Biomedical Engineering, Ph.D.

Biomedical engineering is the application of engineering tools for solving problems in biology and medicine. It is an engineering discipline that is practiced by professionals trained primarily as engineers, who specialize in medical and biological applications. This area of study combines fundamentals of the biomedical sciences with advanced engineering methods of analysis and design, and brings together these two fields in order to contribute to the design of new medical instruments and devices, apply engineering principles for understanding and repairing the human body and other biological systems, and use engineering tools for decision making and cost containment.

The interdisciplinary degree program offers a course of graduate study leading to the master of science or the doctor of philosophy degrees in biomedical engineering. The Department of Biomedical Engineering should be of interest to students who wish to practice engineering or engage in research in an engineering specialization in medicine and biology. An individualized course of study is planned with a faculty advisor. Biomedical engineering faculty and affiliated faculty come from the various colleges and professional schools throughout the university. They specialize in biomedical engineering areas as diverse as biomechanics, bioinstrumentation, biomedical imaging and biophotonics, micro and nanotechnology, systems biology, biomaterials, cellular engineering, tissue engineering, neuroengineering, and rehabilitation and human performance. A list of biomedical engineering faculty, affiliated faculty, and their respective areas of specialization is available from the department website.

ADMISSIONS

Please consult the table below for key information about this degree program’s admissions requirements. The program may have more detailed admissions requirements, which can be found below the table or on the program’s website. Graduate admissions is a two-step process between academic programs and the Graduate School. Applicants must meet the minimum requirements (https://grad.wisc.edu/apply/requirements/) of the Graduate School as well as the program(s).

Once you have researched the graduate program(s) you are interested in, apply online (https://grad.wisc.edu/apply/).

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall Deadline</td>
<td>December 1</td>
</tr>
<tr>
<td>Spring Deadline</td>
<td>October 1</td>
</tr>
<tr>
<td>Summer Deadline</td>
<td>December 1</td>
</tr>
<tr>
<td>GRE (Graduate Record Examinations)</td>
<td>Required*</td>
</tr>
<tr>
<td>English Proficiency Test</td>
<td></td>
</tr>
<tr>
<td>Other Test(s) (e.g., GMAT, MCAT)</td>
<td>The MCAT may be accepted as an alternate to the GRE.</td>
</tr>
</tbody>
</table>

Letters of Recommendation Required

* For the Spring 2021, Summer 2021, and Fall 2021 cycle of admissions, the GRE requirement is waived due to COVID-19.

Applicants should have a bachelor’s degree in engineering (biomedical, chemical, electrical, industrial, mechanical, etc.) or science (biology, biochemistry, chemistry, genetics, immunology, physics, etc.). Each application is judged on the basis of:

- Official academic transcripts
- Graduate Record Examinations (http://www.ets.org/gre/) (GRE) scores or Medical College Admission Test (MCAT) scores for the general test*
- Test of English as a Foreign Language (http://www.ets.org/toefl/) (TOEFL) examination for international students
- Three letters of recommendation
- Statement of purpose (https://grad.wisc.edu/apply/prepare/)
- Resume (for Ph.D. applicants only)

All applicants must satisfy requirements that are set forth by the Graduate School (https://grad.wisc.edu/). Students admitted to the program may be required to make up deficiency course requirements.

To apply to the BME program, complete applications (https://grad.wisc.edu/apply/), including supportive materials, must be submitted as described below and received by the following deadline dates:

- Fall Semester—December 1
- Spring Semester—October 1
- Summer Session¹—December 1

¹Please note that summer admissions are generally limited to continuing BME students at UW–Madison or applicants who have research assistantships already arranged with UW faculty.

OFFICIAL ACADEMIC TRANSCRIPT

Electronically submit one copy of your transcript of all undergraduate and previous graduate work along with your online application to the Graduate School. Unofficial copies of transcripts will be accepted for review, but official copies are required for admitted students. Please do not send transcripts or any other application materials to the Graduate School or the BME department unless requested. If you have questions, please contact bmegradadmission@engr.wisc.edu.

GRADUATE RECORD EXAMINATION (GRE)

Applicants should request ETS to send their official GRE scores by using institution code 1846.

MCAT scores may be substituted for GRE. Domestic applicants who choose to substitute MCAT scores for the GRE should send their MCAT score report to bmegradadmission@engr.wisc.edu.

TEST OF ENGLISH AS A FOREIGN LANGUAGE (TOEFL)

The TOEFL is required for international students unless a degree from a U.S. educational institution is held. Scores should be sent using institution code 1846.

An applicant whose TOEFL (paper-based) test score is below 580; TOEFL computer-based test (CBT) score below 237; (TOEFL internet-based
iBT) test score below 92; IELTS score below 7; or MELAB below 82 must take an English assessment test upon arrival. Depending on your score, you may need to register for any recommended English as a Second Language (ESL) courses in the first semester you are enrolled.

Any international applicant who will hold a teaching assistantship (TA), and whose native language is not English must take the SPEAK test (https://esl.wisc.edu/ita-training/speak/) when arriving on campus.

THREE LETTERS OF RECOMMENDATIONS
These letters are required from people who can accurately judge the applicant’s academic or research performance. Letters of recommendation are submitted electronically to graduate programs through the online application. Applicants should not send any more than three letters (if more than three are sent, only the first three will be considered). See the Graduate School for FAQs (https://grad.wisc.edu/apply/prepare/) regarding letters of recommendation.

STATEMENT OF PURPOSE
In this document, applicants should explain why they want to pursue further education in BME and discuss which UW faculty members they would be interested in doing research with during their graduate study (see the Graduate School for more advice on how to structure a personal statement (https://grad.wisc.edu/apply/prepare/)).

RESUME (FOR PH.D. APPLICATIONS ONLY)
Include your resume ONLY if applying for the Ph.D. program.

APPLICATION FEE
Submission must be accompanied by the one-time application fee. It is non-refundable and can be paid by credit card (Master Card or Visa) or debit/ATM. By state law, this fee can only be waived or deferred through the conditions outlined here by the Graduate School (https://grad.wisc.edu/apply/fee-grant/).

FUNDING

GRADUATE SCHOOL RESOURCES
Resources to help you afford graduate study might include assistantships, fellowships, traineeships, and financial aid. Further funding information (https://grad.wisc.edu/funding/) is available from the Graduate School. Be sure to check with your program for individual policies and restrictions related to funding.

PROGRAM RESOURCES
It is our experience that nearly all doctoral students in the BME department obtain funding, but there are no guarantees. A limited number receive fellowships. A few students enrolled in M.S. coursework program are self-funded.

Research assistantships are available from individual faculty based on their research funding and awarded when grants are funded and after applications for BME admission are accepted. Sometimes there are project assistantships, teaching assistantships, and traineeships also available. A few students enrolled in M.S. coursework program are self-funded.

ADMITTED WITH FUNDING
We have a limited number of university or departmental fellowships to offer each year. In addition, there are research assistantships that are offered to grad applicants from individual faculty members. Teaching assistantships (TA) are possible through specific departments with more opportunity in lower-level courses, such as calculus, chemistry, and physics. Often, funding matches with specific faculty occur during the Visit Wisconsin Weekend in the spring.

ADMITTED WITHOUT FUNDING
If you are admitted without funding, please know that you will be considered by BME faculty for potential support. You are also encouraged to contact faculty in BME (http://www.engr.wisc.edu/bme/faculty/) whose research is of particular interest. Please wait to hear from us about your admission without aid before contacting faculty for support.

You may also apply to BME specific TA positions after being admitted or other TA positions on campus.

REQUIREMENTS

MINIMUM GRADUATE SCHOOL REQUIREMENTS
Review the Graduate School minimum academic progress and degree requirements (http://guide.wisc.edu/graduate/#policiesandrequirementstext), in addition to the program requirements listed below.

MAJOR REQUIREMENTS

MODE OF INSTRUCTION

<table>
<thead>
<tr>
<th>Mode of Instruction</th>
<th>Face to Face</th>
<th>Evening/Weekend</th>
<th>Online</th>
<th>Hybrid</th>
<th>Accelerated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

Mode of Instruction Definitions

Accelerated: Accelerated programs are offered at a fast pace that condenses the time to completion. Students are able to complete a program with minimal disruptions to careers and other commitments.

Evening/Weekend: Courses meet on the UW–Madison campus only in evenings and/ or on weekends to accommodate typical business schedules. Students have the advantages of face-to-face courses with the flexibility to keep work and other life commitments.

Face-to-Face: Courses typically meet during weekdays on the UW-Madison Campus.

Hybrid: These programs combine face-to-face and online learning formats. Contact the program for more specific information.

Online: These programs are offered 100% online. Some programs may require an on-campus orientation or residency experience, but the courses will be facilitated in an online format.

CURRICULAR REQUIREMENTS

Requirements Detail

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Credit</td>
<td>60</td>
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</tbody>
</table>

Minimum Residence Credit Requirement

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum</td>
<td>32</td>
</tr>
</tbody>
</table>
Half of degree coursework (30 credits out of 60 total credits) must be completed graduate-level coursework; courses with the Graduate Level Coursework attribute are identified and searchable in the university’s Course Guide.

Overall 3.00 GPA required.

The Graduate School requires an average grade of B or better in all coursework (300 or above, not including research credits) taken as a graduate student unless conditions for probationary status require higher grades. Grades of Incomplete are considered to be unsatisfactory if they are not removed during the next enrolled semester.

PhD candidates are required to pass a comprehensive qualifying examination, preliminary examination, and final oral defense. Deposit of the doctoral dissertation to the Graduate School is required.

No language requirements.

Breadth is provided via interdisciplinary training (minor requirement waived): The central aim of biomedical engineers is to unravel gaps in biological knowledge through the use of engineering principles. Thus, the doctoral program is inherently interdisciplinary. Prior to obtaining a Ph.D. warrant, students will prepare a summary of their effort in interdisciplinary coursework and training. The purpose of the summary will be to document the effort to meet the spirit of the minor requirement. The summary must be approved by the student’s thesis committee and filed with the department. Students may elect to pursue a doctoral minor.

**REQUIRED COURSES**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td><strong>General Requirements</strong></td>
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<tr>
<td>2 semesters of B M E 701</td>
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<td></td>
</tr>
<tr>
<td>Research Credits (B M E 790, 890, 990)</td>
<td>at least 30</td>
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<tr>
<td>Coursework, including:</td>
<td>at least 26</td>
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</tr>
<tr>
<td>B M E 601 (Topic: Responsible Conduct of Research for Biomedical Engineers)</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>One set of Ph.D. track requirements (credits vary; see below).</td>
<td>18-24</td>
<td></td>
</tr>
<tr>
<td><strong>Total Credits</strong></td>
<td></td>
<td>60</td>
</tr>
</tbody>
</table>

Students who follow the Ph.D. coursework guidelines should fulfill the Biomedical Engineering, Research, M.S. (https://guide.wisc.edu/graduate/biomedical-engineering/biomedical-engineering-ms/biomedical-engineering-research-ms/) requirements. They may file for that degree prior to their preliminary examination.

**Biomaterials & Tissue Engineering Track**

Biomaterials and tissue engineering employ a diverse range of approaches to develop methods to diagnose and treat diseases, create living tissue environments that may be used to restore the function of a damaged organ, and uncover biological mechanisms related to tissue development and disease. Graduate students trained in biomaterials and tissue engineering are expected to gain a detailed understanding of cellular and molecular biology, materials science, and engineering methods relevant to their research focus.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td><strong>Biology Requirement</strong></td>
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<tr>
<td>ZOOLOGY 570</td>
<td>Cell Biology</td>
<td>3</td>
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<tr>
<td>ZOOLOGY/</td>
<td>Cellular Signal Transduction</td>
<td></td>
</tr>
<tr>
<td>BIOCHEM/</td>
<td>Mechanisms</td>
<td></td>
</tr>
<tr>
<td>PHMCOL-M 630</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CRB 640</td>
<td>Fundamentals of Stem Cell and Regenerative Biology</td>
<td></td>
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<tr>
<td>CRB 650</td>
<td>Molecular and Cellular Organogenesis</td>
<td></td>
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<tr>
<td>ONCOLOGY 401</td>
<td>Introduction to Experimental Oncology</td>
<td></td>
</tr>
<tr>
<td><strong>Data Analysis Requirement</strong></td>
<td></td>
<td>3-4</td>
</tr>
<tr>
<td>B M I/STAT 541</td>
<td>Introduction to Biostatistics</td>
<td></td>
</tr>
<tr>
<td>B M I/</td>
<td>Advanced Bioinformatics</td>
<td></td>
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<tr>
<td>COMP SCI 776</td>
<td></td>
<td></td>
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<tr>
<td>COMP SCI 765</td>
<td>Data Visualization</td>
<td></td>
</tr>
<tr>
<td>STAT/F&amp;W ECOL/HORT 571</td>
<td>Statistical Methods for Bioscience I</td>
<td></td>
</tr>
<tr>
<td>STAT/B M I 877</td>
<td>Statistical Methods for Molecular Biology</td>
<td></td>
</tr>
<tr>
<td><strong>Biomaterials &amp; Tissue Engineering Requirement</strong></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>B M E/PHM SCI 430</td>
<td>Biological Interactions with Materials</td>
<td></td>
</tr>
<tr>
<td>B M E/CBE 510</td>
<td>Introduction to Tissue Engineering</td>
<td></td>
</tr>
<tr>
<td>B M E 511</td>
<td>Tissue Engineering Laboratory</td>
<td></td>
</tr>
<tr>
<td>B M E/CBE 520</td>
<td>Stem Cell Bioengineering</td>
<td></td>
</tr>
<tr>
<td>B M E 545</td>
<td>Engineering Extracellular Matrices</td>
<td></td>
</tr>
<tr>
<td>B M E 550</td>
<td>Introduction to Biological and Medical Microsystems</td>
<td></td>
</tr>
<tr>
<td>B M E 601</td>
<td>Special Topics in Biomedical Engineering (Nanomaterials for Biomedical Applications)</td>
<td></td>
</tr>
<tr>
<td>CBE 540</td>
<td>Polymer Science and Technology</td>
<td></td>
</tr>
<tr>
<td>CBE 562</td>
<td>Special Topics in Chemical Engineering (Cellular Biomaterials for Biomedical Applications)</td>
<td></td>
</tr>
<tr>
<td>CBE 648</td>
<td>Synthetic Organic Materials in Biology and Medicine</td>
<td></td>
</tr>
<tr>
<td>CBE 781</td>
<td>Biological Engineering: Molecules, Cells &amp; Systems</td>
<td></td>
</tr>
<tr>
<td>CHEM 654</td>
<td>Materials Chemistry of Polymers</td>
<td></td>
</tr>
<tr>
<td>M S &amp; E 521</td>
<td>Advanced Polymeric Materials</td>
<td></td>
</tr>
<tr>
<td><strong>Elective Requirement</strong></td>
<td></td>
<td>6</td>
</tr>
</tbody>
</table>

To provide breadth, at least 6 credits of electives must be chosen from courses that are not listed above.
These tracks are internal to the program and represent different pathways a student can follow to earn this degree. Track names do not appear in the Graduate School admissions application, and they will not appear on the transcript.

**Biomedical Imaging & Optics Track**

Biomedical imaging and optics research develops and utilizes new experimental and computational tools to characterize tissue structure across multiple size scales. A particular focus is on human health, especially with respect to achieving superior diagnostic/prognostic tools for a spectrum of diseased states. Graduate students trained in this track are expected to gain a detailed understanding of mathematics, biology and engineering both optical and/or physical methods relevant to their research focus.

### Code | Title | Credits
--- | --- | ---
MATH 443 | Applied Linear Algebra | 3
ANAT&PHY 335 | Physiology | 3-5
ZOOLOGY 570 | Cell Biology | 3
COMP SCI 368 | Learning a Programming Language | 3
COMP SCI/E C E/ M E 532 | Matrix Methods in Machine Learning | 3
COMP SCI 766 | Computer Vision | 3
COMP SCI/ B M I 767 | Computational Methods for Medical Image Analysis | 3
E C E 630 | All of Signal Processing | 3
MED PHYS/ B M E 573 | Medical Image Science: Mathematical and Conceptual Foundations | 3
MED PHYS/ B M E 751 | Biomedical Optics and Biophotonics | 3
MED PHYS 777 | Principles of X-ray Computed Tomography | 3

**Elective Requirement**

To provide breadth, at least 6 credits of electives must be taken from courses that are not listed above.

**Biomechanics Track**

Biomechanists use experiments and computational tools to investigate the mechanical aspects of biological systems at levels ranging from whole organisms to organs, tissues, and cells. Graduate students trained in biomechanics are expected to gain a detailed understanding of mechanics, mathematics, biology, and engineering relevant to their research focus.

### Code | Title | Credits
--- | --- | ---
B M E/M E 414 | Orthopaedic Biomechanics - Design of Orthopaedic Implants | 12
B M E/M E 415 | Biomechanics of Human Movement | 12
B M E/M E 505 | Biofluidics | 12
B M E/M E 603 | Topics in Bio-Medical Engineering (Finite Elements for Biomechanics) | 12
B M E/M E 603 | Topics in Bio-Medical Engineering (Imaging Biomechanics) | 12
B M E/M E 603 | Topics in Bio-Medical Engineering (Cell Mechanics) | 12
B M E/M E 603 | Topics in Bio-Medical Engineering (Advanced Cardiovascular Biomechanics) | 12
B M E/M E 615 | Tissue Mechanics | 12
M E 440 | Intermediate Vibrations | 12
M E/CIV ENGR/ E M A 508 | Composite Materials | 12
M E/E M A 540 | Experimental Vibration and Dynamic System Analysis | 12
M E 563 | Intermediate Fluid Dynamics | 12
M E/E M A 570 | Experimental Mechanics | 12
M E 573 | Computational Fluid Dynamics | 12
## Biomedical Engineering, Ph.D.

### Code | Title | Credits
--- | --- | ---
E M A 506 | Advanced Mechanics of Materials I | 3
E M A 545 | Mechanical Vibrations | 3
E M A 605 | Introduction to Finite Elements | 3
E M A/E P 615 | Micro- and Nanoscale Mechanics | 3
E M A 622 | Mechanics of Continua | 3
E M A 630 | Viscoelastic Solids | 3
E M A 700 | Theory of Elasticity | 3

**Biosciences** 3-5

ANAT&PHY 335 | Physiology | 3
ANAT&PHY 435 | Fundamentals of Human Physiology | 3
KINES 773 | Cardiorespiratory Adaptions to Environment and Exercise | 3
ZOOLOGY 570 | Cell Biology | 3

**Elective Requirement** 6

To provide breadth, electives must be courses that are not listed above. Some recommendations are below.

M E/E C E 439 | Introduction to Robotics | 6
B M E/E C E 462 | Medical Instrumentation | 6
B M E/ | Medical Imaging Systems | 6
B M E/MED PHYS/ | Microscopy of Life | 6
PHMCOL-M/ | 6
PHYSICS/ | 6
RADIOL | 6
COMP SCI 368 | Learning a Programming Language (note that there are multiple 1 credit options, including R, C++, and Matlab) | 6
MATH 443 | Applied Linear Algebra | 6
MATH 519 | Ordinary Differential Equations | 6
MATH 619 | Analysis of Partial Differential Equations | 6
M E/COMP SCI/ | Matrix Methods in Machine Learning | 6
E C E 532 | | 6
STAT/M E 424 | Statistical Experimental Design | 6
STAT/B M I 541 | Introduction to Biostatistics | 6

Total Credits | 21-23

1 These tracks are internal to the program and represent different pathways a student can follow to earn this degree. Track names do not appear in the Graduate School admissions application, and they will not appear on the transcript.

### Medical & Microdevices Track 1

Medical and microdevices involve the use of electronic and computational tools to develop devices used in diagnosis and treatment of disease ranging from the systemic to the cellular and molecular levels.

#### Code | Title | Credits
--- | --- | ---
ANAT&PHY 335 | Physiology | 3
BIOCHEM 501 | Introduction to Biochemistry | 3
BIOCHEM/ | Prokaryotic Molecular Biology | 3
GENETICS/ | MICROBIO 612 | 3
BIOCHEM/ | Eukaryotic Molecular Biology | 3
GENETICS/ | MD GENET 620 | 3
PATH 750 | Cellular and Molecular Biology/Pathology | 3
ZOOLOGY/PSYCH 523 | Neurobiology | 3
ZOOLOGY 570 | Cell Biology | 3
ZOOLOGY/ | Cellular Signal Transduction Mechanisms | 3
BIOCHEM/PHMCOL-M 630 | 3

### Data Analysis 3-4

COMP SCI 300 | Programming II | 3
COMP SCI 320 | Data Programming II | 3
COMP SCI 368 | Learning a Programming Language (note that there are multiple 1 credit options, including R, C++, and Matlab) | 3
E C E 630 | All of Signal Processing | 3

### Medical & Microdevices 6

B M E/E C E 462 | Medical Instrumentation | 6
B M E 515 | Therapeutic Medical Devices | 6
B M E/ | Introduction to Energy-Tissue Interactions | 6
MED PHYS 535 | | 6
B M E 550 | Introduction to Biological and Medical Microsystems | 6
B M E 601 | Special Topics in Biomedical Engineering (Medical Design and Manufacturing) | 6
B M E 601 | Special Topics in Biomedical Engineering (Introduction to Neuroengineering) | 6

### Elective Requirement 6

To provide breadth, 6 credits of electives must be from courses that are not listed above. An example of a possible course is listed below.

B M E/E C E 463 | Computers in Medicine | 6
B M E/ | Imaging in Medicine: Applications | 6
MED PHYS 574 | | 6

Total Credits | 21-24

1 These tracks are internal to the program and represent different pathways a student can follow to earn this degree. Track names do not appear in the Graduate School admissions application, and they will not appear on the transcript.

2 The math requirement can be waived by a B- or better in the equivalent course in undergraduate. To request this waiver, please email the Associate Chair of the PhD Degree a copy of your unofficial transcript and indicate the course you are proposing to use. The credits do not transfer; you will instead be able to take a math course of your choice or have a free elective, depending on the track.
Neuroengineering Track

Neuroengineering is the convergence of neuroscience, computation, device development, and mathematics to improve human health. Neuroengineering brings together state-of-the-art technologies for the development of devices and algorithms to assist those with neural disorders. It is also used to reverse engineer living neural systems via new algorithms, technologies and robotics. Students pursuing this track are involved in all of these endeavors so as the next generation of engineers, they will transcend the traditional boundaries of neuroscience, technology, engineering and mathematics.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 443</td>
<td>Applied Linear Algebra</td>
<td>3</td>
</tr>
<tr>
<td>COMP SCI 320</td>
<td>Data Programming II</td>
<td>3-4</td>
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<tr>
<td>COMP SCI 368</td>
<td>Learning a Programming Language</td>
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<tr>
<td>ECE 630</td>
<td>All of Signal Processing</td>
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<tr>
<td>BM E 515</td>
<td>Therapeutic Medical Devices</td>
<td>9-12</td>
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<tr>
<td>BM E 550</td>
<td>Introduction to Biological and Medical Microsystems</td>
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<tr>
<td>BM E 601</td>
<td>Special Topics in Biomedical Engineering (Medical Device Design and Manufacturing)</td>
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</tr>
<tr>
<td>ECE/BME 462</td>
<td>Medical Instrumentation</td>
<td></td>
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<tr>
<td>ECE/BME 463</td>
<td>Computers in Medicine</td>
<td></td>
</tr>
<tr>
<td>NTP/BME 520</td>
<td>Stem Cell Bioengineering</td>
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<tr>
<td>KINES 721</td>
<td>Neural Basis for Movement</td>
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<tr>
<td>KINES 861</td>
<td>Principles of Motor Control and Learning</td>
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</tr>
<tr>
<td>NTP/NEURODPT 610</td>
<td>Cellular and Molecular Neuroscience</td>
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<tr>
<td>NTP/NEURODPT/PSYCH 611</td>
<td>Systems Neuroscience</td>
<td></td>
</tr>
<tr>
<td>NTP/NEURODPT 630</td>
<td>Neuronal Mechanisms for Sensation and Memory in Cerebral Cortex</td>
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<tr>
<td>NTP/NEUROL 735</td>
<td>Neurobiology of Disease</td>
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<tr>
<td>PSYCH 610</td>
<td>Design and Analysis of Psychological Experiments I</td>
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<tr>
<td>PSYCH 733</td>
<td>Perceptual and Cognitive Sciences</td>
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</tr>
<tr>
<td>ZOOLOGY 625</td>
<td>Development of the Nervous System</td>
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<tr>
<td>Electives</td>
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</table>

To provide breadth, 6 credits of electives must be from courses that are not listed above.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANAT&amp;PHY 335</td>
<td>Physiology</td>
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</tr>
<tr>
<td>COMP SCI/BME 567</td>
<td>Medical Image Analysis</td>
<td></td>
</tr>
<tr>
<td>COMP SCI 766</td>
<td>Computer Vision</td>
<td></td>
</tr>
<tr>
<td>COMP SCI/BME 767</td>
<td>Computational Methods for Medical Image Analysis</td>
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These tracks are internal to the program and represent different pathways a student can follow to earn this degree. Track names do not appear in the Graduate School admissions application, and they will not appear on the transcript.

The math requirement can be waived by a B- or better in the equivalent course in undergraduate. To request this waiver, please e-mail the Associate Chair of the PhD Degree a copy of your unofficial transcript and indicate the course you are proposing to use. The credits do not transfer; you will instead be able to take a math course of your choice or have a free elective, depending on the track.

Engineering and Neurobiology courses must total at least 15 credits.

Systems & Synthetic Biology Track

Systems and synthetic biology utilizes experimental and computational tools in an iterative fashion to analyze and regulate biological systems.

Students interested in earning a doctoral minor in Quantitative Biology (http://guide.wisc.edu/graduate/biomedical-engineering/quantitative-biology-doctoral-minor/) enrollment in BME 780 Methods in Quantitative Biology is a requirement. Additionally, students will need to take one additional 3-credit course in quantitative science, biology, or integrated biology/quantitative science from the approved list of courses in the doctoral minor (this course counts toward the elective credits for this track).
The GRADUATE SCHOOL POLICIES

Guidelines for students who earned a master's degree in another field at UW-Madison

1. Students who have earned a master's degree in another field at UW-Madison should contact the Associate Chair of the PhD Degree to understand remaining course requirements. A maximum of 7 credits can be counted from a separate MS degree, in compliance with the Graduate School's Double Degrees policy (https://grad.wisc.edu/documents/double-degrees/).

2. Master's degree students who have been absent for five or more years lose all degree credits earned before their absence.

3. All students with a prior master's degree will still need to complete the Qualifying Exams and Preliminary Exam but may be able to do so at an accelerated pace.

4. Master's degree credits earned five or more years prior to the initiation of the PhD program cannot be used for waivers.

5. To apply for waivers, students should develop a list of course equivalents between their chosen track and courses taken at their prior institution. This list, the syllabi for all courses from the prior institution, and a copy of the unofficial transcript should be provided to the Associate Chair of the PhD Degree.

UW-Madison Undergraduate

A student who has completed their bachelor's degree at UW-Madison may transfer 6 credits of coursework with program approval. These courses must be coursework numbered 400 level or above. Coursework earned five or more years prior to admission to a Ph.D. degree is not allowed to satisfy requirements. These courses may not be used toward the Graduate School’s Minimum Graduate Residence Credit.

UW-Madison University Special

A maximum of 15 credits from the UW-Madison University Special student career may count toward program requirements. Minimum graduate resident credits requirement and minimum graduate degree credit requirement: allowed up to 15 credits numbered 300 or above. Minimum graduate coursework (50%) requirement: allowed up to 15 credits numbered 700 or above. Coursework earned five or more years prior to admission to a Ph.D. program is not allowed to satisfy requirements.

POLICIES

GRADUATE SCHOOL POLICIES

The Graduate School's Academic Policies and Procedures (https://grad.wisc.edu/acadpolicy/) provide essential information regarding general university policies. Program authority to set degree policies beyond the minimum required by the Graduate School lies with the degree program faculty. Policies set by the academic degree program can be found below.

MAJOR-SPECIFIC POLICIES

PRIOR COURSEWORK

Graduate Work from Other Institutions

A student may transfer graduate coursework from other institutions with program approval. These courses may not be used toward the Graduate School's Minimum Graduate Residence Credit at UW-Madison (32 credits). Coursework earned five years or more prior to admission to the PhD program is not allowed to satisfy requirements. Reach out to the BME Graduate Coordinator for more information.

If a student earned a master's degree at another institution, the following guidelines apply:

1. If the previous degree was a master’s in BME the program may waive up to 18 credits of PhD track coursework requirements. Note that the credits do not transfer; students must fulfill the remaining track requirements and then meet the 32 credit minimum at UW-Madison in order to advance to dissertation status (research credits count towards this minimum).

2. Those with a master's in other fields can earn a Master of Science in BME at UW-Madison; only 7 credits of coursework will be waived in this case.

3. All students with a prior master's will still need to complete the Qualifying Exams and Preliminary Exam but may be able to do so at an accelerated pace.

4. Master's degree credits earned five or more years prior to the initiation of the PhD program cannot be used for waivers.

5. To apply for waivers, students should develop a list of course equivalents between their chosen track and courses taken at their prior institution. This list, the syllabi for all courses from the prior institution, and a copy of the unofficial transcript should be provided to the Associate Chair of the PhD Degree.

Introductions to Biostatistics

B M I/STAT 541

Learning a Programming Language (note that there are multiple 1 credit options, including R, C++, and Matlab)

COMP SCI 368

Systems & Synthetic Biology Requirement

B M E 556

B M E 780

CBE/B M E 560

CBE 781

CBE/B M E 782

BIOCHEM 570

BIOCHEM 919

B M I 826

Electives Requirement

To provide breadth, 6 credits of electives must be from courses that are not listed above. Suggested courses include the list below.

Total Credits 19-21

1 These tracks are internal to the program and represent different pathways a student can follow to earn this degree. Track names do not appear in the Graduate School admissions application, and they will not appear on the transcript.

2 The math requirement can be waived by an equivalent course in undergraduate. To request this waiver, please e-mail the Associate Chair of the PhD Degree a copy of your unofficial transcript and indicate the course you are proposing to use. The credits do not transfer; you will instead be able to take a math course of your choice or have a free elective, depending on the track.

1. If a student earned grades of BC, C, D, F, or Incomplete in a graduate course (300 or above), or grade of U in research credits. This review could result
in academic probation with a hold on future enrollment or in being suspended from the Graduate School.

1. Good standing (progressing according to standards; any funding guarantee remains in place).
2. Probation (not progressing according to standards but permitted to enroll; loss of funding guarantee; specific plan with dates and deadlines in place in regard to removal of probationary status).
3. Unsatisfactory progress (not progressing according to standards; not permitted to enroll, dismissal, leave of absence or change of advisor or program).

ADVISOR / COMMITTEE

Advisor: Every BME graduate student must have a faculty advisor. A faculty advisor provides the student with academic guidance in their course program and research oversight in their thesis. The advisor must be a primary BME faculty or a BME affiliate; if the advisor is a BME affiliate, the student must identify a primary BME faculty to serve as co-advisor within their first semester. Graduate students should always seek advice from their advisor and/or co-advisor prior to enrolling for courses.

Doctoral Committee: In addition to the committee requirements put forth by the Graduate School, BME has department-specific criteria that Ph.D. students must meet when forming their committees:

- Committees consist of at least 5 members (one more than the Graduate School’s requirement of four)
- The student’s advisor(s) must be on the committee
- A minimum of two primary BME faculty must be on the committee
- The Ph.D. committee chair must be a primary BME faculty - either the student’s advisor or their co-advisor (if the advisor is an affiliate)
- At least one member must be from outside of the primary BME faculty.
- The Ph.D. committee chair must approve the other members of the committee and any committee changes.
- Students must have a yearly committee meeting after passing the preliminary exam.

CREDITS PER TERM ALLOWED

15 credits

TIME CONSTRAINTS

Students typically complete their degree within six years of entering the program.

Within two years of entering their program, students are required to pass a comprehensive qualifying examination.

Within three years of entering their program, students are required to prepare for a preliminary examination.

GRIEVANCES AND APPEALS

These resources may be helpful in addressing your concerns:

- Bias or Hate Reporting (https://doso.students.wisc.edu/bias-or-hate-reporting/)
- Graduate Assistantship Policies and Procedures (https://hr.wisc.edu/policies/gapp/#grievance-procedure)
- Hostile and Intimidating Behavior Policies and Procedures (https://hr.wisc.edu/hib/)
- Office of the Provost for Faculty and Staff Affairs (https://facstaff.provost.wisc.edu/)
- Dean of Students Office (https://doso.students.wisc.edu/) (for all students to seek grievance assistance and support)
- Employee Assistance (http://www.eao.wisc.edu/) (for personal counseling and workplace consultation around communication and conflict involving graduate assistants and other employees, post-doctoral students, faculty and staff)
- Employee Disability Resource Office (https://employeedisabilities.wisc.edu/) (for qualified employees or applicants with disabilities to have equal employment opportunities)
- Graduate School (https://grad.wisc.edu/) (for informal advice at any level of review and for official appeals of program/departmental or school/college grievance decisions)
- Office of Compliance (https://compliance.wisc.edu/) (for class harassment and discrimination, including sexual harassment and sexual violence)
- Office of Student Conduct and Community Standards (https://conduct.students.wisc.edu/) (for conflicts involving students)
- Ombuds Office for Faculty and Staff (http://www.ombuds.wisc.edu/) (for employed graduate students and post-docs, as well as faculty and staff)
- Title IX (https://compliance.wisc.edu/titleix/) (for concerns about discrimination)

BME Grievance Procedures

If a student feels unfairly treated or aggrieved by faculty, staff, or another student, the University offers several avenues to resolve the grievance.

Step 1

The student is encouraged to speak first with the person toward whom the grievance is directed to see if a situation can be resolved at this level. Students are also encouraged to talk with their faculty advisors regarding concerns or difficulties, or reach out to the Graduate Student Services Coordinator or Associate Chair of BME Graduate Advising for additional assistance. These activities do not rise to the level of a formal grievance; however, the student is encouraged to keep documentation of these interactions as they may be useful if a formal grievance is pursued.

Step 2

Should a satisfactory resolution not be achieved, a formal grievance can be filed with the BME Grievance Committee. To do so, the student contacts the Department Administrator, who will provide the student with the name of the current chair of the Grievance Committee. The student will then contact the Chair of the Grievance Committee, who will reply within seven calendar days. If the grievance is with the current Chair of the Grievance Committee, please let the Department Administrator know and they will identify an alternate committee member to contact. It is advised that grievances are filed within 60 calendar days of the alleged unfair treatment to enable a thorough investigation.

Step 3

If the student does not feel comfortable working through the departmental process, they are encouraged to seek out other campus resources including:

- The Assistant Dean for Graduate Affairs in the College of Engineering
- The Graduate School
- UW Division of Diversity, Equity & Educational Achievement (DDEEA)
Step 4
At this point, if either party (the student or the person toward whom the grievance is directed) is unsatisfied with the decision of the faculty committee, the party may file a written appeal. Either party has ten working days to file a written appeal to the School/College. For more information, students should consult the College of Engineering Academic Advising Policies and Procedures.

Step 5
Documentation of the grievance will be stored for at least seven years. Significant grievances that set a precedent will be stored indefinitely. The Graduate School has procedures for students wishing to appeal a grievance decision made at the school/college level. These policies are described in the Graduate School’s Academic Policies and Procedures.

OTHER
n/a

PROFESSIONAL DEVELOPMENT

GRADUATE SCHOOL RESOURCES
Take advantage of the Graduate School’s professional development resources (https://grad.wisc.edu/pd/) to build skills, thrive academically, and launch your career.

PROGRAM RESOURCES

THE INDIVIDUAL DEVELOPMENT PLAN (IDP)
An Individual Development Plan (IDP) (https://grad.wisc.edu/pd/idp/) helps graduate students and postdoctoral researchers:

- assess current skills, interests, and strengths;
- make a plan for developing skills to meet academic and professional goals; and
- communicate with supervisors, advisors, and mentors about evolving goals and related skills.

The IDP is a document to be revisited again and again, to update and refine as goals change and/or come into focus, and to record progress and accomplishments.

The university recommends IDPs for all postdoctoral researchers and graduate students, and requires IDPs for all postdoctoral researchers and graduate students supported by National Institutes of Health (NIH) funding. See the Graduate School for more information and IDP resources (https://grad.wisc.edu/pd/idp/).

ENGINEERING CAREER SERVICES
The Engineering Career Services (https://ecs.wisc.edu/) staff offers assistance to students searching or preparing for internships, co-ops, and jobs with well-recognized organizations.

THE WRITING CENTER
The Writing Center (https://writing.wisc.edu/) is a campus-wide organization that provides free of charge, face-to-face and online consultations for students writing papers, reports, resumes, and applications.

LEARNING OUTCOMES
1. Demonstrate an ability to synthesize knowledge from a subset of the biological and physical sciences.
2. Conduct original research.
3. Demonstrate an ability to create new knowledge and communicate it to their peers.
4. Foster ethical and professional conduct.

PEOPLE

FACULTY
Paul Campagnola (Chair)
Randolph Ashton
David Beebe
Walter Block
Christopher Brace
Kevin Eliceiri
Shaoqin ‘Sarah’ Gong
Aviad Hai
Melissa Kinney
Pamela Kreeger
Wan-ju Li
Kip Ludwig
Kristyn Masters
Megan McClean
Beth Meyerand
William Murphy
Jeremy Rogers
Krishanu Saha
Melissa Skala
Darryl Thelen
Justin Williams
Colleen Witzenburg
Filiz Yesilkoy

INSTRUCTIONAL STAFF AND FACULTY ASSOCIATES
Amit Nimunkar
John Puccinelli
Tracy Jane Puccinelli
Darlis Suarez-Gonzalez
Aaron Suminski

See also Biomedical Engineering Faculty Directory (http://directory.engr.wisc.edu/bme/).