

Biomedical Engineering Undergraduate Curriculum

Fall 2020

<u>College of Engineering Core Requirements</u>	<u>Credit Hours</u>
Math 115, 116, 215, 216, Calculus I-IV	16
Engineering 100, Intro to Engineering	4
Engineering 101, Intro to Computing	4
Chemistry 125, 126, 130, Intro to Chemistry	5
Physics 140/141, General Physics I	5
Physics 240/241, General Physics II	5
Intellectual Breadth	16
<u>Total</u>	55
 <u>Life, & Materials Science Engineering</u>	
Biology 172 or 174, Intro to Biology (F,W, SS)	4
MatSci 220 or 250, Principles of Engineering Materials (F,W)	4
<u>Total</u>	8
 <u>Biomedical Engineering Core Requirements</u>	
<u>Credit Hours</u>	
BiomedE 211, Circuits & Systems for BME (F,W)	4
BiomedE 221, Biophysical Chemistry & Thermodynamics (F,W)	4
BiomedE 231, Intro to Biomechanics (F,W)	4
BiomedE 241, Statistics, Computation, & Data Analysis (F,W)	4
BiomedE 350, Intro to BME Design (F,W)	4
BiomedE 418, Quantitative Cell Biology (F,W)	3
BiomedE 419, Quantitative Physiology (F)	4
BiomedE 450, BME Design (W)	4
OR	
BiomedE 451(F) AND 452 (W), BME Design, Part I & II	
BiomedE 458 (F,W)	
<u>Total</u>	37-38
BME Depth Requirements	21
Unrestricted Electives	9
<u>Total</u>	128

BME Depth Requirements

Depth Requirements consist of 21 credit hours, which must satisfy criteria in the following three areas:

Engineering Expertise (12 credits)

- 12 credits of engineering courses
- At least 6 credits must be BME courses
- All courses must be at the 300 level or higher
- Seminar courses and independent research do NOT fulfill this requirement
- Some BME 499 courses may count but must be approved by petition to the BME Undergraduate Education Committee (UEC)

Cross-Disciplinary Requirements (STEM, 6 credits)

- 6 credits of courses in science, engineering, math, or related technical field (e.g. Entrepreneurship, Bioinformatics, Movement Science, Med School Department)
- Courses must be at the 200 level or higher
- Science courses must be designated as natural science (NS) in the LSA Course Guide
- Up to 1 credit of seminar may count
- Courses taken under Engineering Expertise and Experiential Electives that exceed the minimum requirements (i.e. 12 credits and 3 credits, respectively) may count; credits may be split (e.g. a 4 credit lab may have 3 credits count for the Experiential Elective and 1 credit for Advanced STEM)

Profession in Practice (3 credits)

- 3 credits of a course that is primarily hands-on or experiential learning (e.g. lab, design, practicum, or research)
- Courses must fall under science, engineering, entrepreneurship or computation
- BME 499: BME-in-Practice, BME 499: Clinical Observation and Needs Finding, Multidisciplinary Design Program (up to 3 credits) and some Entrepreneurship courses satisfy this requirement
- Up to 2 credits of BME 452 (Biomedical Design II) may count towards this requirement
- Independent Research (e.g. BME 490 or UROP) may count if it is science or engineering-focused. Approval must be received by petition to the BME Undergraduate Education Committee (UEC)

Courses cannot be taken Pass/Fail. Students must earn a C- or better in all courses. Elected courses cannot have substantial overlap with other BME core courses or others taken to satisfy the requirements (e.g. EECS 314 overlaps with BME 211 and will not count as a Depth Requirement).

Optional BME Tracks within the Depth Requirements

The following tracks in BME are provided as guidance for students with interest in particular areas of BME. Students may customize their Depth Requirements so long as they fulfill the requirements of Engineering Expertise, Advanced STEM, and Experiential and do NOT have to complete a track.

Neural Engineering

Engineering Expertise

(12 credits: 6 BME, 6 any CoE)

BME 410	Biomaterials
BME 417	Electrical Biophysics
BME 516	Medical Imaging Systems
BME 517	Neural Engineering
EECS 311	Analog Circuits
EECS 320	Intro to Semiconductor Devices
EECS 351	Intro to Digital Signal Processing
EECS 373	Intro to Embedded Systems
EECS 414	Intro to MEMS

Cross-Disciplinary Requirements

(6 credits: 200-level+ math, natural science, and/or engineering)

EECS 216	Signals and Systems
MATH 371	Numerical Methods for Engineers
MATH 417	Matrix Algebra I
MATH 463	Math Modeling of Biology
MATH 465	Intro to Combinatorics
MATH 568	Math and Computational Neuroscience
MCDB 451	Molecular Neurobio of Health and Disease
MCDB 455	Cell Biology of Neurodegeneration

Profession in Practice (3 credits)

BME 510	Medical Imaging lab
EECS 200	Electrical Engineering Systems Design I
MCDB 423	Neurobiology Lab
MCDB 424	Behavioral Neurobiology Lab

Biomedical Imaging and Bioelectrics

Engineering Expertise

(12 credits: 6 BME, 6 any CoE)

BME 442,	Intro to Biomedical Imaging
BME 481,	Engineering Prin. Of Radiation Imaging
BME 484,	Radiological health Engin Fundmls
BME 516,	Medical Imaging systems
EECS 334,	Principles of Optics
EECS 351,	Intro to Digital signal Processing
EECS 445,	Machine Learning

EECS 556, Image Processing

Cross-Disciplinary Requirements (6 credits: 200-level+ math, natural science, and/or engineering)

BIOPHYS 440	Biophysics of Diseases
EECS 216	Signals and Systems
MATH 371	Numerical Methods for Engineers
MATH 417	Matrix Algebra I
MATH 463	Math modeling of Biology
NERS 250	Fundmls of Nuclear Eng & Rad Sciences
NERS 312	Elements of Nuclear Eng Rad Sciences II
MCDB 451	Molecular Neurobio of Health and Disease
MCDB 455	Cell Biology of Neurodegeneration

Profession in Practice (3 credits)

BME 510	Medical Imaging Lab
BIOPHYS 422	Experimental Methods in Structural Bio
BIOPHYS 450	Biophys Chem II: Macromol Struc & Dyn
MCDB 423	Neurobiology Lab

Biocomputation

Engineering Expertise

(12 credits: 6 BME, 6 any CoE)

BME 311	Signals and Systems
Or EECS 216	
BME 499.060	AI in BME
BME 417	Electrical Biophysics
BME 517	Neural Engineering
BME 599	Comp Tools for Genomic Technologies
EECS 445	Machine Learning
EECS 485	Web Databases & Information Systems
EECS 492	Artificial Intelligence

Cross-Disciplinary Requirements (6 credits: 200-level+ math, natural science, and/or engineering)

BIOINF 540/ MATH 540	Math of Biological Networks
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Bioinf 547, Probabilistic Modeling in Bioinformatics

EECS 203, Discrete Math

EECS 280, Programming & Intro to Data Structures

EECS 281, Data Structures & Algorithms

EECS 285, Programming in Java

Math 214/217, Linear Algebra

Math 371, Numerical Methods for Engineers.

Profession in Practice (3 credits)

BIOINF 527	Intro to Bioinformatics & Computational Bio
EECS 441	Mobile App Developmt for Entrepreneurs
EECS 460	Control Systems, Analysis, and Design

Biomechanics

Engineering Expertise

(12 credits: 6 BME, 6 any CoE)

BME 331	Intro to Biofluid Mechanics
BME 332	Intro Biosolid Mechanics
BME 456	Modeling in Biosolid Mechanics
BME 476	Advanced Biofluid Mechanics
BME 479	Biotransport
EECS 414	Intro to MEMS
IOE 333	Ergonomics
IOE 463	Measurement and Design of Work
IOE 491	Applied Physical Ergonomics
BME 534	Occupational Biomechanics /IOE
IOE 438	Occupational Safety Management
ME 250	Design & Manufacturing I
ME 360	Model, Anal & Control of Dynamic Systems
ME 406	Biomechanics for Engineering Students
ME 553	Microelectromechanical Systems

Cross-Disciplinary Requirements (6 credits: 200-level+ math, natural science, and/or engineering)

ANAT 403	Human Body
BIOINF 540/ MATH 540	Math of Biological Networks
MATH 214/ MATH 217	Linear Algebra

Movesci 230, Musculoskeletal Anatomy
 Movesci 231, Musculoskeletal Anatomy Lab
 Movesci 435, Biomechanics of Human Locomotion

Profession in Practice (3 credits)

BME 474, Intro to Tissue Engineering
 ME 482, Machining Processes
 EECS 467, Autonomous Robots
 EECS 367, Intro to Autonomous Robots
 ME 553 Microelectromechanical Systems

Tissue Engineering and Regenerative Medicine

Engineering Expertise

(12 credits: 6 BME, 6 any CoE)

BME 321 Bioreaction Engineering and Design
 BME 331 Intro Biofluid Mechanics
 BME 332 Intro Biosolid Mechanics
 BME 410 Biomaterials
 BME 456 Modeling in Biosolid Mechanics
 BME 474 Tissue Engineering
 BME 479 Biotransport
 BME 504 Cellular Biotechnology
 BME 563/ CHE 563/MSE 563 Biomolecular Engineering of Interfaces
 CHE 558/ MSE 558 Foundations of Nanotechnology I
 CHE 559/ MSE 559 Foundations of Nanotechnology II
 ME 406 Biomechanics for Engineering Students
 MSE 583 Biocompatibility of Materials

Cross-Disciplinary Requirements (6 credits: 200-level+ math, natural science, and/or engineering)

CDB 450 From Stem Cells to Tissues and Organs
 MCDB 436 Human Immunology
 PHYSIOL 415 Lab Techniques in Biomedical Research
 STATS 403 Intro to Quant Research Methods

Profession in Practice (3 credits)

BIO 226 Human and Animal Physiology Lab
 BiolChem 416 Intro to Biochem Lab
 CHEM 246 Biomedical Analytical Chemistry Lab I
 CHEM 247 Biomedical Analytical Chemistry Lab II

MCDB 429 Lab in Cell and Molecular Biology
 MSE 350 Structures of Materials
 MSE 360 Materials Lab I

Biotechnology and Pharmaceutical Engineering

Engineering Expertise

(12 credits: 6 BME, 6 any CoE)

BME 321 Bioreaction Engineering and Design
 BME 331 Intro Biofluid Mechanics
 BME 332 Intro Biosolid Mechanics
 BME 410 Biomaterials
 BME 474 Intro to Tissue Engineering
 BME 476 Adv Biofluid Mechanics
 BME 479 Biotransport
 BME 504 Cellular Biotechnology
 CHE 516 Applied Pharmacokinetics & Toxicokinetics
 CHE 517 Biopharmaceutical Engineering
 CHE 519 Pharmaceutical Engineering
 CHE 558/ MSE 558 Foundations of Nanotechnology I
 CHE 559/ MSE 559 Foundations of Nanotechnology II
 CHE 574 Eng Prin in Drug Delivery & Targeting
 CHE 597 Regulatory Issues for Scientists, Engineers, & Managers
 CHE 696 Tech Innovation, Law, & Regulation

Cross-Disciplinary Requirements (6 credits: 200-level+ math, natural science, and/or engineering)

BIO 207 Intro Microbiology
 CDB 450 From Stem Cells to Tissues and Organs
 CHEM 210 Organic Chemistry I
 CHEM 245 Biomedical Analytical Chemistry
 ENTR 500 Intro to Innovation
 ENTR 560 Project Management & Consulting
 MATH 463 Math Modeling of Biology
 MATH 540/ BIOINF 540 Math of Biological Networks
 MCDB 310 Biochemistry
 Or BiolChem 415 or CHEM 351
 MCDB 408 Genomic Biology
 MCDB 436 Human Immunology
 MicroBiol 405 Medical Microbio & Infectious Diseases
 Phrmacol 310 Pharmacology and Therapeutics

Profession in Practice (3 credits)

BIO 226 Human and Animal Physiology Lab
 BiolChem 416 Intro to Biochem Lab
 CHEM 211 Organic Chemistry Lab
 CHEM 216 Organic Chemistry Lab II
 CHEM 246 Biomedical Analytical Chemistry Lab I
 CHEM 247 Biomedical Analytical Chemistry Lab II
 MCDB 429 Lab in Cell and Molecular Biology
 PHYSIOL 404 Human Physiology Lab

Pre-Health

Engineering Expertise

(12 credits: 6 BME, 6 any CoE)

BME 321 Bioreaction Engineering and Design
 BME 331 Intro Biofluid Mechanics
 BME 332 Intro Biosolid Mechanics
 BME 410 Biomaterials
 BME 442 Biomedical Imaging
 BME 474 Intro to Tissue Engineering
 BME 479 Biotransport
 BME 499.002 Clinical Observation and Needs Finding
 BME 504 Cellular Biotechnology
 CHE 519 Pharmaceutical Engineering
 IOE 333 Ergonomics
 MSE 583 Biocompatibility of Materials

Cross-Disciplinary Requirements (6 credits: 200-level+ math, natural science, and/or engineering)

ANAT 403 Human Body
 BIO 207 Microbiology
 CDB 450 From Stem Cells to Tissues and Organs
 CHEM 210 Organic Chemistry I
 CHEM 215 Organic Chemistry II
 CHEM 245 Biomedical Analytical Chemistry
 MCDB 310 Biochemistry
 or BIOLCHEM 415 or CHEM 351
 MCDB 408 Genomic Biology
 MCDB 436 Human Immunology
 Phrmacol 310 Pharmacology and Therapeutics

Profession in Practice (3 credits)

BIO 226 Human and Animal Physiology Lab
 BiolChem 416 Intro to Biochem Lab
 CHEM 211 Organic Chemistry Lab
 CHEM 216 Organic Chemistry Lab II

CHEM 246, Biomedical Analytical Chemistry Lab I
CHEM 247, Biomedical Analytical Chemistry
Lab II
CHEM 352, Intro to Biochemical Research
Techniques
MCDB 429, Lab in Cell and Molecular Biology
PHYSIOL 404, Human Physiology Lab

Medical Device Development

*Engineering Expertise (12 Credits: 6 BME; 6 any
CoE)*

BME 331, Intro Biofluid Mechanics
BME 332, Intro to Biosolid Mechanics
BME 456, Modeling in Biosolid Mechanics
BME 476, Adv. Fluid Mechanics
BME 479, Biotransport
BME 503, Statistical Methods in BME
BME 588, Global Quality Systems & Regulatory
Innovation
ChE 597, Regulatory Issues for Scientists
ChE 696, Tech Innovation, Law, & Regulation
ME 350, Design & Manufacturing, II
ME 452 Design for Manufacturability
ME 482, Machine Learning
IOE 333, Ergonomics
IOE 463 Measurement & Design of Work

Cross-Disciplinary Requirements

Anat 403, Human Body
Entr 413, Entrepreneurship Marketing
Entr 408, Patent Law
Entr 500, Intro to Innovation
Entr 520, Technology-Inspired Business Models
Entr 530, Innovation & IP Strategy
Entr 550, Interpersonal Skills
Entr, 560, Project Management & Consulting
Math 214/217, Linear Algebra
Math 463, Math Modeling of Biology
Math 540, Math of Biological Networks
Stat 470, Intro to Design of Experiments
Stat 570, Design of Experiments

Profession in Practice (3 credits)

BME 499.002, Clinical Observation & Needs
Finding
BME 499, BME in Practice
EECS 200, Electrical Engineering Systems Design
Entr 399.005, Intro to Entrepreneurial Design
Entr 390.012, Digital Product Design
Entr 412, Advanced Entrepreneurship Practicum
ME 350, Design & Manufacturing II
ME 533, Microelectromechanical Systems
Physiol 404, Human Physiology Lab

Systems Biology

*Engineering Expertise (12 credits: 6 BME; 6 any
CoE)*

BME 321, Bioreaction Engineering & Design
BME 331, Intro to Biofluid Mechanics
BME 332, Intro to Biosolid Mechanics
BME 474, Tissue Engineering
BME 479, Biotransport
BME 484, AI in BME
BME 504, Cellular Biotechnology
ChE 519, Pharmaceutical Engineering
ME 360, Model, Anal, & Control of Dynamic Systems

*Cross-Disciplinary Requirements (6 credits: 200-
level+ math, natural science, and/or engineering)*

Anat 403, Human Body
Bioinfo 540, Mathematics of Biological Networks
Bioinf 547, Probabilistic Modeling in Bioinformatics
MCDB 408, Genomic Biology
MCDB 416, Intro to Bioinformatics
MCDB 436, Human Immunology
MCDB 441, Cell Biology & Disease
MCDB 456, Genes, Circuits, & Behavior
MCDB 469, Signal Transduction
Microbiol 405, Medical Microbiology & Infectious
Disease
Pharmacol 310, Pharmacology & Therapeutics

BME 474, Tissue Engineering
Profession in Practice (3 credits)

Bio 226, Human & Animal Physiology
Bioinf 527, Intro to Bioinformatics
Chem 352, Intro to Biochemical Research
MCDB 429, Lab in Cell & Molecular Biology
Physiol 404, Human Physiology Lab