to Materials Chemistry</td>
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<td>Atmospheric Chemistry and Physics Laboratory</td>
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<td>CHEM C191</td>
<td>Quantum Information Science and Technology</td>
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<td>CHEM 192</td>
<td>Individual Study for Advanced Undergraduates</td>
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<td>Research for Advanced Undergraduates</td>
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<td>CHEM 196</td>
<td>Special Laboratory Study</td>
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<td>Chemistry of Soils</td>
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<td>Scientific Approaches to Consciousness</td>
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<td>COG SCI C126</td>
<td>Perception</td>
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<td>COG SCI C127</td>
<td>Cognitive Neuroscience</td>
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<td>Oceans</td>
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<td>Minerals: Their Constitution and Origin</td>
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<td>Introduction to Aquatic and Marine Geochemistry</td>
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<td>Strong Motion Seismology</td>
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<td>Natural History of Insects</td>
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<td>ESPM 44</td>
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<td>Terrestrial Resource Ecology</td>
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<td>ESPM 102C</td>
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<td>Principles of Conservation Biology</td>
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<td>ESPM 106</td>
<td>American Wildlife: Management and Policy in the 21st Century</td>
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<td>Host-Microbe Interactions</td>
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<td>Biological Clocks: Physiology and Behavior</td>
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<td>Hormones and Behavior</td>
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<td>Comparative Animal Physiology</td>
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<td>INTEGBI C149</td>
<td>Molecular Ecology</td>
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<td>Environmental Toxicology</td>
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<td>Ecology</td>
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<td>Principles of Conservation Biology</td>
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<td>INTEGBI C158LF</td>
<td>Biology and Geomorphology of Tropical Islands</td>
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<td>INTEGBI 159</td>
<td>The Living Planet: Impact of the Biosphere on the Earth System</td>
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<td>Population and Evolutionary Genetics</td>
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<td>Ecological Genetics</td>
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<td>Systemsatics of Vascular Plants</td>
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<td>Systemsatics of Vascular Plants with Laboratory</td>
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<td>INTEGBI 169</td>
<td>Evolutionary Medicine</td>
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<td>Ornithology with Laboratory</td>
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<td>Evolution of the Vertebrates with Laboratory</td>
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<td>INTEGBI 184L</td>
<td>Morphology of the Vertebrate Skeleton with Laboratory</td>
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<td>INTEGBI C187</td>
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<td>Americans and the Global Forest</td>
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<td>Introduction to General Astronomy</td>
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<td>L &amp; S C70W</td>
<td>Physics and Music</td>
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<td>Earthquakes in Your Backyard</td>
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<td>MAT SCI C150</td>
<td>Introduction to Materials Chemistry</td>
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<td>MCELLBI 32</td>
<td>Introduction to Human Physiology</td>
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<td>MCELLBI 41</td>
<td>Genetics and Society</td>
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<td>MCELLBI 50</td>
<td>The Immune System and Disease</td>
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<td>MCELLBI C61</td>
<td>Brain, Mind, and Behavior</td>
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<td>MCELLBI C62</td>
<td>Drugs and the Brain</td>
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<td>MCELLBI C100A</td>
<td>Biophysical Chemistry: Physical Principles and the Molecules of Life</td>
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<td>MCELLBI 100B</td>
<td>Biochemistry: Pathways, Mechanisms, and Regulation</td>
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<td>MCELLBI 102</td>
<td>Survey of the Principles of Biochemistry and Molecular Biology</td>
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<td>MCELLBI C103</td>
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<td>MCELLBI 104</td>
<td>Genetics, Genomics, and Cell Biology</td>
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MCELLBI C112 General Microbiology 4
MCELLBI C114 Introduction to Comparative Virology 4
MCELLBI C116 Microbial Diversity 3
MCELLBI 132 Biology of Human Cancer 4
MCELLBI 133L Physiology and Cell Biology Laboratory 4
MCELLBI 135A Topics in Cell and Developmental Biology: Molecular Endocrinology 3
MCELLBI 136 Physiology 4
MCELLBI 140 General Genetics 4
MCELLBI 140L Genetics Laboratory 4
MCELLBI 141 Developmental Biology 4
MCELLBI 143 Evolution of Genomes, Cells, and Development 3
MCELLBI C148 Microbial Genomics and Genetics 4
MCELLBI 150 Molecular Immunology 4
MCELLBI 160L Neurobiology Laboratory 4
MCELLBI 166 Biophysical Neurobiology 3
NUSCTX 10 Introduction to Human Nutrition 3
NUSCTX 11 Introduction to Toxicology 3
NUSCTX 108A Introduction and Application of Food Science 3
NUSCTX 110 Toxicology 4
NUSCTX 160 Metabolic Bases of Human Health and Diseases 4
NUSCTX 171 Nutrition and Toxicology Laboratory 4
PHYSICS 7C Physics for Scientists and Engineers 4
PHYSICS C21 Physics and Music 3
PHYSICS 105 Analytic Mechanics 4
PHYSICS 110A Electromagnetism and Optics 4
PHYSICS 110B Electromagnetism and Optics 4
PHYSICS 112 Introduction to Statistical and Thermal Physics 4
PHYSICS 129 Particle Physics 4
PHYSICS 130 Quantum and Nonlinear Optics 3
PHYSICS 137B Quantum Mechanics 3
PHYSICS 138 Modern Atomic Physics 3
PHYSICS 141A Solid State Physics 4
PHYSICS 177 Principles of Molecular Biophysics 3
PLANTBI 10 Plants, Agriculture, and Society 2
PLANTBI 40 The (Secret) Life of Plants 3
PLANTBI C103 Bacterial Pathogenesis 3
PLANTBI C107L Principles of Plant Morphology with Laboratory 4
PLANTBI C112 General Microbiology 4
PLANTBI C114 Introduction to Comparative Virology 4
PLANTBI C116 Microbial Diversity 3
PLANTBI 120 Biology of Algae 2
PLANTBI 120L Laboratory for Biology of Algae 2
PLANTBI 122 Bioenergy 2
PLANTBI 135 Physiology and Biochemistry of Plants 3
PLANTBI C148 Microbial Genomics and Genetics 4
PLANTBI 150 Plant Cell Biology 3
PLANTBI 160 Plant Molecular Genetics 3
PLANTBI 170 Modern Applications of Plant Biotechnology 2
PLANTBI 180 Environmental Plant Biology 2
PSYCH 110 Introduction to Biological Psychology 3
PSYCH C113 Biological Clocks: Physiology and Behavior 3
PSYCH 114 Biology of Learning 3
PSYCH C116 Hormones and Behavior 3
PSYCH 117 Human Neuropsychology 3
PSYCH 122 Introduction to Human Learning and Memory 3
PSYCH C126 Perception 3
PSYCH C127 Cognitive Neuroscience 3
PSYCH C129 Scientific Approaches to Consciousness 3
PB HLTH C102 Bacterial Pathogenesis 3
PB HLTH 162A Public Health Microbiology 3

Lower Division Engineering Electives List
CHM ENG 90 Science and Engineering of Sustainable Energy 3
COMPSCI 61B Data Structures 4
EL ENG 16A Designing Information Devices and Systems I 4
EL ENG 16B Designing Information Devices and Systems II 4

Upper Division Engineering Electives List
BIO ENG 101 Instrumentation in Biology and Medicine 4
BIO ENG 102 Biomechanics: Analysis and Design 4
BIO ENG 103 Engineering Molecules 2 4
BIO ENG 104 Biological Transport Phenomena 4
BIO ENG 110 Biomedical Physiology for Engineers 4
BIO ENG 111 Functional Materials Development and Characterization 4
BIO ENG C112 Molecular Biomechanics and Mechanobiology of the Cell 4
BIO ENG 113 Stem Cells and Technologies 4
BIO ENG 114 Cell Engineering 4
BIO ENG 115 Cell Biology for Engineers 4
BIO ENG 116 Cell and Tissue Engineering 4
BIO ENG C117 Structural Aspects of Biomaterials 4
BIO ENG C118 Biological Performance of Materials 4
BIO ENG C119 Orthopedic Biomechanics 4
BIO ENG 121 BioMEMS and Medical Devices 4
BIO ENG 121L BioMEMS and BioNanotechnology Laboratory 4
BIO ENG 124 Basic Principles of Drug Delivery 3
BIO ENG C125 Introduction to Robotics 4
BIO ENG 131 Introduction to Computational Molecular and Cell Biology 4
BIO ENG C125B Robotic Manipulation and Interaction 4
BIO ENG 132 Genetic Devices 4
BIO ENG 135 Frontiers in Microbial Systems Biology 4
BIO ENG C136L Laboratory in the Mechanics of Organisms 3
BIO ENG 140L Synthetic Biology Laboratory 4
BIO ENG 143 Computational Methods in Biology 4
BIO ENG 144 Introduction to Protein Informatics 4
BIO ENG 144L Protein Informatics Laboratory 3
BIO ENG C145L Introductory Electronic Transducers Laboratory 3
BIO ENG C145M Introductory Microcomputer Interfacing Laboratory 3
BIO ENG 147 Principles of Synthetic Biology 4
BIO ENG 148 Bioenergy and Sustainable Chemical Synthesis: Metabolic Engineering and Synthetic Biology Approaches 4
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tr>
<td>BIO ENG 150</td>
<td>Introduction of Bionanoscience and Bionanotechnology</td>
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<tr>
<td>BIO ENG 151</td>
<td>Micro/Nanofluidics for Bioengineering and Lab-On-A-Chip</td>
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<tr>
<td>BIO ENG 163</td>
<td>Principles of Molecular and Cellular Biophotonics</td>
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<tr>
<td>BIO ENG 163L</td>
<td>Molecular and Cellular Biophotonics Laboratory</td>
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<tr>
<td>BIO ENG 164</td>
<td>Optics and Microscopy</td>
<td>4</td>
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<tr>
<td>BIO ENG C165</td>
<td>Medical Imaging Signals and Systems</td>
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<tr>
<td>BIO ENG 168L</td>
<td>Practical Light Microscopy</td>
<td>3</td>
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<tr>
<td>BIO ENG C181</td>
<td>The Berkeley Lectures on Energy: Energy from Biomass</td>
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<tr>
<td>CHM ENG 143</td>
<td>Computational Methods in Chemical Engineering</td>
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<tr>
<td>CHM ENG 170A</td>
<td>Biochemical Engineering</td>
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<td>CHM ENG 170B</td>
<td>Biochemical Engineering</td>
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<tr>
<td>CHM ENG C170L</td>
<td>Biochemical Engineering Laboratory</td>
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<td>CHM ENG 171</td>
<td>Transport Phenomena</td>
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<tr>
<td>CHM ENG 176</td>
<td>Principles of Electrochemical Processes</td>
<td>3</td>
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<tr>
<td>CHM ENG C178</td>
<td>Polymer Science and Technology</td>
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<tr>
<td>CHM ENG 179</td>
<td>Process Technology of Solid-State Materials Devices</td>
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<tr>
<td>CHM ENG 180</td>
<td>Chemical Engineering Economics</td>
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<tr>
<td>CHM ENG H194</td>
<td>Research for Advanced Undergraduates</td>
<td>2-4</td>
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<tr>
<td>CHM ENG C195A</td>
<td>The Berkeley Lectures on Energy: Energy from Biomass (may be repeated for credit when the topic changes)</td>
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<tr>
<td>CHM ENG 196</td>
<td>Special Laboratory Study</td>
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<tr>
<td>CHEM C138</td>
<td>The Berkeley Lectures on Energy: Energy from Biomass</td>
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<tr>
<td>CIV ENG 101</td>
<td>Fluid Mechanics of Rivers, Streams, and Wetlands</td>
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<tr>
<td>CIV ENG 103</td>
<td>Introduction to Hydrology</td>
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<tr>
<td>CIV ENG 105</td>
<td>Environmental Fluid Mechanics and Hydrology</td>
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<tr>
<td>CIV ENG C106</td>
<td>Air Pollution</td>
<td>3</td>
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<tr>
<td>CIV ENG 107</td>
<td>Climate Change Mitigation</td>
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<tr>
<td>CIV ENG 110</td>
<td>Water Systems of the Future</td>
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<td>CIV ENG 111</td>
<td>Environmental Engineering</td>
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<tr>
<td>CIV ENG 111L</td>
<td>Water and Air Quality Laboratory</td>
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<td>CIV ENG 112</td>
<td>Environmental Engineering Design</td>
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<td>CIV ENG 114</td>
<td>Environmental Microbiology</td>
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<tr>
<td>CIV ENG 115</td>
<td>Water Chemistry</td>
<td>3</td>
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<td>CIV ENG C116</td>
<td>Chemistry of Soils</td>
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<td>CIV ENG 120</td>
<td>Structural Engineering</td>
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<td>CIV ENG 121</td>
<td>Structural Analysis</td>
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<td>CIV ENG 122L</td>
<td>Structural Steel Design Project</td>
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<td>CIV ENG 122N</td>
<td>Design of Steel Structures</td>
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<td>CIV ENG 123L</td>
<td>Structural Concrete Design Project</td>
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<td>CIV ENG 123N</td>
<td>Design of Reinforced Concrete Structures</td>
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<td>CIV ENG 124</td>
<td>Structural Design in Timber</td>
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<td>CIV ENG 130N</td>
<td>Mechanics of Structures</td>
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<td>CIV ENG C133</td>
<td>Engineering Analysis Using the Finite Element Method</td>
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<td>CIV ENG 153</td>
<td>Transportation Facility Design</td>
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<td>CIV ENG 155</td>
<td>Transportation Systems Engineering</td>
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<tr>
<td>CIV ENG 156</td>
<td>Infrastructure Planning and Management</td>
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<tr>
<td>CIV ENG 167</td>
<td>Engineering Project Management</td>
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<td>CIV ENG 171</td>
<td>Rock Mechanics</td>
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<tr>
<td>CIV ENG 173</td>
<td>Groundwater and Seepage</td>
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<tr>
<td>CIV ENG 175</td>
<td>Geotechnical and Geoenvironmental Engineering</td>
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<td>CIV ENG 176</td>
<td>Environmental Geotechnics</td>
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<td>CIV ENG C178</td>
<td>Applied Geophysics</td>
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<td>CIV ENG 180</td>
<td>Life-Cycle Design and Construction</td>
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<td>CIV ENG 186</td>
<td>Design of Cyber-Physical Systems</td>
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<td>CIV ENG 191</td>
<td>Civil and Environmental Engineering Systems Analysis</td>
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<td>CIV ENG 193</td>
<td>Engineering Risk Analysis</td>
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<tr>
<td>COMPSCI 161</td>
<td>Computer Security</td>
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<td>COMPSCI 162</td>
<td>Operating Systems and System Programming</td>
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<td>COMPSCI 184</td>
<td>Foundations of Computer Graphics</td>
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<td>COMPSCI 189</td>
<td>Introduction to Machine Learning</td>
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<td>EL ENG 105</td>
<td>Microelectronic Devices and Circuits</td>
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<tr>
<td>EL ENG C106A</td>
<td>Introduction to Robotics</td>
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<td>EL ENG C106B</td>
<td>Robotic Manipulation and Interaction</td>
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<td>EL ENG 113</td>
<td>Power Electronics</td>
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<td>EL ENG 118</td>
<td>Introduction to Optical Engineering</td>
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<td>EL ENG 130</td>
<td>Integrated-Circuit Devices</td>
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<td>EL ENG 134</td>
<td>Fundamentals of Photovoltaic Devices</td>
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<tr>
<td>EL ENG 137A</td>
<td>Introduction to Electric Power Systems</td>
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<td>EL ENG 137B</td>
<td>Introduction to Electric Power Systems</td>
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<tr>
<td>EL ENG 140</td>
<td>Linear Integrated Circuits</td>
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<td>EL ENG 142</td>
<td>Integrated Circuits for Communications</td>
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<tr>
<td>EL ENG 143</td>
<td>Microfabrication Technology</td>
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<td>EL ENG C145B</td>
<td>Medical Imaging Signals and Systems</td>
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<td>EL ENG C145L</td>
<td>Introductory Electronic Transducers Laboratory</td>
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<td>EL ENG C145O</td>
<td>Laboratory in the Mechanics of Organisms</td>
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<tr>
<td>EL ENG 147</td>
<td>Introduction to Microelectromechanical Systems (MEMS)</td>
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<tr>
<td>ENGIN 117</td>
<td>Methods of Engineering Analysis</td>
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<td>ENGIN 120</td>
<td>Principles of Engineering Economics</td>
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<td>IND ENG 153</td>
<td>Logistics Network Design and Supply Chain Management</td>
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<tr>
<td>IND ENG 160</td>
<td>Nonlinear and Discrete Optimization</td>
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<tr>
<td>IND ENG 162</td>
<td>Linear Programming and Network Flows</td>
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<tr>
<td>IND ENG 165</td>
<td>Engineering Statistics, Quality Control, and Forecasting</td>
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<tr>
<td>IND ENG 166</td>
<td>Decision Analytics</td>
<td>3</td>
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<tr>
<td>IND ENG 170</td>
<td>Industrial Design and Human Factors</td>
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<tr>
<td>MAT SCI 102</td>
<td>Bonding, Crystallography, and Crystal Defects</td>
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<tr>
<td>MAT SCI 104</td>
<td>Materials Characterization</td>
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<tr>
<td>MAT SCI 111</td>
<td>Properties of Electronic Materials</td>
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<tr>
<td>MAT SCI 112</td>
<td>Corrosion (Chemical Properties)</td>
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<tr>
<td>MAT SCI 113</td>
<td>Mechanical Behavior of Engineering Materials</td>
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<tr>
<td>MAT SCI 117</td>
<td>Properties of Dielectric and Magnetic Materials</td>
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<tr>
<td>MAT SCI C118</td>
<td>Biological Performance of Materials</td>
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<tr>
<td>MAT SCI 120</td>
<td>Materials Production</td>
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<tr>
<td>MAT SCI 121</td>
<td>Metals Processing</td>
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<tr>
<td>MAT SCI 122</td>
<td>Ceramic Processing</td>
<td>3</td>
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<tr>
<td>MAT SCI 123</td>
<td>ELECTRONIC MATERIALS PROCESSING</td>
<td>4</td>
</tr>
</tbody>
</table>
Concentrations

The concentrations are biotechnology, chemical processing, environmental technology, materials science and technology, and applied physical science. Students who plan to declare a concentration must do so no later than the end of their junior year. Double concentrations are not permitted.

Biotechnology

CHEM 12B Organic Chemistry 5
or MCELLBI C112 General Microbiology
or MCELLBI 104 Genetics, Genomics, and Cell Biology
CHM ENG 170A Biochemical Engineering 3
Choose two from the following, such that at least 3 units come from an engineering course (CHM ENG or BIO ENG)
CHM ENG 170B Biochemical Engineering
CHM ENG C170 Biochemical Engineering Laboratory
CHM ENG C27 Protein Engineering
CHM ENG 274 Biomolecular Engineering
BIO ENG 111 Functional Biomaterials Development and Characterization
BIO ENG 116 Cell and Tissue Engineering
BIO ENG 144 Introduction to Protein Informatics
& 144L and Protein Informatics Laboratory (Students must sign up for Bio Eng 144L (3) if taking 144)
BIO ENG 148 Bioenergy and Sustainable Chemical Synthesis: Metabolic Engineering and Synthetic Biology Approaches
BIO ENG C213 Fluid Mechanics of Biological Systems
MCELLBI 130 Cell and Systems Biology
MCELLBI 150 Molecular Immunology
CHM ENG H19 Research for Advanced Undergraduates (Use of CHM ENG H194 or 196 toward the concentration for undergraduate research in a biotechnology research laboratory will be considered. Requires approval from the faculty. Send requests for approval to the Director of Undergraduate Education.)
CHM ENG 196 Special Laboratory Study (Use of CHM ENG H194 or 196 toward the concentration for undergraduate research in a biotechnology research laboratory will be considered. Requires approval from the faculty. Send requests for approval to the Director of Undergraduate Education.)

Students in the Biotechnology concentration are required to take MCELLBI 102 or CHEM 135 in place of BIOLOGY 1A (even with a score of 4 or 5 on the AP Bio test).

Chemical Processing

CHEM 104A Advanced Inorganic Chemistry 3-5
Select 6 units from the following:

- CHM ENG 170A Biochemical Engineering
- CHM ENG 170B Biochemical Engineering
- CHM ENG C170B Biochemical Engineering Laboratory
- CHM ENG 171 Transport Phenomena
- CHM ENG 176 Principles of Electrochemical Processes
- CHM ENG C177 Polymer Science and Technology
- CHM ENG 179 Process Technology of Solid-State Materials Devices
- CHM ENG 180 Chemical Engineering Economics
- CHM ENG H194 Research for Advanced Undergraduates (up to 3 units)

Select 3 units from the following:

- CIV ENG C30 Introduction to Solid Mechanics
- CIV ENG 111 Environmental Engineering
- CIV ENG 114 Environmental Microbiology
- CIV ENG 173 Groundwater and Seepage
- MAT SCI 111 Properties of Electronic Materials
- MAT SCI 112 Corrosion (Chemical Properties)
- MAT SCI 113 Mechanical Behavior of Engineering Materials
- MAT SCI C118 Biological Performance of Materials
- MAT SCI 120 Materials Production
- MAT SCI 121 Metals Processing
- MAT SCI 122 Ceramic Processing
- MAT SCI 123 ELECTRONIC MATERIALS PROCESSING
- MEC ENG 140 Combustion Processes
- MEC ENG 151 Advanced Heat Transfer

**Energy and Environment**

Select at least 3 units from the following:

- CHEM 12B Organic Chemistry
- CHEM 104A Advanced Inorganic Chemistry
- CHEM 143 Nuclear Chemistry
- PHYSICS 7C Physics for Scientists and Engineers

Select 9 units from the following:

- CHM ENG 170A Biochemical Engineering
- CHM ENG 176 Principles of Electrochemical Processes
- CHM ENG C177 Polymer Science and Technology
- CHM ENG 179 Process Technology of Solid-State Materials Devices
- CHM ENG C195A Berkeley Lectures on Energy: Energy from Biomass
- Or other approved CHM ENG 195 courses with energy or environment topics as the main focus, including Carbon Capture and Sequestration
- NUC ENG 101 Nuclear Reactions and Radiation
- NUC ENG 150 Introduction to Nuclear Reactor Theory
- NUC ENG 161 Nuclear Power Engineering
- CIV ENG 107 Climate Change Mitigation
- CIV ENG 111 Environmental Engineering
- CIV ENG C116 Chemistry of Soils
- CIV ENG 173 Groundwater and Seepage

Select 3 units from the following:

- CHEM 104A Advanced Inorganic Chemistry
- CHEM 108 Inorganic Synthesis and Reactions
- CHEM 12B Organic Chemistry

Select 6 units from the following:

- CIV ENG C30 Introduction to Solid Mechanics
- EL ENG 130 Integrated-Circuit Devices
- EL ENG 143 Microfabrication Technology
- MAT SCI 102 Bonding, Crystallography, and Crystal Defects
- MAT SCI 103 Phase Transformations and Kinetics
- MAT SCI 111 Properties of Electronic Materials
- MAT SCI 112 Corrosion (Chemical Properties)
- MAT SCI 120 Materials Production
- MAT SCI 121 Metals Processing
- MAT SCI 122 Ceramic Processing
- MAT SCI 123 ELECTRONIC MATERIALS PROCESSING
- MEC ENG 122 Processing of Materials in Manufacturing

1 Students may take MEC ENG 122 without the prerequisites of CIV ENG 130N and MEC ENG 108.

**Materials Science and Technology**

Select one of the following:

- CHEM 104A Advanced Inorganic Chemistry
- CHEM 108 Inorganic Synthesis and Reactions
- CHEM 12B Organic Chemistry

Select 3 units from the following:

- CHM ENG 176 Principles of Electrochemical Processes
- CHM ENG C177 Polymer Science and Technology
- CHM ENG 179 Process Technology of Solid-State Materials Devices

Select 6 units from the following:

- CIV ENG C30 Introduction to Solid Mechanics
- EL ENG 130 Integrated-Circuit Devices
- EL ENG 143 Microfabrication Technology
- MAT SCI 102 Bonding, Crystallography, and Crystal Defects
- MAT SCI 103 Phase Transformations and Kinetics
- MAT SCI 111 Properties of Electronic Materials
- MAT SCI 112 Corrosion (Chemical Properties)
- MAT SCI 120 Materials Production
- MAT SCI 121 Metals Processing
- MAT SCI 122 Ceramic Processing
- MAT SCI 123 ELECTRONIC MATERIALS PROCESSING
- MAT SCI 125 Thin-Film Materials Science
- MEC ENG 122 Processing of Materials in Manufacturing

**Business and Management**

- CHM ENG 180 Chemical Engineering Economics

3 units of science electives selected from the list of physical and biological science electives

3 units of engineering electives selected from the list of engineering electives

3 units chosen from the following:

- UGBA 102A Introduction to Financial Accounting
- UGBA 195P Entrepreneurship: How to Successfully start a New Business
- UGBA 10 Principles of Business
- MBA 209F Fundamentals of Business

Upper division preferred.

**Applied Physical Science**

6 units of chemistry or physics courses selected from the list of Physical and Biological Sciences List

3 units of CHM ENG electives (excluding CHM ENG 196)

3 units chosen from engineering electives list

Students who have a strong interest in an area of study outside their major often decide to complete a minor program. These programs
have set requirements and are noted officially on the transcript in the memoranda section but are not noted on diplomas.

**General Guidelines**

1. All courses taken to fulfill the minor requirements below must be taken for graded credit.
2. A minimum of three of the upper division courses taken to fulfill the minor requirements must be completed at UC Berkeley.
3. A minimum grade point average (GPA) of 2.0 is required for courses used to fulfill the minor requirements.
4. Students must consult with their college/school for information regarding overlap of courses between their majors and minors.

**Requirements**

**Upper Division**

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<tr>
<th>Course Code</th>
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<tr>
<td>CHM ENG 140</td>
<td>Introduction to Chemical Process Analysis</td>
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<td>CHM ENG 141</td>
<td>Chemical Engineering Thermodynamics</td>
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<td>CHM ENG 150A</td>
<td>Transport Processes</td>
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<td>CHM ENG 150B</td>
<td>Transport Separation Processes</td>
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<tr>
<td>CHM ENG 162</td>
<td>Dynamics and Control of Chemical Processes</td>
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<td>CHM ENG 170A</td>
<td>Biochemical Engineering</td>
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<tr>
<td>CHM ENG 170B</td>
<td>Biochemical Engineering</td>
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<tr>
<td>CHM ENG 171</td>
<td>Transport Phenomena</td>
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<td>CHM ENG 176</td>
<td>Principles of Electrochemical Processes</td>
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<tr>
<td>CHM ENG C178</td>
<td>Polymer Science and Technology</td>
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<td>CHM ENG 179</td>
<td>Process Technology of Solid-State Materials Devices</td>
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<td>CHM ENG 180</td>
<td>Chemical Engineering Economics</td>
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<tr>
<td>CHM ENG C195A</td>
<td>The Berkeley Lectures on Energy: Energy from Biomass</td>
<td>3</td>
</tr>
</tbody>
</table>

1 Students who have completed courses in other departments at Berkeley that are essentially equivalent to CHM ENG 141 and CHM ENG 150A can substitute other courses from the above list.

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/undergraduate/colleges-schools/chemistry/#collegerequirements) 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 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.

Chemistry or chemical biology majors must also 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

Chemical engineering students 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

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)
- 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.

Mission
The mission of the Department of Chemical and Biomolecular Engineering is:

• To educate people for careers of leadership and innovation in chemical engineering and related fields.
• To expand the base of engineering knowledge through original research and by developing technology to serve the needs of society.
• To benefit the public through service to industry, government, and the engineering profession.

Fulfillment of this mission is achieved in part by the Department of Chemical and Biomolecular Engineering’s accredited undergraduate degree program in chemical engineering. The undergraduate curriculum comprises both a technical curriculum and breadth requirements.

The goals of chemical engineering breadth requirements are to teach the arts of writing clearly and persuasively, to develop the skills to read carefully and evaluate evidence effectively, and to instill an awareness of humanity in historical and social contexts. The Berkeley American Cultures requirement affirms the value of diversity in acquiring knowledge.

The technical curriculum in chemical engineering seeks to provide students with a broad education emphasizing an excellent foundation in scientific and engineering fundamentals.

Learning Goals for the Major
1. An ability to apply knowledge of mathematics, science, and engineering.
2. An ability to design and conduct experiments, as well as to analyze and interpret data.
3. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
4. An ability to function on multidisciplinary teams.
5. An ability to identify, formulate, and solve engineering problems.
6. An understanding of professional and ethical responsibility.
7. An ability to communicate effectively.
8. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
9. A recognition of the need for and an ability to engage in life-long learning.
10. A knowledge of contemporary issues.
11. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Chemical 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.

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.

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.

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
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 multidisciplinary 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.

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
Terms offered: Spring 2018, Fall 2016, Fall 2014
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
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.

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.

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 [+]  
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 [+]  
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 [+]  
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 [+]  
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.

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.

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

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

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