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>
<th>Title</th>
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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>
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<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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<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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<tr>
<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 Engineering Molecules 1</td>
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Students in the Biotechnology concentration are required to take BIO ENG 11 or MCELL 102 or CHEM 135 instead of BIOLOGY 1A (even with a score of 4 or 5 on the AP Bio test).

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<tr>
<th>Course</th>
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<td>MAT SCI 45L</td>
<td>Properties of Materials Laboratory</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. A grade of C- or better is required in CHEM 12A before taking BIOLOGY 1A or CHEM 12B.
4. A grade of C- or better in CHEM 140 is required before enrolling in any other chemical engineering courses.
5. ENGIN W7 may be substituted for ENGIN 7.
6. ENGIN 7 must be taken before or concurrently with CHEM ENG 140 and before CHEM ENG 150B.
7. Students should start MATH 1A in the first semester of their freshman year.
8. Students should start PHYSICS 7A in the second semester of the freshman year.

Upper Division Requirements

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<th>Course</th>
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<tr>
<td>CHEM 120A</td>
<td>Physical Chemistry</td>
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<tr>
<td>or PHYSICS 130 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>
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<td>CHM ENG 150A</td>
<td>Transport Processes</td>
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<td>CHM ENG 150B</td>
<td>Transport and Separation Processes</td>
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<td>CHM ENG 154</td>
<td>Chemical Engineering Laboratory</td>
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<td>CHM ENG 160</td>
<td>Chemical Process Design</td>
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<td>CHM ENG 162</td>
<td>Dynamics and Control of Chemical Processes</td>
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Physical and Biological Sciences Electives List

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<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>Paleoethnobotany: 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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<td>ASTRON 7B</td>
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<td>ASTRON 10</td>
<td>Introduction to General Astronomy</td>
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<td>ASTRON C12</td>
<td>The Planets</td>
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<td>ASTRON C162</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>CHEM 113</td>
<td>Advanced Mechanistic Organic Chemistry</td>
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<td>Advanced Synthetic Organic Chemistry</td>
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<td>Organic Chemistry--Advanced Laboratory Methods</td>
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<td>Physical Chemistry</td>
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<td>CHEM 122</td>
<td>Quantum Mechanics and Spectroscopy</td>
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<td>Physical Chemistry Laboratory</td>
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<td>CHEM C130</td>
<td>Biophysical Chemistry: Physical Principles and the Molecules of Life</td>
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<td>Chemical Biology</td>
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<td>Nuclear Chemistry</td>
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<td>Radiochemical 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>
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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>Earthquakes in Your Backyard</td>
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<td>EPS 50</td>
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<td>EPS 80</td>
<td>Environmental Earth Sciences</td>
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<td>Oceans</td>
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<td>Minerals: Their Constitution and Origin</td>
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<td>EPS 103</td>
<td>Introduction to Aquatic and Marine Geochemistry</td>
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<td>EPS 108</td>
<td>Geodynamics</td>
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<td>Geomorphology</td>
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<td>Biometeorology</td>
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<td>EPS 130</td>
<td>Strong Motion Seismology</td>
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<td>Atmospheric Physics and Dynamics</td>
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<td>Natural Resource Sampling</td>
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<td>ESPM 102C</td>
<td>Resource Management</td>
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<td>Principles of Conservation Biology</td>
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<td>Primate Ecology</td>
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<td>ESPM 112</td>
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<td>Soil Microbiology and Biogeochemistry</td>
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<td>Fire, Insects, and Diseases in Forest Ecosystems</td>
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<td>Pesticide Chemistry and Toxicology</td>
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<td>Applied Forest Ecology</td>
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<td>Management and Conservation of Rangeland Ecosystems</td>
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<td>GEOG 35</td>
<td>Global Ecology and Development</td>
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<td>Terrestrial Hydrology</td>
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<td>Top Ten Global Environmental Problems</td>
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<td>GEOG 140A</td>
<td>Physical Landscapes: Process and Form</td>
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<td>Special Topics in Physical Geography</td>
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<td>INTEGBI 31</td>
<td>The Ecology and Evolution of Animal Behavior</td>
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<td>INTEGBI 41</td>
<td>Marine Mammals</td>
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<td>INTEGBI C82</td>
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<td>INTEGBI 102L</td>
<td>Introduction to California Plant Life with Laboratory</td>
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<td>Hormones and Behavior</td>
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<td>Comparative Animal Physiology</td>
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<tr>
<td>INTEGBI 151</td>
<td>Plant Physiological Ecology</td>
<td>4</td>
</tr>
<tr>
<td>INTEGBI 152</td>
<td>Environmental Toxicology</td>
<td>4</td>
</tr>
<tr>
<td>INTEGBI 153</td>
<td>Ecology</td>
<td>3</td>
</tr>
<tr>
<td>INTEGBI 154</td>
<td>Plant Ecology</td>
<td>3</td>
</tr>
<tr>
<td>INTEGBI 154L</td>
<td>Plant Ecology Laboratory</td>
<td>2</td>
</tr>
<tr>
<td>INTEGBI C156</td>
<td>Principles of Conservation Biology</td>
<td>4</td>
</tr>
<tr>
<td>INTEGBI C158L</td>
<td>Biology and Geomorphology of Tropical Islands</td>
<td>13</td>
</tr>
<tr>
<td>INTEGBI 159</td>
<td>The Living Planet: Impact of the Biosphere on the Earth System</td>
<td>3</td>
</tr>
<tr>
<td>INTEGBI 161</td>
<td>Population and Evolutionary Genetics</td>
<td>4</td>
</tr>
<tr>
<td>INTEGBI 162</td>
<td>Ecological Genetics</td>
<td>4</td>
</tr>
<tr>
<td>INTEGBI 164</td>
<td>Human Genetics and Genomics</td>
<td>4</td>
</tr>
<tr>
<td>INTEGBI 168</td>
<td>Systematics of Vascular Plants</td>
<td>2</td>
</tr>
<tr>
<td>INTEGBI 168L</td>
<td>Systematics of Vascular Plants with Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>INTEGBI 169</td>
<td>Evolutionary Medicine</td>
<td>4</td>
</tr>
<tr>
<td>INTEGBI 174L</td>
<td>Ornithology with Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>INTEGBI 183L</td>
<td>Evolution of the Vertebrates with Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>INTEGBI 184L</td>
<td>Morphology of the Vertebrate Skeleton with Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>INTEGBI C185L</td>
<td>Human Paleontology</td>
<td>5</td>
</tr>
<tr>
<td>INTEGBI C187</td>
<td>Human Biogeography of the Pacific</td>
<td>3</td>
</tr>
<tr>
<td>L &amp; S C30U</td>
<td>Americans and the Global Forest</td>
<td>4</td>
</tr>
<tr>
<td>L &amp; S C30V</td>
<td>Environmental Issues</td>
<td>4</td>
</tr>
<tr>
<td>L &amp; S C70T</td>
<td>The Planets</td>
<td>3</td>
</tr>
<tr>
<td>L &amp; S C70U</td>
<td>Introduction to General Astronomy</td>
<td>4</td>
</tr>
<tr>
<td>L &amp; S C70W</td>
<td>Physics and Music</td>
<td>3</td>
</tr>
<tr>
<td>L &amp; S C70Y</td>
<td>Earthquakes in Your Backyard</td>
<td>3</td>
</tr>
<tr>
<td>MAT SCI C150</td>
<td>Introduction to Materials Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>MCELLBI 32</td>
<td>Introduction to Human Physiology</td>
<td>3</td>
</tr>
<tr>
<td>MCELLBI 41</td>
<td>Genetics and Society</td>
<td>3</td>
</tr>
<tr>
<td>MCELLBI 50</td>
<td>The Immune System and Disease</td>
<td>4</td>
</tr>
<tr>
<td>MCELLBI C61</td>
<td>Brain, Mind, and Behavior</td>
<td>3</td>
</tr>
<tr>
<td>MCELLBI C62</td>
<td>Drugs and the Brain</td>
<td>3</td>
</tr>
<tr>
<td>MCELLBI C100A</td>
<td>Biophysical Chemistry: Physical Principles and the Molecules of Life</td>
<td>4</td>
</tr>
<tr>
<td>MCELLBI 100B</td>
<td>Biochemistry: Pathways, Mechanisms, and Regulation</td>
<td>4</td>
</tr>
<tr>
<td>MCELLBI 102</td>
<td>Survey of the Principles of Biochemistry and Molecular Biology</td>
<td>4</td>
</tr>
<tr>
<td>MCELLBI C103</td>
<td>Bacterial Pathogenesis</td>
<td>3</td>
</tr>
<tr>
<td>MCELLBI 104</td>
<td>Genetics, Genomics, and Cell Biology</td>
<td>4</td>
</tr>
<tr>
<td>MCELLBI C112</td>
<td>General Microbiology</td>
<td>4</td>
</tr>
<tr>
<td>MCELLBI C114</td>
<td>Introduction to Comparative Virology</td>
<td>4</td>
</tr>
<tr>
<td>MCELLBI C116</td>
<td>Microbial Diversity</td>
<td>3</td>
</tr>
<tr>
<td>MCELLBI 132</td>
<td>Biology of Human Cancer</td>
<td>4</td>
</tr>
</tbody>
</table>
PSYCH 126 Perception 3
PSYCH 127 Cognitive Neuroscience 3
PSYCH 129 Scientific Approaches to Consciousness 3
PB HLTH C102 Course Not Available 3
PB HLTH 162A Public Health Microbiology 4

Lower Division Engineering Electives List

CHM ENG 90 Science and Engineering of Sustainable Energy 3
COMPSCI 61B Data Structures 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 Biomaterials 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 Tissue Engineering Lab 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 3
BIO ENG 150 Introduction of Bionanoscience and Bionanotechnology 4
BIO ENG 151 Micro/Nanofluidics for Bioengineering and Lab-On-A-Chip 4
BIO ENG 163 Principles of Molecular and Cellular Biophotonics 4
BIO ENG 163L Molecular and Cellular Biophotonics Laboratory 4
BIO ENG 164 Optics and Microscopy 4
BIO ENG C165 Medical Imaging Signals and Systems 4
BIO ENG 168L Practical Light Microscopy 3
BIO ENG C181 The Berkeley Lectures on Energy: Energy from Biomass 3
CHM ENG 143 Computational Methods in Chemical Engineering 4
CHM ENG 170A Biochemical Engineering 3
CHM ENG 170B Biochemical Engineering 3
CHM ENG C170L Biochemical Engineering Laboratory 3
CHM ENG 171 Transport Phenomena 3
CHM ENG 176 Principles of Electrochemical Processes 3
CHM ENG C178 Polymer Science and Technology 3
CHM ENG 179 Process Technology of Solid-State Materials Devices 3
CHM ENG 180 Chemical Engineering Economics 3
CHM ENG H194 Research for Advanced Undergraduates 2-4
CHM ENG C195A The Berkeley Lectures on Energy: Energy from Biomass (may be repeated for credit when the topic changes) 3
CHM ENG 196 Special Laboratory Study 2-4
CHEM C138 The Berkeley Lectures on Energy: Energy from Biomass 3
CIV ENG 101 Fluid Mechanics of Rivers, Streams, and Wetlands 3
CIV ENG 103 Introduction to Hydrology 3
CIV ENG 105 Water and Wind - Design for a Variable Environment 3
CIV ENG C106 Air Pollution 3
CIV ENG 107 Climate Change Mitigation 3
CIV ENG 110 Water Systems of the Future 3
CIV ENG 111 Environmental Engineering 3
CIV ENG 111L Water and Air Quality Laboratory 1
CIV ENG 112 Environmental Engineering Design 3
CIV ENG 114 Environmental Microbiology 3
CIV ENG 115 Water Chemistry 3
CIV ENG C116 Chemistry of Soils 3
CIV ENG 120 Structural Engineering 3
CIV ENG 121 Structural Analysis 3
CIV ENG 122L Structural Steel Design Project 1
CIV ENG 122N Design of Steel Structures 3
CIV ENG 123L Structural Concrete Design Project 1
CIV ENG 123N Design of Reinforced Concrete Structures 3
CIV ENG 124 Structural Design in Timber 3
CIV ENG 130N Mechanics of Structures 3
CIV ENG C133 Engineering Analysis Using the Finite Element Method 3
CIV ENG 153 Transportation Facility Design 3
CIV ENG 155 Transportation Systems Engineering 3
CIV ENG 156 Infrastructure Planning and Management 3
CIV ENG 167 Engineering Project Management 3
CIV ENG 171 Rock Mechanics 3
CIV ENG 173 Groundwater and Seepage 3
CIV ENG 175 Geotechnical and Geoenvironmental Engineering 3
CIV ENG 176 Environmental Geotechnics 3
CIV ENG C178 Applied Geophysics 3
CIV ENG 180 Life-Cycle Design and Construction 4
CIV ENG 186 Design of Internet-of-Things for Smart Cities 3
CIV ENG 191 Civil and Environmental Engineering Systems Analysis 3
CIV ENG 193 Engineering Risk Analysis 3
COMPSCI 161 Computer Security 4
COMPSCI 162 Operating Systems and System Programming 4
COMPSCI 184 Foundations of Computer Graphics 4
COMPSCI 189 Introduction to Machine Learning 4
EL ENG 105 Microelectronic Devices and Circuits 4
EL ENG C106A Introduction to Robotics 4
EL ENG C106B Robotic Manipulation and Interaction 4
EL ENG 113 Power Electronics 4
EL ENG 118 Introduction to Optical Engineering 3
EL ENG 130 Integrated-Circuit Devices 4
EL ENG 134 Fundamentals of Photovoltaic Devices 4
EL ENG 137A Introduction to Electric Power Systems 4
EL ENG 137B Introduction to Electric Power Systems 4
EL ENG 140 Linear Integrated Circuits 4
EL ENG 142 Integrated Circuits for Communications 4
EL ENG 143 Microfabrication Technology 4
EL ENG C145B Medical Imaging Signals and Systems 4
EL ENG C145L Introductory Electronic Transducers Laboratory 3
EL ENG C145O Laboratory in the Mechanics of Organisms 3
EL ENG 147 Introduction to Microelectromechanical Systems (MEMS) 3
ENGIN 117 Methods of Engineering Analysis 3
ENGIN 120 Principles of Engineering Economics 3
IND ENG 153 Logistics Network Design and Supply Chain Management 3
IND ENG 160 Nonlinear and Discrete Optimization 3
IND ENG 162 Linear Programming and Network Flows 3
IND ENG 165 Engineering Statistics, Quality Control, and Forecasting 4
IND ENG 166 Decision Analytics 3
IND ENG 170 Industrial Design and Human Factors 3
MAT SCI 102 Bonding, Crystallography, and Crystal Defects 3
MAT SCI 104 Materials Characterization 4
MAT SCI 111 Properties of Electronic Materials 4
MAT SCI 112 Corrosion (Chemical Properties) 3
MAT SCI 113 Mechanical Behavior of Engineering Materials 3
MAT SCI 117 Properties of Dielectric and Magnetic Materials 3
MAT SCI C118 Biological Performance of Materials 4
MAT SCI 120 Materials Production 3
MAT SCI 121 Metals Processing 3
MAT SCI 122 Ceramic Processing 3
MAT SCI 123 ELECTRONIC MATERIALS PROCESSING 4
MAT SCI 125 Thin-Film Materials Science 3
MAT SCI 136 Materials in Energy Technologies 4
MAT SCI 140 Nanomaterials for Scientists and Engineers 3
MAT SCI 151 Polymeric Materials 3
MEC ENG 102B Mechatronics Design 4
MEC ENG 104 Engineering Mechanics II 3
## Concentrations

The concentrations are Biotechnology, Chemical Processing, Energy and Environment, Materials Science and Technology, Business and Management, 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

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 12B</td>
<td>Organic Chemistry</td>
<td>5</td>
</tr>
<tr>
<td>or MCELLBI C124</td>
<td>General Microbiology</td>
<td></td>
</tr>
<tr>
<td>or MCELLBI 104</td>
<td>Genetics, Genomics, and Cell Biology</td>
<td></td>
</tr>
<tr>
<td>CHM ENG 170A</td>
<td>Biochemical Engineering</td>
<td>3</td>
</tr>
<tr>
<td>CHM ENG 170B</td>
<td>Biochemical Engineering (Students graduating before May 2021 may opt to replace CHM ENG 170B with a second course from the list of options below.)</td>
<td>3</td>
</tr>
</tbody>
</table>

Choose one of the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHM ENG C170</td>
<td>Biochemical Engineering Laboratory</td>
</tr>
<tr>
<td>CHM ENG 182</td>
<td>Nanoscience and Engineering Biotechnology</td>
</tr>
<tr>
<td>CHM ENG 274</td>
<td>Bimolecular Engineering</td>
</tr>
<tr>
<td>BIO ENG 111</td>
<td>Functional Biomaterials Development and Characterization</td>
</tr>
<tr>
<td>BIO ENG 103</td>
<td>Engineering Molecules 2</td>
</tr>
<tr>
<td>BIO ENG 116</td>
<td>Cell and Tissue Engineering</td>
</tr>
<tr>
<td>BIO ENG 140L</td>
<td>Synthetic Biology Laboratory</td>
</tr>
<tr>
<td>BIO ENG 144</td>
<td>Introduction to Protein Informatics &amp; 144L and Protein Informatics Laboratory (Students must sign up for Bio Eng 144L (3) if taking 144)</td>
</tr>
<tr>
<td>BIO ENG 148</td>
<td>Bioenergy and Sustainable Chemical Synthesis: Metabolic Engineering and Synthetic Biology Approaches</td>
</tr>
<tr>
<td>BIO ENG C213</td>
<td>Fluid Mechanics of Biological Systems</td>
</tr>
<tr>
<td>MCELLBI 130</td>
<td>Cell and Systems Biology</td>
</tr>
<tr>
<td>MCELLBI 150</td>
<td>Molecular Immunology</td>
</tr>
<tr>
<td>CHM ENG H194</td>
<td>Research for Advanced Undergraduates [3-4] (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.)</td>
</tr>
<tr>
<td>CHM ENG 196 Special Laboratory Study [3-4] (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 Professor Wenjun Zhang.)</td>
<td></td>
</tr>
</tbody>
</table>

### Chemical Processing

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 104A</td>
<td>Advanced Inorganic Chemistry</td>
<td>3-5</td>
</tr>
<tr>
<td>or CHEM 12B</td>
<td>Organic Chemistry</td>
<td></td>
</tr>
</tbody>
</table>

Select 6 units from the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHM ENG 170</td>
<td>Biochemical Engineering</td>
</tr>
</tbody>
</table>

### Chemical Processing

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>CHEM 104A</td>
<td>Advanced Inorganic Chemistry</td>
<td>3-5</td>
</tr>
<tr>
<td>or CHEM 12B</td>
<td>Organic Chemistry</td>
<td></td>
</tr>
</tbody>
</table>

Select 6 units from the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHM ENG 170</td>
<td>Biochemical Engineering</td>
</tr>
</tbody>
</table>
CHM ENG 170/Biochemical Engineering [3]
CHM ENG C178/Biochemical Engineering Laboratory [3]
CHM ENG 171 Transport Phenomena [3]
CHM ENG 176 Principles of Electrochemical Processes [3]
CHM ENG C178/Polymer Science and Technology [3]
CHM ENG 179 Process Technology of Solid-State Materials Devices [3]
CHM ENG 180 Chemical Engineering Economics [3]
CHM ENG H198 Research for Advanced Undergraduates [2-4] (up to 3 units)

Select 3 units from the following:

CIV ENG 111 Environmental Engineering [3]
CIV ENG 114 Environmental Microbiology [3]
CIV ENG 173 Groundwater and Seepage [3]
MAT SCI 112 Corrosion (Chemical Properties) [3]
MAT SCI 113 Mechanical Behavior of Engineering Materials [3]
MAT SCI C118 Biological Performance of Materials [4]
MAT SCI 120 Materials Production [3]
MAT SCI 121 Metals Processing [3]
MAT SCI 122 Ceramic Processing [3]
MAT SCI 123 ELECTRONIC MATERIALS PROCESSING [4]
MEC ENG 140 Combustion Processes [3]
MEC ENG 151 Advanced Heat Transfer [3]

Energy and Environment

Select at least 3 units from the following:

CHEM 12B Organic Chemistry [5]
CHEM 104A Advanced Inorganic Chemistry [3]
CHEM 143 Nuclear Chemistry [2]
PHYSICS 7C Physics for Scientists and Engineers [4]

Select 9 units from the following:

CHM ENG 170/Biochemical Engineering [3]
CHM ENG 176 Principles of Electrochemical Processes [3]
CHM ENG C178/Polymer Science and Technology [3]
CHM ENG 179 Process Technology of Solid-State Materials Devices [3]

Other approved CHM ENG 195 courses with energy or environment topics as the main focus, including Carbon Capture and Sequestration

CIV ENG 107 Climate Change Mitigation [3]
CIV ENG 111 Environmental Engineering [3]
CIV ENG 113 Ecological Engineering for Water Quality Improvement [3]
CIV ENG C116 Chemistry of Soils [3]
CIV ENG 173 Groundwater and Seepage [3]
MEC ENG 140 Combustion Processes [3]
MEC ENG 146 Energy Conversion Principles [3]
NUC ENG 101 Nuclear Reactions and Radiation [4]
NUC ENG 150 Introduction to Nuclear Reactor Theory [4]
NUC ENG 161 Nuclear Power Engineering [4]

Materials Science and Technology

Select one of the following:

CHEM 104A Advanced Inorganic Chemistry [3]
CHEM 12B Organic Chemistry [5]

Select 3 units from the following:

CHM ENG 176 Principles of Electrochemical Processes [3]
CHM ENG C178/Polymer Science and Technology [3]
CHM ENG 179 Process Technology of Solid-State Materials Devices [3]

Select 6 units from the following:

CIV ENG 111 Environmental Engineering [3]
CIV ENG 114 Environmental Microbiology [3]
CIV ENG 173 Groundwater and Seepage [3]
MAT SCI 112 Corrosion (Chemical Properties) [3]
MAT SCI 120 Materials Production [3]
MAT SCI 121 Metals Processing [3]
MAT SCI 122 Ceramic Processing [3]
MAT SCI 123 ELECTRONIC MATERIALS PROCESSING [4]
MAT SCI 125 Thin-Film Materials Science [3]
MEC ENG 122 Processing of Materials in Manufacturing [3]

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

Business and Management

CHM ENG 180 Chemical Engineering Economics [3]
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

6 units chosen from the following UGBA courses:

UGBA 102A Financial Accounting [3]
UGBA 105 Leading People [3]
UGBA 106 Marketing [3]
UGBA 119 Leading Strategy Implementation [3]
UGBA 152 Negotiation and Conflict Resolution [3]
UGBA 155 Leadership [3]
UGBA 160 Consumer Behavior [3]
UGBA 161 Market Research: Tools and Techniques for Data Collection and Analysis [3]
UGBA 162 Brand Management and Strategy [3]
UGBA 168B Course Not Available [3]
UGBA 169 Pricing [3]
UGBA 175 Legal Aspects of Management [3]
UGBA 179 International Consulting for Small and Medium-Sized Enterprises [3]
UGBA 192P Sustainable Business Consulting Projects [3]
UGBA 195A Entrepreneurship [3]
Applied Physical Science
6 units of chemistry or physics courses selected from the Physical and Biological Sciences List
3 units of CHM ENG electives (excluding CHM ENG 196)
3 units chosen from the 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 minors must be declared no later than one semester before a student’s Expected Graduation Term (EGT). If the semester before EGT is fall or spring, the deadline is the last day of RRR week. If the semester before EGT is summer, the deadline is the final Friday of Summer Sessions. To declare a minor, contact the department advisor for information on requirements, and the declaration process.
2. All courses taken to fulfill the minor requirements below must be taken for graded credit.
3. A minimum of three of the upper division courses taken to fulfill the minor requirements must be completed at UC Berkeley.
4. A minimum grade point average (GPA) of 2.0 is required for courses used to fulfill the minor requirements.
5. Students must consult with their college/school for information regarding an overlap of courses between their majors and minors.

Requirements

<table>
<thead>
<tr>
<th>Upper Division</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHM ENG 140</td>
<td>Introduction to Chemical Process Analysis</td>
<td>4</td>
</tr>
<tr>
<td>CHM ENG 141</td>
<td>Chemical Engineering Thermodynamics</td>
<td>4</td>
</tr>
<tr>
<td>CHM ENG 150A</td>
<td>Transport Processes</td>
<td>4</td>
</tr>
</tbody>
</table>

Select two of the following:

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHM ENG 142</td>
<td>Chemical Kinetics and Reaction Engineering</td>
</tr>
<tr>
<td>CHM ENG 143</td>
<td>Computational Methods in Chemical Engineering</td>
</tr>
<tr>
<td>CHM ENG 150B</td>
<td>Transport and Separation Processes</td>
</tr>
<tr>
<td>CHM ENG 162</td>
<td>Dynamics and Control of Chemical Processes</td>
</tr>
<tr>
<td>CHM ENG 170A</td>
<td>Biochemical Engineering</td>
</tr>
<tr>
<td>CHM ENG 170B</td>
<td>Biochemical Engineering</td>
</tr>
<tr>
<td>CHM ENG 171</td>
<td>Transport Phenomena</td>
</tr>
<tr>
<td>CHM ENG 176</td>
<td>Principles of Electrochemical Processes</td>
</tr>
<tr>
<td>CHM ENG C178</td>
<td>Polymer Science and Technology</td>
</tr>
<tr>
<td>CHM ENG 179</td>
<td>Process Technology of Solid-State Materials Devices</td>
</tr>
<tr>
<td>CHM ENG 180</td>
<td>Chemical Engineering Economics</td>
</tr>
<tr>
<td>CHM ENG C195A</td>
<td>The Berkeley Lectures on Energy: Energy from Biomass</td>
</tr>
</tbody>
</table>

All students in the College of Chemistry are required to complete the University requirements of American Cultures (http://guide.berkeley.edu/undergraduate/colleges-schools/chemistry/american-cultures-requirement), American History and Institutions (http://guide.berkeley.edu/undergraduate/colleges-schools/chemistry/american-history-institutions-requirements), and Entry-Level Writing (http://guide.berkeley.edu/undergraduate/colleges-schools/chemistry/entry-level-writing-requirement). In addition, they must satisfy the following College requirements:

Reading and Composition (http://guide.berkeley.edu/undergraduate/colleges-schools/chemistry/reading-composition-requirement)

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 Reading and Composition course (e.g., English R1A) by end of the first year
- Chemical Biology and Chemistry majors: A- and B-level courses by end of the second year (http://guide.berkeley.edu/undergraduate/colleges-schools/chemistry/reading-composition-requirement)
- R&C courses must be taken for a letter grade
- English courses at other institutions may satisfy the requirement(s); check with your Undergraduate Adviser
- After admission to Berkeley, credit for English at another institution will not be granted if the Entry Level Writing requirement has not been satisfied

Humanities and Social Sciences Breadth Requirement: Chemistry & Chemical Biology majors

The College of Chemistry’s humanities and social sciences breadth requirement promotes educational experiences that enrich and complement the technical requirements for each major.

- 15 units total; includes Reading & Composition and American Cultures courses
- Remaining units must come from the following L&S breadth areas, excluding courses which only teach a skill (such as drawing or playing an instrument):
  - Arts and Literature
  - Foreign Language (http://guide.berkeley.edu/undergraduate/colleges-schools/chemistry/approved-foreign-language-courses)\(^1,2\)
  - Historical Studies
  - International Studies
  - Philosophy and Values
  - Social and Behavioral Sciences

To find course options for breadth, go to the Berkeley Academic Guide Class Schedule (http://classes.berkeley.edu), select the term of interest, and use the ‘Breadth Requirements’ filter to select the breadth area(s) of interest.

- Breadth courses may be taken on a Pass/No Pass basis (excluding Reading and Composition)
• AP, IB, and GCE A-level exam credit (http://chemistry.berkeley.edu/students/current-undergraduates/exam-credit-info) may be used to satisfy the breadth requirement

1 Elementary-level courses may not be in the student’s native language and may not be structured primarily to teach the reading of scientific literature.

2 For Chemistry and Chemical Biology majors, elementary-level foreign language courses are not accepted toward the 15 unit breadth requirement if they are used (or are duplicates of high school courses used) to satisfy the Foreign Language requirement.

Foreign Language (Language Other Than English [LOTE]) Requirement

Applies to Chemistry and Chemical Biology majors only.

The LOTE requirement may be satisfied with one language other than English, in one of the following ways:

• By completing in high school the third year of one language other than English with minimum grades of C-.

• By completing at Berkeley the second semester of a sequence of courses in one language other than English, or the equivalent at another institution. Only LOTE courses that include reading and composition, as well as conversation, are accepted in satisfaction of this requirement. LOTE courses may be taken on a Pass/No Pass basis.

• By demonstrating equivalent knowledge of a language other than English 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.

Humanities and Social Sciences Breadth Requirement: Chemical Engineering major

• 22 units total; includes Reading and Composition 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 following lists of approved humanities and social science courses, excluding courses which only teach a skill (such as drawing or playing an instrument):

  Arts and Literature
  Foreign Language (http://guide.berkeley.edu/undergraduate/colleges-schools/chemistry/approved-foreign-language-courses)¹²
  Historical Studies
  International Studies
  Philosophy and Values

  To find course options for breadth, go to the Berkeley Academic Guide Class Schedule (http://classes.berkeley.edu), select the term of interest, and use the ‘Breadth Requirements’ filter to select the breadth area(s) of interest.

• Breadth courses may be taken on a Pass/No Pass basis (excluding Reading and Composition)

• AP, IB, and GCE A-level exam (http://chemistry.berkeley.edu/students/current-undergraduates/exam-credit-info) credit may be used to satisfy the breadth requirement

1 Elementary-level courses may not be in the student’s native language and may not be structured primarily to teach the reading of scientific literature.

2 For chemical engineering majors, no more that six units of language other than English may be counted toward the 22 unit 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 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**
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 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 before taking CHEM 4B
- C- or higher in CHEM 4B before taking more advanced courses
- C- or higher in CHEM 12A before taking CHEM 12B
- 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 and CHEM 120B if taken before CHEM 125 or CHEM C182
- 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 CHM ENG 140 before taking any other CBE courses
- C- or higher in CHM ENG 150A 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 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 identify, formulate, and solve complex engineering problems by applying the principles of engineering, science, and mathematics
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. An ability to communicate effectively with a range of audiences
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in a global, economic, environmental, and societal context
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies

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

Freshman Seminars: Read More [+]

**Rules & Requirements**

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

Hours & Format

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

Additional Details

Subject/Course Level: Chemical & Biomolecular Engineering/Undergraduate

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

Freshman Seminars: Read Less [-]

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

Introduction to Chemical Engineering Design: Read More [+]

**Rules & Requirements**

Prerequisites: Math 1B OR Chem 4A

Hours & Format

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

Additional Details

Subject/Course Level: Chemical & Biomolecular Engineering/Undergraduate

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

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

Science and Engineering of Sustainable Energy: Read More [+]

Rules & Requirements

Prerequisites: Chemistry 1A or 4A

Hours & Format

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

Additional Details

Subject/Course Level: Chemical & Biomolecular Engineering/Undergraduate

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

Instructors: Bell, Segalman

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

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

Directed Group Studies for Lower Division Undergraduates: Read More [+]

Rules & Requirements

Prerequisites: Consent of instructor

Credit Restrictions: Enrollment is restricted; see the Introduction to Courses and Curricula section of this catalog.

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

Hours & Format

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

Additional Details

Subject/Course Level: Chemical & Biomolecular Engineering/Undergraduate

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

Directed Group Studies for Lower Division Undergraduates: Read Less [-]

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: Spring 2020, Fall 2019, Spring 2019
Material and energy balances applied to chemical process systems. Determination of thermodynamic properties needed for such calculations. Sources of data. Calculation procedures.

Introduction to Chemical Process Analysis: Read More [+]

Rules & Requirements

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

Hours & Format

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

Additional Details

Subject/Course Level: Chemical & Biomolecular Engineering/Undergraduate

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

Introduction to Chemical Process Analysis: Read Less [-]
CHM ENG 141 Chemical Engineering Thermodynamics 4 Units
Terms offered: Spring 2020, Fall 2019, Spring 2019

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

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

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

Chemical Engineering Thermodynamics: Read More [+]

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

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

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

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

Chemical Kinetics and Reaction Engineering: Read More [+]

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

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

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

Rules & Requirements
Prerequisites: E7 and CHM ENG 140

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 2020, Fall 2019, Spring 2019
Principles of fluid mechanics and heat transfer with application to chemical processes. Laminar and turbulent flow in pipes and around submerged objects. Flow measurement. Heat conduction and convection; heat transfer coefficients. 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: Spring 2020, Fall 2019, Fall 2018
Principles of mass transfer with application to chemical processes. Diffusion and convection. Simultaneous heat and mass transfer; mass transfer coefficients. Design of staged and continuous separations processes. 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: Spring 2020, Fall 2019, Spring 2019
Experiments in physical measurements, fluid mechanics, heat and mass transfer, kinetics, and separation processes. Emphasis on investigation of basic relationships important in engineering. Experimental design, analysis of results, and preparation of engineering reports are stressed. Chemical Engineering Laboratory: Read More [+]

Rules & Requirements

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

Hours & Format

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

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

Additional Details

Subject/Course Level: Chemical & Biomolecular Engineering/ Undergraduate

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

Chemical Engineering Laboratory: Read Less [-]

CHM ENG 160 Chemical Process Design 4 Units
Terms offered: Spring 2020, Fall 2019, Spring 2019
Design principles of chemical process equipment. Design of integrated chemical processes with emphasis upon economic considerations. Chemical Process Design: Read More [+]

Rules & Requirements

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

Hours & Format

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

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

Additional Details

Subject/Course Level: Chemical & Biomolecular Engineering/ Undergraduate

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

Chemical Process Design: Read Less [-]
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: Spring 2020, Fall 2019, Spring 2019
Analysis of the dynamic behavior of chemical processes and methods and theory of their control. Implementation of computer control systems on process simulations.
Dynamics and Control of Chemical Processes: Read More [+]

Rules & Requirements

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

Hours & Format

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

Additional Details

Subject/Course Level: Chemical & Biomolecular Engineering/Undergraduate

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

Instructor: Clark

Dynamics and Control of Chemical Processes: Read Less [-]

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

Rules & Requirements

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

Hours & Format

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

Additional Details

Subject/Course Level: Chemical & Biomolecular Engineering/Undergraduate

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

Instructor: Clark

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

Biochemical Engineering: Read More [+]

Rules & Requirements

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

Hours & Format

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

Additional Details

Subject/Course Level: Chemical & Biomolecular Engineering/Undergraduate

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

Instructor: Clark

Formerly known as: 170

Biochemical Engineering: Read Less [-]

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

Biochemical Engineering Laboratory: Read More [+]

Rules & Requirements

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

Hours & Format

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

Additional Details

Subject/Course Level: Chemical & Biomolecular Engineering/Undergraduate

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

Also listed as: CHEM C170L

Biochemical Engineering Laboratory: Read Less [-]

CHM ENG 171 Transport Phenomena 3 Units
Terms offered: Fall 2018, Spring 2011, Spring 2009
Study of momentum, energy, and mass transfer in laminar and turbulent flow.

Transport Phenomena: Read More [+]

Rules & Requirements

Prerequisites: 150B

Hours & Format

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

Additional Details

Subject/Course Level: Chemical & Biomolecular Engineering/Undergraduate

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

Transport Phenomena: Read Less [-]

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

Principles of Electrochemical Processes: Read More [+]

Rules & Requirements

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

Hours & Format

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

Additional Details

Subject/Course Level: Chemical & Biomolecular Engineering/Undergraduate

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

Principles of Electrochemical Processes: Read Less [-]
**CHM ENG 178 Polymer Science and Technology 3 Units**


An interdisciplinary course on the synthesis, characterization, and properties of polymer materials. Emphasis on the molecular origin of properties of polymeric materials and technological applications. Topics include single molecule properties, polymer mixtures and solutions, melts, glasses, elastomers, and crystals. Experiments in polymer synthesis, characterization, and physical properties.

Polymer Science and Technology: Read More [+]

**Rules & Requirements**

**Prerequisites:** Junior standing

**Hours & Format**

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

**Additional Details**

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

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

Also listed as: CHEM C178

Polymer Science and Technology: Read Less [-]

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

Terms offered: Fall 2019, Fall 2018, Fall 2017

Chemical processing and properties of solid-state materials. Crystal growth and purification. Thin film technology. Application of chemical processing to the manufacture of semiconductors and solid-state devices.

Process Technology of Solid-State Materials Devices: Read More [+]

**Rules & Requirements**

**Prerequisites:** Engineering 45; one course in electronic circuits recommended; senior standing

**Hours & Format**

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

**Additional Details**

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

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

Process Technology of Solid-State Materials Devices: Read Less [-]

**CHM ENG 180 Chemical Engineering Economics 3 Units**

Terms offered: Fall 2019, Spring 2019, Fall 2017

Optimal design of chemical processes and unit operations, emphasizing the interactions between technical and economic considerations. Analysis of process risks. Chemical and biomolecular process design in the presence of uncertainties. Interest rate determinants and their effects on chemical process feasibility and choices. Relationships between structure and behavior of firms in the chemical processing industries. Multivariable input-output analyses.

Chemical Engineering Economics: Read More [+]

**Rules & Requirements**

**Prerequisites:** Chemical and Biomolecular Engineering 142 and 150B. Consent of instructor

**Hours & Format**

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

**Additional Details**

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

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

Chemical Engineering Economics: Read Less [-]

**CHM ENG 182 Nanoscience and Engineering Biotechnology 3 Units**

Terms offered: Spring 2020, Fall 2018

This nanoscale science and biomolecular engineering course will cover emerging topics in applied biotechnology and nanotechnology. Topics include enzyme kinetics, enzyme inhibition, recombinant protein generation, cell culture, genome editing, drug design, nanoparticle-based gene and drug delivery, fluorescence imaging, and sensors. The course will also probe the interface of biology with nanomaterials, and standard microscopic techniques to image biological structures and nanoscale materials.

Nanoscience and Engineering Biotechnology: Read More [+]

**Rules & Requirements**

**Prerequisites:** Bio 1A or BioE 11 and Physics 7A

**Hours & Format**

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

**Additional Details**

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

**Grading/Final exam status:** Letter grade. Alternate method of final assessment during regularly scheduled final exam group (e.g., presentation, final project, etc.).

Instructor: Landry

Nanoscience and Engineering Biotechnology: Read Less [-]
**CHM ENG 183 Climate Solutions Technologies 3 Units**

Terms offered: Not yet offered

This course for upper division students in science and engineering disciplines covers energy and climate and specific technologies that can be implemented to reduce global warming. Topics include renewable energy (wind and solar), carbon management technologies including Carbon Capture, Utilization and Storage, and Negative Emissions Technologies. The technologies will be described and compared from an upper level chemical engineering perspective that includes fundamental concepts in thermodynamics and separations. We will also cover carbon economics and policies and life-cycle analysis. The course will be framed from a systems-thinking perspective. Throughout the course we will focus on key aspects of communicating climate science.  

Course Objectives: After taking this course, students should be able to discuss and explain to peers the role of CO2 in the earth’s climate, the greenhouse effect, the carbon cycle and how it relates to the fate of greenhouse gases on many time scales, and the role of fossil fuel combustion in the energy landscape and in CO2 emissions.  

Students in this class will gain experience in applying principles of systems thinking, engineering design and analysis to specific technologies that are relevant for mitigating climate change in the immediate future.  

Students will appreciate the critical role that communication plays in the path to implementation of solutions and will be comfortable engaging in a discussion about climate solutions with technical and non-technical peers. Students will gain a basic understanding of economics relative to climate policies, and of climate solutions currently being discussed by policymakers; they will gain an understanding of how these individual solutions fit into a global scheme.  

Students will gain knowledge about the most current technologies available for producing energy renewably, managing carbon, and reducing atmospheric greenhouse gas concentrations.

**Objectives & Outcomes**

**Rules & Requirements**

**Prerequisites:** Chem 1A,B or 4A,B, Phys 7A,B, Math 1A,B

**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. Alternative to final exam.

**Instructor:** Went

**Climate Solutions Technologies:** Read More [+]

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**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.

**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 [-]

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**CHM ENG H194 Research for Advanced Undergraduates 2 - 4 Units**

Terms offered: Spring 2020, Spring 2019, Summer 2016 10 Week Session

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

**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: Spring 2020, Fall 2019, Fall 2018
Lectures and/or tutorial instruction on special topics. Please refer to the Notes section in the Academic Guide for the current course description.
Special Topics: Read More [+]

Rules & Requirements
Prerequisites: Consent of instructor
Repeat rules: Course may be repeated for credit without restriction.

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

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

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

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

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

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

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

Rules & Requirements
Prerequisites: Consent of instructor
Repeat rules: Course may be repeated for credit without restriction.

Hours & Format
Fall and/or spring: 15 weeks - 2-3 hours of independent study per week
Summer: 6 weeks - 5-8 hours of independent study per week 8 weeks - 3.5-6 hours of independent study per week 10 weeks - 3-4.5 hours of independent study per week

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

CHM ENG 197 Field Study in Chemical Engineering 1 - 4 Units
Terms offered: Spring 2020, Spring 2016, Fall 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: Spring 2020, Fall 2019, Spring 2019
Supervised research on a specific topic. Enrollment is restricted; see Introduction to Courses and Curricula section in the General Catalog.

Rules & Requirements

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

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

Hours & Format

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

Summer: 6 weeks - 2.5-7.5 hours of lecture per week

Additional Details

Subject/Course Level: Chemical & Biomolecular Engineering/Undergraduate

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

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 [-]