

BIOENGINEERING, BS

Banner Code: VS-BS-BIOE

Academic Advising

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Bioengineering, also referred to as biomedical engineering, is the application of engineering tools and approaches to solve problems in biology and medicine. It is a broad and growing field that draws upon rapid advances in technology and computation, as well as on unprecedented growth in basic biological understanding.

This program concentrates on making measurements and analyzing complex data. It is challenging since it will provide a solid foundation in engineering, and also give in-depth exposure to the life sciences. The impact of engineering and computer science on biomedicine is wide, ranging from improved medical diagnosis through advanced imaging technologies, to enhanced understanding in rehabilitation gained by computational models of limb movement. With the growing demand for better health care, the need for bioengineers is expected to be high.

The multidisciplinary training in this field will make graduates competitive for a position in government or the biomedical industry. It also enables students to continue their education in graduate school or medical school.

The bachelor's program in Bioengineering is accredited by the Engineering Accreditation Commission of ABET (<http://www.abet.org>).

Concentrations

The concentrations in the BS Bioengineering program are:

- Biomedical Signals and Systems (BMSS)
- Bioengineering Healthcare Informatics (BHI)
- Bioengineering Prehealth (BMPH)

The BMSS concentration emphasizes the systems and methods for acquisition and analysis of biomedical signals whereas the BHI concentration focuses on the management, analysis and visualization of data related to biomedical and healthcare applications. The BMPH concentration prepares students for continued studies as a health care professional in medicine, dentistry, or veterinary medicine.

Educational Objectives

The educational objectives of the Bioengineering undergraduate program are the following:

- Alumni electing to work after graduation (for example, in industry or government) will contribute to the development or application of new products or processes that are of benefit to society.
- Alumni electing to continue their formal education will have completed their studies, or will have made demonstrable progress toward an advanced degree in their chosen profession.
- Alumni will communicate and perform effectively as members or leaders of multi-disciplinary teams.
- Alumni will continue to enhance their skills and knowledge in a quest for further professional development.

Admissions & Policies

Policies

For policies governing all undergraduate degrees, see AP.5 Undergraduate Policies.

Advising

All Bioengineering students are required to meet with their departmental academic advisor prior to course registration each semester. Students who are considering bioengineering as their major must meet with the Volgenau School of Engineering Coordinator of Undergraduate Advising in 2500 Nguyen Engineering Building.

Change of Major

See Change of Major for more information.

Termination from the Major

No math, science, or Volgenau School of Engineering course that is required for the major may be attempted more than three times. Those students who do not successfully complete such a course within three attempts will be terminated from the major. Undeclared students in the Volgenau School who do not successfully complete a course required for a Volgenau School major within three attempts will also be terminated. For more information, see AP.5.2.4 Termination from the Major.

Once a student has attempted one of these courses twice unsuccessfully, the third attempt must be no later than the next semester of enrollment, excluding summers. Failure to take the course at that time will result in termination from the major. If the student is unable to take the course when required, the student may request an extension to a future semester; extensions require approval of the student's advisor, their department, and the Associate Dean for Undergraduate Programs. The deadline for extension requests is the add deadline for the semester in which the course is required.

Students who have been terminated from a Volgenau School of Engineering major may not register for a Volgenau School course without permission of the department offering the course. This applies to all undergraduate courses offered by the Volgenau School except IT 104 Introduction to Computing (Mason Core) and STAT 250 Introductory Statistics I (Mason Core).

A student may not declare any major in the Volgenau School of Engineering if the student has previously met the termination criteria for that major at any time, regardless of what the student's major was at the time the courses were taken.

Writing-Intensive Requirement

Mason's writing-intensive requirement is satisfied by BENG 304 Modeling and Control of Physiological Systems and BENG 495 Bioengineering Senior Seminar II in which faculty provide feedback on student writing assignments.

Requirements

Degree Requirements

Total credits: 120-135

Students must complete each BENG, BIOL, ECE and ENGR course presented as part of the required credits for the degree with a grade of C or better.

Required Courses

Bioengineering

BENG 101	Introduction to Bioengineering	3
BENG 220	Physical Bases of Biomedical Systems	3
BENG 301	Bioengineering Measurements	3
BENG 302	Bioengineering Measurements Lab	1
BENG 304	Modeling and Control of Physiological Systems	3
BENG 320	Bioengineering Signals and Systems	3
BENG 380	Introduction to Circuits and Electronics	3
BENG 381	Circuits and Electronics Lab	1
BENG 420	Bioinformatics for Engineers	3
BENG 491	Bioengineering Senior Seminar I	1
BENG 492	Senior Advanced Design Project I (Mason Core)	2
BENG 493	RS: Senior Advanced Design Project II (Mason Core)	2
BENG 495	Bioengineering Senior Seminar II	1
Total Credits		29

Biology

BIOL 213	Cell Structure and Function (Mason Core)	4
BENG 313	Physiology for Engineers	3
Total Credits		7

Computer Science

CS 112	Introduction to Computer Programming (Mason Core)	4
CS 211	Object-Oriented Programming	3
or CS 222	Computer Programming for Engineers	
Total Credits		7

Mathematics and Statistics

MATH 113	Analytic Geometry and Calculus I (Mason Core)	4
MATH 114	Analytic Geometry and Calculus II	4
MATH 203	Linear Algebra ¹	3
MATH 213	Analytic Geometry and Calculus III	3
MATH 214	Elementary Differential Equations	3
STAT 344	Probability and Statistics for Engineers and Scientists I	3
Total Credits		20

¹ All students in the Bioengineering program are required to register for the specific section of MATH 203 that includes a 1-hour recitation with Matlab applications.

Physics

PHYS 160	University Physics I (Mason Core)	3
PHYS 161	University Physics I Laboratory (Mason Core)	1
PHYS 260	University Physics II (Mason Core)	3
PHYS 261	University Physics II Laboratory (Mason Core)	1
Total Credits		8

Engineering

ENGR 107	Introduction to Engineering (Mason Core)	2
Total Credits		2

Communication

COMM 100	Public Speaking (Mason Core)	3
or COMM 101	Interpersonal and Group Interaction (Mason Core)	
Total Credits		3

Concentrations

Select one concentration and complete all requirements therein.

Concentration in Bioengineering Healthcare Informatics (BHI)

Bioengineering

BENG 322	Health Data Challenges	3
or HAP 436	Electronic Health Data in Process Improvement	

Chemistry

Select 4 credits from the following:		4
CHEM 251	General Chemistry for Engineers (Mason Core)	
CHEM 211 & CHEM 213	General Chemistry I (Mason Core) and General Chemistry Laboratory I (Mason Core)	

Health Administration & Policy

HAP 301	Health Care Delivery in the United States	3
HAP 360	Introduction to Health Information Systems	3

Information Technology

IT 214	Database Fundamentals	3
or HAP 361	Health Databases	

Social and Behavioral Science

Choose one of the following:		3
ECON 103	Contemporary Microeconomic Principles (Mason Core)	
PSYC 100	Basic Concepts in Psychology (Mason Core)	
SOCI 101	Introductory Sociology (Mason Core)	

Technical Electives

Select 9 credits from the following:		9
BENG 341	Introduction to Biomaterials	
BENG 390	Engineering Design and Fabrication	
BENG 392	Engineering Design Studio	
BENG 395	RS: Mentored Research in Bioengineering	
BENG 406	Introduction to Biomechanics	
BENG 421	Introduction to Tissue Engineering	
BENG 437	Medical Image Processing	

BENG 441	Nanotechnology in Health	
BENG 451	Translation and Entrepreneurship in Bioengineering	
BENG 499	Special Topics in Bioengineering	
BENG 525	Neural Engineering	
BENG 538	Medical Imaging	
BENG 541	Biomaterials	
BENG 550	Advanced Biomechanics	
ECE 305	Electromagnetic Theory	
ECE 350	Embedded Systems and Hardware Interfaces	
ECE 370	Robot Design	
ECE 410	Applications of Discrete-Time Signal Processing	
ECE 421	Classical Systems and Control Theory	
ECE 450	Introduction to Robotics	
ME 313	Material Science	
Total Credits		28

Students may choose to substitute one of the technical electives with one of the following:

BIOL 305 & BIOL 306	Biology of Microorganisms and Biology of Microorganisms Laboratory	4
CHEM 313 & CHEM 315	Organic Chemistry I and Organic Chemistry Lab I	5
CS 310	Data Structures	3
CS 444	Introduction to Computational Biology	3
CS 445	Computational Methods for Genomics	3
NEUR 327	Cellular, Neurophysiological, and Pharmacological Neuroscience	3
PSYC 372	Physiological Psychology	3

Concentration in Bioengineering Prehealth (BMPH)

Biology

BIOL 483	General Biochemistry	4
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And select one from the following: 3-4

BIOL 305 & BIOL 306	Biology of Microorganisms and Biology of Microorganisms Laboratory	
BIOL 311	General Genetics	
BIOL 322 & BIOL 323	Developmental Biology and Lab for Developmental Biology	
BIOL 326	Animal Physiology	
BIOL 382	Introduction to Virology	
BIOL 430	Advanced Human Anatomy and Physiology I	

Chemistry

CHEM 211 & CHEM 213	General Chemistry I (Mason Core) and General Chemistry Laboratory I (Mason Core)	4
CHEM 212 & CHEM 214	General Chemistry II (Mason Core) and General Chemistry Laboratory II (Mason Core)	4
CHEM 313	Organic Chemistry I	3

CHEM 314	Organic Chemistry II	3
CHEM 315	Organic Chemistry Lab I	2
CHEM 318	Organic Chemistry Lab II	2

Electrical and Computer Engineering

ECE 301	Digital Electronics	3
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Psychology and Sociology

PSYC 100	Basic Concepts in Psychology (Mason Core)	3
SOCI 101	Introductory Sociology (Mason Core)	3

Technical Electives

Select 6 credits from the following: 6

BENG 341	Introduction to Biomaterials	
BENG 390	Engineering Design and Fabrication	
BENG 392	Engineering Design Studio	
BENG 395	RS: Mentored Research in Bioengineering	
BENG 406	Introduction to Biomechanics	
BENG 421	Introduction to Tissue Engineering	
BENG 437	Medical Image Processing	
BENG 441	Nanotechnology in Health	
BENG 451	Translation and Entrepreneurship in Bioengineering	
BENG 499	Special Topics in Bioengineering	
BENG 525	Neural Engineering	
BENG 538	Medical Imaging	
BENG 541	Biomaterials	
BENG 550	Advanced Biomechanics	
ECE 305	Electromagnetic Theory	
ECE 350	Embedded Systems and Hardware Interfaces	
ECE 370	Robot Design	
ECE 410	Applications of Discrete-Time Signal Processing	
ECE 421	Classical Systems and Control Theory	
ECE 450	Introduction to Robotics	
ME 313	Material Science	
Total Credits		40-41

Concentration in Biomedical Signals and Systems (BMSS)

Chemistry/Physics

Choose one of the following: 4

CHEM 251	General Chemistry for Engineers (Mason Core)	
CHEM 211 & CHEM 213	General Chemistry I (Mason Core) and General Chemistry Laboratory I (Mason Core)	

Select one sequence of Mason Core Natural Science 4

PHYS 262 & PHYS 263	University Physics III (Mason Core) and University Physics III Laboratory (Mason Core)	
CHEM 212 & CHEM 214	General Chemistry II (Mason Core) and General Chemistry Laboratory II (Mason Core)	

Social and Behavioral Science

Choose one of the following: 3

ECON 103	Contemporary Microeconomic Principles (Mason Core)	
PSYC 100	Basic Concepts in Psychology (Mason Core)	
SOCI 101	Introductory Sociology (Mason Core)	
Electrical and Computer Engineering		
ECE 301	Digital Electronics	3
Technical Electives		
Select 12 credits from the following:		12
BENG 341	Introduction to Biomaterials	3
BENG 390	Engineering Design and Fabrication	3
BENG 392	Engineering Design Studio	1
BENG 395	RS: Mentored Research in Bioengineering	1-3
BENG 406	Introduction to Biomechanics	3
BENG 421	Introduction to Tissue Engineering	3
BENG 437	Medical Image Processing	3
BENG 441	Nanotechnology in Health	3
BENG 451	Translation and Entrepreneurship in Bioengineering	3
BENG 499	Special Topics in Bioengineering	4
BENG 525	Neural Engineering	3
BENG 538	Medical Imaging	3
BENG 541	Biomaterials	3
BENG 550	Advanced Biomechanics	3
ECE 305	Electromagnetic Theory	3
ECE 350	Embedded Systems and Hardware Interfaces	3
ECE 370	Robot Design	3
ECE 410	Applications of Discrete-Time Signal Processing	3
ECE 421	Classical Systems and Control Theory	3
ECE 450	Introduction to Robotics	3
ME 313	Material Science	3
Total Credits		86-88

¹ Students may substitute CHEM 212 and CHEM 214 for PHYS 262 and PHYS 263.

Students may choose to substitute one of the technical electives with one of the following:

BIOL 305 & BIOL 306	Biology of Microorganisms and Biology of Microorganisms Laboratory	4
CHEM 313 & CHEM 315	Organic Chemistry I and Organic Chemistry Lab I	5
CS 310	Data Structures	3
CS 444	Introduction to Computational Biology	3
CS 445	Computational Methods for Genomics	3
NEUR 327	Cellular, Neurophysiological, and Pharmacological Neuroscience	3
PSYC 372	Physiological Psychology	3

Additional Mason Core

Students must complete all Mason Core requirements not fulfilled by major requirements. BENG 492 Senior Advanced Design Project I (Mason Core) and BENG 493 RS: Senior Advanced Design Project II (Mason Core) are approved to meet the Synthesis/Capstone requirement.

Written Communication	6
Literature	3
Arts	3
Western Civilization/World History	3
Global Understanding	3
Total Credits	18

Honors

Honors in the Major

The Department of Bioengineering offers an Honors Program that creates a community of outstanding scholars in bioengineering who share a commitment to learning, service, and leadership. The Program is based on the bioengineering curriculum, and is distinct from the University Honors Curriculum.

Eligibility

Entry to the Honors Program is by invitation, extended to students with a declared major in Bioengineering who have completed a minimum of 30 credit hours at Mason with a minimum cumulative GPA of 3.50 and a minimum GPA of 3.20 in each prior semester.

Honors Requirements

The Honors Program is challenging and designed for the highly motivated student with interests in any of the bioengineering concentrations. Honors students must satisfy requirements in addition to those of the normal BS degree in bioengineering, including:

- Successful completion of BENG 395 RS: Mentored Research in Bioengineering
- Six credits must be earned by taking a combination of BENG 5XX/6XX level courses. With permission of the Department of Bioengineering, 5XX/6XX level courses from other Volgenau School of Engineering programs may be considered.

Once admitted to the Honors Program, students must remain in good standing and maintain a minimum cumulative GPA of 3.50 and a minimum GPA of 3.20 in each semester for all courses counting toward the BS degree in bioengineering, maintain continuous enrollment working towards the degree, and abide by the Mason Honor Code.

Accelerated Master's

BS (selected)/Statistical Science, Accelerated MS

Overview

Highly-qualified students in selected BS programs (see below) have the option of obtaining an accelerated Statistical Science, MS. Students in an accelerated degree program must fulfill all university requirements for the master's degree.

For more detailed information, see AP.6.7 Bachelor's/Accelerated Master's Degrees. For policies governing all graduate degrees, see AP.6 Graduate Policies.

Admission Requirements

Students enrolled in a BS degree in any one of the Volgenau School major areas, in the Mathematics, BS program from the College of Science, or in the Economics, BS program from the College of Humanities and Social Sciences may apply to this option if they have earned 90 undergraduate credits with an overall GPA of 3.00. Criteria for admission are identical to criteria for admission to the Statistical Science, MS program, which include successful completion of the following Mason courses each with a grade of C or better:

Code	Title	Credits
MATH 113	Analytic Geometry and Calculus I (Mason Core)	4
MATH 114	Analytic Geometry and Calculus II	4
MATH 213	Analytic Geometry and Calculus III	3
MATH 203 or MATH 321	Linear Algebra Abstract Algebra	3
STAT 250 or STAT 344	Introductory Statistics I (Mason Core) Probability and Statistics for Engineers and Scientists I	3
STAT 346 or MATH 351	Probability for Engineers Probability	3

Accelerated Option Requirements

Students must complete all credits that satisfy requirements for the BS and MS programs, with 6 credits overlapping with grades of B or better in two 500-level STAT courses selected from STAT 544 Applied Probability, STAT 554 Applied Statistics I, and STAT 574 Survey Sampling I.

Degree Conferral

Students must apply the semester before they expect to complete the BS requirements to have the BS degree conferred. In addition, at the beginning of the student's final undergraduate semester, students must complete a Bachelor's/Accelerated Master's Transition form that is submitted to the Office of the University Registrar and Graduate Recruitment and Enrollment Services. At the completion of MS requirements, a master's degree is conferred.

BS (selected)/Data Analytics Engineering, Accelerated MS

Overview

Qualified undergraduate students have the option of obtaining an accelerated Data Analytics Engineering, MS with a concentration in predictive analytics.

For more detailed information, see AP.6.7 Bachelor's/Accelerated Master's Degrees. For policies governing all graduate degrees, see AP.6 Graduate Policies.

Admission Requirements

While no specific undergraduate degree is required, Mason undergraduate students majoring in systems engineering or any other engineering, business, computer science, statistics, mathematics, or

information technology may apply to this option if they have earned 90 undergraduate credits with an overall GPA of at least 3.30.

For the predictive analytics concentration, students must submit evidence of:

- Satisfactory completion of courses in calculus, applied probability and statistics, and a scientific programming language.
- Familiarity with analytical modeling software, such as spreadsheets or math packages.

Accelerated Option Requirements

Students must complete all credits that satisfy requirements for the BS and MS programs, with six credits overlap chosen from the courses in the following table. For BS candidates, these graduate courses replace the corresponding undergraduate courses listed. The undergraduate version of these courses may not be applied toward the MS degree.

Undergraduate	Graduate	
SYST 473	SYST 573	Credit may not be received for both courses.
OR 441	OR 541	Credit may not be received for both courses.

For the predictive analytics concentration, any other 500-level course may be applied to both the undergraduate and graduate degrees with approval of the advisor and SEOR department chair.

OR 541 Operations Research: Deterministic Models will substitute for the OR 531 Analytics and Decision Analysis core requirement in the MS DAE program.

Degree Conferral

Students must apply the semester before they expect to complete the BS requirements to have the BS degree conferred. In addition, at the beginning of the student's final undergraduate semester, students must complete a Bachelor's/Accelerated Master's Transition form that is submitted to the Office of the University Registrar and the VSE Graduate Admissions Office. At the completion of MS requirements, a master's degree is conferred.

Bioengineering, BS/Data Analytics Engineering, Accelerated MS Overview

Highly-qualified students in the Bioengineering, BS have the option of obtaining an accelerated Data Analytics Engineering, MS with a concentration in Bioengineering.

Students in an accelerated degree program must fulfill all university requirements for the master's degree. For policies governing all graduate degrees, see AP.6 Graduate Policies.

Admission Requirements

Students in the Bioengineering, BS program may apply to this option if they have earned 95 undergraduate credits with an overall GPA of at least 3.30. Students must have successfully completed CS 222 Computer Programming for Engineers and BENG 320 Bioengineering Signals and Systems. Criteria for admission are identical to criteria for admission

to the Bioengineering concentration of the Data Analytics Engineering, MS program.

Accelerated Option Requirements

Students must complete all requirements for the BS and MS programs, with 6 credits overlap.

Students register for 6 credits of 500-level basic courses in place of the corresponding BENG 400-level courses required for the undergraduate degree requirements. Specifically, students must register for:

Code	Title	Credits
BENG 501	Bioengineering Research Methods	3
CS 504	Principles of Data Management and Mining (in place of BENG 420)	3
Total Credits		6

Note:

Students are permitted to take additional graduate basic courses in their undergraduate programs. In such cases, those classes cannot be counted toward requirements for the MS.

Degree Conferral

Students must apply the semester before they expect to complete the BS requirements to have the BS degree conferred. In addition, at the beginning of the student's final undergraduate semester, students must complete a Bachelor's/Accelerated Master's Transition form that is submitted to the Office of the University Registrar and the VSE Graduate Admissions Office. At the completion of MS requirements, a master's degree is conferred.