BIOMEDICAL ENGINEERING, B.S.

The BS Biomedical Engineering program is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org, under the General Criteria and the Bioengineering and Biomedical and Similarly Named Engineering Programs Criteria.

Learning Outcomes
1. Ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. 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. Ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgement to draw conclusions.
4. Ability to acquire and apply new knowledge as needed, using appropriate learning strategies.
5. Ability to communicate effectively with a range of audiences.
6. Ability to 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.
7. 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.

Academic Standards

Program GPA
Program GPA requirement policies are described in the College of Engineering and Computing section of this bulletin. For the purpose of these policies, the following courses are used to determine the Program GPA for the Biomedical Engineering B.S. program: all Biomedical Engineering Major courses, all courses used to satisfy a Biomedical Engineering Elective, all courses used to satisfy an Engineering Elective, and ECHE 320 or equivalent.

Minimum Course Grades
The Biomedical Engineering program requires that a grade of “C” or better be earned in each of the following courses: ENGL 101, MATH 141, MATH 142, MATH 241, MATH 242, BIOL 101, BIOL 101L, CHEM 111, CHEM 111L, CHEM 112, CHEM 112L, CHEM 333, CHEM 334, PHYS 211, PHYS 211L, BMEN 212, BMEN 240, BMEN 263, and BMEN 290.

Admissions

Entrance Requirements
Admission requirements and processes for freshman, transfer students, and former students seeking readmission are managed by the Office of Undergraduate Admissions (http://sc.edu/about/offices_and_divisions/undergraduate_admissions/).

Transfer applicants from regionally accredited colleges and universities must have a cumulative 2.75 GPA on a 4.00 scale to enter the College of Engineering and Computing. In addition, transfer applicants for the Aerospace Engineering, Biomedical Engineering, Chemical Engineering, Civil Engineering, Computer Engineering, Electrical Engineering, or Mechanical Engineering majors must also have completed a four semester-hour calculus course equivalent to MATH 141 with a grade of “C” or better.

Current University of South Carolina students who wish to enter the College of Engineering and Computing, and former students seeking readmission, must have an institutional GPA of 2.50 or better on at least 15 hours earned at USC. In addition, such applicants for the Aerospace Engineering, Biomedical Engineering, Chemical Engineering, Civil Engineering, Computer Engineering, Electrical Engineering, or Mechanical Engineering majors must also have completed a four semester-hour calculus course equivalent to MATH 141 with a grade of “C” or better.

Degree Requirements (130-142 hours)
See College of Engineering and Computing (https://academicbulletins.sc.edu/undergraduate/engineering-computing/) for progression requirements and special academic opportunities.

Program of Study

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Credit Hours</th>
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<tr>
<td>1. Carolina Core Requirements</td>
<td>34-46</td>
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<tr>
<td>2. College Requirements</td>
<td>0</td>
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<tr>
<td>3. Program Requirements</td>
<td>48</td>
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<tr>
<td>4. Major Requirements</td>
<td>48</td>
</tr>
</tbody>
</table>

Founding Documents Requirement
All undergraduate students must take a 3-credit course or its equivalent with a passing grade in the subject areas of History, Political Science, or African American Studies that covers the founding documents including the United State Constitution, the Declaration of Independence, the Emancipation Proclamation and one or more documents that are foundational to the African American Freedom struggle, and a minimum of five essays from the Federalist papers. This course may count as a requirement in any part of the program of study including the Carolina Core, the major, minor or cognate, or as a general elective. Courses that meet this requirement are listed here (https://academicbulletins.sc.edu/undergraduate/founding-document-courses/).

1. Carolina Core Requirements (34-46 hours)

CMW – Effective, Engaged, and Persuasive Communication: Written (6 hours)
- ENGL 101 must be passed with a grade of C or higher
- ENGL 102

ARP – Analytical Reasoning and Problem Solving (8 hours)
must be passed with a grade of C or higher
- MATH 141
- MATH 142

SCI – Scientific Literacy (8 hours)
must be passed with a grade of C or higher
• BIOL 101
• BIOL 101L
• CHEM 111
• CHEM 111L

GFL – Global Citizenship and Multicultural Understanding: Foreign Language (0-6 hours)
Score two or better on foreign language placement test; or complete the 109 and 110 courses in FREN, GERM, LATN or SPAN; or complete the 121 course in another foreign language.
• CC-GFL courses (https://academicbulletins.sc.edu/undergraduate/carolina-core-courses/)

GHS – Global Citizenship and Multicultural Understanding: Historical Thinking (3 hours)
• any CC-GHS course (https://academicbulletins.sc.edu/undergraduate/carolina-core-courses/)

GSS – Global Citizenship and Multicultural Understanding: Social Sciences (3 hours)
• any CC-GSS course (https://academicbulletins.sc.edu/undergraduate/carolina-core-courses/)

AIU – Aesthetic and Interpretive Understanding (3 hours)
• any CC-AIU course (https://academicbulletins.sc.edu/undergraduate/carolina-core-courses/)

CMS – Effective, Engaged, and Persuasive Communication: Spoken Component 1 (0-3 hours)
• any overlay or stand-alone CC-CMS course (https://academicbulletins.sc.edu/undergraduate/carolina-core-courses/)

INF – Information Literacy 1 (0-3 hours)
• any overlay or stand-alone CC-INF course (https://academicbulletins.sc.edu/undergraduate/carolina-core-courses/)

VSR – Values, Ethics, and Social Responsibility 1 (0-3 hours)
• any overlay or stand-alone CC-VSR course (https://academicbulletins.sc.edu/undergraduate/carolina-core-courses/)

1 Carolina Core Stand Alone or Overlay Eligible Requirements — Overlay-approved courses offer students the option of meeting two Carolina Core components in a single course. A maximum of two overlays is allowed. The total Carolina Core credit hours for this program must add up to a minimum of 34 hours.

2. College Requirements (0 hours)
No college-required courses for this program.

3. Program Requirements (48 hours)
Supporting Courses (48 hours)
Foundational Courses (33 hours)
Complete all of the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 112</td>
<td>General Chemistry II (must be passed with a grade of C or higher)</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 112L</td>
<td>General Chemistry II Lab (must be passed with a grade of C or higher)</td>
<td>1</td>
</tr>
<tr>
<td>CHEM 333</td>
<td>Organic Chemistry I (must be passed with a grade of C or higher)</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 334</td>
<td>Organic Chemistry II (must be passed with a grade of C or higher)</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 550</td>
<td>Biochemistry</td>
<td>3</td>
</tr>
<tr>
<td>or BIOL 541</td>
<td>Biochemistry</td>
<td>3</td>
</tr>
<tr>
<td>MATH 241</td>
<td>Vector Calculus (must be passed with a grade of C or higher)</td>
<td>3</td>
</tr>
<tr>
<td>MATH 242</td>
<td>Elementary Differential Equations (must be passed with a grade of C or higher)</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 211</td>
<td>Essentials of Physics I (must be passed with a grade of C or higher)</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 211L</td>
<td>Essentials of Physics I Lab (must be passed with a grade of C or higher)</td>
<td>1</td>
</tr>
<tr>
<td>PHYS 212</td>
<td>Essentials of Physics II</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 212L</td>
<td>Essentials of Physics II Lab</td>
<td>1</td>
</tr>
<tr>
<td>STAT 509</td>
<td>Statistics for Engineers</td>
<td>3</td>
</tr>
<tr>
<td>Select one of the following:</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>ECHE 320</td>
<td>Chemical Engineering Fluid Mechanics</td>
<td></td>
</tr>
<tr>
<td>ENCP 360</td>
<td>Fluid Mechanics</td>
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<tr>
<td>EMCH 360</td>
<td>Fluid Mechanics</td>
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</tr>
</tbody>
</table>

Total Credit Hours 33

Biomedical Engineering Electives (6 hours)
Students must take 6 credit hours of Biomedical Engineering electives. Of these 6 credit hours, at most 3 credit hours may come from BMEN 499. Undergraduate courses that may be used to satisfy this requirement are listed below. In addition, BMEN courses numbered 700 and above may be used to satisfy this requirement, provided the student is admitted to an Accelerated Bachelor's/Graduate Program.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMEN 342</td>
<td>Infectious Disease &amp; Immunology for Biomedical Engineers</td>
<td>3</td>
</tr>
<tr>
<td>BMEN 346</td>
<td>Medical Microbiology for Biomedical Engineers</td>
<td>3</td>
</tr>
<tr>
<td>BMEN 389</td>
<td>Special Topics in Biomedical Engineering for Undergraduates</td>
<td>1-3</td>
</tr>
<tr>
<td>BMEN 392</td>
<td>Fundamentals of Biochemical Engineering</td>
<td>3</td>
</tr>
<tr>
<td>BMEN 499</td>
<td>Independent Research</td>
<td>1-3</td>
</tr>
<tr>
<td>BMEN 532</td>
<td>Micro/nanofluids and Lab-on-a-Chip</td>
<td>3</td>
</tr>
<tr>
<td>BMEN 537</td>
<td>Bio Nano/Micro Electro-Mechanical Systems</td>
<td>3</td>
</tr>
<tr>
<td>BMEN 546</td>
<td>Delivery of Bioactive Agents</td>
<td>3</td>
</tr>
<tr>
<td>BMEN 547</td>
<td>Immuoneengineering</td>
<td>3</td>
</tr>
<tr>
<td>BMEN 548</td>
<td>Cardiovascular System: From Development to Disease</td>
<td>3</td>
</tr>
<tr>
<td>BMEN 565</td>
<td>Advanced Biomechanics</td>
<td>3</td>
</tr>
<tr>
<td>BMEN 572</td>
<td>Tissue Engineering</td>
<td>3</td>
</tr>
<tr>
<td>BMEN 575</td>
<td>Engineering of Soft Materials</td>
<td>3</td>
</tr>
<tr>
<td>BMEN 589</td>
<td>Special Topics in Biomedical Engineering</td>
<td>1-3</td>
</tr>
<tr>
<td>ECHE 430</td>
<td>Chemical Engineering Kinetics</td>
<td>3</td>
</tr>
</tbody>
</table>
EMCH 580  Mechanics of Solid Biomaterials  3
EXSC 335  Biomechanics of Human Movement  3

Engineering Elective (3 hours)
Students must take 3 credit hours of engineering electives. The engineering elective within the Biomedical Engineering Program may be satisfied by any CSCE course at a 200 level and above, as well as any ECHE, ELCT, or EMCH course at a 300 level and above with the following exceptions: CSCE 205, ECHE 310, ECHE 320 and EMCH 360.

Additionally, all courses approved as Biomedical Engineering Electives may be used as an Engineering Elective.

Technical Electives (6 hours)
Students must take 6 credit hours of technical electives. A listing of acceptable technical electives is maintained in the Biomedical Engineering office and on its website. Technical Electives include all Biomedical Engineering Electives, all Engineering Electives and the following:

Course  Title  Credits
BIOL 102  Biological Principles II  3
BIOL 102L  Biological Principles II Laboratory  1
BIOL 250  Microbiology  3
BIOL 250L  Microbiology Laboratory  1
BIOL 270  Introduction to Environmental Biology  3
BIOL 270L  Introduction to Environmental Biology Laboratory  1
BIOL 301  Ecology and Evolution  3
BIOL 302L  Cell and Molecular Biology Laboratory  1
BIOL 303  Fundamental Genetics  3
BIOL 415  Comparative Vertebrate Anatomy  4
BIOL 460  Advanced Human Physiology  3
BIOL 505  Developmental Biology  3
BIOL 530  Histology  4
BIOL 531  Parasitology  4
or ENHS 661  Parasitology  3
or EPID 661  Parasitology  3
BIOL 534  Animal Behavior  3
BIOL 541L  Biochemistry Laboratory  1
or CHEM 550L  Biochemistry Laboratory  1
BIOL 553  Genomics  3
BIOL 610  Hallmarks of Cancer  3
BIOL 612  Virology - Classical and Emerging Concepts  3
BIOL 620  Immunobiology  3
BIOL 635  Neurophysiology  4
BIOL 653  Bioinformatics  3
BIOL 655  Biotechnology  3
BIOL 656  Experimental Biotechnology  4
BIOL 662  Signal Transduction and Pathogenesis  3
BIOL 665  Human Molecular Genetics  3
BIOL 667  Molecular and Genetic Mechanisms of Disease Pathogenesis  3
BIOL 690  Ultramicroscopy  3
CHEM 321  Quantitative Analysis  3
or CHEM 322  Analytical Chemistry  3
CHEM 321L  Quantitative Analysis Laboratory  1
CHEM 331L  Essentials of Organic Chemistry Laboratory I  1
CHEM 332L  Essentials of Organic Chemistry Laboratory II  1
CHEM 340  Elementary Biophysical Chemistry  3
CHEM 541  Physical Chemistry  3
CHEM 542  Physical Chemistry  3
CHEM 545  Physical Biochemistry  3
CHEM 550L  Biochemistry Laboratory  1
EXSC 330  Exercise Physiology  3
EXSC 562  Impairments of the Human Motor System  3
MATH 344  Applied Linear Algebra  3
or MATH 526  Numerical Linear Algebra  3
MATH 374  Discrete Structures  3
MATH 520  Ordinary Differential Equations  3
MATH 524  Nonlinear Optimization  3
MATH 544  Linear Algebra  3
MATH 546  Algebraic Structures I  3
MATH 547  Algebraic Structures II  3
MATH 550  Vector Analysis  3
MATH 552  Applied Complex Variables  3
PHYS 515  Mathematical Physics I  3
PHYS 516  Mathematical Physics II  3
PHYS 517  Computational Physics  3
STAT 516  Statistical Methods II  3
STAT 518  Nonparametric Statistical Methods  3
STAT 519  Sampling  3
STAT 520  Forecasting and Time Series  3
or MGSC 520  Forecasting and Time Series  3
STAT 523  Financial Mathematics II  3
STAT 525  Statistical Quality Control  3
or MGSC 525  Statistical Quality Control  3
STAT 528  Environmental Statistics  3
STAT 530  Applied Multivariate Statistics and Data Mining  3
STAT/CSCE 582  Bayesian Networks and Decision Graphs  3
EMCH 111  Introduction to Computer-Aided Design  3
CSCE 145  Algorithmic Design I  4
MGMT 371  Principles of Management  3

4. Major Requirements (48 hours)
Major Courses (48 hours)

Course  Title  Credits
BMEN 101  Introduction to Biomedical Engineering  1
BMEN 212  Fundamentals of Biomedical Systems (must be passed with a grade of C or higher)  3
BMEN 240  Cellular and Molecular Biology with Engineering Applications (must be passed with a grade of C or higher)  4
BMEN 263  Introduction to Biomechanics (must be passed with a grade of C or higher)  3
BMEN 271  Introduction to Biomaterials  3
BMEN 290   Thermodynamics of Biomolecular Systems (must be passed with a grade of C or higher)  3
BMEN 302   Professional Development and Ethics in Biomedical Engineering  2
BMEN 321   Biomonitoring and Electrophysiology  3
BMEN 345   Human Anatomy and Physiology for Biomedical Engineers  4
BMEN 354   Biotransport  3
BMEN 363   Biomedical Instrumentation  3
BMEN 381   Biomedical Engineering Laboratory I  2
BMEN 382   Biomedical Engineering Laboratory II  2
BMEN 391   Kinetics in Biomolecular Systems  3
BMEN 411   Modeling and Simulation of Biomedical Systems  3
BMEN 427   Senior Biomedical Engineering Design I  3
BMEN 428   Senior Biomedical Engineering Design II  3

Total Credit Hours  48

Major Map

A major map is a layout of required courses in a given program of study, including critical courses and suggested course sequences to ensure a clear path to graduation.

Major maps are only a suggested or recommended sequence of courses required in a program of study. Please contact your academic advisor for assistance in the application of specific coursework to a program of study and course selection and planning for upcoming semesters.

Biomedical Engineering, B.S.