

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 provides 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 makes graduates competitive positions in government or the biomedical industry. It also enables students to continue their education in graduate school or medical school.

Accreditation

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

Program Educational Objectives

Graduates of the Bioengineering bachelor's program are expected within 3-5 years of graduation to:

1. Contribute to the development or application of health-related products or processes that are a benefit to society.
2. Continue their formal education by making demonstrable progress toward an advanced degree or professional development milestone.
3. Communicate and perform effectively as members and/or leaders of multidisciplinary teams.

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.

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.

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.

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.

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

| Code | Title | Credits |
|---------------|--|---------|
| 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

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

Computer Science

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

Mathematics and Statistics

| Code | Title | Credits |
|----------|---|---------|
| 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

| Code | Title | Credits |
|---------------|---|---------|
| 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

| Code | Title | Credits |
|---------------|--|---------|
| ENGR 107 | Introduction to Engineering (Mason Core) | 2 |
| Total Credits | | 2 |

Communication

| Code | Title | Credits |
|---------------|--|---------|
| COMM 100 | Public Speaking (Mason Core) | 3 |
| or COMM 101 | Fundamentals of Communication (Mason Core) | |
| Total Credits | | 3 |

Concentrations

Available Concentrations

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

Select one concentration and complete all requirements therein.

Concentration in Bioengineering Healthcare Informatics (BHI)

| Code | Title | Credits |
|------------------------|---|---------|
| Bioengineering | | |
| BENG 322 or HAP 436 | Health Data Challenges Electronic Health Data in Process Improvement | 3 |

Chemistry

| | | |
|--|---|--|
| Select 3-4 credits from the following: | | |
| 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 or HAP 361 | Database Fundamentals Health Databases | 3 |
|----------------------|---|---|

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 327 | Cellular, Neurophysiological, and Pharmacological Neuroscience |
| BENG 341 | Introduction to Biomaterials |
| BENG 390 | Engineering Design and Fabrication |
| BENG 395 | RS: Mentored Research in Bioengineering |
| BENG 406 | Introduction to Biomechanics |
| BENG 417 | Bioengineering World Health |
| BENG 421 | Introduction to Tissue Engineering |
| BENG 429 | Mason-Inova Applied Technologies |
| 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 |

Total Credits 28

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

| Code | Title | Credits |
|---------------------|--|---------|
| CS 310 | Data Structures | |
| CS 444 | Introduction to Computational Biology | |
| CS 445 | Computational Methods for Genomics | |
| 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 | Mobile Robots | |
| ME 313 | Material Science | |
| BIOL 305 & BIOL 306 | Biology of Microorganisms and Biology of Microorganisms Laboratory | |
| BIOL 311 | General Genetics | |
| BIOL 483 & CHEM 463 | General Biochemistry and General Biochemistry I | |
| CHEM 313 & CHEM 315 | Organic Chemistry I and Organic Chemistry Lab I | |
| PSYC 372 | Physiological Psychology | |

Code Title Credits

Biology

BIOL 483 General Biochemistry 4

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 General Chemistry I (Mason Core) 4
& CHEM 213 and General Chemistry Laboratory I (Mason Core)

CHEM 212 General Chemistry II (Mason Core) 4
& CHEM 214 and General Chemistry Laboratory II (Mason Core)

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

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 327 | Cellular, Neurophysiological, and Pharmacological Neuroscience |
| BENG 341 | Introduction to Biomaterials |
| BENG 390 | Engineering Design and Fabrication |
| BENG 395 | RS: Mentored Research in Bioengineering |
| BENG 406 | Introduction to Biomechanics |
| BENG 417 | Bioengineering World Health |
| BENG 421 | Introduction to Tissue Engineering |
| BENG 429 | Mason-Inova Applied Technologies |
| 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 |

Total Credits 40-41

Concentration in Bioengineering Prehealth (BMPH)

Concentration in Biomedical Signals and Systems (BMSS)

| Code | Title | Credits |
|---|--|---------|
| Chemistry/Physics | | |
| Choose one of the following: | | 4 |
| CHEM 211 & CHEM 213 | General Chemistry I (Mason Core) and General Chemistry Laboratory I (Mason Core) | |
| CHEM 251 | General Chemistry for Engineers (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 327 | Cellular, Neurophysiological, and Pharmacological Neuroscience | |
| BENG 341 | Introduction to Biomaterials | |
| BENG 390 | Engineering Design and Fabrication | |
| BENG 395 | RS: Mentored Research in Bioengineering | |
| BENG 406 | Introduction to Biomechanics | |
| BENG 417 | Bioengineering World Health | |
| BENG 421 | Introduction to Tissue Engineering | |
| BENG 429 | Mason-Inova Applied Technologies | |
| 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 | |
| Total Credits | | 26 |

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:

| Code | Title | Credits |
|---------------------|--|---------|
| CS 310 | Data Structures | |
| CS 444 | Introduction to Computational Biology | |
| CS 445 | Computational Methods for Genomics | |
| 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 | Mobile Robots | |
| ME 313 | Material Science | |
| BIOL 305 & BIOL 306 | Biology of Microorganisms and Biology of Microorganisms Laboratory | |
| BIOL 311 | General Genetics | |
| BIOL 483 & CHEM 463 | General Biochemistry and General Biochemistry I | |
| CHEM 313 & CHEM 315 | Organic Chemistry I and Organic Chemistry Lab I | |
| PSYC 372 | Physiological Psychology | |

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.

| Code | Title | Credits |
|------------------------------------|-------|---------|
| 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.

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.

Bioengineering, BS/Operations Research, Accelerated MS

Overview

Highly-qualified students in the Bioengineering, BS have the option of obtaining an accelerated Operations Research, MS.

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

Mason undergraduate students majoring in Bioengineering, BS may apply to this option if they have earned 90 undergraduate credits with an overall GPA of at least 3.30 and completed all MATH and PHYS requirements. Criteria for admission are identical to criteria for admission to the Operations Research, MS program.

Accelerated Options Requirement

Students must complete all credits that satisfy requirements for both the BS and MS programs. Up to two courses (6 credits) of approved master's level courses taken as part of the undergraduate degree may be applied to the graduate degree. The courses selected for this purpose must be approved by the academic advisors of both the BS and MS programs and by the SEOR department chair. For the BS programs that allow undergraduate electives from the department of system engineering and operations research, the students may chose the graduate version of such elective courses to replace the corresponding undergraduate courses.

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/Systems Engineering, Accelerated MS

Overview

Highly-qualified students in the Bioengineering, BS have the option of obtaining an accelerated Systems Engineering, MS.

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

Mason undergraduate students majoring in Bioengineering, BS may apply to this option if they have earned 90 undergraduate credits with an overall GPA of at least 3.30 and completed all MATH and PHYS requirements. Criteria for admission are identical to criteria for admission to the Systems Engineering, MS program.

Accelerated Options Requirement

Students must complete all credits that satisfy requirements for both the BS and MS programs. Up to two courses (6 credits) of approved master's level courses taken as part of the undergraduate degree may be applied

to the graduate degree. The courses selected for this purpose must be approved by the academic advisors of both the BS and MS programs and by the SEOR department chair. For the BS programs that allow undergraduate electives from the department of system engineering and operations research, the students may chose the graduate version of such elective courses to replace the corresponding undergraduate courses.

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.