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BULLETIN
For clarification about University policies concerning master’s degrees in the School of Engineering and Applied Science, please see the relevant University Bulletin at:
http://bulletin.wustl.edu/grad/engineering/biomedical/

ADMISSIONS DEADLINES
APPLICATION SUBMISSION
- **MS – ENTERING IN FALL**: March 1
- **MS – ENTERING IN SPRING**: October 1
- **BS/MS**: September 1
- **MEng**: January 15

ENROLLMENT DECISION
- **MS – ENTERING IN FALL**: May 15
- **MS – ENTERING IN SPRING**: November 1
- **BS/MS**: May 15
- **MEng**: March 15

REGISTRATION & ADVISING
Registration takes place each semester on dates announced by the University. Detailed instructions for registration plus necessary materials are mailed directly to all graduate students enrolled during the previous semester.

All master’s students in the department must register each semester until all degree requirements are completed. Any master’s degree must be completed within six years from the time the student is admitted to graduate standing.

**Full-time**: 9 credits or more
Normally students register in this category until they have earned the total number of credit hours required for their degree. Master’s students register for 9 credits or more of courses and/or research each semester until 30 hours are completed.
**Part-time:** 1-8 credits. This option is typically not available for international students. The one exception is if the student is in the final semester and his/her F-1 Application for a Reduced Course Load is approved by the Office of International Students and Scholars (OISS).

**Inactive:** Students who have not completed their course requirements but who, because of personal reasons, must suspend their studies temporarily may register as inactive students with the approval of the Director of Master’s Studies. Not available for international students.

**Academic Advisor:** Each entering master’s student will be assigned an academic advisor by the Director of Master’s Studies. This advisor will be a full-time faculty member in the Department of Biomedical Engineering and will be responsible for acquainting the student with degree requirements.

**Academic Performance**

Master’s students must maintain a cumulative grade point average of at least 2.70. Academic probation occurs if a semester or cumulative grade point average drops below 2.70. A master’s student is eligible for academic suspension if any one of the following occurs.

The student
- receives an F grade in a course, or
- earns a semester or cumulative grade point average less than 2.00, or
- has been on probation for two semesters and has not attained a 2.70 cumulative grade point average.

**Academic Integrity**

All students in the School of Engineering & Applied Science are expected to conform to high standards of conduct. This statement on student academic integrity is intended to provide guidelines on academic behaviors that are not acceptable. Please visit the Engineering Student Services website for examples of violations and a link to the University-wide policy: [http://engineering.wustl.edu/current-students/student-services/Pages/academic-integrity-policy.aspx](http://engineering.wustl.edu/current-students/student-services/Pages/academic-integrity-policy.aspx)
INDEPENDENT STUDY
A maximum of 3 credits of independent study (BME 500 or BME 5799) may be counted toward a master’s degree. Registration for independent study requires submission of the Independent Study form and approval by the Director of Master’s Studies. MS students pursuing a thesis should not plan to register for independent study.

DEADLINES
Graduation requirements must be fulfilled and forms submitted prior to deadlines established by the School and University. Current dates can be found at https://engineering.wustl.edu/current-students/student-services/Pages/Academic-Calendar.aspx.

MASTER OF SCIENCE PROGRAMS

REQUIREMENTS
A maximum of six units of graduate credit obtained at institutions other than Washington University may be applied toward the MS degree awarded by Engineering provided that they have not been applied toward any other degree. Transfer credit must satisfy a master’s degree requirement and be approved by the Director of Master’s Studies as well as by the Engineering Registrar. No courses carrying grades lower than B can be accepted for transfer credit. Up to two 400-level courses may be counted toward the 30 credits of graduate coursework required for the MS (but not including independent study courses, journal clubs or seminar-based courses).

Two options exist for the Master of Science (MS) degree, thesis and non-thesis:

Thesis option: For this option, a minimum of 24 credits of course work is required, with the balance being thesis research. The courses must fulfill the core curriculum requirement (see the “Course Selection” section). The remainder of the coursework is generally driven by the student’s research interest. Students must declare the thesis option before the second semester of MS studies begins.

Registration & Requirements for Thesis: Thesis students must register for E62 BME 599 Master’s Research with the section of the intended thesis mentor at least twice, one each semester s/he conducts research (up to 6 credits).
Every semester a student intends to register for E62 BME 599 Master’s Research:

- they must submit to the Director of Master’s Studies an updated Title, Scope and Procedure form, found on the BME website. The Director must approve this form before this course registration will be allowed.
- the thesis mentor of the student must assign a midterm grade for this course, so students know they are making suitable progress toward a thesis prior to the withdrawal deadline of the course. Grades will reflect research performance.

A grade of B– or higher must be obtained for at least 6 credits of this course in order to graduate with the thesis option. These grades are assigned by the thesis mentor. Important note: failure to complete a thesis in the indicated lab would lead to a failing grade in one or more of these courses.

**Thesis Committee:** Students preparing a thesis for the Master of Science will have a three-member thesis committee appointed by the Director of Master’s Studies and headed by the research mentor. This committee will be responsible for hearing, critiquing and approving the student’s thesis. The structure of the Master’s Thesis Committee should be as follows:

1. At least three faculty approved by the Director
2. The committee chair is the thesis advisor. This person must be identified and approved by the Director the first time a student submits the Title, Scope and Procedure form.
3. At least one member of the committee must be a primary or affiliate faculty member of BME.
4. Committee membership must be determined no later than the second time a student submits the Title, Scope and Procedure form. Approval of this second form by the Director is indication that the student is free to plan the thesis defense. Discussion with the thesis mentor and the Director is encouraged in order to select appropriate committee members.

Students are encouraged to establish their committees and schedule their thesis defenses early; the deadlines having scheduled a defense date are as follows:

October 31 for December graduates
March 31 for May graduates
June 30 for August graduates
Upon completion of the thesis, the candidate must pass an oral defense conducted by their thesis committee. This will consist of a public presentation followed by questions from the committee. Candidates must have a cumulative grade point average of 2.7 or better to receive the degree.

**Non-thesis (Course) option:** Candidates must accumulate a total of 30 graduate credits (up to six can be at the 400 level), have a cumulative grade point average of 2.7 or better, and satisfy the curriculum distribution requirements. The balance of the course credits should be selected with a view toward coherence reflecting a specialization in a research area.

**Seminars**
Each year the department sponsors or participates in a series of seminars by visiting lecturers and Washington University faculty and students. All MS students are required to enroll in E62 BME 501 Graduate Seminar, which is a pass/fail course carrying no credit, for a minimum of 2 semesters (1 if only an MS student for 1 semester prior to graduation). A passing grade is required for each semester and is earned by regular attendance at these events. The number of required seminars is determined each semester but will not be fewer than 10 or more than 1 per week. Seminars outside the departmental seminar series may be substituted but should still be documented.

**Course Selection**
MS students formulate their course program in consultation with their academic advisor. The curriculum to be completed by MS students requires the following minimum course distribution from the approved lists:

- 3 graduate courses (9 credits) in the area of BME
- 2 graduate courses (6 credits) in the area of life sciences
- 1 graduate course (3 credits) in the area of mathematics
- 1 graduate course (3 credits) in the area of computer science
- 3 graduate engineering or technical electives

Other than E62 BME 501 Graduate Seminar, all courses for the MS-BME must be taken for a letter grade.
**Educational Programs and Constituent Courses**
For the most up-to-date information, please contact the Department of Biomedical Engineering’s Director of Master’s Studies.

**COURSES THAT FULFILL THE BME REQUIREMENT (IN ANY COMBINATION):**

**General Biomedical Engineering**
- BME 5771 Biomedical Product Development
- BME 5772 Biomedical Business Development
- BIOL 5014 Biotech Industry Innovators

**Biomaterials & Tissue Engineering**
- BME 523 Biomaterial Science
- BME 524 Tissue Engineering
- BME 559 Intermediate Biomechanics
- BME 564 Orthopedic Biomechanics – Cartilage/Tendon
- BME 565 Biosolid Mechanics
- BME 5565 Mechanobiology of Cells and Matrices
- MEMS 5560 Interfaces and Attachments in Natural and Engineered Structures
- MEMS 5566 Engineering Mechanobiology
- MEMS 5606 Soft Nanomaterials
- MEMS 5607 Introduction to Polymer Blends and Composites
- MEMS 5608 Introduction to Polymer Science & Engineering

**Cardiovascular Engineering**
- BME 562 Mechanics of Growth and Development
- BME 574 Quantitative Bioelectricity and Cardiac Excitation
- BME 575 Molecular Basis of Bioelectrical Excitation
- BME 5901 Integrative Cardiac Electrophysiology

**Imaging**
- MED 502 Radiological Physics and Dosimetry
- MED 506 Radiation Oncology Physics
- BME 544 Biomedical Instrumentation
- BME 589 Biological Imaging Technology
- BME 5820 Fundamentals and Applications of Modern Optical Imaging
- BME 591 Biomedical Optics 1: Principles
- BME 592 Biomedical Optics 2: Imaging
- BME 5907 Advanced Concepts in Image Science
- BME 570 Mathematics of Image Science
- BME 593 Computational Methods for Inverse Problems
BME 594  Ultrasound Imaging
BIOL 5146  Principles and Applications of Biological Imaging
BIOL 5147  Contrast Agents for Biological Imaging
CSE 568M  Imaging Sensors
ESE 438  Applied Optics
ESE 588  Quantitative Image Processing
PSYCH 4450  Functional Neuroimaging Methods

**Molecular, Cellular, and Systems Engineering**
BME 537  Computational Molecular Biology (Algorithms for Computational Biology)
BME 542  Biomacromolecules Design and Engineering
BME 543  Molecular and Cellular Engineering
BME 550  Numerical Methods for Computational Modeling in Biomedicine
BME 5610  Protein Structures and Dynamics
BME 5903  Physical Methods for Biomedical Scientists
BME 5913  Molecular Systems Biology: Computation & Measurements for Understanding Cell Physiology and Disease
BME 595  Drug Delivery Systems: Principles and Applications
BIOL 5311  Dynamics in Mesoscopic Molecular Systems
BIOL 5312  Macromolecular Interactions

**Neural Engineering**
BME 471  Bioelectric Phenomena
BME 533  Biomedical Signal Processing
BME 572  Biological Neural Computation
ESE 546  Dynamics & Control in Neuroscience

**Courses that fulfill:**

**Life Sciences requirement**
BME 503A  Cell & Organ Systems
MED 505  Radiobiology
BME 530A  Molecular Cell Biology for Engineers
BME 538  Cell Signal Transduction
BME 5902  Cellular Neurophysiology
BME 5909  Physiology of the Heart
BIOL 404  Laboratory of Neurophysiology
BIOL 4071  Developmental Biology (4CR)
BIOL 4580  Principles of Human Anatomy & Development
BIOL 4810  General Biochemistry I
BIOL 4820  General Biochemistry II
BIOL 5051  Foundations in Immunology (4Cr)
BIOL 5053  Immunobiology (4Cr)
BIOL 5062  Central Questions in Cell Biology
BIOL 5068  Fundamentals of Molecular Cell Biology
BIOL 5079  The Science, Medicine, and Business of Vaccines & Drugs (2CR)
BIOL 5224  Molecular, Cell, and Organ Systems
BIOL 5285  Fundamentals of Mammalian Genetics
BIOL 5319  Molecular Foundations of Medicine
BIOL 5352  Developmental Biology
BIOL 5357  Chemistry and Physics of Biomolecules
BIOL 548  Nucleic Acids and Protein Biosynthesis
BIOL 5488  Genomics (4CR)
BIOL 5501  The Biology and Pathology of the Visual System
BIOL 5571  Cellular Neurobiology (4Cr)
BIOL 5651  Neural Systems
BIOL 5663  Neurobiology of Disease

Mathematics requirement
BME 570  Mathematics of Image Science
BME 5912  Applied Mathematics for Biomedical Sciences
BME 593  Computational Methods for Inverse Problems
ESE 501  Mathematics of Modern Eng. I
ESE 502  Mathematics of Modern Eng. II
ESE 517  Partial Differential Equations
ESE 520  Probability and Stochastic Processes
MATH 449  Numerical Applied Mathematics
MEMS 5001  Optimization Methods in Engineering
PHY501  Methods of Theoretical Physics I
PHY502  Methods of Theoretical Physics II
PHY503  Advanced Math Methods for Physicist & Eng. I
PHY504  Advanced Math Methods for Physicist & Eng. II

Computer Science requirement
BME 550  Numerical Methods for Computational Modeling in Biomedicine
BME 5913  Molecular Systems Biology: Computation & Measurements for Understanding Cell Physiology and Disease
BMI 5304  Introduction to Biomedical Computing
CSE 501N  Programming Concepts and Practice
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>CSE 502N</td>
<td>Fundamentals of Computer Science</td>
</tr>
<tr>
<td>CSE 503S</td>
<td>Rapid Prototype Development and Creative Programming</td>
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<tr>
<td>CSE 504N</td>
<td>Object-oriented Software Development Lab</td>
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<tr>
<td>CSE 511A</td>
<td>Introduction to Artificial Intelligence</td>
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<tr>
<td>CSE 515T</td>
<td>Bayesian Methods in Machine Learning</td>
</tr>
<tr>
<td>CSE 517A</td>
<td>Machine Learning</td>
</tr>
<tr>
<td>CSE 543T</td>
<td>Algorithms for Nonlinear Optimization</td>
</tr>
<tr>
<td>CSE 554A</td>
<td>Geometric Computing for Biomedicine</td>
</tr>
<tr>
<td>CSE 555A</td>
<td>Computational Photography</td>
</tr>
<tr>
<td>CSE 559A</td>
<td>Computer Vision</td>
</tr>
<tr>
<td>CSE 541T</td>
<td>Advanced Algorithms</td>
</tr>
<tr>
<td>MEMS 5515</td>
<td>Numerical Simulation in Solid Mechanics I</td>
</tr>
</tbody>
</table>

Some courses fall into multiple categories but can only be used to fulfill a single degree requirement.

Additional courses may fulfill the BME, life science, mathematics or computer science requirements, dependent upon your background and at the discretion of the Director of Master’s Studies. All courses outside of SEAS other than those listed above require approval of the Director for those requirements.

Courses listed above and SEAS courses except E60 ENGR, Sever Institute courses, and journal clubs or surveys automatically count as graduate engineering electives. Additional courses that have been approved are included below.

**ADDITIONAL COURSES THAT FULFILL THE ELECTIVE REQUIREMENT:**

<table>
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<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 5075</td>
<td>Fundamentals of Biostatistics for Graduate Students</td>
</tr>
<tr>
<td>PHY 589</td>
<td>Selected Topics in Physics 1</td>
</tr>
<tr>
<td>PHY 590</td>
<td>Selected Topics in Physics 2</td>
</tr>
</tbody>
</table>

For additional requirements for the MS degree, see the School of Engineering and Applied Sciences website at: http://bulletin.wustl.edu/grad/engineering/biomedical/
Bachelor's/Master's (BS/MS) Additional Information

BS/MS students may transfer up to 6 credits of shared coursework from their BS toward the MS upon the approval of the Director of Master’s Studies. These transfer/shared credits must be determined at the first advising session and be sent to the registrar’s office for notification and approval.

Master of Engineering in Biomedical Innovation (MEng-BMI)

The MEng-BMI is a 12-month intensive, hands-on program for students seeking to hone their engineering skills and acquire the entrepreneurial skills necessary to convert great ideas into products that benefit people. This professional training program allows students to develop a well-rounded skillset comparable to engineers with multiple years of healthcare industry experience.

Requirements

Students are required to take the core curriculum courses. Only 6 of the 30 graduate course credits may be transferred from another university and are subject to approval by the Director of Master’s Studies. Only the MEng-BMI electives can be satisfied in this manner. Students in the MEng-BMI program must maintain the School's minimum cumulative GPA of 2.7, which is a B– average.
MEng Core Curriculum – 24 CR

**SUMMER – 7Cr**

- **BME 5701**  Mastery of Engineering Skills for Biomedical Innovators – 3Cr
- **BME 5711**  Ideation of Biomedical Problems and Solutions – 3Cr
- **BME 5721**  Analysis of Biomedical Market Needs – 1Cr

**FALL – 10Cr**

- **BME 5702**  Application of Advanced Engineering Skills for Biomedical Innovators – 3Cr
- **BME 5712**  Implementation of Biomedical Solutions – 3Cr
- **BME 5722**  Feasibility Evaluation of Biomedical Products – 3Cr
- **BME 5731**  Business Foundations for Biomedical Innovators – 2Cr

**SPRING – 7Cr**

- **BME 5713**  Translation of Biomedical Solutions to Products – 4Cr
- **BME 5723**  Realization of Biomedical Products in the Marketplace – 1Cr
- **BME 5732**  Entrepreneurship for Biomedical Innovators – 2Cr

**Electives* – 6 CR**

Targeted Electives (6CR) must be approved by the Director of Master’s studies.

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**OTHER POLICIES**

**Secretarial Service**

Department secretaries do not generally provide clerical services to graduate students except in connection with scheduled courses and sponsored research projects.

**Copying Service**

Graduate students may not charge copying work to the department or a research project without prior authorization. Personal copies can be charged to a student’s personal account.
This is a compilation of policies and regulations applicable to graduate students in the Department of Biomedical Engineering. Students should also become familiar with the general regulations of the Henry Edwin Sever Graduate School of Engineering and Applied Science as described in the School’s Web site: www.engineering.wustl.edu

CONTACTS

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Websites
http://bulletin.wustl.edu/grad/engineering/biomedical/

https://bme.wustl.edu/graduate/ms/Pages/default.aspx

https://engineering.wustl.edu/current-students/graduate-student-services/Pages/default.aspx

https://engineering.wustl.edu/current-students/student-services/Pages/Academic-Calendar.aspx

http://engineering.wustl.edu/current-students/student-services/Pages/academic-integrity-policy.aspx

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