CHEMICAL AND BIOLOGICAL ENGINEERING - BACHELOR OF SCIENCE (BSCB)

The Department of Chemical and Biological Engineering’s undergraduate programs provide a challenging curriculum that allows students to pursue a variety of career options. Not only do graduates work in a variety of high-tech industries, they are well prepared to pursue careers in medicine, business, or law.

Requirements

Prerequisites and Passing Grades

Unless specified otherwise, the minimum passing grade for a course that is a prerequisite for another required course is C-. If a grade of D+ or lower is received in a course which is a prerequisite to another, the student may not register for the subsequent course until the first grade has been raised to a C- or higher.

Unless specified otherwise, the minimum passing grade for a course that is not specifically a prerequisite for another required course is D-.

Students may be dropped from courses if they do not meet the minimum prerequisite grade requirements. It is the student’s responsibility to communicate with the department if summer coursework and/or transfer credit will be used to meet the prerequisite requirement.

Course Requirements

Required Engineering Courses

A total of 128 credit hours is required.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEN 1300</td>
<td>Introduction to Chemical Engineering (This course is an optional Engineering Technical Elective.)</td>
<td>1</td>
</tr>
<tr>
<td>CHEN 1310</td>
<td>Introduction to Engineering Computing</td>
<td>3</td>
</tr>
<tr>
<td>CHEN 2120</td>
<td>Chemical Engineering Material and Energy Balances</td>
<td>3</td>
</tr>
<tr>
<td>CHEN 2810</td>
<td>Biology for Engineers</td>
<td>3</td>
</tr>
<tr>
<td>or MCDB 1150</td>
<td>Introduction to Cellular and Molecular Biology</td>
<td></td>
</tr>
<tr>
<td>or EBIO 1210 &amp; EBIO 1220</td>
<td>General Biology 1 and General Biology 2</td>
<td></td>
</tr>
<tr>
<td>CHEN 3010</td>
<td>Applied Data Analysis</td>
<td>3</td>
</tr>
<tr>
<td>or STAT 4000 &amp; STAT 4010</td>
<td>Statistical Methods and Applications I and Statistical Methods and Applications II</td>
<td></td>
</tr>
<tr>
<td>CHEN 3200</td>
<td>Chemical Engineering Fluid Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>or MCEN 3021</td>
<td>Fluid Mechanics</td>
<td></td>
</tr>
<tr>
<td>CHEN 3210</td>
<td>Chemical Engineering Heat and Mass Transfer</td>
<td>4</td>
</tr>
<tr>
<td>CHEN 3220</td>
<td>Chemical Engineering Separations</td>
<td>3</td>
</tr>
<tr>
<td>CHEN 3320</td>
<td>Chemical Engineering Thermodynamics</td>
<td>3</td>
</tr>
<tr>
<td>CHEN 4090</td>
<td>Undergraduate Seminar</td>
<td>1</td>
</tr>
<tr>
<td>CHEN 4520</td>
<td>Chemical Process Synthesis</td>
<td>3</td>
</tr>
<tr>
<td>CHEN 4521</td>
<td>Physical Chemistry for Engineers</td>
<td>3</td>
</tr>
<tr>
<td>CHEN 4530</td>
<td>Chemical Engineering Design Project</td>
<td>2</td>
</tr>
<tr>
<td>CHEN 4570</td>
<td>Instrumentation and Process Control</td>
<td>4</td>
</tr>
<tr>
<td>CHEN 4805</td>
<td>Biomaterials</td>
<td>3</td>
</tr>
<tr>
<td>CHEN 4810</td>
<td>Biological Engineering Laboratory</td>
<td>3</td>
</tr>
<tr>
<td>or CHEN 4010 &amp; CHEN 4020</td>
<td>Chemical Engineering Senior Thesis 1 and Chemical Engineering Senior Thesis 2</td>
<td></td>
</tr>
<tr>
<td>CHEN 4820</td>
<td>Biochemical Separations</td>
<td>3</td>
</tr>
<tr>
<td>CHEN 4830</td>
<td>Chemical Engineering Biokinetics</td>
<td>3</td>
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</tbody>
</table>

Focus Technical Electives

Choose one of the following:

- CHEN 4801 | Pharmaceutical Biotechnology                                           |
- CHEN 4802 | Tissue Engineering and Medical Devices                                 |
- CHEN 4803 | Metabolic Engineering                                                  |
- CHEN 4838 | Special Topics in Chemical Engineering (Protein and Enzyme Engineering) |

Required Mathematics Courses

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>APPM 1350</td>
<td>Calculus 1 for Engineers</td>
<td>4</td>
</tr>
<tr>
<td>or MATH 1300</td>
<td>Calculus 1</td>
<td></td>
</tr>
<tr>
<td>APPM 1360</td>
<td>Calculus 2 for Engineers</td>
<td>4</td>
</tr>
<tr>
<td>or MATH 2300</td>
<td>Calculus 2</td>
<td></td>
</tr>
<tr>
<td>APPM 2350</td>
<td>Calculus 3 for Engineers</td>
<td>4</td>
</tr>
<tr>
<td>or MATH 2400</td>
<td>Calculus 3</td>
<td></td>
</tr>
<tr>
<td>APPM 2360</td>
<td>Introduction to Differential Equations with Linear Algebra</td>
<td>4</td>
</tr>
<tr>
<td>or MATH 2130 &amp; MATH 3430</td>
<td>Introduction to Linear Algebra for Non-Mathematics Majors and Ordinary Differential Equations</td>
<td></td>
</tr>
</tbody>
</table>

Required Science Courses

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 1221</td>
<td>Engineering General Chemistry Lab</td>
<td>1</td>
</tr>
<tr>
<td>CHEM 1201</td>
<td>General Chemistry for Engineers</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 1203</td>
<td>General Chemistry for Engineers 2 (If student completes CHEM 1211 instead of CHEM 1201 &amp; CHEM 1203, then student must complete 5 Free Electives.)</td>
<td>2-4</td>
</tr>
<tr>
<td>or CHEM 1133</td>
<td>General Chemistry 2</td>
<td></td>
</tr>
<tr>
<td>BCHM 4611</td>
<td>Principles of Biochemistry</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 3311</td>
<td>Organic Chemistry 1</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 3321</td>
<td>Laboratory in Organic Chemistry 1</td>
<td>1</td>
</tr>
<tr>
<td>CHEM 3331</td>
<td>Organic Chemistry 2</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 3341</td>
<td>Laboratory in Organic Chemistry 2</td>
<td>1</td>
</tr>
<tr>
<td>PHYS 1110</td>
<td>General Physics 1</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 1120</td>
<td>General Physics 2</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 1140</td>
<td>Experimental Physics 1</td>
<td>1</td>
</tr>
</tbody>
</table>

Humanities, Social Sciences and Writing

Complete the College’s Humanities, Social Sciences, and Writing requirements (18 credits total) as specified at on the Engineering Advising (https://www.colorado.edu/engineering-advising/get-your-degree/degree-requirements/humanities-social-sciences-and-writing-requirements/) website.
**Recommended Four-Year Plan of Study**

**Course** | **Title** | **Credit Hours**
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### Year One

**Fall Semester**

- APPM 1350 Calculus 1 for Engineers 4
- CHEN 1201 General Chemistry for Engineers 4
- CHEN 1300 Introduction to Chemical Engineering 1
- CHEN 1310 Introduction to Engineering Computing 3
- Humanities or social science elective 2

**Spring Semester**

- APPM 1360 Calculus 2 for Engineers 4
- CHEM 1221 Engineering General Chemistry Lab 1
- CHEN 1203 General Chemistry for Engineers 2
- CHEN 2810 Biology for Engineers 3
- PHYS 1110 General Physics 1 4
- Humanities or social science elective 2

**Year Two**

**Fall Semester**

- APPM 2350 Calculus 3 for Engineers 4
- CHEM 3311 Organic Chemistry 1 4
- CHEM 3321 Laboratory in Organic Chemistry 1 1
- CHEN 2120 Chemical Engineering Material and Energy Balances 3
- PHYS 1120 General Physics 2 4
- PHYS 1140 Experimental Physics 1 1

**Spring Semester**

- APPM 2360 Introduction to Differential Equations with Linear Algebra 4
- CHEM 3331 Organic Chemistry 2 4
- CHEM 3341 Laboratory in Organic Chemistry 2 1
- CHEN 3200 Chemical Engineering Fluid Mechanics 3
- CHEN 4090 Undergraduate Seminar 1
- CHEN 4521 Physical Chemistry for Engineers 3
- Humanities or social science elective 2

**Year Three**

**Fall Semester**

- CHEN 3010 Applied Data Analysis 3
- CHEN 3210 Chemical Engineering Heat and Mass Transfer 4
- CHEN 3320 Chemical Engineering Thermodynamics 3
- College-approved writing course 4
- Free electives 3

**Spring Semester**

- BCHM 4611 Principles of Biochemistry 3
- CHEN 3220 Chemical Engineering Separations 3
- CHEN 4805 Biomaterials 3
- CHEN 4830 Chemical Engineering Biokinetics 3
- Humanities or social science elective 2

**Year Four**

**Fall Semester**

- CHEN 4520 Chemical Process Synthesis 3
- CHEN 4810 Biological Engineering Laboratory 3
- CHEN 4820 Biochemical Separations 3
- Technical electives 3
- Focus tech elective 5
- Humanities or social science elective 2

**Spring Semester**

- CHEN 4530 Chemical Engineering Design Project 2
- CHEN 4570 Instrumentation and Process Control 4
- Technical elective 3
- Focus tech elective 5
- Humanities or social science elective 2

**Total Credit Hours** 128

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1 (CHEN 1300-1) Introduction to Chemical Engineering is an optional Engineering Technical Elective.

2 Students may choose courses from the list of college-approved humanities and social sciences (HSS) electives (https://www.colorado.edu/engineering-advising/get-your-degree/degree-requirements/humanities-social-sciences-and-writing-requirements/).

3 Electives must meet specific requirements. Visit the department’s Current Students (http://www.colorado.edu/chbe/academics/undergraduate-program/current-students/) webpage and consult the current advising guide.

4 Students may choose a course from the list of college-approved writing courses (https://www.colorado.edu/engineering-advising/get-your-degree/degree-requirements/humanities-social-sciences-and-writing-requirements/).
One of the following courses must be taken as the focus technical elective: Pharmaceutical Biotechnology (CHEN 4801, 3), or Tissue Engineering and Medical Devices (CHEN 4802, 3), or Metabolic Engineering (CHEN 4803, 3). These courses will be taught in alternating years and should be taken in the junior or senior year as available.

**Learning Outcomes**

**Program Educational Objectives**

The department prepares graduates to make significant contributions in many diverse areas. Specifically, within a few years of graduation our graduates will have achieved one or more of the following attributes:

- In their chosen field, be established in a professional career, be pursuing an advanced degree or be seeking advanced certification.
- Be recognized as academic, industrial or entrepreneurial leaders.
- Be successfully working and communicating in a variety of technical fields.
- Be adapting to new technologies and changing professional environments.

**Student Outcomes**

Upon graduation, students are expected to be able to:

- Identify, formulate and solve complex engineering problems by applying principles of engineering, science and mathematics.
- 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.
- Communicate effectively with a range of audiences.
- Recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental and societal contexts.
- Function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks and meet objectives.
- Develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
- Acquire and apply new knowledge as needed, using appropriate learning strategies.

**Bachelor's–Accelerated Master's Degree Program(s)**

The Bachelor's–Accelerated Master's (BAM) degree program options offer currently enrolled CU Boulder undergraduate students the opportunity to receive a bachelor's and master's degree in a shorter period of time. Students receive the bachelor's degree first, but begin taking graduate coursework as undergraduates (typically in their senior year). Because some courses are allowed to double count for both the bachelor's and the master's degrees, students receive a master's degree in less time and at a lower cost than if they were to enroll in a stand-alone master's degree program after completion of their baccalaureate degree.

In addition, staying at CU Boulder to pursue a bachelor's–accelerated master's program enables students to continue working with their established faculty mentors.

**BS in Chemical and Biological Engineering, MS in Chemical Engineering**

**Admissions Requirements**

In order to gain admission to the BAM program named above, a student must meet the following criteria:

- Have a cumulative GPA of 3.250 or higher.
- Have a minimum GPA of 3.0 in CHEN coursework.
- Have completed CHEN 2120, CHEN 3200, CHEN 3210, CHEN 3320 and CHEN 3010 prerequisite courses with grades of B- in each course.
- Have at least junior class standing.
- Complete MAPS requirements.
- Provide a one-page statement of purpose. The statement should describes briefly your past work in the field, including noncourse educational experiences, teaching, or other relevant employment, publication, theses, research in progress, other scholarly activities, and your plans for graduate study and a professional career.
- GRE.
- Provide an unofficial transcript.

**Program Requirements**

Students may take up to and including 12 credit hours while in the undergraduate program which can later be used toward the master's degree. However, only six credit hours may be double counted toward the bachelor's degree and the master's degree. Students must apply to graduate with the bachelor's degree, and apply to continue with the master's degree, early in the semester in which the undergraduate requirements will be completed.

Please see the BAM degree program (https://www.colorado.edu/chbe/undergraduate-program/undergraduate-opportunities/) web page for more information.