

BIOMEDICAL ENGINEERING UNDERGRADUATE CURRICULUM

Catalog Year 2020

Last update: May 13, 2020

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	220-1, 220-1	Single Variable Calculus
MATH	228-1, 228-2	Multivariable 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
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D. Probability, Statistics, and Quality Control - 1 course listed from those below

BMD_ENG	220	Introduction to Biostatistics
IEMS	303	Statistics I (follow pre-reqs)

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	201	Molecular Biology
BMD_ENG	301	Systems Physiology I
BMD_ENG	302	Systems Physiology II
BMD_ENG	303	Systems Physiology III
BMD_ENG	207	BME Lab: Experimental Design
BMD_ENG	308	Biomedical Signals and Circuits
BMD_ENG	309	Biomedical Systems Analysis
BMD_ENG	378	Transport Fundamentals
BMD_ENG	390-1	Biomedical Engineering Design

B. Technical Electives - 2 units

Technical electives (2 units required). In Biomedical Engineering, these may include: BIOLSCI 202, BIOLSCI 301, CHEM 210-2 and 3, DSGN 240 (0.5 unit), DSGN 321 (0.5 unit), CS 211, 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 311	BME 333	BME 347	BME 377
BME 317	BME 343	BME 353	
BME 325	BME 344	BME 366	
BME 327	BME 346	BME 371	

Category B			
Bio 202*	BME 344	ChBE 376	IEMS 385
Bio 301*	BME 346	ChBE 379	ME 301
BME 311	BME 347	CIV ENV 327	ME 314
BME 314	BME 348	CS 211	ME 315
BME 315	BME 353	DSGN 360	ME 333
BME 316	BME 365	EE 302	ME 362
BME 317	BME 366	EE 332	ME 382
BME 323	BME 371	EE 360	ME 390
BME 325	BME 377	EE 379	MSE 318
BME 327	BME 380	EE 382	MSE 360
BME 333	BME 388-SA	EE 395**	Phy 357*
BME 343	ChBE 361	ESAM 370	

*Only one non-engineering course can be counted toward the BME electives.

** There are many EE 395 courses. Get approval from BME UG Program Chair for specific 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	BME 377	ME 315
BME 366	BME 365	EE 360	ME 333

Biomaterials and Regenerative Medicine

Category A	Category B		
BME 343 or 344	Bio 219*	BME 343 or 344	BME 371
BME 346 or 347	Bio 301*	BME 317	BME 377
	BME 314	BME 346 or 347	ChBE 361
	BME 315	BME 348	ChBE 379

Imaging and Biophotonics

Category A	Category B		
BME 325	BME 323	EE 302	EE 382
BME 327 or 333	BME 327	EE 332	EE 395**
	BME 333	EE 360	MSE 360
	CS 211	EE 379	PHY 357*

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 of Biochemistry and Molecular Biology	junior standing recommended; Bio 215 and Bio 219	
B	1	BMD ENG 315	Applications of Genetic Engineering to Immunochemistry	junior standing recommended; Bio 215 and Bio 219	
B	1	BMD ENG 316	Engineering Design of Therapeutic Antibodies	junior standing recommended; Bio 215 and Bio 219	
A	1	BMD ENG 317	Biochemical Sensors	BIOL SCI 215; CHEM 210-1; PHYSICS 135-2,3; Bio 215 and 219; Chem 210-1; Phys 135-2,3	
B	1	BMD ENG 323	Visual Engineering 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 347	Regenerative Engineering Principles and Technologies	BIOL_SCI 215-0 and BIOL_SCI 219-0	
B	1	BMD ENG 348	Regenerative Engineering Applications	BIOL_SCI 215-0 or BIOL_SCI 219-0	
A	0	BMD ENG 353	Bioelectronics		
B	1	BMD ENG 365	Control of Human Limbs and Their Artificial Replacements	Senior standing with engineering or physical science background	
A	1	BMD ENG 366	Biomechanics of Movement	BME 271	
A	1	BMD ENG 371	Mechanics of Biological Tissues	GEN ENG 205-3,4; BME 271	
A	1	BMD ENG 377	Intermediate Fluid Mechanics	BME 270 or consent of instructor	
B	1	BMD ENG 380	Medical Devices, Disease, and Global Health	None; junior or senior standing and BME 309 preferred	Note that this course carries less than 1 eng unit and 18 total eng units are required
B	.5	BMD ENG 388-SA	Healthcare Technology in Resource Poor Environments	Global Health Technologies program only	
Biological Sciences					
B	0	BIOL SCI 219	Cell Biology	Chem 131, 151, or 171	

B	0	BIOL SCI 301	Principles of Biochemistry	CHEM 210-2 or 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 376	Principles of Synthetic Biology	CHEM ENG 275 or BIOL SCI 201 (Molecular Biology) or BIOL SCI 202 (Cell Biology)	
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	Permission number required, available if the Winter workshops are completed.	
Electrical Engineering					
B	0	EE 302	Probabilistic Systems	MATH 234 or equiv.	Note that these courses carry less than 1 eng unit and 18 total eng units are required
B	1	EE 332	Introduction to Computer Vision	CS 214; ECE 222; ECE 302	
B	1	EE 360	Introduction to Feedback Systems	ECE 222	
B	1	EE 379	Lasers and Coherent Optics	ECE 222 and 224	
B	1	EE 382	Photonic Information Processing	ECE 222 and 224	
B	1	EE 395			There are many ECE 395 courses. Get approval from BME UG Program Chair for specific courses.
Computer Science					
B	1	CS 211	Fundamentals of Computer Programming II	CS 111	
Engineering Sciences and Applied Mathematics					
B	0.1	ES APPM 370-1	Introduction to Computational Neuroscience		Note that this course is less than 1 eng unit and 18 total eng units are req'd
Industrial Engineering and Management Sciences					
B	1	IEMS 385	Introduction to Health Systems Engineering	IEMS 303 and 313	
Materials Science and Engineering					
B	1	MAT SCI 318	Materials Selection	MAT SCI 201 or equiv.	
B	1	MAT SCI 360	Electron Microscopy	MAT SCI 301; PHYSICS 135-2,3 or equiv.	
B	1	MAT SCI 376	Nanomaterials	Senior undergraduate or graduate students in materials science, engineering, chemistry, physics, or biology	
Mechanical Engineering					
B		MECH ENG 301	Introduction to Robotics Laboratory	Some programming experience (110 or 111 or	

	1			230), or permission of instructor	
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, ECE 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 382	Micro/Nano Science and Engineering		
B	1	MECH ENG 390	Introduction to Dynamic Systems	GEN ENG 205-4	
Physics and Astronomy					
B	0	PHYSICS 357	Optics Laboratory	Consent of instructor	Only one non-engineering course can be used as a BME Elective