

# 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/](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

Requirements	Credit Hours
1. Carolina Core Requirements	34-46
2. College Requirements	0
3. Program Requirements	48
4. Major Requirements	48

### 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 <sup>1</sup> (0-3 hours)

- any overlay or stand-alone CC-CMS course (<https://academicbulletins.sc.edu/undergraduate/carolina-core-courses/>)

### INF – Information Literacy <sup>1</sup> (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 <sup>1</sup> (0-3 hours)

- any overlay or stand-alone CC-VSR course (<https://academicbulletins.sc.edu/undergraduate/carolina-core-courses/>)

<sup>1</sup> **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:

Course	Title	Credits
CHEM 112	General Chemistry II (must be passed with a grade of C or higher)	3
CHEM 112L	General Chemistry II Lab (must be passed with a grade of C or higher)	1
CHEM 333	Organic Chemistry I (must be passed with a grade of C or higher)	3
CHEM 334	Organic Chemistry II (must be passed with a grade of C or higher)	3
CHEM 550 or BIOL 541	Biochemistry	3
MATH 241	Vector Calculus (must be passed with a grade of C or higher)	3
MATH 242	Elementary Differential Equations (must be passed with a grade of C or higher)	3
PHYS 211	Essentials of Physics I (must be passed with a grade of C or higher)	3
PHYS 211L	Essentials of Physics I Lab (must be passed with a grade of C or higher)	1
PHYS 212	Essentials of Physics II	3
PHYS 212L	Essentials of Physics II Lab	1
STAT 509	Statistics for Engineers	3
Select one of the following:		3
ECHE 320	Chemical Engineering Fluid Mechanics	
ENCP 360	Fluid Mechanics	
EMCH 360	Fluid Mechanics	
<b>Total Credit Hours</b>		<b>33</b>

### 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.

Course	Title	Credits
BMEN 342	Infectious Disease & Immunology for Biomedical Engineers	3
BMEN 346	Medical Microbiology for Biomedical Engineers	3
BMEN 389	Special Topics in Biomedical Engineering for Undergraduates	1-3
BMEN 392	Fundamentals of Biochemical Engineering	3
BMEN 499	Independent Research	1-3
BMEN 532	Micro/nanofluidics and Lab-on-a-Chip	3
BMEN 537	Bio Nano/Micro Electro-Mechanical Systems	3
BMEN 546	Delivery of Bioactive Agents	3
BMEN 547	Immunoengineering	3
BMEN 548	Cardiovascular System: From Development to Disease	3
BMEN 565	Advanced Biomechanics	3
BMEN 572	Tissue Engineering	3
BMEN 575	Engineering of Soft Materials	3
BMEN 589	Special Topics in Biomedical Engineering	1-3
ECHE 430	Chemical Engineering Kinetics	3

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	
or EPID 661	Parasitology	
BIOL 534	Animal Behavior	3
BIOL 541L	Biochemistry Laboratory	1
or CHEM 550L	Biochemistry Laboratory	
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	
CHEM 321L	Quantitative Analysis Laboratory	1

or CHEM 322L	Analytical Chemistry Laboratory	
CHEM 331L	Essentials of Organic Chemistry Laboratory I	1
or CHEM 333L	Comprehensive Organic Chemistry Laboratory I	
CHEM 332L	Essentials of Organic Chemistry Laboratory II	1
or CHEM 333L	Comprehensive Organic Chemistry Laboratory I	
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	
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	
STAT 523	Financial Mathematics II	3
STAT 525	Statistical Quality Control	3
or MGSC 525	Statistical Quality Control	
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
<b>Total Credit Hours</b>		<b>48</b>

## 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