The MS in Bioengineering prepares students for research and professional practice in bioengineering and related fields. The program includes both fundamentals and advanced work to apply engineering techniques to solve problems in biology and medicine. A major distinguishing feature of the curriculum is that it is designed to educate leaders who understand and appreciate how biomedical technology is translated from bench to bedside. Graduates from this program will eventually work in universities, industry or government in a variety of roles due to the breadth of this program and its content specific clinical translation of new technologies.

Admissions & Policies

Admissions

Applicants must have completed a baccalaureate degree in engineering or the sciences from an accredited program and an earned GPA of 3.0 or better in their 60 highest-level credits.

In addition to fulfilling Mason's admission requirements for graduate study, applicants seeking to be admitted must demonstrate or provide the following:

1. Demonstrate strong knowledge in ordinary differential equations cell biology and general chemistry as demonstrated by the BS degree, course selection, or project work.
2. Additional knowledge in molecular biology, physiology, organic chemistry, linear algebra, and/or statistics is recommended.
3. Provide two letters of recommendation, from references who are familiar with the applicant's professional accomplishments.
4. Provide a resume and detailed statement of career goals and professional aspirations.
5. If their native language is not English, students must take the English Proficiency exam. Test score minimum requirements are available at [this link](https://www2.gmu.edu/admissions-aid/how-apply/graduate/standardized-test-information)

Program Requirements

Degree Requirements

Total credits: 30-33

Students complete the Core Bioengineering requirements, and requirements within one selected option: thesis, practicum or coursework.

Core Bioengineering

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>BENG 520</td>
<td>Biomedical Data Analytics</td>
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</tr>
<tr>
<td>BENG 521</td>
<td>Cell and Tissue Engineering</td>
<td>3</td>
</tr>
<tr>
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<td>Advanced Biomaterials and Biomimetic Devices for Nanomedicine</td>
<td></td>
</tr>
<tr>
<td>BENG 526</td>
<td>Neural Engineering</td>
<td>3</td>
</tr>
<tr>
<td>BENG 537</td>
<td>Medical Image Processing</td>
<td>3</td>
</tr>
<tr>
<td>or BENG 538</td>
<td>Medical Imaging</td>
<td></td>
</tr>
</tbody>
</table>

Choose two courses from the following:

- BENG 501 Bioengineering Research Methods
- BENG 514 Pathophysiology and the Role of New Technologies in Human Diseases
- BENG 575 Intellectual Property, Regulatory Concepts and Product Development
- BENG 601 Collaborative Bioengineering Basic Science Research
- BENG 602 Collaborative Bioengineering Clinical Science Research
- STAT 535 Analysis of Experimental Data
- STAT 560 Biostatistical Methods

Total Credits: 18

Thesis Option

Research Thesis

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BENG 799</td>
<td>Master's Thesis 1</td>
<td>6</td>
</tr>
</tbody>
</table>

Total Credits: 6

Students are expected to complete 6 credits of BENG 799 Master’s Thesis towards their degree. Students cannot enroll in BENG 799 Master’s Thesis until the completion of 15 credits of coursework. Once enrolled students must maintain continuous registration in thesis research until graduation, excluding summers. Students who defend in the summer must be registered for at least 1 credit of thesis research during that summer term.

Students choose from a restricted list of technical specialization courses below and/or from the list of core courses that are not already being taken as part of their core requirement to increase technical depth in an area of their interest, under the guidance and with the approval of the student’s advisor. Students must choose six credits from these courses. At least half of the selected classes must be at the 600 or 700 level.

<table>
<thead>
<tr>
<th>Code</th>
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<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BENG 530</td>
<td>Continuum Biomechanics and Biotransport II</td>
<td>6</td>
</tr>
<tr>
<td>BENG 535</td>
<td>Multi-Scale Modeling and Simulation in Biomedicine</td>
<td></td>
</tr>
<tr>
<td>BENG 615</td>
<td>Biomanufacturing</td>
<td></td>
</tr>
<tr>
<td>BENG 699</td>
<td>Advanced Topics in Bioengineering</td>
<td></td>
</tr>
</tbody>
</table>
BENG 725  Computational Motor Control
BENG 738  Advanced Medical Image Processing
BENG 798  Independent Reading and Research in Bioengineering

Electrical, Computer & Mechanical Engineering
ECE 511  Computer Architecture
ECE 528  Introduction to Random Processes in Electrical and Computer Engineering
ECE 530  Sensor Engineering
ECE 550  System Engineering Design
ECE 635  Adaptive Signal Processing
ME 621  Foundations of Fluid Mechanics

Bioinformatics
BINF 631  Molecular Cell Biology for Bioinformatics
BINF 641  Biomolecular Modeling
BINF 690  Numerical Methods for Bioinformatics
BINF 701  Systems Biology
BINF 731  Protein Structure Analysis
BINF 740  Introduction to Biophysics
BINF 741  Introduction to Computer Simulations of Molecules
BINF 751  Biochemical and Cellular Systems Modeling
BINF 760  Machine Learning for Bioinformatics

Biology and Chemistry
BIOL 562  Personalized Medicine
BIOL 563  Virology
BIOL 566  Cancer Genomics
BIOL 572  Human Genetics
BIOL 583  General Biochemistry
BIOL 682  Advanced Eukaryotic Cell Biology
CHEM 563  General Biochemistry I
CHEM 568  Bioorganic Chemistry
CHEM 613  Modern Polymer Chemistry
CHEM 660  Protein Biochemistry

Physics
PHYS 510  Computational Physics I
PHYS 612  Physics of Modern Imaging
PHYS 640  Finite Element Analysis of Solids and Fluids
PHYS 694  Applied Mechanics of Solids
PHYS 695  Applied Fluid Mechanics

Mathematics and Statistics
MATH 685  Numerical Analysis
STAT 517  Experimental Design
STAT 522  Applied Multivariate Statistics
STAT 526  Applied Regression Analysis
STAT 560  Biostatistical Methods
STAT 662  Multivariate Analysis and Statistical Learning
STAT 672  Statistical Learning and Data Analytics

Neurotechnology and Neuroscience
NEUR 601  Developmental Neuroscience
NEUR 602  Cellular Neuroscience
NEUR 651  Molecular Neuropharmacology
NEUR 734  Computational Neurobiology

Committee Selection
Each student must form a master’s committee comprising three individuals. A minimum of two members of the committee must be tenured or tenure-track faculty in the Department of Bioengineering (http://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/bioengineering/). The other member must be from outside the department.

Thesis Research Proposal
Each student must prepare a written thesis proposal, and it must be presented before the completion of the second semester. The proposal must be made available to the committee at least two weeks in advance of the presentation. The proposal must be presented to and approved by the committee. The committee determines whether the proposal has merit and can lead to significant contributions to the area and whether the student has the knowledge and skills to complete the proposed work successfully and in a timely manner. If the student fails to defend the proposal, the student may present a proposal a second time, no later than 60 days from the first attempt. Failure in the second attempt results in dismissal from the program.

Thesis Preparation and Defense
While preparing the thesis, the candidate enrolls in thesis research. The candidate can proceed to a public defense of the thesis once it has been approved by the committee.

The defense must be announced at least two weeks in advance. The thesis draft must be submitted to the library and made publicly available at least two weeks in advance of the defense. The entire committee must be present at the defense. If the candidate fails to defend the thesis, the candidate may request a second defense, following the same procedures as for the initial defense. A candidate who fails a second attempt to defend the thesis is terminated from the program.

Practicum Option

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Internship/Co-Op</td>
<td>6</td>
</tr>
<tr>
<td>BENG 797</td>
<td>Graduate Practicum</td>
<td>1</td>
</tr>
</tbody>
</table>

Total Credits: 6

1 Students are expected to complete 6 credits of BENG 797 Graduate Practicum towards their degree. Students cannot enroll in BENG 797 Graduate Practicum until the completion of 15 credits of coursework. BENG 797 Graduate Practicum credits must be taken along with an internship/co-op opportunity. Therefore, a letter from the specific employer must be provided on behalf of the student.

Students choose from a restricted list of technical specialization courses below and/or from the list of core courses that are not already being taken as part of their core requirement to increase technical depth in an area of their interest, under the guidance and with the approval of the student’s advisor. Students must choose six credits from these courses. At least half of the selected classes must be at the 600 or 700 level.
### Code | Title | Credits
--- | --- | ---
**Technical Specialization** | **Bioengineering** | 6
BENG 530 | Continuum Biomechanics and Biotransport II | 
BENG 535 | Multi-Scale Modeling and Simulation in Biomedicine | 
BENG 615 | Biomanufacturing | 
BENG 699 | Advanced Topics in Bioengineering | 
BENG 725 | Computational Motor Control | 
BENG 738 | Advanced Medical Image Processing | 
BENG 798 | Independent Reading and Research in Bioengineering | 

**Electrical, Computer & Mechanical Engineering**
ECE 511 | Computer Architecture | 
ECE 528 | Introduction to Random Processes in Electrical and Computer Engineering | 
ECE 530 | Sensor Engineering | 
ECE 550 | System Engineering Design | 
ECE 635 | Adaptive Signal Processing | 
ME 621 | Foundations of Fluid Mechanics | 

**Bioinformatics**
BINF 631 | Molecular Cell Biology for Bioinformatics | 
BINF 641 | Biomolecular Modeling | 
BINF 690 | Numerical Methods for Bioinformatics | 
BINF 701 | Systems Biology | 
BINF 731 | Protein Structure Analysis | 
BINF 740 | Introduction to Biophysics | 
BINF 741 | Introduction to Computer Simulations of Biomolecules | 
BINF 751 | Biochemical and Cellular Systems Modeling | 
BINF 760 | Machine Learning for Bioinformatics | 

**Biology and Chemistry**
BIOL 562 | Personalized Medicine | 
BIOL 563 | Virology | 
BIOL 566 | Cancer Genomics | 
BIOL 572 | Human Genetics | 
BIOL 583 | General Biochemistry | 
BIOL 682 | Advanced Eukaryotic Cell Biology | 
CHEM 563 | General Biochemistry I | 
CHEM 568 | Bioorganic Chemistry | 
CHEM 613 | Modern Polymer Chemistry | 
CHEM 660 | Protein Biochemistry | 

**Physics**
PHYS 510 | Computational Physics I | 
PHYS 612 | Physics of Modern Imaging | 
PHYS 640 | Finite Element Analysis of Solids and Fluids | 
PHYS 694 | Applied Mechanics of Solids | 
PHYS 695 | Applied Fluid Mechanics | 

**Mathematics and Statistics**
MATH 685 | Numerical Analysis | 

**Committee Selection**
Each student must form a master’s committee, comprising two or three individuals. In this case, the committee will help identify the goals of the internship and make sure that they are in line with the MS program’s objectives. The committee will also be responsible to evaluate a final report and presentation to assess the successful completion of the internship. A minimum of one member of the committee must be a full-time faculty member in the Department of Bioengineering. The other two members must be representatives from the internship program.

**Project Preparation and Presentation**
During the internship, the candidate enrolls in BENG 797 Graduate Practicum (Internship/Co-op) and prepares the project report and presentation. The candidate can proceed to the final presentation of the project once it has been approved by the committee.

The presentation must be announced at least two weeks in advance. The report draft must be submitted to the library and made publicly available at least two weeks in advance of the defense. The entire committee must be present at the presentation. If the candidate fails to defend the project, the candidate may request a second attempt, following the same procedures as for the initial one. A candidate who fails a second attempt is terminated from the program.

**Coursework Option**
Students choose from a restricted list of technical specialization courses below and/or from the list of core courses that are not already being taken as part of their core requirement to increase technical depth in an area of their interest, under the guidance and with the approval of the student’s advisor. Students must choose 15 credits from these courses.

At least half of the selected classes must be at the 600 or 700 level.
Bioengineering, MS

ECE 511 Computer Architecture
ECE 528 Introduction to Random Processes in Electrical and Computer Engineering
ECE 530 Sensor Engineering
ECE 550 System Engineering Design
ECE 635 Adaptive Signal Processing
ME 621 Foundations of Fluid Mechanics

Bioinformatics
BINF 631 Molecular Cell Biology for Bioinformatics
BINF 641 Biomolecular Modeling
BINF 690 Numerical Methods for Bioinformatics
BINF 701 Systems Biology
BINF 731 Protein Structure Analysis
BINF 740 Introduction to Biophysics
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BINF 751 Biochemical and Cellular Systems Modeling
BINF 760 Machine Learning for Bioinformatics

Biology and Chemistry
BIOL 562 Personalized Medicine
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CHEM 563 General Biochemistry I
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Physics
PHYS 510 Computational Physics I
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PHYS 695 Applied Fluid Mechanics

Mathematics and Statistics
MATH 685 Numerical Analysis
STAT 517 Experimental Design
STAT 522 Applied Multivariate Statistics
STAT 526 Applied Regression Analysis
STAT 560 Biostatistical Methods
STAT 662 Multivariate Analysis and Statistical Learning
STAT 672 Statistical Learning and Data Analytics

Neurotechnology and Neuroscience
NEUR 601 Developmental Neuroscience
NEUR 602 Cellular Neuroscience
NEUR 651 Molecular Neuropharmacology
NEUR 734 Computational Neurobiology

Note: Students who elect to the coursework option will complete a minimum of 33 credit hours.

Additional Training Requirement
Bioengineering Seminar
All MS students are required to attend a minimum of two departmental seminars per semester. Students will sign an attendance sheet available at the end of each seminar.

Accelerated Master's

Bioengineering, BS/Bioengineering, Accelerated MS

Overview
Highly-qualified undergraduates may be admitted to the bachelor’s/accelerated master’s program and obtain a BS in Bioengineering (http://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/bioengineering/bioengineering-bs/) and a MS in Bioengineering in an accelerated time-frame after satisfactory completion of a minimum of 140 credits.

See AP.6.7 Bachelor’s/Accelerated Master’s Degrees (https://catalog.gmu.edu/policies/academic/graduate-policies/#text) for policies related to this program.

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 (https://catalog.gmu.edu/policies/academic/graduate-policies/).

BAM Pathway Admission Requirements
Applicants to all graduate programs at George Mason University must meet the admission standards and application requirements for graduate study as specified in the Graduate Admissions Policies and Bachelor’s/Accelerated Master’s Degree policies.

Students majoring in Bioengineering, BS (http://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/bioengineering/bioengineering-bs/) will be considered for admission into the BAM Pathway after completion of a minimum of 60 undergraduate credits with an overall GPA of at least 3.0 and have completed all MATH and PHYS requirements. Criteria for admission are identical to criteria for admission to the Bioengineering, MS program.

Students who are accepted into the BAM Pathway will be allowed to register for graduate level courses after successful completion of a minimum of 75 undergraduate credits and course-specific pre-requisites.

Accelerated Master’s Admission Requirements
Students already admitted in the BAM Pathway will be admitted to the Bioengineering, MS program, if they have met the following criteria, as verified on the Bachelor's/Accelerated Master's Transition form:

- A GPA of 3.0 or better in their 60 highest-level credits
- Successfully meeting Mason’s requirements for undergraduate degree conferral (graduation) and completing the application for graduation.
Accelerated Pathway Requirements

To maintain the integrity and quality of both the undergraduate and graduate degree programs, undergraduate students must complete all credits that satisfy requirements for both the BS and MS programs, with up to four classes (twelve credits) overlap chosen from the following graduate courses:

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</tr>
<tr>
<td>BENG 514</td>
<td>Pathophysiology and the Role of New Technologies in Human Diseases</td>
<td>3</td>
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</table>

ALL graduate course prerequisites must be completed prior to enrollment. Each graduate course must be completed with a grade of B or better to apply toward the MS program. The graduate courses may be counted as Technical Electives or Concentration Core courses towards the Bioengineering, BS (http://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/bioengineering/bioengineering-bs/) program requirements with approval by the academic advisor of the BS program and the program director of the MS program (or the bioengineering department chair).

While still in undergraduate status, a maximum of six additional graduate credits may be taken as reserve graduate credit and applied to the master’s program. Reserve graduate credits do not apply to the undergraduate degree. These reserve credits can be chosen from the list of graduate level courses given above with approval by the academic advisor of the BS program and the program director of the MS program (or the bioengineering department chair).

For more detailed information on coursework and timeline requirements, see AP6.7 Bachelor’s/Accelerated Master’s Degrees policies.

Degree Conferral

Students are recommended to meet with the Bioengineering academic advisor one year before and must apply to the program one 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. At the completion of MS requirements, a MS degree is conferred.

Mechanical Engineering, BS / Bioengineering, Accelerated MS

Overview

Highly-qualified students in the Mechanical Engineering, BS (http://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/mechanical/mechanical-engineering-bs/) have the option of obtaining an accelerated Bioengineering, MS.

Admission Requirements

Mason undergraduate students majoring in Mechanical Engineering, BS (http://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/mechanical/mechanical-engineering-bs/) may apply to this option if they have earned 60 undergraduate credits with an overall GPA of at least 3.20, completed all MATH and PHYS requirements, and passed BENG 320 Bioengineering Signals and Systems and BIOL 213 Cell Structure and Function with the grade of C or better. It is also recommended that students take BENG 214 Physiology for Engineers and are proficient in MATLAB. Criteria for admission are identical to criteria for admission to the Bioengineering, MS program.

Students who are accepted into the BAM Pathway will be allowed to register for graduate level courses after successful completion of a minimum of 75 undergraduate credits and course-specific pre-requisites.

Accelerated Options Requirement

Students must complete all credits that satisfy requirements for both the BS and MS programs. Students take up to 9 credits of approved MS level BENG courses as part of their undergraduate degree that will also be applied to the graduate degree. The courses selected for this purpose must be approved by the academic advisor of both the BS and MS programs and by the Bioengineering department chair.

Specifically, students are encouraged to take up to three of the following courses to apply towards both their undergraduate and graduate degree.

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<tr>
<td>or BENG 541</td>
<td>Biomaterials</td>
<td>3</td>
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<td>BENG 526</td>
<td>Neural Engineering</td>
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For more detailed information, see AP6.7 Bachelor's/Accelerated Master's Degrees (http://catalog.gmu.edu/policies/academic/graduate-policies/#text). For policies governing all graduate degrees, see AP6 Graduate Policies (http://catalog.gmu.edu/policies/academic/graduate-policies/#text).

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. At the completion of MS requirements, a master’s degree is conferred.