BIOENGINEERING, MS

Banner Code: EC-MS-BIOE

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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:

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

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

Code	Title	Credits
BENG 520	Biomedical Data Analytics	3
BENG 521	Cell and Tissue Engineering	3
or BENG 541	Biomaterials	
BENG 526	Neural Engineering	3
BENG 537	Medical Image Processing	3
or BENG 538	Medical Imaging	
Choose two courses from the following:		6
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

Code	Title	Credits
Research Thesis		**6**
BENG 799	Master's Thesis [1]	
Total Credits		6

[1] 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 their second semester 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.

Code	Title	Credits
Technical Specialization		**6**
Bioengineering		
BENG 699	Advanced Topics in Bioengineering	
BENG 725	Computational Motor Control	
BENG 738	Advanced Medical Image Processing	
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
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

Code	Title	Credits
Internship/Co-Op		**6**
BENG 798	Independent Reading and Research in Bioengineering [1]	
Total Credits		6

[1] Students are expected to complete 6 credits of BENG 798 Independent Reading and Research in Bioengineering towards their degree. Students cannot enroll in BENG 798 Independent Reading and Research in Bioengineering until the completion of their second semester of coursework. These 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		**6**
Bioengineering		
BENG 699	Advanced Topics in Bioengineering	
BENG 725	Computational Motor Control	
BENG 738	Advanced Medical Image Processing	
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
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 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 tenured or tenure-track faculty 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 798 Independent Reading and Research in Bioengineering (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.

Code	Title	Credits
Technical Specialization		**15**
Bioengineering		
BENG 699	Advanced Topics in Bioengineering	
BENG 725	Computational Motor Control	
BENG 738	Advanced Medical Image Processing	
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
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:

Code	Title	Credits
BENG 520	Biomedical Data Analytics	3
BENG 521 or BENG 541	Cell and Tissue Engineering Biomaterials	3
BENG 526	Neural Engineering	3
BENG 537 or BENG 538	Medical Image Processing Medical Imaging	3
BENG 501	Bioengineering Research Methods	3
BENG 514	Pathophysiology and the Role of New Technologies in Human Diseases	3
BENG 575	Intellectual Property, Regulatory Concepts and Product Development	3

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 AP.6.7 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.

For more detailed information, see AP.6.7 Bachelor's/Accelerated Master's Degrees (http://catalog.gmu.edu/policies/academic/graduate-policies/#text). For policies governing all graduate degrees, see AP.6 Graduate Policies (http://catalog.gmu.edu/policies/academic/graduate-policies/#text).

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.

Code	Title	Credits
BENG 520	Biomedical Data Analytics	3
BENG 521 or BENG 541	Cell and Tissue Engineering Biomaterials	3
BENG 526	Neural Engineering	3
BENG 537 or BENG 538	Medical Image Processing Medical Imaging	3
BENG 501	Bioengineering Research Methods	3
BENG 514	Pathophysiology and the Role of New Technologies in Human Diseases	3
BENG 575	Intellectual Property, Regulatory Concepts and Product Development	3

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.