Biomedical Engineering
College of Engineering and Computing

Advisement Booklet

Bachelor of Science in Biomedical Engineering

Fall 2017
(For students entering Fall 2017 or after)
MESSAGE FROM THE DIRECTOR

Dr. Melissa Moss, Program Director

BME@USC: Past, Present and Future

The Biomedical Engineering Program was formed in 2006 in response to initiatives at the state and university levels requiring expertise in biomedical engineering. The decision to invest strategically in biomedical engineering emerged from the rapidly growing need for health care. This need includes the advancement of technology to develop innovative interventions, medical devices, and pharmaceuticals. Since its inception, growth of the program infrastructure has been supported by two Research Infrastructure Improvement (RII) grants from the National Science Foundation and an IdeA Networks of Biomedical Research Excellence (INBRE) grant from the National Institutes of Health.

The Biomedical Engineering Program currently offers four degree options: a Bachelor of Science (BS), a Masters of Engineering (ME), a Masters of Science (MS), and a Doctor of Philosophy (PhD). These degree programs were designed around the goal of training students to initiate, to integrate, to imagine, and to develop new processes and new products that will improve human health. Our faculty members are committed to develop within students the intellectual, technological, and professional skills that will allow them to thrive in industry, medicine, and academia. Our alumni include engineers and researchers within industries such as GE Healthcare, Cook Medical, and Amgen, as well as graduate and medical students studying at top-ranked programs across the nation.

In just over ten years, the Biomedical Engineering Program has reached several milestones and accomplishments. Our undergraduate program has grown to become the second largest within the College of Engineering and Computing. Our undergraduate curriculum has earned ABET accreditation. Our undergraduate alumni include 4 Goldwater Scholars or Honorable Mention, 5 National Science Foundation Fellows, and 2 Whitaker International Fellows, while our graduate alumni now include 23 PhD and 11 MS graduates. Our graduate program has also recently added the ME degree to its curricula offerings.

The Biomedical Engineering faculty includes members from Chemical Engineering, Computer Science and Engineering, Mechanical Engineering, and School of Medicine. This diverse faculty works collaboratively in both teaching and research efforts to create a program environment that is rich for learning, discovery, and innovation. Collectively, we are advancing science at the interface of engineering and biology to improve medicine and train the next generation of engineers who will provide and innovate health care.
**Biomedical Engineering at USC**

Biomedical engineering degree programs at the University of South Carolina were designed and developed to train students to initiate, to integrate, to imagine, and to invent new processes and new products in order to improve human health. The students who enter our programs are among the very best within the University and in the nation. Our faculty members are committed to helping students develop the intellectual, technological, and personal skills that will allow them to thrive in academia, medicine, or industry. We anticipate that our graduates will utilize their unique education and research experience to excel in positions ranging from professors in top-ranked universities to executives in new medical device or large pharmaceutical companies.

The Biomedical Engineering degree programs represent Carolina’s commitment to a true synthesis of biology, medicine, and engineering. Our current and proposed research will be among the best. Nonetheless, there is no doubt that what makes biomedical engineering at Carolina so special the solid commitment by the College and the University to recruit the best faculty, students, and staff who will provide an environment of unique collegiality in which world class research and education thrive side by side.

We will be able to apply the knowledge gained in fundamental studies to finding cures and treatments for such devastating diseases as heart failure and cystic fibrosis. Not only are we using the most advanced engineering technologies and concepts in our research, but we are moving the frontiers of engineering ahead by developing new technologies. Just as important, we will develop new theoretical and computational algorithms that are applied in medical imaging and drug design.

**Bachelor of Science in Biomedical Engineering:**

**Program Overview**

Biomedical engineers are involved in the design and advancement of products and procedures that promote improved health. Contributions of biomedical engineers range from the design of artificial organs to the discovery of new therapeutic pharmaceuticals to the development of surgical procedures and associated instrumentation.

The Bachelor of Science in Biomedical Engineering is a collaborative effort among the Chemical and Mechanical Engineering departments at USC and the USC School of Medicine. The objectives of the biomedical engineering undergraduate program are to provide students with a thorough grounding in mathematics, chemistry, physics, biology, and engineering; to educate students in the application of mathematics and science at the interface between engineering and biology; and to prepare students for graduate studies in biomedical engineering, professional studies in medical school, or professional careers in biomedical engineering industries.

The objectives are met through a curriculum that provides a strong foundation in the basic and applied sciences, as well as in the liberal arts, to provide students with a well-balanced education. Increasing emphasis is placed upon the application of engineering principles to biological systems in the junior and senior years. The curriculum provides the opportunity to engage in technical and engineering electives, laboratory course components, and a capstone design experience. Students will choose a chemical or mechanical track, and elective components and design experiences will be tailored to the specific interests of the student.
Student Progress, Advisement, and Checkpoints within the Biomedical Engineering Curriculum

Freshman Year

Sophomore Year

Junior Year

Senior Year

Freshman Advising
CEC Student Services
GPA Review
USC Registrar

Academic Advising
Biomedical Engineering
Block Advisement
Courses
Academic Advisor
Continuing Consultation

GPA Review
USC Registrar

Senior Check
CEC Student Services
Initiated via student request

Degree Certification
CEC Student Services
Progression Policies and Requirements

Entrance Requirements

Admission requirements and processes for freshman, transfer students, and former students seeking readmission are managed by the Office of Undergraduate Admissions. All engineering and computing students must earn a minimum of 30 semester hours, including at least half of the hours of work in the major, in residence.

Grade Forgiveness

It is the policy of the University of South Carolina that every currently enrolled, fully admitted, degree-seeking undergraduate earning a D+, D, F, or WF in a University course may take up to two undergraduate courses for a second time for the purpose of grade forgiveness. Both the first and second grades shall appear on the University permanent record, but only the second grade will be used in computing the University of South Carolina cumulative grade point average. An explanatory notice will appear on the record. Once grade forgiveness is applied to a repeated course, the action may not be revoked.

An eligible student wishing to apply the course grade forgiveness policy to a course enrollment may do so at any time during his/her undergraduate enrollment, but no applications will be honored after the degree is awarded. Grade forgiveness can only be applied once per course for a maximum of two courses (not to exceed 8 credits) on a student’s undergraduate academic record, without regard to the number of degrees sought. Under the grade forgiveness policy, the forgiven and repeated class must be taken at the University of South Carolina-Columbia campus or a regional campus. Courses transferred from other institutions are excluded from this policy.

Established requirements for repeating classes, admission to, or progression in, specific academic programs of the University take precedence over the grade forgiveness policy. Program or progression grade point averages are not affected by this policy. Courses intended to be repeated for additional credit, such as research or applied music, are not eligible for grade forgiveness. Semester honors (dean’s or president’s honor list), or academic standing (scholastic deficiency, probation, suspension), or previous grade point totals will not change retroactively as a result of applying this policy.

Students who have been granted academic forgiveness to reset the grade point average after readmission are not eligible for course grade forgiveness.

The documentation to be completed to enact grade forgiveness can be found at http://registrar.sc.edu/html/students/grade_forgiv.stm
Repetition of Coursework

A student cannot repeat courses from the College of Engineering and Computing in which they earned a grade of $C$ or better. Regardless of whether or not grade forgiveness is applied, students may not attempt a CEC course for a third time. For this purpose, withdrawal from a course with a grade of $W$ is not regarded as enrollment in that course. A student that does not satisfactorily complete a degree-required College course within two attempts must change major or transfer out of the College of Engineering and Computing.

A student can repeat no more than four courses from the College of Engineering and Computing in order to satisfy the requirements for any degree from the College, regardless of satisfactory work. For this purpose, withdrawal from a course with a grade of $W$ is not regarded as enrollment in that course. A student not meeting these requirements must change major or transfer out of the College of Engineering and Computing.

Cooperative Education

The Cooperative Education Program is an option program designed to provide career-related work experiences, which can either alternate, or run concurrently with academic semesters. The purpose of the co-op experience is to give direction and enrichment to the student’s education, to help the student in career decision making, to improve after-graduation job prospects, and to enable students to pay for a significant portion of their college expenses.

To qualify for the co-op program, students must have completed 30 semester hours and have at least a 2.50 grade point average. The program requires that students participate in at least two work experiences, each equal to one academic semester, and maintain at least a 2.50 grade point average. Students are encouraged to enroll with the Engineering and Computing Career Services Office during their freshman year. More information is available from the Career Center’s co-op website.

Graduation Requirements

In addition to the general University and program specific requirements for a bachelor’s degree, engineering and computing students must have a GPA of 2.00 or better on all major courses in their degree programs. A listing of major courses for each degree program is maintained in the Student Services Office. The GPA computation will include all repeated grades, with the exception of those for which the university-approved grade forgiveness has been applied. A student not meeting these requirements must change major or transfer out of the College of Engineering and Computing.
# Suggested Four-Year Curriculum Plan for BS in Biomedical Engineering

The four-year curriculum for a BS degree in Biomedical Engineering is given in the table below with core biomedical engineering core courses (pink), elective courses (purple), basic science courses (yellow), and general education\(^1\) courses (green) indicated by color.

<table>
<thead>
<tr>
<th>Year</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BMEN 101</td>
<td>Intro to Biomedical Engr</td>
</tr>
<tr>
<td></td>
<td>BMEN 211(^c)</td>
<td>Computational Tools for Modeling Biomedical Systems</td>
</tr>
<tr>
<td></td>
<td>BIOL 101(^c)/L</td>
<td>Biological Principles I</td>
</tr>
<tr>
<td></td>
<td>PHYS 211(^c)/L</td>
<td>Essentials of Physics I &amp; Lab</td>
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<tr>
<td></td>
<td>CHEM 111(^c)/L</td>
<td>General Chemistry &amp; Lab</td>
</tr>
<tr>
<td></td>
<td>MATH 141(^c)</td>
<td>Calculus I</td>
</tr>
<tr>
<td></td>
<td>ENGL 101(^c)</td>
<td>Critical Reading &amp; Composition</td>
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<tr>
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<td>Total 17</td>
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<th>Year</th>
<th>Fall</th>
<th>Spring</th>
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<tbody>
<tr>
<td>2</td>
<td>BMEN 212(^c)</td>
<td>Fundamentals of Biomedical Systems</td>
</tr>
<tr>
<td></td>
<td>BMEN 263(^c)</td>
<td>Intro to Biomechanics</td>
</tr>
<tr>
<td></td>
<td>BIOM 240(^c)</td>
<td>Cellular &amp; Molecular Biology w/ Engr App</td>
</tr>
<tr>
<td></td>
<td>BMEN 290(^c)</td>
<td>Thermodynamics of Biomolecular Systems</td>
</tr>
<tr>
<td></td>
<td>CHEM 333(^c)</td>
<td>Organic Chemistry I</td>
</tr>
<tr>
<td></td>
<td>CHEM 334(^c)</td>
<td>Organic Chemistry II</td>
</tr>
<tr>
<td></td>
<td>MATH 241(^c)</td>
<td>Vector Calculus</td>
</tr>
<tr>
<td></td>
<td>MATH 242(^c)</td>
<td>Elementary Differential Equations</td>
</tr>
<tr>
<td></td>
<td>PHYS 212/L</td>
<td>Essentials of Physics II &amp; Lab</td>
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<td>STAT 509</td>
<td>Statistics for Engineers</td>
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<th>Fall</th>
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<tbody>
<tr>
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<td>BMEN 271</td>
<td>Intro to Biomaterials</td>
</tr>
<tr>
<td></td>
<td>BMEN 303</td>
<td>Prof Dev &amp; Ethics in Biomedical Engr</td>
</tr>
<tr>
<td></td>
<td>BIOM 321</td>
<td>Biomonitoring &amp; Electrophysiology</td>
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<td></td>
<td>BMEN 345</td>
<td>Human Anatomy &amp; Physiology for Biomedical Engrs</td>
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<td></td>
<td>BMEN 381</td>
<td>Biomedical Engr Lab I</td>
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<td></td>
<td>BMEN 354</td>
<td>Biotransport</td>
</tr>
<tr>
<td></td>
<td>ECHE 320 or ENCP 360 or EMCH 360</td>
<td>Fluid Mechanics</td>
</tr>
<tr>
<td></td>
<td>ECHE 560 or BIOL 541</td>
<td>Biomechanics</td>
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<tr>
<td></td>
<td>CHEM 550 or BIOL 541</td>
<td>Biochemistry</td>
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<td></td>
<td>CHEM Elective (AIU)(^2)</td>
<td>Aesthetic/Interpretive Understanding</td>
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<td>CC Elective (GSS)(^3)</td>
<td>CC Elective (GSS)(^3)</td>
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<td>Total 17</td>
<td>Total 16</td>
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<thead>
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<th>Year</th>
<th>Fall</th>
<th>Spring</th>
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<tbody>
<tr>
<td>4</td>
<td>BMEN 391</td>
<td>Kinetics in Biomolecular Systems</td>
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<tr>
<td></td>
<td>BMEN 428</td>
<td>Biomedical Engr Design II</td>
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<tr>
<td></td>
<td>BMEN 427</td>
<td>Biomedical Engr Design I</td>
</tr>
<tr>
<td></td>
<td>BME Elective</td>
<td>Biomedical Engr Elective</td>
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<tr>
<td></td>
<td>BME Elective</td>
<td>Biomedical Engr Elective</td>
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<td></td>
<td>TECH Elective</td>
<td>Technical Elective</td>
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<td></td>
<td>TECH Elective</td>
<td>Technical Elective</td>
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<td>CC Elective (GHS)(^5)</td>
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<td>CC Elective (VSR)(^4)</td>
<td>Values, Ethics, Social Resp</td>
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<td>Total 15</td>
<td>Total 15</td>
</tr>
</tbody>
</table>

\(^1\)A grade of "C" or better required for future coursework

\(^2\)In addition to the requirements below, students must also score at least a score of 2 on the foreign language placement test, or complete the 109 and 110 courses in French, German, Latin, or Spanish, or complete the 121 course in another foreign language

\(^3\)Also satisfies core requirement in foundational courses

\(^4\)Searchable database of course options can be found at: http://www.sc.edu/about/offices_and_divisions/provost/academicpriorities/undergradstudies/carolina/core/courses/foundational-courses.php

\(^5\)Select from the following classes to obtain an overlap with CC Requirement Effective, Engaged, and Persuasive Communication (CMS): PHIL 213 Communicating Moral Issues, PHIL 325 Engineering Ethics, SAEL Social Advocacy & Ethical Life, SPCH 213 Communicating Moral Issues

\(^6\)An overlay class with CC Requirement Effective, Engaged, and Persuasive Communication (CMS) is not selected, one of the following additional courses is required: SPCH 140 Public Communication, SPCH 145 Online Public Communication, SPCH 230 Business and Professional Speaking, SPCH 260 Argumentation & Debate

5/31/2017 Update

BMEN Curriculum 2017/2018
## Index of Required Classes

Note that electives are not included in this index, but are still required for graduation.

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Prerequisites; (C) = prerequisite requires C or better</th>
<th>Co-requisites</th>
<th>≥C required</th>
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<tbody>
<tr>
<td>BIOL 101</td>
<td>Biological Principles I</td>
<td></td>
<td>BIOL 101L</td>
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<tr>
<td>BIOL 101L</td>
<td>Biological Principles I Lab</td>
<td></td>
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<tr>
<td>BMEN 101</td>
<td>Introduction to Biomedical Engineering</td>
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</tr>
<tr>
<td>BMEN 211</td>
<td>Computational Tools for Modeling Biomedical Systems</td>
<td>MATH 141 (C)</td>
<td></td>
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<tr>
<td>BMEN 212</td>
<td>Fundamentals of Biomedical Systems</td>
<td>BMEN 211 (C) or CHEM 111 (C) or CHEM 141 (C) or MATH 142 (C)</td>
<td></td>
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<tr>
<td>BMEN 240</td>
<td>Cellular &amp; Molecular Biology with Engineering Applications</td>
<td>BIOL 101 (C) or BMEN 211 (C) or CHEM 112 (C) or CHEM 142 (C) or MATH 142 (C)</td>
<td></td>
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<tr>
<td>BMEN 263</td>
<td>Introduction to Biomechanics</td>
<td>BMEN 212 (C) or MATH 241 (C) or PHYS 211 (C)</td>
<td></td>
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<tr>
<td>BMEN 271</td>
<td>Biomaterials</td>
<td>CHEM 303, and BMEN 240 (C), and BMEN 263 (C), and BMEN 290 (C)</td>
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<tr>
<td>BMEN 290</td>
<td>Thermodynamics of Biomolecular Systems</td>
<td>BMEN 260 (C), and MATH 241 (C), and PHYS 211 (C)</td>
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<tr>
<td>BMEN 303</td>
<td>Professional Development &amp; Ethics in Biomedical Engineering</td>
<td>BMEN 101</td>
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<tr>
<td>BMEN 321</td>
<td>Biomonitoring &amp; Electrophysiology</td>
<td>PHYS 212, and BMEN 212 (C), and BMEN 240 (C), and MATH 242 (C)</td>
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<tr>
<td>BMEN 345</td>
<td>Anatomy &amp; Physiology for Biomedical Engineers</td>
<td>BMEN 271, and BMEN 240 (C)</td>
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<tr>
<td>BMEN 354</td>
<td>Biotransport</td>
<td>ECH 320, EMCH 360, or ENCP 360, and MATH 242 (C)</td>
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<tr>
<td>BMEN 363</td>
<td>Biomedical Instrumentation</td>
<td>BMEN 321</td>
<td></td>
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<tr>
<td>BMEN 381</td>
<td>Biomedical Engineering Laboratory I</td>
<td>BMEN 285, and STAT 509</td>
<td>BMEN 271 (pre or co)</td>
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<tr>
<td>BMEN 382</td>
<td>Biomedical Engineering Laboratory II</td>
<td>BMEN 385, and BMEN 381</td>
<td>MATH 503 (pre or co)</td>
<td>X</td>
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<tr>
<td>BMEN 391</td>
<td>Kinetics in Biomolecular Systems</td>
<td>CHEM 350, or BIOL 541, and BMEN 290 (C), and MATH 242 (C)</td>
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<tr>
<td>BMEN 427</td>
<td>Senior Biomedical Engineering Design I</td>
<td>BMEN 271, and BMEN 354, and BMEN 363</td>
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<tr>
<td>BMEN 428</td>
<td>Senior Biomedical Engineering Design II</td>
<td>BMEN 427</td>
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<tr>
<td>CHEM 111</td>
<td>General Chemistry I</td>
<td>MATH 111 (C), MATH 115 (C), MATH 122 (C), MATH 141 (C), or placement into MATH 122, MATH 141, or higher</td>
<td>CHEM 111L</td>
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<tr>
<td>CHEM 111L</td>
<td>General Chemistry I Laboratory</td>
<td>MATH 111, MATH 115, or higher</td>
<td>CHEM 111 (pre or co)</td>
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<tr>
<td>CHEM 112</td>
<td>General Chemistry II</td>
<td>CHEM 221 (C) or CHEM 141 (C), and MATH 111 (C), MATH 115 (C), MATH 122 (C), MATH 141 (C) or higher (C)</td>
<td>MATH 112, and MATH 122, MATH 141 or higher (C)</td>
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<tr>
<td>CHEM 112L</td>
<td>General Chemistry II Laboratory</td>
<td>CHEM 311 (C) or CHEM 111L (C) or CHEM 141 (C) or CHEM 111L (C) or CHEM 141 (C)</td>
<td>CHEM 112 (pre or co)</td>
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<tr>
<td>CHEM 333</td>
<td>Organic Chemistry I</td>
<td>CHEM 112 (C) or CHEM 142 (C)</td>
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<td>CHEM 334</td>
<td>Organic Chemistry II</td>
<td>CHEM 333 (C)</td>
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<td>CHEM 550</td>
<td>Biochemistry</td>
<td>CHEM 550, or BIOL 541</td>
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<tr>
<td>ECH 320</td>
<td>Fluid Mechanics</td>
<td>PHYS 211</td>
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<tr>
<td>ENGL 101</td>
<td>Critical Reading &amp; Composition</td>
<td>ENGL 101 (C)</td>
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<tr>
<td>MATH 141</td>
<td>Calculus I</td>
<td>MATH 112 (C), MATH 115 (C), MATH 116 (C) or by Pre-Calculus Placement Test</td>
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<tr>
<td>MATH 142</td>
<td>Calculus II</td>
<td>MATH 141 (C)</td>
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<tr>
<td>MATH 241</td>
<td>Vector Calculus</td>
<td>MATH 142 (C)</td>
<td></td>
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<tr>
<td>MATH 242</td>
<td>Elementary Differential Equations</td>
<td>MATH 142 (C)</td>
<td></td>
<td>X</td>
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<td>PHYS 211</td>
<td>Essentials of Physics I</td>
<td>MATH 141 (C)</td>
<td></td>
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<tr>
<td>PHYS 211L</td>
<td>Essentials of Physics I Lab</td>
<td>PHYS 211L (pre or co)</td>
<td>PHYS 211 or PHYS 206 (pre or co)</td>
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<td>PHYS 212</td>
<td>Essentials of Physics II</td>
<td>MATH 142 (C) or PHYS 211 (C)</td>
<td>MECH 212</td>
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<td>PHYS 212L</td>
<td>Essentials of Physics II Lab</td>
<td>PHYS 212L (pre or co)</td>
<td>PHYS 212 or PHYS 207 (pre or co)</td>
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<td>STAT 309</td>
<td>Statistics for Engineers</td>
<td>MATH 142</td>
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</table>
Biomedical Engineering Core-Course Descriptions

BMEN 101 - Introduction to Biomedical Engineering I. (2) Introduction to topics comprising the field of Biomedical Engineering, including their ethical impacts. Familiarization with resources and basic skills necessary to succeed in this major and field.

BMEN 211 - Computational Tools for Modeling Biomedical Systems. (3) Introduction to modern computational modeling tools used in biomedical engineering. Analysis and visualization using engineering software as applied to problems of interest in biomedical engineering. Material balance modeling of biomedical systems.

BMEN 212- Fundamentals of Biomedical Systems. (3) Fundamentals of static equilibrium, free body diagrams, force and momentum balances; viscoelastic mechanical behavior and models of viscoelasticity; introduction to linear circuit analysis, filters, and amplifiers.

BMEN 240 - Cellular and Molecular Biology with Engineering Applications. (4) Introduction to molecular, cellular, and physical biology principles and concepts and application of engineering principles to further the understanding of biological systems. Protein and nucleic acid structure and function; DNA replication, mutations, and repair; transcription, translation, and post-translational processing; cellular organization; molecular transport and trafficking; and cellular models.

BMEN 263 - Introduction to Biomechanics. (3) Mathematical and theoretical analysis of the mechanical properties and functions of materials, including those of biological origin and clinical relevance. Stress, strain, mechanical properties of materials, axial loading, torsion, bending, and stress/strain transformations. Application of the categories and methodology of solid mechanics to study biological tissues and events.

BMEN 271 - Introduction to Biomaterials. (3) Properties of metals, ceramics, polymers, natural materials and composites; methods to modify surface and bulk properties of biomaterials; mechanisms of degradation in physiological environments; cell- and tissue-biomaterial interactions; host response to implanted biomaterials; blood-biomaterial interactions; rational design of biomaterials for specific biomedical applications.

BMEN 290 - Thermodynamics of Biomolecular Systems. (3) First, second, and third law of thermodynamics; free energy and chemical equilibrium in biological processes; phase equilibrium for biomedical systems; energy and metabolism; membrane potentials and depolarization.

BMEN 303 - Professional Development and Ethics in Biomedical Engineering III. (1). Analysis and discussion of industries, products, patents, industrial inventiveness, and biomedical research. Ethical issues associated with research, introduction of new products, animal subjects and human subjects.

EHCE 320 – Chemical Engineering Fluid Mechanics. (3). Fluid statics and dynamics with emphasis on chemical engineering applications.

BMEN 345 - Human Anatomy and Physiology for Biomedical Engineers. (4) Foundations for biomedical engineering with a focus on human anatomy and physiology. Introduction to the inter-relationships between tissue/organ structure and function; demonstration of how an engineering approach can promote understanding of these relationships. Recent biomedical engineering advances and their relations to underlying anatomy and physiology.

BMEN 354 – Biotransport. (3) Basics of convective and diffusive transport applied to biological and biomedical systems. The effect of fluid flow and mass transport upon biochemical interactions. Scaling and design of biotransport systems.


BMEN 381 - Biomedical Engineering Laboratory I. (2) Introduction to laboratory techniques and tools used for physiological measurements in biomedical engineering, with focus on biological, physical, and biomaterial methods. Data processing and analysis, as well as effective communication of results in written and oral form.

BMEN 382 - Biomedical Engineering Laboratory II. (2) Introduction to laboratory techniques and tools used for physiological measurements in biomedical engineering, with focus on measurement of biosignals and common analytical methods employed in biomedical research and clinical settings. Data processing and analysis, as well as effective communication of results in written and oral form.

BMEN 391 - Kinetics in Biomolecular Systems. (3) Kinetic theory applied to biomedical systems, including enzymatic reactions, cell growth, and kinetic models of biological systems.

BMEN 427 - Senior Biomedical Engineering Design I. (3) Integrated team work/project management, “voice of the patient,” design specifications, design functions, design concepts, economic factors, concept selection and product architecture. The initial feasibility study, selection of the final design approach, and preliminary specifications are required by the end of the semester.

BMEN 428 - Senior Biomedical Engineering Design II. (3) Design for manufacturability, ergonomic and aesthetic considerations, prototype construction and testing, fabrication and biological testing of tissue engineered constructs, statistical methods/design of experiments, ethics/product liability and social/environmental impact. The final engineering design (specifications, drawings, bill of materials, including assessment of economics) will be completed by the end of the semester. Both written and oral reports are to be provided.
Biomedical Engineering Elective Course Descriptions

BMEN 342 - Infectious Disease and Immunology for Biomedical Engineers. (3) Qualitative and quantitative aspects of infectious diseases; principles of diagnosis and control. Elements of human immunological response and immune disorders; influence on biomedical engineering of explants and implants.

BMEN 389 - Special Topics in Biomedical Engineering for Undergraduates. (3) Course content varies and will be announced in the schedule of classes by suffix and title. May be repeated as topic varies.

BMEN 392 - Fundamentals of Biochemical Engineering. (3) Biological systems are used in chemical industries for a wide variety of applications, including the formation of important products (e.g. pharmaceuticals), sensor technology, degradation, and waste water treatment. This class will provide an overview of materials needed to investigate and model biosystems.

BMEN 499 - Independent Research. (1-3) Summer internship, REU, or co-op experience in biomedical engineering. Students enroll in this course following their research experience and prepare a summary paper and research seminar on their technical accomplishments. A maximum of 3 credits may be applied toward the degree.

BMEN 546 - Delivery of Bioactive Agents. (3) Routes of administration; mechanisms of drug absorption and biological barriers; pharmacokinetic modeling of drug distribution; drug excretion and biotransformation; design and evaluation of controlled release systems, targeted release systems, and responsive release systems.

BMEN 572 - Tissue Engineering. (3) Molecular basis of bioregenerative engineering; biomaterial design; biocompatibility assessment; cell isolation and characterization; rapid prototyping, scaffold fabrication, and biofabrication; protein and gene delivery; bioreactor design; transport in biological tissues; applications of tissue engineering in regenerative medicine.

BMEN 589 - Special Topics in Biomedical Engineering. (3) Course content varies and will be announced in the schedule of classes by suffix and title. May be repeated as topic varies.


EXSC 535 – Biomechanics of Human Movement. (3) Kinetic and kinematic principles governing efficient human movement. Selected methods of analyzing human movement will be reviewed.

PSYC 507 – Cognitive Neuroscience. (3) Research and theories on the role of the brain in facets of cognitive behavior, including attention, short-term and working memory, perception, language, executive function, thinking, and problem solving.
UNDERGRADUATE INDEPENDENT STUDY CONTRACT
ALL required signatures must be obtained prior to registration.
**Students - once this form is signed by your advisor, keep a copy for your records**

<table>
<thead>
<tr>
<th>Instructor and Student to complete</th>
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<tbody>
<tr>
<td>Student’s Name (Print)</td>
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<tr>
<td>Student VIP ID or USC ID</td>
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<tr>
<td>Course</td>
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<td>Term Code</td>
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<tr>
<td>Term</td>
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</table>

| Instructor Name (Print or Type)   | Instructor VIP ID |
| Course Topic (Print or Type)      |

The course topic will appear on the Academic Record. Character Limit: 100 characters including spaces.

| Course Summary (Print or Type)    |
| Objectives (What new skills and/or information will the student acquire?) |

| Textbooks, Readings, or other Resources to be used |
| Method of Evaluation |

**Student to complete**

I certify that this Independent Study: □ Major* □ Minor* □ Cognate* □ Will be used as part of my: □ Major* □ Minor* □ Cognate*

*This grade will be computed in my Grade Point Average (GPA)

□ Will NOT be used as part of my major, minor, or cognate. I will receive a pass/fail grade. (Pass/fail grades do not affect your GPA)

Completion of this form does not constitute registration. Present completed form to the Office of the University Registrar and then register via Self-Service Carolina.

Student signature ___________________________ Date ___________________________

**Instructor to complete**

☐ Yes, this student is conducting undergraduate research (an academic effort intentionally aimed at developing the student’s skills in inquiry and opportunities to contribute to and/or pursue original intellectual, scientific, or creative work).

☐ No. For more information please contact the Office of Undergraduate Research at 777-1141 or our@sc.edu. Instructor’s signature ___________________________ Date ___________________________

| GPA: |
| Grade Point Average of 2.5 or greater required to enroll in independent study courses. (Dean should verify GPA before signing.) |

Only students who take an independent study as part of their major, minor, or cognate may receive grade point credit for independent study.

Independent study credits applied toward any undergraduate degree may account for no more than 10% of the total credit hours for that degree. The total amount of independent study credit per term is limited to six hours.

Instructor’s signature ___________________________ Date ___________________________

| Department Chair/Area of Course Head |
| Student’s Dean’s Signature |
| Date |

AS 6U – 05-2014
Undergraduate Petition Process

It is recognized that at times exceptions to the content of the approved curriculum might be warranted. To provide an avenue for such requests, a petition process has been established. Examples of petitions might include:

- The use of alternative courses as technical electives, technical lab electives, engineering electives, or biomedical engineering electives, particularly new or experimental courses that might not have been offered at the time of curriculum development or a course taken at another institution.

The approved procedure for a student to request faculty review of a proposed curriculum change and the ensuing review process is as follows:

1) The student will complete the petition form, which is included in this advisement booklet or available on the Biomedical Engineering website, and gather the required course information including:
   - Information about non BMEN classes, such as a catalog description, course syllabus, or example course materials and assignments.
   The petition will be considered based upon the information required. If insufficient information is provided for the committee to reach a decision, the petition will be returned to the student without a decision.

2) The student will attach to the petition an unofficial copy of their transcript.

3) The student will discuss the petition with their academic advisor and obtain their signature.

4) The student will submit the completed petition form to the biomedical engineering office, 1B33 Swearingen Engineering Center.

5) The biomedical engineering undergraduate committee will discuss the petition and vote on approval or denial.

6) The undergraduate director will inform the student of the committee decision via email and submit the decision to CEC student services for inclusion in the student’s file.

The petition process may require 1-2 months to allow sufficient review. At any point, the biomedical engineering undergraduate committee or faculty may request additional information from the student concerning the details of the course(s) in question. It is the student’s responsibility to gather and provide this information. The petition process will be facilitated if ample information is provided at the time of submission of the petition.

Students should be aware that submission of a petition is a request for committee approval. As such, there exists a possibility that the petition may be denied. Therefore, it is strongly recommended that a student petition for a curriculum exception prior to enrolling in the course in question.
Undergraduate Student Petition

The petition process is intended to allow students to request faculty approval for modifications to their program of study that deviate from the established BMEN curriculum.

These requests include, but are not limited to, substitution of a core course or elective. These petition requests do not include enrolling in a BMEN course prior to completion of the prerequisites, for which a Prerequisite Waiver Form should be completed instead.

Students should be aware that petitions will be considered on a case-by-case basis. Students are strongly encouraged to complete the petition process prior to enrolling in the course in question. Relevant course syllabi and the student’s transcript from my.sc.edu must be attached.

To be completed by student

Student Name:

VIP ID:

Student Email Address:

Planned Graduation:

Petition Date:

Course Number and Title:

Curriculum Change for:  ☐ Core Course  ☐ Technical Elect  ☐ Technical Lab Elect
☐ Engineering Elect  ☐ Biomed Eng Elect

Petition Summary: Provide a 1-sentence description of the requested curriculum modification, followed by a concise summary for the reason(s) for the request. Use additional pages as needed.

Signature: ________________________________

Academic Advisor

Signature: ________________________________

Undergraduate Director

BMEN Use Only

Submission Date: __________________________ Meeting Attendance: ______
Decision Date: ____________________________ Approve: ______
Notification Date: _________________________ Disapprove: ______
Undergraduate Student Petition

The petition process is intended to allow students to request faculty approval for modifications to their program of study that deviate from the established BMEN curriculum.

These requests include, but are not limited to, substitution of a core course or elective. These petition requests do not include enrolling in a BMEN course prior to completion of the prerequisites, for which a Prerequisite Waiver Form should be completed instead.

Students should be aware that petitions will be considered on a case-by-case basis. Students are strongly encouraged to complete the petition process prior to enrolling in the course in question. Relevant course syllabi and the student’s transcript from my.sc.edu must be attached.

To be completed by student

Student Name:  Ian M. Student
VIP ID:  12345678
Student Email Address:  instudent@mailbox.sc.edu
Planned Graduation:  May 2025
Petition Date:  September 1, 2018
Course Number and Title:  ECHE 499
Curriculum Change for:  ☐ Core Course  ☐ Technical Elect  ☐ Technical Lab Elect
☐ Engineering Elect  ☐ Biomed Engr Elect
Petition Summary:  Provide a 1-sentence description of the requested curriculum modification, followed by a concise summary for the reason(s) for the request. Use additional pages as needed.

I request that ECHE 499 be used as a Biomedical Engineering elective in my program of study.
The research that I will conduct during my enrollment in ECHE 499 will entail the study of the amyloid-β protein involved in Alzheimer’s disease. This research will be biomedical in nature and will implement several biomedical engineering concepts. Attached is a summary of the project that I proposed to complete during the semester.

Signature:  
Academic Advisor

Signature:  
Undergraduate Director

BMEN Use Only

Submission Date:  
Meeting Attendance:  
Decision Date:  
Approve:  
Notification Date:  
Disapprove:  

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Undergraduate Pre-Requisite Waiver Process

Certain extenuating circumstances may lead a student to consider taking a course prior to fulfillement of pre- or co- requisites. To provide an avenue for such requests, a pre-requisite waiver process has been established.

The approved procedure for a student to request faculty review of a pre-requisite waiver and the ensuing review process is as follows:

1) The student will complete the pre-requisite waiver form, which is included in this advisement booklet or available on the Biomedical Engineering website, and gather any supporting materials. Examples include:
   - Information about non BMEN classes relevant to the petition, such as a catalog description, course syllabus, or example course materials and assignments

   The pre-requisite waiver will be considered based upon the information required. If insufficient information is provided for the committee to reach a decision, the pre-requisite waiver will be returned to the student without a decision.

2) The student will attach to the pre-requisite waiver form an unofficial copy of their transcript.

3) The student will discuss the pre-requisite waiver with the instructor on record for the course they wish to take. The student will submit the form to this instructor.

4) The INSTRUCTOR will sign and submit the completed pre-requisite waiver form to the biomedical engineering office, 1B33 Swearingen Engineering Center.

5) The biomedical engineering undergraduate committee will discuss the request and vote on approval or denial.

6) The undergraduate director will inform the student of the committee decision via email and submit the decision to CEC student services for inclusion in the student’s file.

The pre-requisite waiver process may require 1-2 months to allow sufficient review. At any point, the biomedical engineering undergraduate committee or faculty may request additional information from the student concerning the details of the course(s) in question. It is the student’s responsibility to gather and provide this information. The petition process will be facilitated if ample information is provided at the time of submission of the petition.

Students must submit a pre-requisite waiver prior to enrollment in a course. Submission of a waiver is a request for committee approval. As such, there exists a possibility that the petition may be denied.
Prerequisite Waiver Form

This form is required for requests to enroll in a BMEN course prior to completion of the prerequisites. Students should be aware that each request will be considered on a case-by-case basis. Relevant course syllabi and the student’s transcript from my.sc.edu must be attached. Students must complete this process by the third class period of the course in question. The completed form is to be submitted to the instructor.

To be completed by student

Student Name:

VIP ID:

Student Email Address:

Planned Graduation Date:

BMEN Course: (Include the Semester, e.g. BMEN XXX Fall 2018)

Prerequisites Not Satisfied:

Why the Prerequisites are Not Satisfied:

What is being done to make up the necessary material:

Provide a concise description of what you have done to ensure that you will be prepared for the material in this class. Taking the pre-requisite as a co-requisite is not an acceptable approach.

To be completed by faculty (course instructor)

Instructor’s Recommendation: □ Favorable □ Unfavorable

Instructor’s Signature: ____________________________

The instructor is to return the completed and signed form to Leslie Jenkins

BMEN Use Only

Submission Date: ____________________________ Meeting Attendance: ________

Decision Date: ____________________________ Approve: ________

Notification Date: ____________________________ Disapprove: ________
Prerequisite Waiver Form

This form is required for requests to enroll in a BMEN course prior to completion of the prerequisites. Students should be aware that each request will be considered on a case-by-case basis. Relevant course syllabi and the student’s transcript from my.sc.edu must be attached. Students must complete this process by the third class period of the course in question. The completed form is to be submitted to the instructor.

To be completed by student

Student Name: Ian M. Student
VIP ID: 12345678
Student Email Address: instudent@mailbox.sc.edu
Planned Graduation Date: May 2025
BMEN Course: BMEN 427, Fall 2024
Prerequisites Not Satisfied: BMEN 391

Why the Prerequisites are Not Satisfied:
I participated in study abroad during the fall of my junior year and was unable to identify an equivalent course for BMEN 391.

What is being done to make up the necessary material?
Provide a concise description of what you have done to ensure that you will be prepared for the material in this class. Taking the pre-requisite as a co-requisite is not an acceptable approach!
During my study abroad, I completed both a Biochemistry course and a Chemical Engineering Kinetics course. The material from these classes has provided me with some fundamentals of the course material for BMEN 391. In addition, I completed tutoring over the summer in the area of biokinetics. In combination with my concurrent enrollment in BMEN 391 and BMEN 427, I believe that I have the knowledge and skills to not fall behind on the material in BMEN 427 and to make significant contributions to my design project.

To be completed by faculty (course instructor)

Instructor’s Recommendation: ☐ Favorable ☐ Unfavorable
Instructor’s Signature: ________________________________

The instructor is to return the completed and signed form to Leslie Jenkins

BMEN Use Only

Submission Date: ____________________ Meeting Attendance: _______
Decision Date: ____________________ Approve: _______
Notification Date: ____________________ Disapprove: _______
The Bachelor’s/Master’s Degrees Accelerated Program in Biomedical Engineering allows undergraduate students to complete both the B.S. degree and the M.S. degree in as few as five years. The use of dual credit—courses that can be used toward both degrees—enables acceleration of the program by reducing the total enrollment of the student by one semester.

Biomedical Engineering undergraduate students may apply for approval of an accelerated education plan in the semester in which they will complete 90 hours of undergraduate course work. In addition, students must have a sufficient foundation in biomedical engineering course work to enable them to take graduate-level courses. University and program regulations stipulate that applicants must have a minimum GPA of 3.40, both overall and in biomedical engineering courses. Students in the accelerated program must maintain a GPA of 3.40 while pursuing the B.S. degree.

Students applying to this program must submit to the Graduate School a completed “Application for Admission to a Combined Bachelor’s/Master’s Education Plan” (G-BMPA) with endorsements of their undergraduate advisor, their research advisor, and the program graduate director. The dean of the Graduate School has final authority for approving accelerated education plans. A “Bachelor’s/Master’s Degree Accelerated Plan Course Work Authorization” form must be submitted for each semester in which one or more graduate-level courses are taken.

Participation in the accelerated program does not require or insure acceptance into the Graduate School. Students wishing to continue towards a Master’s degree in biomedical engineering at USC must apply formally to the Graduate School by submitting the appropriate application and all required supporting documents. Students in the accelerated program will be eligible for graduate assistantships upon admission to the Graduate School.

Only graduate-level courses (numbered 500 and above, including up to 3 credit hours of project/research work) satisfying both B.S. and Master’s degree requirements may be used for dual credit. BMEN core graduate courses (excluding 1-hour seminar courses and thesis preparation, BMEN 799) or courses from the list of the approved BMEN graduate electives (refer to the graduate student handbook) may be used for graduate-level coursework. The graduate courses used for dual credit must be taken during the student’s final undergraduate year. No more than 12 credit hours may be applied towards both the Bachelor’s and Master’s degree.

Eligibility criterion and applications procedures are summarized on the following page.
Eligibility Criterion

- GPA 3.4, both overall and in BMEN courses
- Senior Standing (90 hours by the end of the semester)

Application Procedure

1. Students should first discuss the BS/MS program with their undergraduate academic advisor, their research advisor, and the graduate director, to ensure that they are a good candidate.
2. Fill out the G-BMPA Form (Application for Admission to a Combined Bachelor’s/Master’s Education Plan) found at http://gradschool.sc.edu/DocLibrary/. Complete this form in consultation with the academic advisor and the graduate director. Obtain required signatures.
3. Fill out the G-BMCA Form (Bachelor’s/Master’s Degree Accelerated Plan Course Work Authorization) found at http://gradschool.sc.edu/DocLibrary/. Complete this form in consultation with the academic advisor and the graduate director. Obtain required signatures.
4. Submit the completed G-BMPA and G-BMCA forms to the Graduate School for approval. Approval of admission to the accelerated program and course enrollment privileges must be obtained before classes for the term begin. No retroactive permission is given.
5. Students who wish to be considered for graduate admission to a Master’s program at USC must also submit to the Graduate School a completed application and any additional credentials, scores and/or documentation as required by that Master’s program (http://www.gradschool.sc.edu/apply.htm).

Additional Considerations

- Dual credit courses must be taken during the student’s final undergraduate year.
- No more than 12 graduate credit hours may be applied towards both the Bachelor’s and Master’s degree.
- Admission to the Accelerated Bachelor’s/Master’s program does not guarantee admission to the Graduate School or to the Master’s program.
Still Have Questions?

Contact Us:
Email: BMEUndergrad@cec.sc.edu
Phone: 803-777-2310
Location: 1B33, Swearingen Engineering Center

Visit our websites:
Program Information:
http://sc.edu/study/colleges_schools/engineering_and_computing/study/areas_of_study/biomedical_engineering/index.php
Information and links for current undergraduate students:
http://sc.edu/study/colleges_schools/engineering_and_computing/my_cec/bme/undergraduates/index.php
Advisement FAQs:
http://sc.edu/study/colleges_schools/engineering_and_computing/my_cec/bme/undergraduates/faqs_advisement.php