BACHELOR OF SCIENCE IN BIOENGINEERING (BSBE) DEGREE

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

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 exhibit or achieve with the Bachelor of Science in Bioengineering (BSBE) degree from Rice University 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 (https://ga.rice.edu/undergraduate-students/academic-policies-procedures/graduation-requirements/). Students pursuing the BSBE degree must complete:

- A minimum of 37 courses (97-99 credit hours, depending on course selection) to satisfy major requirements.
- A minimum of 131 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

Code	Title	Credit Hours
Total Credit Hours Required for the Major in Bioengineering		97-99
Total Credit Hours Required for the BSBE Degree		131

Degree Requirements

Code	Title	Credit Hours
Core Requirements		
Biosciences		
BIOS 201	INTRODUCTORY BIOLOGY I [2]	3
BIOS 341	CELL BIOLOGY [7]	3
Chemistry		
CHEM 121	GENERAL CHEMISTRY I [1]	3
or CHEM 111	AP/OTH CREDIT IN GENERAL CHEMISTRY I	
CHEM 123	GENERAL CHEMISTRY LABORATORY I [1]	1
or CHEM 113	AP/OTH CREDIT IN GENERAL CHEMISTRY LAB I	
CHEM 122	GENERAL CHEMISTRY II [1]	3
or CHEM 112	AP/OTH CREDIT IN GENERAL CHEMISTRY II	
CHEM 124	GENERAL CHEMISTRY LABORATORY II [1]	1
or CHEM 114	AP/OTH CREDIT IN GENERAL CHEMISTRY LAB II	
CHEM 211 & CHEM 213	ORGANIC CHEMISTRY I and ORGANIC CHEMISTRY DISCUSSION I [2]	3
Computational Applied Mathematics and Operations Research		
CMOR 220	INTRODUCTION TO ENGINEERING COMPUTATION [1]	3
Electrical Engineering		
ELEC 243	ELECTRONIC MEASUREMENT SYSTEMS [2]	4
Mathematics		
MATH 101	SINGLE VARIABLE CALCULUS I [1]	3
or MATH 105	AP/OTH CREDIT IN CALCULUS I	

MATH 102	SINGLE VARIABLE CALCULUS II [1]	3
or MATH 106	AP/OTH CREDIT IN CALCULUS II	
MATH 211	ORDINARY DIFFERENTIAL EQUATIONS AND LINEAR ALGEBRA [2]	3
MATH 212	MULTIVARIABLE CALCULUS [2]	3
Mechanical Engineering		
MECH 202	MECHANICS/STATICS	3
or MECH 211 / CEVE 211	ENGINEERING MECHANICS	
Physics		
Select 1 from the following:		*4*
PHYS 101 & PHYS 103	MECHANICS (WITH LAB) and MECHANICS DISCUSSION [1, 3]	
PHYS 111	HONORS MECHANICS (WITH LAB) [1, 3]	
PHYS 125	GENERAL PHYSICS (WITH LAB) [1, 3]	
Select 1 from the following:		*4*
PHYS 102 & PHYS 104	ELECTRICITY & MAGNETISM (WITH LAB) and ELECTRICITY AND MAGNETISM DISCUSSION [1, 3]	
PHYS 112	HONORS ELECTRICITY & MAGNETISM (WITH LAB) [1, 3]	
PHYS 126	GENERAL PHYSICS II (WITH LAB) [1, 3]	
Bioengineering Core Courses		
BIOE 252	BIOENGINEERING FUNDAMENTALS [2]	4
BIOE 320	SYSTEMS PHYSIOLOGY LAB MODULE [2]	1
BIOE 322	FUNDAMENTALS OF SYSTEMS PHYSIOLOGY [2]	3
BIOE 330	BIOREACTION ENGINEERING [5]	3
BIOE 332	BIOENGINEERING THERMODYNAMICS [5]	3
BIOE 342	LABORATORY IN TISSUE CULTURE	1
BIOE 370	BIOMATERIALS	3
BIOE 372	BIOMECHANICS	3
BIOE 383	BIOMEDICAL ENGINEERING INSTRUMENTATION	3
BIOE 385	BIOMEDICAL INSTRUMENTATION LAB	1
BIOE 391	NUMERICAL METHODS [2]	3
BIOE 420 / CHBE 420	TRANSPORT PHENOMENA IN BIOENGINEERING [5]	3
Select 1 course from the following:		*1 or 3*
BIOE 439	APPLIED STATISTICS FOR BIOENGINEERING AND BIOTECHNOLOGY	
BIOE 440 / STAT 440	STATISTICS FOR BIOENGINEERING [2]	
BIOE 451	BIOENGINEERING DESIGN I	4
BIOE 452	BIOENGINEERING DESIGN II	3
Bioengineering Laboratory Courses [4]		
Select 2 courses from the following (different laboratory modules may be offered each year):		*2*
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 [6]	
BIOE 449 / GLHT 449	TROUBLESHOOTING WORKSHOP FOR CLINICALLY-RELEVANT BIOMEDICAL EQUIPMENT	
Technical Electives		
Select a minimum of 3 elective courses and 6 Engineering Points from the Technical Elective course offerings (see course list below)		*9*
Total Credit Hours Required for the Major in Bioengineering		**97-99**
Additional Credit Hours to Complete Degree Requirements *		2-4
University Graduation Requirements (https://ga.rice.edu/undergraduate-students/academic-policies-procedures/graduation-requirements/) *		31
Total Credit Hours		**131**

Footnotes and Additional Information

* **Note:** University Graduation Requirements include 31 credit hours, comprised of Distribution Requirements (Groups I, II, and III), FWIS, and LPAP coursework. In some instances, courses satisfying FWIS or distribution requirements may additionally meet other requirements, such as the Analyzing Diversity (AD) requirement, or some of the student's declared major, minor, or certificate requirements. Additional Credit Hours to Complete Degree Requirements include general electives, coursework completed as upper-level, residency (hours taken at Rice), and/or any other additional academic program requirements.

1 Students should complete these courses during their freshman year.

2 Students should complete these courses during their sophomore year.

3 The Bioengineering department has determined that credit awarded for PHYS 141 *CONCEPTS IN PHYSICS I* and credit awarded for PHYS 142 *CONCEPTS IN PHYSICS II* are not eligible for meeting the requirements of the Bioengineering major.

4 BIOE 400 can be counted in place of one of the required senior laboratory courses if taken for at least 3 credit hours at once. If used in this capacity, the student cannot also count that iteration of the course towards an Engineering Point or Technical Elective Requirements.

5 One of BIOE 330, BIOE 332, or BIOE 420 can be replaced with one or more additional Technical Elective courses of equal or greater BIOE Engineering Points value. Engineering points for the courses are: BIOE 330 (2 points), BIOE 332 (3 points), or BIOE 420 (3 points).

6 If BIOE 447 is taken as a Bioengineering Laboratory course, the student should note that ENGI 355, listed in the Technical Electives section, will not count as a course that satisfies the Technical Electives Requirement.

7 Students may choose to take BIOE 341 *Cell and Molecular Biology for Engineers* in place of BIOS 341.

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. If a student should choose to replace one of the optional core courses (BIOE 330, BIOE 332, or BIOE 420), then a minimum of 4 Technical Electives will be required as

well as adequate Engineering Points for the replaced course's value (2 to 3 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.

Code	Title	Credit Hours
Zero (0) Engineering Points		
BIOE 401	UNDERGRADUATE RESEARCH	1-4
One (1) Engineering Point		
BIOE 380 / ELEC 380 / NEUR 383	INTRODUCTION TO NEUROENGINEERING: MEASURING AND MANIPULATING NEURAL ACTIVITY	3
BIOE 392 / GLHT 392	NEEDS FINDING AND DEVELOPMENT IN BIOENGINEERING [3]	3
BIOE 400	ENGINEERING UNDERGRADUATE RESEARCH [1,2,5]	1-4
BIOE 408	SYNTHETIC BIOLOGY	3
BIOE 422	GENE THERAPY	3
BIOE 464	EXTRACELLULAR MATRIX	3
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 543	DNA BIOTECHNOLOGY, BIOPHYSICS, AND MODELING	3
BIOE 580 / CHBE 580	PROTEIN ENGINEERING	3
BIOE 587	OPTICAL IMAGING AND NANOBIOPHOTONICS	3
BIOE 589	COMPUTATIONAL MOLECULAR BIOENGINEERING/BIOPHYSICS	3
BIOE 615	BIOENGINEERING AND CARDIAC SURGERY	3
CEVE 316	URBAN WATER SYSTEMS LAB: WATER QUALITY PARAMETERS AND TREATMENT TECHNIQUES	1
CHBE 310	FUNDAMENTALS OF BIOMOLECULAR ENGINEERING	3
CMOR 303	MATRIX ANALYSIS FOR DATA SCIENCE [6]	3
CMOR 360	INTRODUCTION TO OPERATIONS RESEARCH AND OPTIMIZATION	3
ELEC 220	FUNDAMENTALS OF COMPUTER ENGINEERING	4
ELEC 489 / CMOR 416 / NEUR 416	NEURAL COMPUTATION	3
ENGI 300	ENGINEERING DESIGN WORKSHOP [2]	2-3
MECH 311 / CEVE 311	MECHANICS OF SOLIDS AND STRUCTURES	3
Two (2) Engineering Points		
BIOE 321	CELLULAR ENGINEERING	3
BIOE 348	MOLECULAR TECHNIQUES IN BIOENGINEERING	3
BIOE 406 / CHBE 406	TISSUE ENGINEERING	3
BIOE 431	BIOMATERIALS APPLICATIONS	3
BIOE 518	INTRODUCTION TO COMPUTATIONAL BIOLOGY	3
CEVE 315	URBAN WATER SYSTEMS: SOURCES, TREATMENT, DISTRIBUTION, RESOURCE RECOVERY AND REUSE	3
CHBE 640	METABOLIC ENGINEERING	3
CMOR 302	MATRIX ANALYSIS [6]	3
COMP 571	BIOINFORMATICS: SEQUENCE ANALYSIS	3
DSCI 303	MACHINE LEARNING FOR DATA SCIENCE	3
ELEC 305	INTRODUCTION TO PHYSICAL ELECTRONICS II	3
ELEC 327	IMPLEMENTATION OF DIGITAL SYSTEMS	3
ELEC 432	MOBILE BIO-BEHAVIORAL SENSING	3
ENGI 301	INTRODUCTION TO PRACTICAL ELECTRICAL ENGINEERING	3
Three (3) Engineering Points		
BIOE 360 / GLHT 360	APPROPRIATE DESIGN FOR GLOBAL HEALTH [3]	3
BIOE 421	MICROCONTROLLER APPLICATONS	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 509	POINT-OF-CARE DIAGNOSTICS	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 487	IMAGING OPTICS	3
ENGI 355	DIGITAL DESIGN AND VISUALIZATION [4]	3
MECH 371	FLUID MECHANICS I	3
MECH 400 / CEVE 400	ADVANCED MECHANICS OF MATERIALS	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		
MECH 343	MODELING OF DYNAMIC SYSTEMS	4

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 Engineering 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, BIOE 392/GLHT 392.)

3 BIOE 360 or BIOE 392: These courses are design courses. 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 ENGI 355 can be applied toward the Technical Elective requirement only in the event that BIOE 447 is not completed as a Senior Lab requirement. Both MECH 403 and ENGI 355 cannot be counted towards Technical Elective or Engineering Point Requirements.

5 BIOE 400: Students may substitute 3 credit hours (in one semester) of BIOE 400 in place of one credit of the BIOE Laboratory Requirement for BIOE 442, BIOE 443, BIOE 444, BIOE 445, BIOE 446, BIOE 447, or BIOE 449. If this option is chosen, student may not use the same BIOE 400 credit for the Technical Elective or Engineering Point Requirements.

6 Only one of CMOR 302 and CMOR 303 may be counted towards technical elective and engineering point requirements.

Policies for the BSBE Degree

Transfer Credit

For Rice University's policy regarding transfer credit, see Transfer Credit (https://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 (https://oaa.rice.edu/advising-network/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/

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 (https://ga.rice.edu/undergraduate-students/honors-distinctions/university/) (*summa cum laude*, *magna cum laude*, and *cum laude*) and Distinction in Research and Creative Work (https://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

In certain situations and with some terminal master's degree programs, Rice students have an option to pursue a master's degree by adding an additional fifth year to their four years of undergraduate studies.

Advanced Rice undergraduate students in good academic standing typically apply to the master's 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 major advisor and the master's degree 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 (https://ga.rice.edu/undergraduate-students/academic-opportunities/undergraduate-graduate-concurrent-enrollment/).

Rice undergraduate students completing studies in science and engineering may have the option to pursue the Master of Bioengineering (MBE) degree. For additional information, students should contact their undergraduate major advisor and the MBE program director.

Additional Information

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