BACHELOR OF SCIENCE IN BIOENGINEERING (BSBE) DEGREE

The program leading to the BSBE degree is accredited by the Engineering Accreditation Commission (EAC) of ABET, https://www.abet.org.

Program Learning Outcomes (Student Outcomes) for the BSBE Degree

Upon completing the BSBE degree, students will be able to demonstrate:

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

Program Educational Objectives for the BSBE Degree

The overall goal of the Bachelor of Science in Bioengineering (BSBE) degree is to prepare graduates to succeed in professional careers by equipping them with the conceptual and technical expertise sought after by top graduate and medical schools, as well as by companies seeking technical skills in bioengineering. Recognizing that graduates may embark on a number of different educational and career paths, the Program Educational Objectives (PEOs) that graduates are expected to meet by top graduate and medical schools, as well as by companies seeking technical skills in bioengineering. Recognizing that graduates may embark on a number of different educational and career paths, the Program Educational Objectives (PEOs) that graduates are expected to meet are:

1. Graduates demonstrate technical and/or professional skills, which may include engineering problem-solving, scientific inquiry, and/or engineering design, to solve challenging problems in bioengineering and related fields.
2. Graduates are accomplished at communicating and working collaboratively in diverse work environments.
3. Graduates seeking further education at graduate, medical or other professional schools find appropriate levels of success in admission to and progression through these programs. Graduates entering professional careers find appropriate career progression and success.

Requirements for the BSBE Degree

For general university requirements, see Graduation Requirements (ga.rice.edu/undergraduate-students/academic-policies-procedures/graduation-requirements). Students pursuing the BSBE degree must complete:

- A minimum of 37 courses (95 or 97 credit hours, depending on course selection) to satisfy major requirements.
- A minimum of 134 credit hours to satisfy degree requirements.
- A minimum of 20 courses (48 credit hours) taken at the 300-level or above.

The courses listed below satisfy the requirements for this major. In certain instances, courses not on this official list may be substituted upon approval of the major’s academic advisor, or where applicable, the department’s Director of Undergraduate Studies. (Course substitutions must be formally applied and entered into Degree Works by the major’s Official Certifier (https://registrar.rice.edu/facstaff/degreeworks/officialcertifier).) Students and their academic advisors should identify and clearly document the courses to be taken.

Summary

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Total Credit Hours Required for the Major in Bioengineering</td>
<td>95 or 97</td>
</tr>
<tr>
<td></td>
<td>Total Credit Hours Required for the BSBE Degree</td>
<td>134</td>
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Degree Requirements

<table>
<thead>
<tr>
<th>Code</th>
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<th>Credit Hours</th>
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<tbody>
<tr>
<td></td>
<td>Core Requirements</td>
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<tr>
<td></td>
<td>Bioengineering Core Courses</td>
<td></td>
</tr>
<tr>
<td>BIOE 252</td>
<td>BIOENGINEERING FUNDAMENTALS ³</td>
<td>3</td>
</tr>
<tr>
<td>BIOE 320</td>
<td>SYSTEMS PHYSIOLOGY LAB MODULE ³</td>
<td>1</td>
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<tr>
<td>BIOE 322</td>
<td>FUNDAMENTALS OF SYSTEMS PHYSIOLOGY ³</td>
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<td>BIOE 330</td>
<td>BIOREACTION ENGINEERING</td>
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</tr>
<tr>
<td>BIOE 332</td>
<td>BIOENGINEERING THERMODYNAMICS</td>
<td></td>
</tr>
<tr>
<td>BIOE 342 / BIOC 320</td>
<td>LABORATORY IN TISSUE CULTURE</td>
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<tr>
<td>BIOE 370</td>
<td>BIOMATERIALS</td>
<td></td>
</tr>
<tr>
<td>BIOE 372</td>
<td>BIOMECHANICS</td>
<td></td>
</tr>
<tr>
<td>BIOE 383</td>
<td>BIOMEDICAL ENGINEERING INSTRUMENTATION</td>
<td></td>
</tr>
<tr>
<td>BIOE 385</td>
<td>BIOMEDICAL INSTRUMENTATION LAB</td>
<td></td>
</tr>
<tr>
<td>BIOE 391</td>
<td>NUMERICAL METHODS ³</td>
<td>3</td>
</tr>
<tr>
<td>BIOE 420 / CHBE 420</td>
<td>TRANSPORT PHENOMENA IN BIOENGINEERING</td>
<td>3</td>
</tr>
<tr>
<td>Select 1 course from the following:</td>
<td>1 or 3</td>
<td></td>
</tr>
<tr>
<td>BIOE 439</td>
<td>APPLIED STATISTICS FOR BIOENGINEERING AND BIOTECHNOLOGY</td>
<td></td>
</tr>
<tr>
<td>BIOE 440 / STAT 440</td>
<td>STATISTICS FOR BIOENGINEERING ³</td>
<td></td>
</tr>
<tr>
<td>BIOE 451</td>
<td>BIOENGINEERING DESIGN I</td>
<td>3</td>
</tr>
<tr>
<td>BIOE 452</td>
<td>BIOENGINEERING DESIGN II</td>
<td>3</td>
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<tr>
<td>Bioengineering Laboratory Courses</td>
<td></td>
<td></td>
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</table>
Select 2 courses from the following (different laboratory modules may be offered each year):

- BIOE 442 TISSUE ENGINEERING LAB MODULE
- BIOE 443 BIOPROCESSING LAB MODULE
- BIOE 444 MECHANICAL TESTING LAB MODULE
- BIOE 445 ADVANCED INSTRUMENTATION LAB MODULE
- BIOE 446 COMPUTATIONAL MODELING LAB
- BIOE 447 DIGITAL DESIGN & VISUALIZATION
- BIOE 449 / GLHT 449 TROUBLESHOOTING WORKSHOP FOR CLINICALLY-RELEVANT BIOMEDICAL EQUIPMENT

Biosciences
- BIOC 201 INTRODUCTORY BIOLOGY
- BIOC 341 CELL BIOLOGY

Chemistry
- CHEM 121 GENERAL CHEMISTRY I
- CHEM 122 GENERAL CHEMISTRY II
- CHEM 123 and GENERAL CHEMISTRY LABORATORY I
- CHEM 211 ORGANIC CHEMISTRY I
- CHEM 212 ORGANIC CHEMISTRY II

Computational and Applied Mathematics
- CAAM 210 INTRODUCTION TO ENGINEERING COMPUTATION

Electrical Engineering
- ELEC 243 ELECTRONIC MEASUREMENT SYSTEMS

Mathematics
- MATH 101 SINGLE VARIABLE CALCULUS I
- MATH 102 SINGLE VARIABLE CALCULUS II
- MATH 105 or AP/OTH CREDIT IN CALCULUS I
- MATH 106 or AP/OTH CREDIT IN CALCULUS II
- MATH 211 ORDINARY DIFFERENTIAL EQUATIONS
- MATH 212 MULTIVARIABLE CALCULUS

Mechanical Engineering
- MECH 403 ENGINEERING MECHANICS

Physics
- PHYS 101 MECHANICS (WITH LAB)
- PHYS 102 ELECTRICITY & MAGNETISM (WITH LAB)
- PHYS 111 HONORS MECHANICS (WITH LAB)
- PHYS 112 HONORS ELECTRICITY & MAGNETISM (WITH LAB)
- PHYS 125 GENERAL PHYSICS (WITH LAB)
- PHYS 126 GENERAL PHYSICS II (WITH LAB)

Select 1 course from the following:

- PHYS 101 MECHANICS (WITH LAB)
- PHYS 102 ELECTRICITY & MAGNETISM (WITH LAB)
- PHYS 103 MECHANICS DISCUSSION
- PHYS 111 HONORS MECHANICS (WITH LAB)
- PHYS 112 HONORS ELECTRICITY & MAGNETISM (WITH LAB)
- PHYS 125 GENERAL PHYSICS (WITH LAB)
- PHYS 126 GENERAL PHYSICS II (WITH LAB)

Select 1 course from the following:

- PHYS 103 MECHANICS DISCUSSION
- PHYS 111 HONORS MECHANICS (WITH LAB)
- PHYS 112 HONORS ELECTRICITY & MAGNETISM (WITH LAB)
- PHYS 125 GENERAL PHYSICS (WITH LAB)
- PHYS 126 GENERAL PHYSICS II (WITH LAB)

Select a minimum of 3 elective courses and 6 Engineering Points from the Technical Elective course offerings (see course list below)

Total Credit Hours Required for the Major in Bioengineering: 95-97

Footnotes and Additional Information

- Includes coursework completed as distribution credit, FWIS, LPAP, upper-level, residency (hours taken at Rice), 60 hours outside of the major (if applicable), and any additional academic program requirements. The “hours outside of the major” requirement may include all of the above university requirements.
- Students should complete these courses during their freshman year.
- If BIOE 447 is taken as a Bioengineering Laboratory Course, the student should note that MECH 403, listed in the Technical Electives section, will not count as a course that satisfies the Technical Elective requirement.
- Students should complete these courses during their sophomore year.

Course Lists to Satisfy Requirements

Technical Electives
To fulfill the remaining BIOE major requirements, students must complete a minimum of 3 courses (9 credit hours) and 6 engineering points from the Technical Elective course offerings. A combination of technical electives must be selected that meets this minimum of 3 courses (9 credit hours) and 6 engineering points.

Please Note: The following list of courses are those that satisfy the approved Technical Electives requirement. In certain instances, courses not on this official list may be substituted upon approval of the department’s Director of Undergraduate Studies. Students and their academic advisors should identify and clearly document the courses to be taken.

Engineering Points
Courses listed below may count toward the Technical Elective requirement (minimum of 3 courses (9 credit hours) and 6 engineering points), and will carry the following Engineering Point values.

Please Note: the list of courses and their associated engineering point values may change. Students should check with their academic advisor before registering for technical elective courses.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOE 401</td>
<td>UNDERGRADUATE RESEARCH</td>
<td>1-4</td>
</tr>
<tr>
<td>BIOE 392 / GLHT 392</td>
<td>NEEDS FINDING AND DEVELOPMENT IN BIOENGINEERING</td>
<td>3</td>
</tr>
<tr>
<td>BIOE 400</td>
<td>ENGINEERING UNDERGRADUATE RESEARCH</td>
<td>1-4</td>
</tr>
<tr>
<td>BIOE 403</td>
<td>ADVANCES IN BIONANOTECHNOLOGY</td>
<td>3</td>
</tr>
<tr>
<td>BIOE 408</td>
<td>SYNTHETIC BIOLOGY</td>
<td>3</td>
</tr>
<tr>
<td>BIOE 422</td>
<td>GENE THERAPY</td>
<td>3</td>
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</table>
Bachelor of Science in Bioengineering (BSBE) Degree

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
</table>
| BIOE 464 /  
BIOC 464  | EXTRACELLULAR MATRIX                             |         |
| BIOE 524 /  
BIOC 523  | EXTRACELLULAR MATRIX                             |         |
| BIOE 485 /  
COMP 485 /  
ELEC 485  | FUNDAMENTALS OF MEDICAL IMAGING I                | 3       |
| BIOE 486 /  
COMP 486 /  
ELEC 486  | FUNDAMENTALS OF MEDICAL IMAGING II               | 3       |
| BIOE 492    | SENSORY NEUROENGINEERING                        | 3       |
| BIOE 523 /  
CHBE 523   | BIOENGINEERING SYSTEMS AND CONTROL              | 3       |
| BIOE 580 /  
CHBE 580   | PROTEIN ENGINEERING                              | 3       |
| BIOE 587    | OPTICAL IMAGING AND NANOBIPHOTONICS             | 3       |
| BIOE 589 /  
BIOS 589    | COMPUTATIONAL MOLECULAR BIOENGINEERING/BIOPHYSICS | 3     |
| BIOE 620 /  
CHBE 620   | TISSUE ENGINEERING                              | 3       |
| CHBE 310    | FUNDAMENTALS OF BIOMOLECULAR ENGINEERING        | 3       |
| ENGI 300    | ENGINEERING DESIGN WORKSHOP                     | 2-3     |
| ELEC 220    | FUNDAMENTALS OF COMPUTER ENGINEERING            | 4       |
| MECH 311 /  
CEVE 311   | MECHANICS OF SOLIDS AND STRUCTURES              | 3       |

**Two (2) Engineering Points**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>BIOE 321</td>
<td>CELLULAR ENGINEERING</td>
<td>3</td>
</tr>
</tbody>
</table>
| BIOE 381 /  
ELEC 381   | FUNDAMENTALS OF NERVE AND MUSCLE ELECTROPHYSIOLOGY | 3     |
| BIOE 431    | BIOMATERIALS APPLICATIONS                        | 3       |
| BIOE 481 /  
ELEC 481 /  
NEUR 481   | COMPUTATIONAL NEUROSCIENCE AND NEURAL ENGINEERING | 3     |
| BIOE 482 /  
ELEC 482   | PHYSIOLOGICAL CONTROL SYSTEMS                   | 3       |
| BIOE 643 /  
BIOS 643 /  
PHYS 643   | CELL MECHANICS, MECHANOTRANSDUCTION AND THE CELL MICROENVIRONMENT | 3 |
| CHBE 640 /  
BIOS 540   | METABOLIC ENGINEERING                            | 3       |
| COMP 571 /  
BIOS 571   | BIOINFORMATICS: SEQUENCE ANALYSIS                | 3       |
| ELEC 327    | IMPLEMENTATION OF DIGITAL SYSTEMS               | 3       |
| ELEC 432    | MOBILE BIO-BEHAVIORAL SENSING                    | 3       |

**Three (3) Engineering Points**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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</table>
| BIOE 360 /  
GLHT 360   | APPROPRIATE DESIGN FOR GLOBAL HEALTH             | 3       |
| BIOE 421    | MICROCONTROLLER APPLICATIONS                     | 3       |
| BIOE 454 /  
MECH 454 /  
CEVE 454   | COMPUTATIONAL FLUID MECHANICS                    | 3       |
| BIOE 484    | BIOPHOTONICS INSTRUMENTATION AND APPLICATIONS    | 3       |
| BIOE 490    | INTRO COMPUTATIONAL SYSTEMS BIOLOGY: MODELING & DESIGN PRINCIPLES OF BIOCHEM NETWORKS | 3 |
| BIOE 574    | CONTINUUM BIOMECHANICS                           | 3       |
| CHBE 390    | CHEMICAL KINETICS AND REACTOR DESIGN             | 3       |
| COMP 502 /  
ELEC 502 /  
STAT 502   | NEURAL MACHINE LEARNING I                        | 3       |
| ELEC 301    | SIGNALS, SYSTEMS, AND LEARNING                   | 3       |
| ELEC 326 /  
COMP 326   | DIGITAL LOGIC DESIGN                             | 3       |
| ELEC 342    | ANALOG ELECTRONIC CIRCUITS                       | 3       |
| ELEC 422    | VLSI SYSTEMS DESIGN                              | 3       |
| ELEC 435 /  
MECH 435   | INTRODUCTION TO ENERGY-EFFICIENT MECHATRONICS    | 3       |
| MECH 371    | FLUID MECHANICS I                                | 3       |
| MECH 400 /  
CEVE 400   | ADVANCED MECHANICS OF MATERIALS                  | 3       |
| MECH 403    | COMPUTER AIDED DESIGN 4                          | 3       |
| MECH 417 /  
CEVE 417   | FINITE ELEMENT ANALYSIS                          | 3       |
| MECH 420 /  
ELEC 436   | FUNDAMENTALS OF CONTROL SYSTEMS                  | 3       |
| MECH 488    | DESIGN OF MECHATRONIC SYSTEMS                    | 3       |
| MSNE 402    | MECH PROPERTIES OF MATERIALS                     | 3       |

**Four (4) Engineering Points**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
</table>
| BIOE 364 /  
BIOC 364 /  
GLHT 364   | APPROPRIATE DESIGN FOR GLOBAL HEALTH              | 3       |
| BIOE 421    | MICROCONTROLLER APPLICATIONS                     | 3       |
| BIOE 454 /  
MECH 454 /  
CEVE 454   | COMPUTATIONAL FLUID MECHANICS                    | 3       |
| BIOE 484    | BIOPHOTONICS INSTRUMENTATION AND APPLICATIONS    | 3       |

**Footnotes and Additional Information**

1 BIOE 400: Students may earn 1 engineering point for every 3 credit hours completed. A maximum of 2 engineering points can be applied towards the 6 points requirement by completing BIOE 400 courses.

2 ENGI 300: Students may earn 1 engineering point for every credit hour completed. A maximum of 4 engineering points, and 6 credit hours, may be applied towards the Technical Elective requirement from ENGI 300 or from a combination of independent research and/or design courses (i.e. ENGI 300, BIOE 400, BIOE 401, BIOE 360/GLHT 360).

3 BIOE 360: This course is a design course. See ENGI 300 Note. A maximum of 4 engineering points, and 6 credit hours, may be applied towards the Technical Elective requirement from independent research and/or design courses.

4 MECH 403 can be applied toward the Technical Elective requirement only in the event that BIOE 447 is not completed as a Senior Lab requirement.

**Policies for the BSBE Degree**

**Transfer Credit**

For Rice University’s policy regarding transfer credit, see Transfer Credit (ga.rice.edu/undergraduate-students/academic-policies-procedures/transfer-credit). Some departments and programs have additional restrictions on transfer credit. The Office of Academic Advising maintains the university’s official list of transfer credit advisors on their website: https://oaa.rice.edu. Students are encouraged to meet with their
academic program's transfer credit advisor when considering transfer credit possibilities.

**Departmental Transfer Credit Guidelines**

Students pursuing the BSBE degree should be aware of the following departmental transfer credit guidelines:

- Requests for transfer credit will be considered by the program director (and/or the program's official transfer credit advisor) on an individual case-by-case basis.

**Additional Information**

For additional information, please see the Bioengineering website: [https://bioengineering.rice.edu/](https://bioengineering.rice.edu/)

**Opportunities for the BSBE Degree**

**Academic Honors**

The university recognizes academic excellence achieved over an undergraduate's academic history at Rice. For information on university honors, please see Latin Honors ([ga.rice.edu/undergraduate-students/honors-distinctions/university](ga.rice.edu/undergraduate-students/honors-distinctions/university)) (summa cum laude, magna cum laude, and cum laude) and Distinction in Research and Creative Work ([ga.rice.edu/undergraduate-students/honors-distinctions/university](ga.rice.edu/undergraduate-students/honors-distinctions/university)). Some departments have department-specific Honors awards or designations.

**Fifth-Year Master's Degree Option for Rice Undergraduate Students**

Rice students have an option to pursue the Master of Bioengineering (MBE) degree by adding an additional fifth year to their four undergraduate years of science and engineering studies.

Advanced Rice undergraduate students in good academic standing may apply to the MBE degree program during their junior or senior year. Upon acceptance, depending on course load, financial aid status, and other variables, they may then start taking some required courses of the master’s degree program. A plan of study will need to be approved by the student's undergraduate advisor and the MBE program director.

As part of this option and opportunity, Rice undergraduate students:

- must complete the requirements for a bachelor's degree and the master's degree independently of each other (i.e. no course may be counted toward the fulfillment of both degrees).
- should be aware there could be financial aid implications if the conversion of undergraduate coursework to that of graduate level reduces their earned undergraduate credit for any semester below that of full-time status (12 credit hours).
- more information on this Undergraduate - Graduate Concurrent Enrollment opportunity, including specific information on the registration process can be found here ([ga.rice.edu/undergraduate-students/academic-opportunities/undergraduate-graduate-concurrent-enrollment](ga.rice.edu/undergraduate-students/academic-opportunities/undergraduate-graduate-concurrent-enrollment)).

**Additional Information**

For additional information, please see the Bioengineering website: [https://bioengineering.rice.edu/](https://bioengineering.rice.edu/)