Chemical Engineering (BS): Sustainable Engineering, Energy, and the Environment

To see more about what you will learn in this program, visit the Learning Outcomes website (https://apps.oirp.ncsu.edu/pgas/).

The Sustainable Engineering, Energy, and Environment Concentration connects chemical engineering concepts with global grand challenges in the generation of clean and affordable energy, as well as sustainable and environmentally responsible engineering practices.

Plan Requirements

Chemical Engineering (BS): Sustainable Engineering, Energy, and the Environment: 125 Total Units

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First Year</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Fall Semester</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 101</td>
<td>Chemistry - A Molecular Science (^1)</td>
<td>3</td>
</tr>
<tr>
<td>or CH 103</td>
<td>or General Chemistry I for Students in Chemical Sciences</td>
<td></td>
</tr>
<tr>
<td>CH 102</td>
<td>General Chemistry Laboratory (^1)</td>
<td>1</td>
</tr>
<tr>
<td>or CH 104</td>
<td>or General Chemistry Laboratory I for Students in Chemical Sciences</td>
<td></td>
</tr>
<tr>
<td>E 101</td>
<td>Introduction to Engineering &amp; Problem Solving (^2)</td>
<td>1</td>
</tr>
<tr>
<td>E 115</td>
<td>Introduction to Computing Environments</td>
<td>1</td>
</tr>
<tr>
<td>MA 141</td>
<td>Calculus I (^1)</td>
<td>4</td>
</tr>
<tr>
<td>ENG 101</td>
<td>Academic Writing and Research (^2)</td>
<td>4</td>
</tr>
<tr>
<td><strong>Hours</strong></td>
<td></td>
<td>14</td>
</tr>
<tr>
<td><strong>Spring Semester</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 201</td>
<td>Chemistry - A Quantitative Science (^2)</td>
<td>3</td>
</tr>
<tr>
<td>or CH 203</td>
<td>or General Chemistry II for Students in Chemical Sciences</td>
<td></td>
</tr>
<tr>
<td>CH 202</td>
<td>Quantitative Chemistry Laboratory (^2)</td>
<td>1</td>
</tr>
<tr>
<td>or CH 204</td>
<td>or General Chemistry Laboratory II for Students in Chemical Sciences</td>
<td></td>
</tr>
<tr>
<td>MA 241</td>
<td>Calculus II (^1)</td>
<td>4</td>
</tr>
<tr>
<td>PY 205</td>
<td>Physics for Engineers and Scientists I</td>
<td>4</td>
</tr>
<tr>
<td>&amp; PY 206</td>
<td>and Physics for Engineers and Scientists I Laboratory (^1)</td>
<td></td>
</tr>
<tr>
<td>Select one of the following:</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>ARE 201</td>
<td>Introduction to Agricultural &amp; Resource Economics</td>
<td></td>
</tr>
<tr>
<td>ARE 201A</td>
<td>Introduction to Agricultural &amp; Resource Economics</td>
<td></td>
</tr>
<tr>
<td>EC 201</td>
<td>Principles of Microeconomics</td>
<td></td>
</tr>
<tr>
<td>EC 205</td>
<td>Fundamentals of Economics</td>
<td></td>
</tr>
<tr>
<td>E 102</td>
<td>Engineering in the 21st Century</td>
<td>2</td>
</tr>
<tr>
<td><strong>Hours</strong></td>
<td></td>
<td>17</td>
</tr>
<tr>
<td><strong>Second Year</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Fall Semester</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 221</td>
<td>Organic Chemistry I (^2)</td>
<td>3</td>
</tr>
<tr>
<td>or CH 225</td>
<td>or Organic Chemistry I for Students in Chemical Sciences</td>
<td></td>
</tr>
<tr>
<td>CH 222</td>
<td>Organic Chemistry Lab (^2)</td>
<td>1</td>
</tr>
<tr>
<td>or CH 226</td>
<td>or Organic Chemistry Laboratory I for Students in Chemical Sciences</td>
<td></td>
</tr>
<tr>
<td>CHE 205</td>
<td>Chemical Process Principles (^2)</td>
<td>4</td>
</tr>
<tr>
<td>MA 242</td>
<td>Calculus III (^2)</td>
<td>4</td>
</tr>
<tr>
<td><strong>Hours</strong></td>
<td></td>
<td>12</td>
</tr>
<tr>
<td><strong>Spring Semester</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH 223</td>
<td>Organic Chemistry II</td>
<td>3</td>
</tr>
<tr>
<td>or CH 227</td>
<td>or Organic Chemistry II for Students in Chemical Sciences</td>
<td></td>
</tr>
<tr>
<td>CH 224</td>
<td>Organic Chemistry II Lab</td>
<td>1</td>
</tr>
<tr>
<td>or CH 228</td>
<td>or Organic Chemistry Laboratory II for Students in Chemical Sciences</td>
<td></td>
</tr>
<tr>
<td>CHE 225</td>
<td>Introduction to Chemical Engineering Analysis (^2)</td>
<td>3</td>
</tr>
<tr>
<td>MA 341</td>
<td>Applied Differential Equations (^2)</td>
<td>3</td>
</tr>
<tr>
<td>PY 208</td>
<td>Physics for Engineers and Scientists II</td>
<td>4</td>
</tr>
<tr>
<td>&amp; PY 209</td>
<td>and Physics for Engineers and Scientists II Laboratory</td>
<td></td>
</tr>
<tr>
<td><strong>Third Year</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Fall Semester</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PSE 335</td>
<td>Principles of Green Chemistry</td>
<td>4</td>
</tr>
<tr>
<td>CHE 311</td>
<td>Transport Processes (^2)</td>
<td>3</td>
</tr>
<tr>
<td>CHE 315</td>
<td>Chemical Process Thermodynamics (^2)</td>
<td>3</td>
</tr>
<tr>
<td>CHE 497</td>
<td>Chemical Engineering Projects I</td>
<td>3</td>
</tr>
<tr>
<td><strong>Hours</strong></td>
<td></td>
<td>13</td>
</tr>
<tr>
<td><strong>Spring Semester</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Select one of the following Chemistry Electives:</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>PCC 464</td>
<td>Chemistry of Polymeric Materials Laboratory</td>
<td></td>
</tr>
<tr>
<td>&amp; PCC 461</td>
<td>and Chemistry of Polymeric Materials</td>
<td></td>
</tr>
<tr>
<td>BCH 451</td>
<td>Principles of Biochemistry</td>
<td></td>
</tr>
<tr>
<td>CH 437</td>
<td>Physical Chemistry for Engineers</td>
<td></td>
</tr>
<tr>
<td>CH 610</td>
<td>Special Topics In Chemistry</td>
<td></td>
</tr>
<tr>
<td>BIO 183</td>
<td>Introductory Biology: Cellular and Molecular Biology</td>
<td></td>
</tr>
<tr>
<td>FS 402</td>
<td>Chemistry of Food and Bioprocessed Materials</td>
<td></td>
</tr>
<tr>
<td>CHE 312</td>
<td>Transport Processes II</td>
<td>3</td>
</tr>
<tr>
<td>CHE 316</td>
<td>Thermodynamics of Chemical and Phase Equilibria</td>
<td>3</td>
</tr>
<tr>
<td>CHE 330</td>
<td>Chemical Engineering Lab I</td>
<td>4</td>
</tr>
<tr>
<td><strong>Fourth Year</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Fall Semester</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHE 331</td>
<td>Chemical Engineering Lab II</td>
<td>2</td>
</tr>
<tr>
<td>CHE 446</td>
<td>Design and Analysis of Chemical Reactors</td>
<td>3</td>
</tr>
<tr>
<td>CHE 450</td>
<td>Chemical Engineering Design I</td>
<td>3</td>
</tr>
</tbody>
</table>
Concentration Elective (p. 2)  3
CHE 395  Professional Development Seminar  1

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHE 435</td>
<td>Process Systems Analysis and Control</td>
<td>3</td>
</tr>
<tr>
<td>CHE 451</td>
<td>Chemical Engineering Design II</td>
<td>3</td>
</tr>
<tr>
<td>Concentration Elective (p. 2)</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

Total Hours  12

1  A grade of C or higher is required.
2  A grade of C- or higher is required.

Semester Sequence

This is a sample.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHE 101</td>
<td>Chemistry - A Molecular Science</td>
<td>1,2 3</td>
</tr>
<tr>
<td>CHE 102</td>
<td>General Chemistry Laboratory</td>
<td>1,2 1</td>
</tr>
<tr>
<td>E 101</td>
<td>Introduction to Engineering &amp; Problem Solving</td>
<td>1</td>
</tr>
<tr>
<td>E 115</td>
<td>Introduction to Computing Environments</td>
<td>1</td>
</tr>
<tr>
<td>ENG 101</td>
<td>Academic Writing and Research</td>
<td>3 4</td>
</tr>
<tr>
<td>MA 141</td>
<td>Calculus I</td>
<td>1 4</td>
</tr>
<tr>
<td>GEP Health and Exercise Studies (<a href="http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-health-exercise-studies/">http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-health-exercise-studies/</a>)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH 201</td>
<td>Chemistry - A Quantitative Science</td>
<td>2,3 3</td>
</tr>
<tr>
<td>CH 202</td>
<td>Quantitative Chemistry Laboratory</td>
<td>2 1</td>
</tr>
<tr>
<td>MA 241</td>
<td>Calculus II</td>
<td>1 4</td>
</tr>
<tr>
<td>PY 205</td>
<td>Physics for Engineers and Scientists I</td>
<td>1 3</td>
</tr>
<tr>
<td>PY 206</td>
<td>Physics for Engineers and Scientists I Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>Select one of the following:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EC 205</td>
<td>Fundamentals of Economics</td>
<td></td>
</tr>
<tr>
<td>EC 201</td>
<td>Principles of Microeconomics</td>
<td></td>
</tr>
<tr>
<td>ARE 201</td>
<td>Introduction to Agricultural &amp; Resource Economics</td>
<td></td>
</tr>
<tr>
<td>GEP Health and Exercise Studies (<a href="http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-health-exercise-studies/">http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-health-exercise-studies/</a>)</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>E 102</td>
<td>Engineering in the 21st Century</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHE 221</td>
<td>Organic Chemistry I</td>
<td>4 3</td>
</tr>
<tr>
<td>CHE 222</td>
<td>Organic Chemistry I Lab</td>
<td>4 1</td>
</tr>
<tr>
<td>CHE 205</td>
<td>Chemical Process Principles</td>
<td>3 4</td>
</tr>
<tr>
<td>MA 242</td>
<td>Calculus III</td>
<td>3 4</td>
</tr>
<tr>
<td>GEP Requirement (<a href="http://catalog.ncsu.edu/undergraduate/gep-category-requirements/">http://catalog.ncsu.edu/undergraduate/gep-category-requirements/</a>)</td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHE 223</td>
<td>Organic Chemistry II</td>
<td>3,4 3</td>
</tr>
<tr>
<td>CHE 224</td>
<td>Organic Chemistry II Lab</td>
<td>4 1</td>
</tr>
<tr>
<td>CHE 225</td>
<td>Introduction to Chemical Engineering Analysis</td>
<td>3</td>
</tr>
<tr>
<td>MA 341</td>
<td>Applied Differential Equations I</td>
<td>3</td>
</tr>
<tr>
<td>PY 208</td>
<td>Physics for Engineers and Scientists II</td>
<td>3</td>
</tr>
<tr>
<td>PY 209</td>
<td>Physics for Engineers and Scientists II Laboratory</td>
<td>1</td>
</tr>
</tbody>
</table>

Concentration Electives

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAE 528</td>
<td>Biomass to Renewable Energy Processes</td>
<td>3</td>
</tr>
<tr>
<td>CE 373</td>
<td>Fundamentals of Environmental Engineering</td>
<td>3</td>
</tr>
<tr>
<td>CE 476</td>
<td>Air Pollution Control</td>
<td>3</td>
</tr>
<tr>
<td>CE 477</td>
<td>Principles of Solid Waste Engineering</td>
<td>3</td>
</tr>
<tr>
<td>CE 478</td>
<td>Energy and Climate</td>
<td>3</td>
</tr>
<tr>
<td>CE 484</td>
<td>Water Supply and Waste Water Systems</td>
<td>3</td>
</tr>
<tr>
<td>CE 578</td>
<td>Energy and Climate</td>
<td>3</td>
</tr>
<tr>
<td>FB 576</td>
<td>Environmental Life Cycle Analysis</td>
<td>3</td>
</tr>
<tr>
<td>PSE 425</td>
<td>Bioenergy &amp; Biomaterials Engineering</td>
<td>3</td>
</tr>
<tr>
<td>PSE 476</td>
<td>Environmental Life Cycle Analysis</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHE 395</td>
<td>Professional Development Seminar</td>
<td>1</td>
</tr>
</tbody>
</table>
GEP Requirement (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/)  

<table>
<thead>
<tr>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
</tr>
</tbody>
</table>

**Third Year**

**Fall Semester**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSE 335</td>
<td>Principles of Green Chemistry</td>
<td>4</td>
</tr>
<tr>
<td>CHE 311</td>
<td>Transport Processes I ³</td>
<td>3</td>
</tr>
<tr>
<td>CHE 315</td>
<td>Chemical Process Thermodynamics ³</td>
<td>3</td>
</tr>
<tr>
<td>CHE 497</td>
<td>Chemical Engineering Projects I</td>
<td>3</td>
</tr>
<tr>
<td>Free Elective</td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
</tr>
</tbody>
</table>

**Spring Semester**

Select one of the following Chemistry Electives:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCC 461 &amp; PCC 464</td>
<td>Chemistry of Polymeric Materials and Chemistry of Polymeric Materials Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>BCH 451</td>
<td>Principles of Biochemistry</td>
<td></td>
</tr>
<tr>
<td>CH 437</td>
<td>Physical Chemistry for Engineers</td>
<td></td>
</tr>
<tr>
<td>BIO 183</td>
<td>Introductory Biology: Cellular and Molecular Biology</td>
<td></td>
</tr>
<tr>
<td>FS 402</td>
<td>Chemistry of Food and Bioprocessed Materials</td>
<td></td>
</tr>
<tr>
<td>CHE 312</td>
<td>Transport Processes II</td>
<td>3</td>
</tr>
<tr>
<td>CHE 316</td>
<td>Thermodynamics of Chemical and Phase Equilibria</td>
<td>3</td>
</tr>
<tr>
<td>CHE 330</td>
<td>Chemical Engineering Lab I</td>
<td>4</td>
</tr>
<tr>
<td>GEP Requirement (<a href="http://catalog.ncsu.edu/undergraduate/gep-category-requirements/">http://catalog.ncsu.edu/undergraduate/gep-category-requirements/</a>)</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
</tr>
</tbody>
</table>

**Fourth Year**

**Fall Semester**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHE 331</td>
<td>Chemical Engineering Lab II</td>
<td>2</td>
</tr>
<tr>
<td>CHE 446</td>
<td>Design and Analysis of Chemical Reactors</td>
<td>3</td>
</tr>
<tr>
<td>CHE 450</td>
<td>Chemical Engineering Design I</td>
<td>3</td>
</tr>
<tr>
<td>Concentration Elective</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>GEP Requirement (<a href="http://catalog.ncsu.edu/undergraduate/gep-category-requirements/">http://catalog.ncsu.edu/undergraduate/gep-category-requirements/</a>)</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>CHE 395</td>
<td>Professional Development Seminar</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
</tr>
</tbody>
</table>

**Spring Semester**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHE 435</td>
<td>Process Systems Analysis and Control</td>
<td>3</td>
</tr>
<tr>
<td>CHE 451</td>
<td>Chemical Engineering Design II</td>
<td>3</td>
</tr>
<tr>
<td>Concentration Elective</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>GEP Requirement (<a href="http://catalog.ncsu.edu/undergraduate/gep-category-requirements/">http://catalog.ncsu.edu/undergraduate/gep-category-requirements/</a>)</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
</tr>
</tbody>
</table>

**Total Hours**

<table>
<thead>
<tr>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>125</td>
</tr>
</tbody>
</table>

1. Grade of C (2.0) or higher required.
2. CH 103 General Chemistry I for Students in Chemical Sciences/CH 104 General Chemistry Laboratory I for Students in Chemical Sciences may substitute for CH 101 Chemistry - A Molecular Science/CH 102 General Chemistry Laboratory, and CH 203 General Chemistry II for Students in Chemical Sciences/CH 204 General Chemistry Laboratory II for Students in Chemical Sciences may substitute for CH 201 Chemistry - A Quantitative Science/CH 202 Quantitative Chemistry Laboratory.
3. Minimum grade of (C-) required.
4. CH 225 Organic Chemistry I for Students in Chemical Sciences/CH 226 Organic Chemistry Laboratory I for Students in Chemical Sciences may substitute for CH 221 Organic Chemistry I/CH 222 Organic Chemistry I Lab and CH 227 Organic Chemistry II for Students in Chemical Sciences/CH 228 Organic Chemistry Laboratory II for Students in Chemical Sciences may substitute for CH 223 Organic Chemistry II/CH 224 Organic Chemistry II Lab.

**Career Opportunities**

Careers in chemical engineering are sometimes exciting, always demanding, and ultimately provide a sense of accomplishment and achievement. Graduates find employment in sub-disciplines such as production, technical service, sales, management and administration; research and development; and consulting and teaching. Students desiring careers in teaching, research, or consulting are encouraged to continue their education and pursue a graduate degree (consult the Graduate Catalog). The undergraduate curriculum also provides strong preparation for graduate study in a wide range of professional specialties, and chemical engineering graduates often pursue careers in the medical sciences, business management, and law.