Chemical engineering is the study and practice of transforming substances on a large scale to produce products or energy for the improvement of society. Such processes are the fundamental core of the chemical, petroleum, pharmaceutical, and electronics industries. Chemical Engineers work in a variety of segments within these industries, including processing, manufacturing, research and development, management, environmental compliance, and business. Chemical Engineering differs from Chemistry in that Chemical Engineers produce products on a large scale, so that they are affordable and available to as many consumers as possible. In this way, Chemical Engineering emphasizes fundamentals required to design, optimize, and operate chemical processes as safely and efficiently as possible.

For the Degree of Bachelor of Science in Chemical Engineering

Major in Specialized Curriculum in Chemical Engineering

The first two years of the Chemical Engineering curriculum provide a strong foundation in basic sciences through Physics, Mathematics, Chemistry, an introduction to what Chemical Engineers do, and the fundamental basis of Chemical Engineering (Mass and Energy Balances and Thermodynamics.) In the third year, students delve deeper into more specialized Chemistry courses such as Physical and Analytical Chemistry, while exploring fundamental Chemical Engineering courses such as Momentum Transfer, Separations, and Reactor Design. The Senior year incorporates all of this learning through high level technical electives, Process Control, Capstone Lab, and Capstone Design courses. It is through the lab and design class that students apply everything they have learned in previous Chemical Engineering courses to real-world team projects and presentations.

The Chemical Engineering specialized curriculum provides two concentrations: Chemical Engineering and Biomolecular Engineering. Each concentration is based on a strong fundamental understanding of Chemical Engineering, however the Biomolecular concentration’s technical electives focus more on bio-applied processing and technology.

Areas of Concentration

- Chemical Engineering: The chemical engineering concentration is designed to prepare students for careers in the energy, chemical, food, energy, pharmaceutical, semiconductor processing, personal care, fiber and materials industries.
- Biomolecular Engineering: The Biomolecular Engineering concentration builds upon the traditional principles of chemical engineering, but specializes in biological and biotechnological systems in order to better prepare students who are interested in or seek employment in the food, pharmaceutical, and biotechnology industries.

Overview of Curricular Requirements

The curriculum requires 129 hours for graduation and is organized as shown below.

A grade point average of 2.5 or higher in all courses required for the major earned on the UIUC campus is required in order to be accepted by the department as juniors and seniors.

Orientation and Professional Development

These courses introduce opportunities and resources the college, department, and curriculum offers students. They also provide background on the Chemical Engineering curriculum, what chemical engineers do, and the skills to work effectively and successfully in the engineering profession.

### Foundational Mathematics and Science

These courses stress the basic mathematical and scientific principles upon which the engineering discipline is based.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHBE 121</td>
<td>CHBE Profession ¹</td>
<td>1</td>
</tr>
<tr>
<td>ENG 100</td>
<td>Engineering Orientation ¹</td>
<td>0</td>
</tr>
<tr>
<td>Total Hours</td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

¹ For students entering the curriculum after the freshman year, 1 additional hour of credit from the list of approved engineering technical electives may be substituted in place of CHBE 121.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 202</td>
<td>Accelerated Chemistry I ¹</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 203</td>
<td>Accelerated Chemistry Lab I</td>
<td>2</td>
</tr>
<tr>
<td>CHEM 204</td>
<td>Accelerated Chemistry II</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 205</td>
<td>Accelerated Chemistry Lab II</td>
<td>2</td>
</tr>
<tr>
<td>MATH 221</td>
<td>Calculus I ²</td>
<td>4</td>
</tr>
<tr>
<td>MATH 231</td>
<td>Calculus II</td>
<td>3</td>
</tr>
<tr>
<td>MATH 241</td>
<td>Calculus III</td>
<td>4</td>
</tr>
<tr>
<td>MATH 285</td>
<td>Intro Differential Equations ³</td>
<td>3</td>
</tr>
<tr>
<td>MATH 415</td>
<td>Applied Linear Algebra</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 211</td>
<td>University Physics: Mechanics</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 212</td>
<td>University Physics: Elec &amp; Mag</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 214</td>
<td>Univ Physics: Quantum Physics</td>
<td>2</td>
</tr>
<tr>
<td>Total Hours</td>
<td></td>
<td>37</td>
</tr>
</tbody>
</table>

¹ Students who do not place into CHEM 202, or who do not satisfy the mathematics prerequisite for CHEM 202, may substitute the sequence CHEM 102, CHEM 103, CHEM 104, CHEM 222, and CHEM 223 for CHEM 202, CHEM 203, CHEM 204, and CHEM 205.  
² MATH 220 may be substituted, with four of the five credit hours applying toward the degree. MATH 220 is appropriate for students with no background in calculus.  
³ MATH 441 may be substituted for MATH 285. MATH 286 (4 hours) may be substituted for MATH 285 (3 hours).

Chemical and Biomolecular Engineering Technical Core

These courses stress fundamental concepts and basic laboratory techniques that comprise the common intellectual understanding of chemical engineering and chemical science.
For Both Concentrations

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHBE 221</td>
<td>Principles of CHE</td>
<td>3</td>
</tr>
<tr>
<td>CHBE 321</td>
<td>Thermodynamics</td>
<td>4</td>
</tr>
<tr>
<td>CHBE 421</td>
<td>Momentum and Heat Transfer</td>
<td>4</td>
</tr>
<tr>
<td>CHBE 422</td>
<td>Mass Transfer Operations</td>
<td>4</td>
</tr>
<tr>
<td>CHBE 424</td>
<td>Chemical Reaction Engineering</td>
<td>3</td>
</tr>
<tr>
<td>CHBE 430</td>
<td>Unit Operations Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>CHBE 431</td>
<td>Process Design</td>
<td>4</td>
</tr>
<tr>
<td>CHBE 440</td>
<td>Process Control and Dynamics</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 236</td>
<td>Fundamental Organic Chem I</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 237</td>
<td>Structure and Synthesis</td>
<td>2</td>
</tr>
<tr>
<td>CHEM 315</td>
<td>Instrumental Chem Systems Lab</td>
<td>2</td>
</tr>
<tr>
<td>CHEM 420</td>
<td>Instrumental Characterization</td>
<td>2</td>
</tr>
<tr>
<td>CHEM 442</td>
<td>Physical Chemistry I</td>
<td>4</td>
</tr>
<tr>
<td>CS 101</td>
<td>Intro Computing: Engrg &amp; Sci</td>
<td>3</td>
</tr>
<tr>
<td>IE 300</td>
<td>Analysis of Data</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Hours: 49

1 Students must register in one of the Chemical Engineering-specific CHEM 315 lab sections.

For the Concentration in Chemical Engineering

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical Core</td>
<td></td>
<td>49</td>
</tr>
<tr>
<td>CHEM 436</td>
<td>Fundamental Organic Chem II</td>
<td>3</td>
</tr>
<tr>
<td>or MCB 450</td>
<td>Introductory Biochemistry</td>
<td></td>
</tr>
</tbody>
</table>

Total Hours: 52

For the Concentration in Biomolecular Engineering

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical Core</td>
<td></td>
<td>49</td>
</tr>
<tr>
<td>MCB 450</td>
<td>Introductory Biochemistry</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Hours: 52

Technical Electives

These courses stress the rigorous analysis and design principles practiced in the major subdisciplines of chemical engineering embodied in the chemical engineering and biomolecular engineering concentrations.

For the Concentration in Chemical Engineering

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selected from the departmentally approved List of Approved Chemical Engineering Technical Electives, satisfying these distribution requirements: 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>400-level ChBE courses, with not more than 3 hours being CHBE 497 or CHBE 499 2</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Any 400-level course from List 1 2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Any courses from List 1 2</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Any 400-level course from List 2</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

Total Hours: 19

2 A maximum of 10 total hours of undergraduate research may be counted toward Technical Elective credit.

For the Concentration in Biomolecular Engineering

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selected from the departmentally approved List of Approved Biomolecular Engineering Technical Electives Categories A and B, satisfying these distribution requirements: 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any courses from Category A 2,3</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Any courses from Category B 3</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Any 400-level course from List 3</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

Total Hours: 19


2 A maximum of 3 hours from this Category may be undergraduate research credit.

3 A maximum of 9 total hours of undergraduate research may be counted toward Technical Elective credit.

Social Sciences and Humanities

The social sciences and humanities courses ensure that students have exposure in breadth and depth to areas of intellectual activity that are essential to the general education of any college graduate.

| Code   | Title                                | Hours |
| Electives in social sciences and humanities satisfying the campus general education requirements for social sciences and humanities, including cultural studies western and non-western components. |

| Code   | Title                                | Hours |
| RHET 105 | Writing and Research                  | 4     |

Advanced Composition (satisfied by completing the sequence CHBE 430 and CHBE 431 in the Chemical Engineering Technical Core).

Total Hours: 4

Suggested Sequence

The schedule that follows is illustrative, showing the typical sequence in which courses would be taken by a student with no college course credit already earned and who intends to graduate in four years. Each individual's case may vary, but the position of required named courses is generally indicative of the order in which they should be taken. The first three semesters of the Suggested Sequence is the same for all chemical engineering students. The fifth through eights semesters vary with the Concentration chosen. Refer to the appropriate sequence continuation below.

First Year

First Semester

| Code   | Title                                | Hours |
| CHEM 202 | Accelerated Chemistry I               | 3     |
| CHEM 203 | Accelerated Chemistry Lab I           | 2     |
| ENG 100  | Engineering Orientation               | 0     |
| MATH 221 | Calculus I                            | 4     |
RHET 105 Writing and Research 4
Elective in Social Sciences or Humanities 4,5 3

Semester Hours 16

Second Semester
CHBE 121 CHBE Profession 1
CHEM 204 Accelerated Chemistry II 3
CHEM 205 Accelerated Chemistry Lab II 2
CS 101 Intro Computing: Engrg Sci 3
MATH 231 Calculus II 3
PHYS 211 University Physics: Mechanics 4

Semester Hours 16

Second Year
First Semester
CHBE 221 Principles of CHE 3
CHEM 236 Fundamental Organic Chem I 4
CHEM 237 Structure and Synthesis 2
MATH 241 Calculus III 4
PHYS 212 University Physics: Elec Mag 4

Semester Hours 17

Concentration in Chemical Engineering
For the Concentration in Biomolecular Engineering, see below (p. 3)

Second Year
First Semester
Second Year First Semester course information is above in the Suggested Sequence that is common for all students 17

Semester Hours 17

Second Semester
CHBE 321 Thermodynamics 4
CHEM 436 Fundamental Organic Chem II or MCB 450 3
MATH 285 Intro Differential Equations 3
MATH 415 Applied Linear Algebra 3
PHYS 214 Univ Physics: Quantum Physics 2
Elective in Social Sciences or Humanities or Technical Elective 4,5,8a 3

Semester Hours 18

Third Year
First Semester
CHBE 421 Momentum and Heat Transfer 4
CHEM 315 Instrumental Chem Systems Lab 2
CHEM 420 Instrumental Characterization 2
CHEM 442 Physical Chemistry I 4
Elective in Social Sciences or Humanities or Technical Elective 4,5,8a 3

Semester Hours 15

Second Semester
CHBE 422 Mass Transfer Operations 4
CHBE 424 Chemical Reaction Engineering 3
IE 300 Analysis of Data 3

Semester Hours 15

Fourth Year
First Semester
CHBE 430 Unit Operations Laboratory 4
CHBE 440 Process Control and Dynamics 3

Semester Hours 17

Concentration in Biomolecular Engineering
Second Year
First Semester
Second Year First Semester course information is above in the Suggested Sequence that is common for all students 17

Semester Hours 17

Second Semester
CHBE 431 Process Design 4
Elective in Social Sciences or Humanities or Technical Elective 4,5,8a 10

Semester Hours 14

Total Hours: 97

Information listed in this catalog is current as of 10/2017
Elective in Social Sciences or Humanities or Technical Elective

<table>
<thead>
<tr>
<th>Semester Hours</th>
<th>9</th>
</tr>
</thead>
</table>

**Second Semester**

| Course to be selected from a departmentally approved list of approved engineering technical electives (List 1) may be substituted in place of CHBE 121. The ENGR 100 requirement will be waived. Under no circumstances will these requirements be waived for students who are in the chemical engineering curriculum during their freshman year. |
|----------------|---|
| Semester Hours | 14 |

**Total Hours:** 97

1. Students who do not place into CHEM 202, or who do not satisfy the mathematics prerequisite for CHEM 202, may substitute the sequence CHEM 102, CHEM 103, CHEM 104, CHEM 105, CHEM 222, and CHEM 223 for CHEM 202, CHEM 203, CHEM 204, and CHEM 205.

2. For students entering the curriculum after the freshman year, 1 additional hr of credit from the list of approved engineering technical electives (List 1) may be substituted in place of CHBE 121. The ENGR 100 requirement will be waived. Under no circumstances will these requirements be waived for students who are in the chemical engineering curriculum during their freshman year.

3. MATH 220 may be substituted, with four of the five credit hours applying toward the degree. MATH 220 is appropriate for students with no background in calculus.

4. At least 16 hours must be taken. All Campus General Education requirements must be satisfied, including those in approved course work in the Humanities/Arts, Social/Behavioral Sciences, and Cultural Studies, including the Western, Non-Western and/or U.S. Minorities components. The requirements for the Campus General Education categories Natural Sciences/Technology, Quantitative Reasoning I and II, Composition I, and Advanced Composition are fulfilled through required course work in the curriculum.

5. Three semesters of college credit in one foreign language is required.

6. Under no circumstances will PHYS 101-PHYS 102 be accepted as a substitute for any part of the Physics sequence.

7a. MATH 441 may be substituted for MATH 285. MATH 286 may be substituted for MATH 285.

7b. MATH 441 may be substituted for MATH 285. MATH 286 may be substituted for MATH 285.

8a. At least 19 hours must be selected from the departmentally approved List of Approved Chemical Engineering Technical Electives (http://chbe.illinois.edu/wp-content/uploads/2015/11/Technical.Electives.Current.pdf), satisfying these distribution requirements:

a) 6 hours must be 400-level ChBE courses, with not more than 3 hours being ChBE 497 or 499.

b) 3 hours any 400-level course from List 1.

c) 6 hours any courses from List 1.

d) 4 hours any 400-level courses from List 2.

A maximum of 10 total hours of undergraduate research may be counted toward Technical Elective credit. The List of Approved Chemical Engineering Technical Electives may be obtained in 209 RAL or from the department Web site. (http://chbe.illinois.edu/undergraduate/explore-chbe-at-illinois/curriculum-academic-advising)

8b. At least 19 hours must be selected from the departmentally approved List of Approved Biomolecular Engineering Technical Electives Categories (http://chbe.illinois.edu/wp-content/uploads/2015/11/Technical.Electives.Current.pdf), satisfying these distribution requirements:

a) 9 hours must be from Category A

b) 6 hours must be from Category B

c) 4 hours must be 400-level courses from List 2.

A maximum of 3 hours from Category A may be undergraduate research credit. A maximum of 9 total hours of undergraduate research may be counted toward Technical Elective credit. The List of Approved Biomolecular Engineering Technical Electives may be obtained in Room 209 RAL or from the department Web site. (http://chbe.illinois.edu/undergraduate/explore-chbe-at-illinois/curriculum-academic-advising)

9. Students must register in one of the Chemical Engineering-specific CHEM 315 lab sections.

10. Enrollment in CHBE 430 is limited. Thus CHBE 430 may need to be taken in the second semester and CHBE 431 and/or additional electives taken in the first semester instead. Students in their final semester will have priority for getting into CHBE 430 and CHBE 431.

11. The sequence CHBE 430 and CHBE 431 satisfies the General Education Advanced Composition requirement.

**Minor in Biomolecular Engineering**

Biomolecular Engineering is a broad, interdisciplinary field with its main goal of engineering value-added biomolecules and biomolecular systems for applications in medical, chemical, agricultural and food industries. Its practice ranges from fundamental study of biomolecules and biomolecular systems to the design of cellular factories and artificial organs. The Biomolecular Engineering minor is designed to better prepare non-chemical engineering students for careers in the food, pharmaceutical, personal care, and biotechnology industries. This minor is not open to students majoring in chemical engineering. Those students should instead take the biomolecular engineering concentration if they are interested in biomolecular engineering coursework.

Students may fulfill the requirements for a minor in biomolecular engineering by completing the following course sequence. For further information, please contact the Department of Chemical and Biomolecular Engineering.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCB 450</td>
<td>Introductory Biochemistry</td>
<td>3</td>
</tr>
<tr>
<td>CHBE 221</td>
<td>Principles of CHE</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 232</td>
<td>Elementary Organic Chemistry I</td>
<td>3</td>
</tr>
<tr>
<td>Biomolecular Engineering Electives</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Technical Electives</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

**Total Hours:** 21

1. Students must take at least three "Biomolecular Engineering" courses offered by the Department of Chemical and Biomolecular Engineering (for example, including CHBE 471, CHBE 472, CHBE 473, and CHBE 474). Students may obtain a current list of courses that may be used to satisfy this requirement in Room 209 RAL.

2. Course to be selected from a departmentally approved list of biomolecular engineering related technical electives.

For more information regarding to the Biomolecular Engineering minor, contact the Chemical and Biomolecular Engineering Department.

Information listed in this catalog is current as of 10/2017
Office, 114 Roger Adams Laboratory, (217) 244-2021, chbe-
advising@scs.illinois.edu.

CHBE Class Schedule (https://courses.illinois.edu/schedule/DEFAULT/ DEFAULT/CHBE)

Courses

CHBE 101  Hidden World of Engineering  credit: 3 Hours.
Tells the stories of everyday objects: bathtubs, pop cans and screws. These simple objects shape our lives, yet are engineering masterpieces. To unveil this hidden world the course uses a humanistic approach. Designed to appeal to all majors, it uses human science - filled with failures and triumphs - to reveal the methods of engineers. The course enchants with tales of ancient steel making, today’s pop cans, huge stone monuments, and salt. The course will change how a student looks at his or her world. Several sessions focus on women engineers and the environment.
This course satisfies the General Education Criteria for: Nat Sci Tech - Phys Sciences

CHBE 121  CHBE Profession  credit: 1 Hour.
Lectures and problems on the history and scope of chemical engineering endeavors; decisions and criteria for process development and plant design. Approved for S/U grading only. Prerequisite: CHEM 102 or CHEM 202.

CHBE 199  Undergraduate Open Seminar  credit: 1 to 5 Hours.
Approved for letter and S/U grading. May be repeated.

CHBE 202  Cooperative Education Practice  credit: 0 Hours.
Same as CHEM 293. See CHEM 293.

CHBE 210  CHBE Internship  credit: 0 Hours.
Full-time practice of chemical science in an off-campus industrial setting or research laboratory environment. Summary report required. Approved for S/U grading. May be repeated. Prerequisite: Completion of freshman year or equivalent, or consent of Director of Cooperative Education in Chemical and Biomolecular Engineering.

CHBE 221  Principles of CHE  credit: 3 Hours.
Lectures and problems on material and energy balances. Prerequisite: CHEM 104 or CHEM 204; credit or concurrent registration in CS 101.

CHBE 297  Individual Study Sophomores  credit: 1 to 3 Hours.
Individual study of problems related to Chemical and Biomolecular Engineering. May be repeated to a maximum of 6 hours. Prerequisite: Sophomore standing and consent of instructor.

CHBE 321  Thermodynamics  credit: 4 Hours.
Fundamental concepts and the laws of thermodynamics; the first and second law applications to phase equilibrium and chemical equilibrium and other applications in the Chemical and Biomolecular Engineering profession. Prerequisite: CHBE 221.

CHBE 397  Individual Study for Juniors  credit: 1 to 3 Hours.
Individual study of problems related to Chemical and Biomolecular Engineering. May be repeated to a maximum of 6 hours. Prerequisite: Junior standing and consent of instructor.

CHBE 421  Momentum and Heat Transfer  credit: 4 Hours.
Introduction to fluid statics and dynamics; dimensional analysis; design of flow systems; introduction to heat transfer; conduction, convection, and radiation. 4 undergraduate hours. 4 graduate hours. Credit is not given for both CHBE 421 AND ABE 341. Prerequisite: CHBE 221.

CHBE 422  Mass Transfer Operations  credit: 4 Hours.
Introduction to mass transfer processes and design methods for separation equipment. 4 undergraduate hours. 4 graduate hours. Prerequisite: CHBE 421.

CHBE 424  Chemical Reaction Engineering  credit: 3 Hours.
Chemical kinetics; chemical reactor design; the interrelationship between transport, thermodynamics, and chemical reaction in open and closed systems. 3 undergraduate hours. 3 graduate hours. Prerequisite: Credit or registration in CHBE 422.

CHBE 430  Unit Operations Laboratory  credit: 4 Hours.
Experiments and computation in fluid mechanics, heat transfer, mass transfer, and chemical reaction engineering. Exercises in effective Chemical and Biomolecular Engineering communications. 4 undergraduate hours. 4 graduate hours. Prerequisite: CHBE 422; credit or concurrent registration in CHBE 424; senior standing in Chemical and Biomolecular Engineering. This course satisfies the General Education Criteria for: Advanced Composition

CHBE 431  Process Design  credit: 4 Hours.
Capstone design course where students apply principles from previous courses to the design of complete chemical process systems. Topics include: techniques used in the synthesis and analysis of chemical processes, process simulation and optimization, effective communication in a chemical process engineering environment. 4 undergraduate hours. 4 graduate hours. Prerequisite: CHBE 422; credit or concurrent registration in CHBE 424. This course satisfies the General Education Criteria for: Advanced Composition

CHBE 440  Process Control and Dynamics  credit: 3 Hours.
Techniques used in the analysis of process dynamics and in the design of process control systems. Laplace transforms, stability analysis, and frequency response methods. 3 undergraduate hours. 3 graduate hours. Prerequisite: CHBE 421 and senior standing in Chemical and Biomolecular Engineering; MATH 285; CS 101.

CHBE 451  Transport Phenomena  credit: 3 Hours.
Unifying treatment of physical rate processes with particular emphasis on the formulation and solution of typical boundary value problems associated with heat, mass, and momentum transport. 3 undergraduate hours. 3 graduate hours. Prerequisite: CHBE 421; MATH 285.

CHBE 452  Chemical Kinetics & Catalysis  credit: 3 Hours.
Problems in chemical kinetics; techniques for the prediction and measurement of rates of reactions; homogeneous and heterogeneous catalysis chain reactions. 3 undergraduate hours. 3 graduate hours. Prerequisite: CHEM 442 or CHBE 321.

CHBE 453  Electrochemical Engineering  credit: 2 or 3 Hours.
Fundamentals of analysis, design, and optimization of electrochemical systems. 2 or 3 undergraduate hours. 2 or 3 graduate hours. Prerequisite: Senior standing in physical science or engineering.

CHBE 454  CHBE Projects  credit: 2 Hours.
Laboratory; development of an individual project. 2 undergraduate hours. 2 graduate hours. Prerequisite: Senior standing in Chemical and Biomolecular Engineering.
CHBE 455   Polymers Synthesis and Industrial Applications  credit: 3 Hours.
Explores the fundamentals of polymer production by providing a broad overview of several topics within the field. Students will gain an appreciation of the relationships between polymer composition, synthesis, and processing, all of which ultimately determine bulk polymer properties. 3 undergraduate hours. No graduate credit. Credit is not given for both CHBE 455 and MSE 457.

CHBE 456   Polymer Science & Engineering  credit: 3 Hours.
Fundamentals of polymer science and engineering: polymerization mechanisms, kinetics, and processes; physical chemistry and characterization of polymers; polymer rheology, mechanical properties, and processing. 3 undergraduate hours. 3 graduate hours. Credit is not given for both CHBE 456 and MSE 450. Prerequisite: CHBE 321; credit or concurrent registration in CHBE 421; CHEM 444.

CHBE 457   Microelectronics Processing  credit: 3 Hours.
Introductory survey of chemical processing principles applied to microelectronic fabrication. Key concepts originate from chemical kinetics; thermodynamics; mass and energy balances; transport of mass, momentum and heat; and process synthesis and integration. 3 undergraduate hours. 3 graduate hours. Prerequisite: Junior or senior standing in Chemical and Biomolecular Engineering, Electrical and Computer Engineering, or Materials Science and Computer Engineering.

CHBE 471   Biochemical Engineering  credit: 3 or 4 Hours.
Applications of chemical engineering principles to biological processes. Topics include enzyme mechanisms and kinetics, bioreactor design, cellular growth and metabolism, fermentation, and bioseparations. 3 undergraduate hours. 4 graduate hours. Prerequisite: Junior, senior, or graduate standing, or consent of instructor.

CHBE 472   Techniques in Biomolecular Eng  credit: 3 or 4 Hours.
Engineering principles that underlie many of the powerful tools in biotechnology and how scientific discoveries and engineering approaches are used in current industrial applications. Physical principles that govern self-organization and repair in biological systems; tools developed to characterize, manipulate, and quantify biomolecules; use of analytical tools and genetic manipulation in modern bioengineering and biotechnology applications. 3 undergraduate hours. 4 graduate hours. Prerequisite: CHEM 202, CHEM 203, CHEM 204 or equivalent; MATH 220 or MATH 221; PHYS 211, PHYS 214 or equivalent; MCB 450.

CHBE 473   Biomolecular Engineering  credit: 3 or 4 Hours.
Fundamental principles of biomolecular engineering and its applications in pharmaceutical, agriculture, chemical and food industries. Topics include gene discovery, rational design, directed evolution, pathway engineering, and functional genomics and proteomics. 3 undergraduate hours. 4 graduate hours.

CHBE 474   Metabolic Engineering  credit: 3 or 4 Hours.
Introduction to the principles and methodology of metabolic engineering. Experimental and mathematical techniques for the quantitative description, modeling, control, and design of metabolic pathways. Same as BIOE 474. 3 undergraduate hours. 4 graduate hours. Prerequisite: MATH 225 and MATH 285.

CHBE 475   Tissue Engineering  credit: 3 Hours.
Principles and practices of Chemical Engineering will be applied to the topic of tissue engineering. Topics include: methods for employing selected cells, biomaterial scaffolds, soluble regulators or their genes, and mechanical loading and culture conditions for regenerative repair of tissues and organs in vitro and in vivo; understanding intrinsic wound healing processes; quantifying cell behaviors/phenotypes; regulatory compliance and clinical translation. 3 undergraduate hours. 3 graduate hours. Prerequisites: CHBE 421 and CHBE 422, or consent of instructor.

CHBE 476   Biotransport  credit: 3 Hours.
Investigates the critical roles the transports of mass, energy and momentum play in the function of living systems at varied levels (e.g., cells, tissues, and organs) and time scales. Transport phenomena are also central to the design and operation of devices for biological research, imaging, biochemical processes, and therapeutic interventions including drug delivery, gene therapy and tissue engineering. Students will explore conservation laws of mass, energy, and momentum to mathematically describe cell and molecular biology, immunology, physiology and biomedical engineering systems. 3 undergraduate hours. No graduate credit. Prerequisites: CHBE 421 and CHBE 422 or consent of instructor.

CHBE 477   Bioenergy Technology  credit: 3 Hours.
Introduction to emerging bioenergy technologies including: world energy consumption and greenhouse gas concerns; fundamental biochemistry of biomass conversion; structural chemistry of lignocelluloses; pretreatment of biomass; enzymatic deconstruction; bioethanol production and fermentation; metabolic engineering for improved biofuels production; feedstock development; industrial fermentation and fermentor design; economics of bioethanol; alternative biofuels, including biodiesel, syngas, Fischer-Tropsch diesel, butanol, ABE fermentation and biohydrogen; anaerobic microbiology; and the biorefinery concept. 3 undergraduate hours. No graduate credit. Prerequisites: CHBE 421 and MCB 450.

CHBE 494   Special Topics  credit: 1 to 3 Hours.
Study of topics in chemical engineering; content varies from term to term. Typical topics include optimization, chemical kinetics, phase equilibrium, biochemical engineering, kinetic theory, and transport properties. 1 to 3 undergraduate hours. 1 to 3 graduate hours. May be repeated. Prerequisite: Senior standing in Chemical and Biomolecular Engineering or consent of instructor.

CHBE 495   Undergraduate Research Abroad  credit: 1 to 3 Hours.
Study assist in research under faculty supervision at a location outside of the United States. Topic and type of assistance vary. 1 to 3 undergraduate hours. No graduate credit. May be repeated in separate terms up to 6 hours. Research credit hours in the course are included under department limits for maximum hours of research/independent study credit allowed toward degree requirements. Prerequisite: Evidence of adequate preparation for such study; consent of faculty member supervising the work (who will have examined the proposed research plan); and approval of the department. Not available to freshman.

CHBE 497   Individual Study for Seniors  credit: 1 to 3 Hours.
Individual study of problems related to Chemical and Biomolecular Engineering. 1 to 3 undergraduate hours. No graduate credit. May be repeated to a maximum of 6 hours. Prerequisite: Senior standing and consent of instructor.
CHBE 499  Senior Thesis  credit: 1 to 6 Hours.
Limited in general to seniors in the curriculum in chemical and
biomolecular engineering. Any others must have the consent of the
head of the department. Each student taking the course must register
in a minimum of 5 hours either in one term or divided over two terms.
A maximum registration of 10 hours in two terms is permitted. 1 to 6
undergraduate hours. No graduate credit. In order to receive credit, a
thesis must be presented by each student registered in CHBE 499.