

BIOMEDICAL ENGINEERING UNDERGRADUATE CURRICULUM

Catalog Year 2017

Last update: August 12, 2017

This program is accredited by the Engineering Accreditation Commission of ABET, <http://www.abet.org>.

Undergraduate Program Mission Statement

To provide education that prepares students to lead, innovate, and self-educate through their careers in bioengineering and biomedical professions and industries.

Program Objectives

Career Achievements – Using a knowledge base with a core foundation in engineering and biology, our students will be able to apply their skills to a variety of challenges in their chosen field. Our graduates will demonstrate skills such as innovation, creativity, adaptability, and critical thinking to solve problems in biomedical industry, medicine, academia, and consulting.

Professionalism – Our graduates will demonstrate leadership in their chosen fields, and make decisions that are socially and ethically responsible. Graduates will function effectively in multidisciplinary team environments and communicate effectively to a variety of audiences.

Life-long Learning – Our graduates will build and expand upon their undergraduate foundations by engaging in learning opportunities throughout their careers.

To obtain the B.S. in Biomedical Engineering, a student must obtain 18 course credits in engineering topics.

I. MATHEMATICS (4 courses)

MATH	220, 224, 230	Calculus
MATH	234	Multiple Integration and Vector Calculus

II. BASIC SCIENCES (4 courses)

PHYSICS	135-2,3	General Physics plus labs* 136-2 and 136-3 <i>and</i>
CHEM	131, 132	General Chemistry plus labs* 141 and 142 <i>or</i>
CHEM	151, 152	General Chemistry plus labs* 161 and 162 <i>or</i>
CHEM	171, 172	Accelerated Chemistry plus labs* 181 and 182

*Labs may be combined and used as technical electives or unrestricted electives.

III. ENGINEERING ANALYSIS (4 courses)

GEN ENG	205-1	Computational Methods and Linear Algebra
GEN ENG	205-2	Linear Algebra and Mechanics
GEN ENG	205-3	Dynamic System Modeling
GEN ENG	205-4	Differential Equations

IV. ENGINEERING DESIGN AND COMMUNICATION (3 courses)

DSGN	106-1, 2	Design Thinking and Communication (0.5 each) plus English 106-1,2 (0.5 each)
BMD_ENG	390-2	Biomedical Engineering Design Another capstone design course (including BME 391-SA) may be substituted for this course by petition.

V. BASIC ENGINEERING (5 courses)

A. Thermodynamics - 1 course listed from those below

BMD_ENG	250	Thermodynamics
MECH ENG	222	Thermodynamics & Statistical Mechanics I

B. Fluids and Solids - 2 courses as specified below

BMD_ENG	271	Introduction to Biomechanics <i>and</i>
BMD_ENG	270	Fluid Mechanics <i>or</i>
MECH ENG	241	Fluid Mechanics I

C. Material Science - 1 course

MAT SCI	201	Principles of the Properties of Materials
---------	-----	---

D. Probability, Statistics, and Quality Control - 1 course listed from those below

BMD_ENG	220	Introduction to Biostatistics
---------	-----	-------------------------------

IEMS	303	Statistics I
MECH ENG	359	Reliability Engineering

VI. SOCIAL SCIENCES/HUMANITIES THEME (7 courses)

VII. UNRESTRICTED ELECTIVES (5 courses)

VIII. BIOMEDICAL ENGINEERING PROGRAM (16 courses, none of which may be taken P/N*)

Students seeking admission to physical therapy, dental, or medical schools should familiarize themselves with the specific entrance requirements of those schools to which they intend to apply. In addition to the specifically required courses of the BME program, many professional schools also require additional courses in physics, organic and/or physical chemistry, biochemistry, and laboratory biology. These requirements can be satisfied through the BME curriculum and by judicious use of electives.

A. Core – 10 courses + 1 zero credit seminar

BMD_ENG	101	Introduction to Biomedical Engineering (zero credit seminar)
CHEM	210-1	Organic Chemistry
BIOLSCI	215-0	Genetics and Molecular Biology
<u>Or</u>		
BIOLSCI	219-0	Cell Biology
BMD_ENG	301	Systems Physiology I
BMD_ENG	302	Systems Physiology II
BMD_ENG	303	Systems Physiology III
BMD_ENG	305	Biomedical Signals Analysis
BMD_ENG	306	Biomedical Systems Analysis
BMD_ENG	307	Quantitative Experimentation and Design
BMD_ENG	378	Transport Fundamentals (formerly numbered BME 350)
BMD_ENG	390-1	Biomedical Engineering Design

B. Technical Electives - 2 units

Technical electives (2 units required). In Biomedical Engineering, these may include: BIOLSCI 215 or BIOLSCI 219 (the one not used to satisfy the core requirement), BIOLSCI 301, CHEM 210-2 and 3, DSGN 240 (0.5 unit), DSGN 245 (0.5 unit), and DSGN 246 (0.5 unit), EECS 211, EECS 230, ME 240, and graded, 300-level or higher courses in engineering*, science, or mathematics. Three, 0.34 unit basic science and biology labs may also be combined and counted as a technical elective. Six total labs can be used.

*395 courses must be approved; not all are acceptable. BME 399 Independent Study is only graded P/N and may not be used as a technical elective. BME 499 is graded and may be used as a technical elective.

C. Biomedical Engineering Electives - 4 courses

Students are required to take two courses from Category A and two courses from Category B.

Category A			
BME 317	BME 333	BME 346	BME 371
BME 325	BME 343 or MSE 370*	BME 349-1	BME 377
BME 327	BME 344	BME 366	

Category B			
Bio 215**	BME 346	EECS 211 or 230*	ME 315
Bio 219**	BME 349-1	EECS 302	ME 333
Bio 301**	BME 349-2	EECS 328	ME 341
BME 314	BME 359	EECS 332	ME 362
BME 315	BME 365	EECS 360	ME 385
BME 316	BME 366	EECS 379	ME 389
BME 317	BME 371	EECS 382	ME 390
BME 323	BME 377	EECS 395-0 23	MSE 318
BME 325	BME 380**	EECS 395-0 27	MSE 360
BME 327	CIV ENG 327	ESAM 346	MSE 376
BME 333	ChBE 361	ESAM 370-1	Phy 357**
BME 343 or MSE 370*	ChBE 379	IEMS 385	
BME 344	DSGN 360	ME 314	

*BME 343 and MSE 370 are duplicate courses and only one may be taken; EECS 211 and 230 cover the same material and cannot both be used toward the BME degree

**Only one course that is less than 1 engineering unit can be counted toward the BME Electives. While not required for BME, it is recommended that students take the lab courses associated with the Bio courses.

Students who seek depth in one particular area may find the guidelines below helpful in selecting their courses.

Biological Mechanics and Rehabilitation

Category A	Category B		
BME 371	BME 343 or 344	EECS 360	ME 341
BME 366	BME 365	ME 315	
	BME 377	ME 333	

Biomaterials and Regenerative Medicine

Category A	Category B		
BME 343 or 344	Bio 215**	BME 343 or 344	ChBE 361
BME 346 or 349-1	Bio 219**	BME 346 or 349-1	ChBE 379
	Bio 301**	BME 349-2	ME 385

	BME 314	BME 371	MSE 370*
	BME 315	BME 377	
	BME 317	BME 395-0 20	

Imaging and Biophotonics

Category A	Category B		
BME 325	BME 323	EECS 302	EECS 382
BME 327 or 333	BME 327	EECS 328	EECS 395-0 23
	BME 333	EECS 332	MAT SCI 360
	BME 495	EECS 360	PHY 357**
	EECS 230	EECS 379	

Biomedical Engineering Electives

Students are required to take two courses from Category A and two courses from Category B.

Category	Eng credit	Course	Course Name	Prerequisites	Add'l Info
Biomedical Engineering					
B	1	BMD ENG 314	Models in Biochemistry and Molecular Biology	junior standing recommended	
B	1	BMD ENG 315	Applications of Genetic Engineering to Immunochemistry	junior standing recommended	
B	1	BMD ENG 316	Engineering Design of Therapeutic Antibodies	junior standing recommended	
A	1	BMD ENG 317	Biochemical Sensors	BIOL SCI 215; CHEM 210-1; PHYSICS 135-2,3	
B	1	BMD ENG 323	Visual Science	PHYSICS 135-2	
A	1	BMD ENG 325	Introduction to Medical Imaging	PHYSICS 135-3 or equivalent	
A	1	BMD ENG 327	Magnetic Resonance Imaging	PHYSICS 135-3	
A	1	BMD ENG 333	Modern Optical Microscopy and Imaging	PHYSICS 135-2, MATH 220, MATH 230, GEN ENG 205-4	
A	1	BMD ENG 343	Biomaterials and Medical Devices	BIOL SCI 215 and MAT SCI 201 For 2018-19: BIOL SCI 215 and BIOL SCI 219, MAT SCI 201	Can not be used with MAT SCI 370
A	1	BMD ENG 344	Biological Performance of Materials	BIOL SCI 215 and MAT SCI 201 For 2018-19: BIOL SCI 215 and BIOL SCI 219, MAT SCI 201	
A	1	BMD ENG 346	Tissue Engineering	BIOL SCI 215 For 2018-19: BIOL SCI 215 and BIOL SCI 219	
A	1	BMD ENG 349-1	Bioregenerative Engineering	BIOL SCI 215	
B	1	BMD ENG 349-2	Regenerative Engineering Laboratory	BMD ENG 349-1	
B	1	BMD ENG 365	Human Limbs and Their Artificial Replacements		
A	1	BMD ENG 366	Biomechanics of Movement	BMD ENG 271	
A	1	BMD ENG 371	Mechanics of Biological Tissues	GEN ENG 205-3,4; BMD ENG 271	
A	1	BMD ENG 377	Intermediate Fluid Mechanics in Engineering and Biology	BMD ENG 270 or consent of instructor	
B	0.5	BMD ENG 380	Medical Devices, Disease, and Global Health		Note that this course carries less than 1 eng unit and 18 total eng units are required
Biological Sciences					
B	0	BIOL SCI 215	Genetics and Molecular Biology	Chem 102, 131, 151, or 171	Only one non-engineering course can be used as a BME Elective
B	0	BIOL SCI 219	Cell Biology	Chem 102, 131, 151, or 171	
B	0	BIOL SCI 301	Biochemistry	CHEM 210-2 or CHEM 212-2	
Chemical Engineering					
B	1	CHEM ENG 361	Introduction to Polymers	CHEM ENG 211 or other thermodynamics course; CHEM 210-1	
B	1	CHEM ENG 379	Computational Biology: Principles and		

			Applications		
Civil and Environmental Engineering					
B	1	CIV ENV 327	Finite Element Methods in Mechanics		
Manufacturing and Design Engineering					
B	1	DSGN 360	Design Competition		
Electrical Engineering and Computer Science					
B	1	EECS 211	Fundamentals of Computer Programming II	EECS 111	Only one of these courses can be counted toward the BME degree
B	1	EECS 230	Programming for Computer Engineers	GEN ENG 205-1,2	
B	0.5	EECS 302	Probabilistic Systems and Random Signals	MATH 234	Note that these courses carry less than 1 eng unit and 18 total eng units are required
B	0.5	EECS 328	Numerical Methods for Engineers	GEN ENG 205-1,2,3; MATH 220, 224, 230	
B	1	EECS 332	Digital Image Analysis	EECS 214; IEMS 202; MATH 240	
B	1	EECS 360	Introduction to Feedback Systems	EECS 222	
B	1	EECS 379	Lasers and Coherent Optics	EECS 222 and 224	
B	1	EECS 382	Photonic Information Processing	EECS 222 and 224	
B	1	EECS 395-0 27	Bioinformatics		
B	1	EECS 395-0 23	Cardiovascular Instrumentation		
Engineering Sciences and Applied Mathematics					
B	0.2	ES APPM 346	Modeling and Computation in Science and Engineering	MATH 234, 240, and 250 or GEN ENG 205-4; PHYSICS 135-1,2 or equivalent; familiarity with a programming language; or consent of instructor	Note that these courses carry less than 1 eng unit and 18 total eng units are required
B	0.1	ES APPM 370-1	Introduction to Computational Neuroscience		
Industrial Engineering and Management Sciences					
B	1	IEMS 385	Introduction to Health Systems Management	IEMS 303 and 313	
Materials Science and Engineering					
B	1	MAT SCI 318	Materials Selection	MAT SCI 201	
B	1	MAT SCI 360	Introduction to Electron Microscopy	MAT SCI 301; PHYSICS 135-2,3 or equivalent	
A	1	MAT SCI 370	Biomaterials		Can not be used with BME 343
B	1	MAT SCI 376	Nanomaterials	Senior undergraduate or graduate students in materials science, engineering, chemistry, physics, or biology	
Mechanical Engineering					
B	1	MECH ENG 314	Theory of Machines - Dynamics	ME 202	
B	1	MECH ENG 315	Theory of Machines – Design of Elements	ME 240; MAT SCI 201; CIV ENV 216	
B	1	MECH ENG 333	Introduction to Mechatronics	MECH ENG 233, EECS 221	
B	1	MECH ENG 341	Computational Methods for Engineering Design	Graduate standing, senior standing or consent of instructor	
B	1	MECH ENG 362	Stress Analysis	CIV ENV 216	
B	1	MECH ENG 385	Nanotechnology		
B	1	MECH ENG 389	Molecular Machines in Biology	MATH 230 or consent of instructor	

B	1	MECH ENG 390	Introduction to Dynamic Systems	GEN ENG 205-4	
Physics and Astronomy					
B	0	PHYSICS 357	Photonics Laboratory	Consent of instructor	Only one non-engineering course can be used as a BME Elective