BIOMEDICAL ENGINEERING: ACCELERATED PROGRAM, MS

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.

NAMED OPTION REQUIREMENTS

MODE OF INSTRUCTION

Face to Face	Evening/ Weekend	Online	Hybrid	Accelerated
Yes	No	No	No	Yes

Mode of Instruction Definitions

Accelerated: Accelerated programs are offered at a fast pace that condenses the time to completion. Students typically take enough credits aimed at completing the program in a year or two.

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
Minimum Credit Requirement	30 credits
Minimum Residence Credit Requirement	16 credits
Minimum Graduate Coursework Requirement	15 credits must be graduate-level coursework. Refer to the Graduate School: Minimum Graduate Coursework (50%) Requirement policy: https://policy.wisc.edu/library/UW-1244 (https://policy.wisc.edu/library/UW-1244/).
Overall Graduate GPA Requirement	3.00 GPA required. Refer to the Graduate School: Grade Point Average (GPA) Requirement policy: https://policy.wisc.edu/library/UW-1203 (https://policy.wisc.edu/library/UW-1203/).
Other Grade Requirements	n/a
Assessments and Examinations	There are no degree-specific assessments and examinations outside of those given in individual courses.
Language Requirements	None.

REQUIRED COURSES

The required coursework is designed to complement each student's interests and background in biomedical engineering.

Code	Title	Credits
General Requirements		
2 semesters of B M E 701		2
Bioscience credits		3
Engineering credits, numbered 400 and above		12
Elective credits selected in consultation with advisor		7-13
Project or Independent Study (B M E 790 or B M E 799)		0-6
Total Credits		**30**

Students choose one of the following areas of specialization. Of the credits above, 15 credits must be in one area of specialization.

Biomaterials and Tissue Engineering [1]

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.

Code	Title	Credits
Required courses:		
At least 3 credits of Bioscience. Relevant options include:		*3 or more*
BIOCHEM 501	Introduction to Biochemistry	
BIOCHEM/ GENETICS/ MICROBIO 612	Prokaryotic Molecular Biology	
BIOCHEM/ GENETICS/ MD GENET 620	Eukaryotic Molecular Biology	
CRB 640	Fundamentals of Stem Cell and Regenerative Biology	
CRB 650	Molecular and Cellular Organogenesis	
CRB/B M E 670	Biology of Heart Disease and Regeneration	
M M & I/PATH-BIO 528	Immunology	
ONCOLOGY 401	Introduction to Experimental Oncology	

PATH 750	Cellular and Molecular Biology/ Pathology	
PATH 752	Cellular and Molecular Biology/ Pathology Seminar	
ZOOLOGY 570	Cell Biology	
At least 12 credits of Engineering. Relevant options include:		*12 or more*
B M E/ PHM SCI 430	Biological Interactions with Materials	
B M E 510	Introduction to Tissue Engineering	
B M E 511	Tissue Engineering Laboratory	
B M E 520	Stem Cell Bioengineering	
B M E 545	Engineering Extracellular Matrices	
B M E 550	Introduction to Biological and Medical Microsystems	
B M E 602	Special Topics in Biomedical Engineering (Advanced Stem Cell Engineering)	
B M E 602	Special Topics in Biomedical Engineering (CRISPR Genome Editing and Engineering Laboratory)	
CBE 540	Polymer Science and Technology	
CBE 648	Synthetic Organic Materials in Biology and Medicine	
CBE 781	Biological Engineering: Molecules, Cells & Systems	
CHEM 654	Materials Chemistry of Polymers	
M S & E 521	Advanced Polymeric Materials	
Electives (taken in consultation with your faculty advisor):		
B M E 556	Systems Biology: Mammalian Signaling Networks	
B M E/CBE 560	Biochemical Engineering	
B M E/ MED PHYS/ PHMCOL-M/PHYSICS/ RADIOL 619	Microscopy of Life	
B M E 740	Biomanufacturing Entrepreneurship	
B M E/CHEM/ MED PHYS 750	Biological Optical Microscopy	
B M E/CBE 782	Modeling Biological Systems	
B M E/CBE 783	Design of Biological Molecules	
B M I/STAT 541	Introduction to Biostatistics	
B M I/ COMP SCI 776	Advanced Bioinformatics	
COMP SCI 765	Data Visualization	
STAT/F&W ECOL/ HORT 571	Statistical Methods for Bioscience I	
STAT/B M I 877	Statistical Methods for Molecular Biology	

Biomechanics [1]

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.

Code	Title	Credits
Required courses:		
At least 3 credits of a Bioscience. Relevant options include:		*3 or more*
ANAT&PHY 335	Physiology	
ANAT&PHY 435	Fundamentals of Human Physiology	
BIOCHEM/ GENETICS/ MD GENET 620	Eukaryotic Molecular Biology	
CRB/B M E 670	Biology of Heart Disease and Regeneration	
KINES 773	Cardiorespiratory Adaptions to Environment and Exercise	
ZOOLOGY 570	Cell Biology	
At least 12 credits of Engineering. Relevant options include:		*12 or more*
B M E/M E 414	Orthopaedic Biomechanics - Design of Orthopaedic Implants	
B M E/M E 415	Biomechanics of Human Movement	
B M E/M E 505	Biofluidics	
B M E/M E 516	Finite Elements for Biological and Other Soft Materials	
B M E/I SY E 564	Occupational Ergonomics and Biomechanics	
B M E 603	Special Topics in Bioinstrumentation and Medical Devices (Image-Based Biomechanics)	
B M E/M E 615	Tissue Mechanics	
B M E/I SY E 662	Design and Human Disability and Aging	
B M E/M E 715	Advanced Tissue Mechanics	
Electives (taken in consultation with your faculty advisor):		
B M E/ MED PHYS/ PHMCOL-M/PHYSICS/ RADIOL 619	Microscopy of Life	
B M I/STAT 541	Introduction to Biostatistics	
COMP SCI 368	Learning a Programming Language	
E M A 506	Advanced Mechanics of Materials I	
E M A 519	Fracture Mechanics	
E M A/ M S & E 541	Heterogeneous and Multiphase Materials	
E M A 545	Mechanical Vibrations	
E M A 605	Introduction to Finite Elements	
E M A/E P 615	Micro- and Nanoscale Mechanics	
E M A 630	Viscoelastic Solids	
E M A 710	Mechanics of Continua	
MATH 443	Applied Linear Algebra	
MATH 519	Ordinary Differential Equations	
MATH 619	Analysis of Partial Differential Equations	
M E/STAT 424	Statistical Experimental Design	

M E/E C E 439	Introduction to Robotics
M E/CIV ENGR/ E M A 508	Composite Materials
M E/COMP SCI/ E C E 532	Matrix Methods in Machine Learning
M E/E M A 540	Experimental Vibration and Dynamic System Analysis
M E 563	Intermediate Fluid Dynamics
M E/E M A 570	Experimental Mechanics
M E 573	Computational Fluid Dynamics

Biomedical Imaging and Optics [1]

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 as well as optical and/or physical methods.

Code	Title	Credits
Required courses:		
At least 3 credits of Bioscience. Relevant options include:		*3 or more*
ANAT&PHY 335	Physiology	
BIOCHEM 501	Introduction to Biochemistry	
ZOOLOGY 570	Cell Biology	
At least 12 credits of Engineering. Relevant options include:		*12 or more*
B M E/H ONCOL/ MED PHYS/ PHYSICS 501	Radiation Physics and Dosimetry	
B M E/ MED PHYS 573	Mathematical Methods in Medical Physics	
B M E/ MED PHYS 574	Data Science in Medical Physics	
B M E/ MED PHYS 575	Diagnostic Ultrasound Imaging	
B M E/ MED PHYS 578	Non-Ionizing Diagnostic Imaging	
B M E/ MED PHYS 580	The Physics of Medical Imaging with Ionizing Radiation	
B M E/ MED PHYS/ PHMCOL-M/PHYSICS/ RADIOL 619	Microscopy of Life	
B M E/ MED PHYS 710	Advances in Medical Magnetic Resonance	
B M E/CHEM/ MED PHYS 750	Biological Optical Microscopy	
B M E 751	Biomedical Optics and Biophotonics	
B M E/E C E/ MED PHYS 778	Machine Learning in Ultrasound Imaging	
B M E 780	Methods in Quantitative Biology	
MED PHYS 777	Principles of X-ray Computed Tomography	
Electives (taken in consultation with your faculty advisor):		
B M I/ COMP SCI 567	Medical Image Analysis	
COMP SCI 300	Programming II	
COMP SCI 320	Data Science Programming II	
COMP SCI 368	Learning a Programming Language	
COMP SCI/ E C E 766	Computer Vision	
COMP SCI/ B M I 767	Computational Methods for Medical Image Analysis	
E C E/ COMP SCI 533	Image Processing	
E C E/COMP SCI/ M E 539	Introduction to Artificial Neural Networks	
MATH 443	Applied Linear Algebra	
M E/COMP SCI/ E C E 532	Matrix Methods in Machine Learning	

Medical and Microdevices [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
Required courses:		
At least 3 credits of Bioscience. Relevant options include:		*3 or more*
ANAT&PHY 335	Physiology	
BIOCHEM 501	Introduction to Biochemistry	
BIOCHEM/ GENETICS/ MICROBIO 612	Prokaryotic Molecular Biology	
BIOCHEM/ GENETICS/ MD GENET 620	Eukaryotic Molecular Biology	
PATH 750	Cellular and Molecular Biology/ Pathology	
PATH 752	Cellular and Molecular Biology/ Pathology Seminar	
ZOOLOGY/ PSYCH 523	Neurobiology	
ZOOLOGY 570	Cell Biology	
At least 12 credits of Engineering. Relevant options include:		*12 or more*
B M E/E C E 462	Medical Instrumentation	
B M E/ MED PHYS 535	Introduction to Energy-Tissue Interactions	
B M E 550	Introduction to Biological and Medical Microsystems	
B M E 602	Special Topics in Biomedical Engineering (Introduction to Neuroengineering)	
B M E 640	Medical Devices Ecosystem: The Path to Product	
B M E 651	Biophotonics Laboratory	
B M E/CHEM/ MED PHYS 750	Biological Optical Microscopy	
Electives (taken in consultation with your faculty advisor):		
COMP SCI 300	Programming II	

COMP SCI 320	Data Science Programming II
COMP SCI 368	Learning a Programming Language (multiple 1-credit options, including R, C++, and Matlab)
MATH 443	Applied Linear Algebra
MATH 519	Ordinary Differential Equations
MATH 619	Analysis of Partial Differential Equations

Neuroengineering [1]

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 pursing this track are involved in all of these endeavors so that as the next generation of engineers, they will transcend the traditional boundaries of neuroscience, technology, engineering and mathematics.

Code	Title	Credits
Required courses:		
At least 3 credits of Bioscience. Relevant options include:		*3 or more*
ANAT&PHY 335	Physiology	
KINES 721	Neural Basis for Movement	
KINES 861	Principles of Motor Control and Learning	
NTP/ NEURODPT 610	Cellular and Molecular Neuroscience	
NTP/NEURODPT/ PSYCH 611	Systems Neuroscience	
NTP 735	Neurobiology of Disease	
PSYCH 610	Design and Analysis of Psychological Experiments I	
PSYCH 733	Perceptual and Cognitive Sciences	
ZOOLOGY 625	Development of the Nervous System	
At least 12 credits of Engineering. Relevant options include:		*12 or more*
B M E/E C E 462	Medical Instrumentation	
B M E/E C E 463	Computers in Medicine	
B M E 520	Stem Cell Bioengineering	
B M E 550	Introduction to Biological and Medical Microsystems	
B M E 602	Special Topics in Biomedical Engineering (Introduction to Neuroengineering)	
B M E 640	Medical Devices Ecosystem: The Path to Product	
E C E/COMP SCI/ I SY E 524	Introduction to Optimization	
E C E/ COMP SCI 533	Image Processing	
E C E/COMP SCI/ M E 539	Introduction to Artificial Neural Networks	
NTP/ MED PHYS 651	Methods for Neuroimaging Research	
Electives (taken in consultation with your faculty advisor):		
COMP SCI 320	Data Science Programming II	
COMP SCI 368	Learning a Programming Language (multiple 1-credit options, including R, C++, and Matlab)	
COMP SCI/ B M I 567	Medical Image Analysis	
COMP SCI/ E C E 766	Computer Vision	
COMP SCI/ B M I 767	Computational Methods for Medical Image Analysis	
MATH 443	Applied Linear Algebra	

Systems and Synthetic Biology [1]

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

Code	Title	Credits
Required courses:		
At least 3 credits of Bioscience. Relevant options include:		*3 or more*
BIOCHEM 570	Computational Modeling of Biological Systems	
BIOCHEM 919	Synthetic Biology Seminar	
BIOCHEM 501	Introduction to Biochemistry	
BIOCHEM/ GENETICS/ MICROBIO 612	Prokaryotic Molecular Biology	
BIOCHEM/ GENETICS/ MD GENET 620	Eukaryotic Molecular Biology	
BIOCHEM 729	Advanced Topics	
M M & I/PATH-BIO 528	Immunology	
ZOOLOGY 570	Cell Biology	
At least 12 credits of Engineering. Relevant options include:		*12 or more*
B M E 550	Introduction to Biological and Medical Microsystems	
B M E 556	Systems Biology: Mammalian Signaling Networks	
B M E 780	Methods in Quantitative Biology	
B M E/CBE 560	Biochemical Engineering	
B M E 602	Special Topics in Biomedical Engineering (CRISPR Genome Editing and Engineering Laboratory)	
CBE 781	Biological Engineering: Molecules, Cells & Systems	
CBE/B M E 782	Modeling Biological Systems	
CBE 660	Intermediate Problems in Chemical Engineering	
Electives (taken in consultation with your faculty advisor):		
B M I/STAT 541	Introduction to Biostatistics	
B M I/ COMP SCI 576	Introduction to Bioinformatics	
B M I/ COMP SCI 775	Computational Network Biology	

B M I/ COMP SCI 776	Advanced Bioinformatics
B M I 826	Special Topics in Biostatistics and Biomedical Informatics
COMP SCI 368	Learning a Programming Language (multiple 1-credit options available, including R, C++, and Matlab)
MATH 443	Applied Linear Algebra
MATH 519	Ordinary Differential Equations
MATH 619	Analysis of Partial Differential Equations

Footnotes

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

Other Policy

Students in this program may not take courses outside the prescribed curriculum without faculty advisor and program director approval. Students in this program cannot enroll concurrently in other undergraduate or graduate degree programs.