CHEMICAL AND BIOLOGICAL ENGINEERING - BACHELOR OF SCIENCE (BSCB)

Vaccine, therapeutic and antimicrobials development. Tissue engineering directing tissue growth for regenerating cartilage and cardiac muscle using stem cells. Quantum dots for imaging and therapeutics. Genome-engineering for gene therapy and pharmaceutical applications. Nanomaterials for labs-on-a-chip diagnostics. Polymers for drug delivery and in vivo imaging (e.g., detecting cancer).

Chemical and biological engineers at CU Boulder learn the skills necessary to work on these cutting-edge technologies and more. Learn from world-class faculty leveraging innovative, award-winning education practices and hands-on lab experiences. Join the ranks of engineers making an impact in these life-saving fields!

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 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>
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<tr>
<td>or MCDB 1150</td>
<td>Introduction to Cellular and Molecular Biology</td>
<td>3</td>
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<tr>
<td>or EBIO 1220</td>
<td>General Biology 2</td>
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<tr>
<td>CHEN 3010</td>
<td>Applied Data Analysis</td>
<td>3</td>
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<tr>
<td>or STAT 4010</td>
<td>Statistical Methods and Applications II</td>
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<tr>
<td>CHEN 3200</td>
<td>Chemical Engineering Fluid Mechanics</td>
<td>3</td>
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<tr>
<td>or MCEN 3021</td>
<td>Fluid Mechanics</td>
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<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>
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<tr>
<td>CHEN 4090</td>
<td>Undergraduate Seminar</td>
<td>1</td>
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<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>
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<tr>
<td>CHEN 4570</td>
<td>Instrumentation and Process Control</td>
<td>4</td>
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<tr>
<td>CHEN 4805</td>
<td>Biomaterials</td>
<td>3</td>
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<tr>
<td>CHEN 4810</td>
<td>Biological Engineering Laboratory</td>
<td>3</td>
</tr>
<tr>
<td>or CHEN 4010</td>
<td>Chemical Engineering Senior Thesis 1</td>
<td></td>
</tr>
<tr>
<td>&amp; CHEN 4020</td>
<td>Chemical Engineering Senior Thesis 2</td>
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<tr>
<td>CHEN 4820</td>
<td>Biochemical Separations</td>
<td>3</td>
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<tr>
<td>CHEN 4830</td>
<td>Chemical Engineering Biokinetics</td>
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<tr>
<td>CHEN 4831</td>
<td>Chemical Engineering Biokinetics</td>
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</table>

Focus Technical Electives 3

Choose one of the following:

- CHEN 4801 Pharmaceutical Biotechnology
- CHEN 4802 Tissue Engineering and Medical Devices
- CHEN 4803 Metabolic Engineering
- CHEN 4804 Protein and Enzyme Engineering
- CHEN 4838 Special Topics in Chemical Engineering (Immunoengineering)

Required Mathematics Courses

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
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<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>or APPM 1345</td>
<td>Calculus 1 with Algebra, Part B</td>
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<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>
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<tr>
<td>APPM 2360</td>
<td>Introduction to Differential Equations with Linear Algebra</td>
<td>4</td>
</tr>
<tr>
<td>or MATH 2130</td>
<td>Introduction to Linear Algebra</td>
<td></td>
</tr>
<tr>
<td>&amp; MATH 3430</td>
<td>Introduction to Non-Mathematics Majors and Ordinary Differential Equations</td>
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</table>

Required Science Courses

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
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<tbody>
<tr>
<td>CHEM 1221</td>
<td>Engineering General Chemistry Lab Laboratory in General Chemistry</td>
<td>1</td>
</tr>
<tr>
<td>or CHEM 1134</td>
<td>Engineering General Chemistry 2</td>
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<tr>
<td>CHEN 1201</td>
<td>General Chemistry for Engineers 1 (If a student completes CHEN 1211 instead of CHEN 1201 &amp; CHEN 1203)</td>
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<tr>
<td>or CHEM 1211</td>
<td>General Chemistry for Engineers 2 (If a student completes CHEN 1211 instead of CHEN 1201 &amp; CHEN 1203)</td>
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<tr>
<td>CHEN 1203</td>
<td>General Chemistry for Engineers 2 (If a student completes CHEN 1211 instead of CHEN 1201 &amp; CHEN 1203)</td>
<td>2</td>
</tr>
<tr>
<td>or CHEM 1131</td>
<td>General Chemistry 2</td>
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</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>
</tbody>
</table>
CHEM 3321 Laboratory in Organic Chemistry 1 1
CHEM 3331 Organic Chemistry 2 4
CHEM 3341 Laboratory in Organic Chemistry 2 1
PHYS 1110 General Physics 1 4
or PHYS 1115 General Physics 1 for Majors
PHYS 1120 General Physics 2 4
or PHYS 1125 General Physics 2 for Majors
PHYS 1140 Experimental Physics 1 1

Humanities, Social Sciences and Writing
Complete the College’s Humanities, Social Sciences, and Writing requirements (https://www.colorado.edu/engineering-advising/get-your-degree/degree-requirements/humanities-social-sciences-and-writing-requirements/) (18 credits total).

Technical Electives
General Technical and Engineering Technical Electives must meet specific requirements (9 credits total). Visit the department’s Current Students (http://www.colorado.edu/chbe/academics/undergraduate-program/current-students/) webpage and consult the current advising guide.

Free Electives
3 credits of Free Electives allowed.

Modified Pathways

Premed Path
This path is offered for students preparing for medical school. Since chemical & biological engineering already requires most of the premed courses, it is a logical choice for students who desire an engineering degree and the opportunity to pursue a medical profession. For information on the premed path, visit the department’s current students (http://www.colorado.edu/chbe/academics/undergraduate-program/current-students/) webpage and consult the current advising guide.

Recommended Four-Year Plan of Study

Year One
Fall Semester
APPM 1350 Calculus 1 for Engineers 4
CHEN 1201 General Chemistry for Engineers 1 4
CHEN 1300 Introduction to Chemical Engineering (Optional 1-Credit Technical Elective) 1
CHEN 1310 Introduction to Engineering Computing 3
Humanities or Social Science Elective 2 3
Credit Hours 14
Spring Semester
APPM 1360 Calculus 2 for Engineers 4
CHEM 1221 Engineering General Chemistry Lab 1
CHEN 1203 General Chemistry for Engineers 2 2
CHEN 2810 Biology for Engineers 3
PHYS 1110 General Physics 1 4
Humanities or Social Science Elective 2 3
Credit Hours 17

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
Credit Hours 17
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
Credit Hours 16

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 2 3
Free Electives 3 3
Credit Hours 16
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 6
Credit Hours 18

Year Four
Fall Semester
CHEN 4520 Chemical Process Synthesis 3
CHEN 4810 Biological Engineering Laboratory 3
CHEN 4820 Biochemical Separations 3
Technical Electives 1, 3 6
Credit Hours 15
Spring Semester
CHEN 4530 Chemical Engineering Design Project 2
CHEN 4570 Instrumentation and Process Control 4
Technical Elective 1, 3 3
Focus Technical Elective 5 3
Humanities or Social Science Elective 2 3
Credit Hours 15
Total Credit Hours 128
Upon graduation, students are expected to be able to:

**Student 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.

**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:

- 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 3.000 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.
- Completion of all MAPS requirements and no deficiencies remaining.
- Provide a one-page statement of purpose. The statement should describe briefly your past work in the field, including non-course 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.

**BS in Chemical and Biological Engineering, Professional MS in Materials Science**

**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 3.25 or higher.
- Completion of all MAPS requirements.

1 CHEN 1300-1 Introduction to Chemical Engineering is an optional Engineering Technical Elective. If it is taken, one of the Technical Elective courses in this Plan of Study will only require 2 credits (instead of 3 credits).
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 General Technical Electives, Engineering Technical Electives, and Free 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/).
5 At least one of the following courses must be taken as the Focus Technical Elective: Pharmaceutical Biotechnology (CHEN 4801, 3), Tissue Engineering and Medical Devices (CHEN 4802, 3), Metabolic Engineering (CHEN 4803, 3), Protein and Enzyme Engineering (CHEN 4804, 3), or Immunoengineering (CHEN 4838, 3). These courses will be taught in alternating years and should be taken in the junior or senior year as available.
• Completion of the following five CHEN core courses with a minimum grade of B- in each course: CHEN 2120, CHEN 3200, CHEN 3210, CHEN 3320 and CHEN 3010.
• Be enrolled in CHEN 4805.
• Provide an unofficial transcript.

Students with a GPA below 3.25 (but above 3.0, the university minimum standard) may submit a petition with a letter of recommendation from a professor and a one-page statement of purpose. The statement should briefly describe the student’s past work in the field, including any non-course educational experiences or other relevant employment, and the student’s plans for graduate study and a professional career.

Program Requirements
Students must declare a track in which to specialize. Students may take up to and including 12 hours while in the undergraduate program that satisfy the specialized track courses and/or the breadth elective courses, 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.