BIOMEDICAL ENGINEERING, BACHELOR OF SCIENCE

College of Engineering

The Biomedical Engineering Undergraduate Major

The Biomedical Engineering (BS) program is accredited by the Engineering Accreditation Commission of ABET (http://www.abet.org) under the commission's General Criteria and Program Criteria for Bioengineering and Biomedical and Similarly Named Engineering Programs.

Biomedical engineering is an interdisciplinary field of study that integrates knowledge of engineering principles with the biomedical sciences. It is a very diverse field with biomedical engineers working in areas ranging from medical imaging to regenerative medicine. Some major contributions of Biomedical Engineering include the left ventricular assist device (LVAD), artificial joints, hemodialysis, bioengineered skin, coronary stents, computed tomography (CT), and flexible endoscopes.

Students who choose biomedical engineering are interested in contributing to human health and quality of life, but do not routinely interact directly with patients, as do physicians. Due to the need to complete additional coursework beyond BME degree requirements, this major is not a primary route for pre-medical studies.

The mission of the BS degree program of the Department of Biomedical Engineering is to combine exceptional teaching with state-of-the-art research for the advancement of technologies and computational techniques that meet medical and societal challenges.

The educational objectives of our program are that a B.S. degree in Biomedical Engineering should prepare students to:

- Be successfully engaged in their chosen career through engineering practice, academic or clinical research, healthcare, education, service, or related activities, or through the pursuit of graduate or professional degrees; and
- Contribute effectively to society through responsible professional practice, fostering of cross-disciplinary collaboration, generation of innovative solutions to problems, and continuous pursuit of knowledge for personal and technological advancement.

The biomedical engineering curriculum is designed to provide a solid interdisciplinary foundation in life and physical sciences, mathematics and engineering, while allowing for sufficient flexibility in the upper division requirements to encourage students to explore specializations within the field. Our instructional program is designed to impart knowledge of contemporary issues at the forefront of biomedical engineering research. Employment opportunities exist in industry, hospitals, academic research and teaching institutions, national laboratories, government regulatory agencies, consulting and finance. The major also provides excellent grounding in the skills necessary for graduate-level studies in engineering disciplines and biological sciences, as well as for professional studies in health (medicine, dentistry, optometry, prosthetics), business and law.

For information about graduate degree options, see Prospective Graduate Students | Biomedical Engineering. (https://bme.ucdavis.edu/admissions/graduate-programs/)

Areas of Specialization

As Biomedical engineering is a broad field, specializing in a subfield of engineering can provide more in-depth expertise in a focus area. Through the judicious selection of upper division engineering and science electives, students can create this depth in one of our suggested areas of specialization or in an area of the student's choosing. One of the strengths of the UC Davis program is the flexibility to design one's own emphasis of study. These specializations are neither required nor degree-notated.

Biomechanics

This is a broad subfield that includes orthopedic/rehabilitation engineering and the study of mechanical forces produced by biological systems. This subfield helps us understand the fluid dynamics of blood flow and the forces acting on tissue in the artery allowing us to design better cardiovascular interventional devices. This field involves a more intensive study of mechanics, dynamics and thermodynamics.

Cellular & Tissue

The cellular and tissue specialization applies biomedical engineering principles to control behavior at the gene, protein, cell, and tissue level. Engineers in this area work with cellular therapies, protein production, gene therapy, tissue engineering and regeneration, and biomaterials development. This subfield draws heavily from the chemical and biological sciences and can involve studying biomedical transport, natural or synthetic biomaterials, pharmacokinetics and pharmacodynamics.

Imaging

Visualizing anatomical structure, physiological processes, metabolic activity and molecular expression in living tissues is essential for the diagnosis of disease, development of new therapeutics, evaluation of the response to therapeutics, and guidance of interventional procedures. An imaging biomedical engineer can develop instruments for imaging, create algorithms for three-dimensional reconstruction of imaging data, and generate new contrast agents to enhance image quality. Our program has a particular strength in molecular imaging, which involves detecting molecular-scale events within living systems. Depending upon your area of interest, the imaging specialization can require further study in electronics, signal processing, chemistry or computer programming.

Medical Devices

Biomedical engineers can develop devices, instruments and implants ranging from the nano- to macro-scale that can be used in the diagnosis, treatment or prevention of disease. This involves combining technologies like pharmaceuticals, electronics and mechanical devices to develop combination medical treatments.

Systems & Synthetic Biology

In systems and synthetic biology, students apply engineering principles to better understand, design and build biological systems at the cellular level. They integrate cellular, biochemical, genetic, electromechanical and computational approaches in their work, which can be applied to health and other applications. Systems and synthetic biology specialists can build engineered or artificial cells for fighting cancer or antibiotic resistance, improve tissue engineering and drug production approaches and study how complex and dynamic molecular systems control cellular behavior.

Pre-Medical Student

As engineering is playing an increasing role in the practice of medicine, students can focus on the intersection of engineering and medicine for future careers as physician-scientists. Please note that to meet admission requirements for medical school, students must complete extra coursework in addition to the listed Department of Biomedical Engineering Curriculum Requirements.

Graduate Programs in Biomedical Engineering

Doctoral and Master of Science degrees in Biomedical Engineering are offered through the interdisciplinary Graduate Group in Biomedical Engineering; see Biomedical Engineering Graduate Group. (https://bmegg.ucdavis.edu/)

Biomedical Engineering also offers a Master of Engineering in Medical Device Development; see Master of Engineering in Medical Device Development | Biomedical Engineering (https://bme.ucdavis.edu/graduate/medical-device/).

Major Advisors

Andrew Cones, Marquis Aaron

The major requirements below are in addition to meeting University Degree Requirements (https://catalog.ucdavis.edu/undergraduate-education/university-degree-requirements/) & College Degree Requirements (https://catalog.ucdavis.edu/undergraduate-education/college-degree-requirements/); unless otherwise noted. The minimum number of units required for the Biomedical Engineering Bachelor of Science is 158.

Code	Title	Units
Lower Division Required Courses		
Students are encouraged to adhere carefully to all prerequisite requirements. The instructor is authorized to drop students from a course for which stated prerequisites have not been completed.		
Mathematics		
MAT 021A	Calculus	4
MAT 021B	Calculus	4
MAT 021C	Calculus	4
MAT 021D	Vector Analysis	4
MAT 022A	Linear Algebra	3-4
or MAT 027A	Linear Algebra with Applications to Biology	
or BIS 027A	Linear Algebra with Applications to Biology	
MAT 022B	Differential Equations	3-4
or MAT 027B	Differential Equations with Applications to Biology	
or BIS 027B	Differential Equations with Applications to Biology	
Physics		
PHY 009A	Classical Physics	5
or PHY 009HA	Honors Physics	
PHY 009B	Classical Physics	5
PHY 009C	Classical Physics	5
Chemistry		
CHE 002A & CHE 002B & CHE 002C	General Chemistry and General Chemistry and General Chemistry	15
CHE 008A	Organic Chemistry: Brief Course	2-4
or CHE 118A	Organic Chemistry for Health & Life Sciences	
CHE 008B	Organic Chemistry: Brief Course	4
or CHE 118B	Organic Chemistry for Health & Life Sciences	
Engineering		
ENG 006	Engineering Problem Solving	4
ENG 017	Circuits I	4
or ENG 017V	Circuits I	
Biological Science		
BIS 002A	Introduction to Biology: Essentials of Life on Earth	5
Biomedical Engineering		
BIM 001	Introduction to Biomedical Engineering	2
BIM 020	Fundamentals of Bioengineering	4
BIM 020L	Graphics Design for BME	2
Lower Division Composition/Writing; choose one; a grade of C- or better is required:		4
COM 001	Major Works of the Ancient World	
COM 002	Major Works of the Medieval & Early Modern World	
COM 003	Major Works of the Modern World	
COM 004	Major Works of the Contemporary World	
ENL 003	Introduction to Literature	
or ENL 003V	Introduction to Literature	
NAS 005	Introduction to Native American Literature	
UWP 001	Introduction to Academic Literacies	
UWP 001V	Introduction to Academic Literacies: Online	
UWP 001Y	Introduction to Academic Literacies	
Lower Division Required Courses Subtotal		83-87
Upper Division Required Courses		
Engineering		
ENG 100	Electronic Circuits & Systems	3-5
or EEC 100	Circuits II	
ENG 105	Thermodynamics	4
ENG 190	Professional Responsibilities of Engineers	3
Biomedical Engineering		
BIM 105	Probability & Data Science for Biomedical Engineers	4
BIM 106	Biotransport Phenomena	4
BIM 107	Manufacturing Processes for BME	2
BIM 108	Biomedical Signals & Control	4
BIM 109	Biomaterials	4
BIM 110A	Biomedical Engineering Senior Design Experience	3
BIM 110B	Biomedical Engineering Senior Design Experience	3
BIM 110C	Biomedical Engineering Senior Design Experience	3
BIM 111	Biomedical Instrumentation Laboratory	6
BIM 116	Quantitative Physiology	5
or NPB 101	Systemic Physiology	
Science & Engineering Electives are to be selected in consultation with a staff or faculty advisor.		
Science Electives		
To be chosen according to specialization:		7
BIS 002B	Introduction to Biology: Principles of Ecology & Evolution	

BIS 002C	Introduction to Biology: Biodiversity & the Tree of Life
BIM 102	Cellular Dynamics
BIM 161A	Biomolecular Engineering
BIM 161L	Biomolecular Engineering Laboratory
ECS 032A	Introduction to Programming
or ECS 032AV	Introduction to Programming
ECS 032B	Introduction to Data Structures
PHY 009D	Modern Physics
Any letter graded upper division course in the Biological Sciences, Chemistry or Physics that is designated as Science & Engineering topical breadth.	
With the approval of the Biomedical Engineering Undergraduate Committee; 4 units:	
BIM 192	Internship in Biomedical Engineering
or BIM 199	Special Study for Advanced Undergraduates

Engineering Electives

Any letter graded upper division Biomedical Engineering course that is not required. Courses that do not count are BIM 102, BIM 161A, BIM 161L, and select variable unit classes from BIM 099, BIM 192, BIM 189A, BIM 189B, BIM 189C, BIM 199.	20
With the approval of the Biomedical Engineering Undergraduate Committee; 4 units:	
BIM 192	Internship in Biomedical Engineering
or BIM 199	Special Study for Advanced Undergraduates
No more than 4 units allowed from lower division coursework.	
EBS 128	Biomechanics & Ergonomics
EBS 130	Modeling of Dynamic Processes in Biological Systems
EBS 165	Bioinstrumentation & Control
EBS 175	Rheology of Biological Materials
ECH 141	Fluid Mechanics for Biochemical & Chemical Engineers
ECH 144	Rheology & Polymer Processing
ECH 145A	Chemical Engineering Thermodynamics Laboratory
ECH 145B	Chemical Engineering Transport Lab
ECH 155	Chemical Engineering Kinetics & Reactor Design Laboratory
ECH 160	Fundamentals of Biomanufacturing
ECH 161A	(Discontinued)
ECH 161B	(Discontinued)
ECH 161L	Bioprocess Engineering Laboratory
ECH 170	Introduction to Colloid & Surface Phenomena
ECS 124	Theory & Practice of Bioinformatics
EEC 110A	Electronic Circuits I
EEC 110B	Electronic Circuits II
EEC 118	Digital Integrated Circuits
EEC 130A	Electromagnetics I
EEC 130B	Introductory Electromagnetics II
EEC 140A	Principles of Device Physics I
or EEC 140AV	Principles of Device Physics I
EEC 140B	Principles of Device Physics II
EEC 151	Digital Signals & Systems
EEC 157A	Control Systems
or EEC 157AV	Control Systems
EEC 157B	Control Systems II
or EEC 157BY	Control Systems II
EEC 160	Signal Analysis & Communications
EME 150A	Mechanical Design
EME 150B	Mechanical Design
EME 151	Statistical Methods in Design & Manufacturing
EME 152	Computer-Aided Mechanism Design
EME 154	Mechatronics
EME 165	Heat Transfer
EME 171	Analysis, Simulation & Design of Mechatronic Systems
EME 172	Automatic Control of Engineering Systems
EMS 147/FPS 100	Principles of Polymer Materials Science
EMS 160	Thermodynamics of Materials
EMS 162	Structure & Characterization of Engineering Materials
EMS 162L	Structure & Characterization of Materials Laboratory
EMS 164	Kinetics of Materials
EMS 172	Smart Materials
EMS 172L	Smart Materials Laboratory
EMS 174	Mechanical Behavior of Materials
EMS 174L	Mechanical Behavior Laboratory
EMS 180	Materials in Engineering Design
EMS 181	Manufacturing of 3D & Composite Materials
EMS 182	Failure Analysis
ENG 035	Statics
ENG 045	Properties of Materials
or ENG 045Y	Properties of Materials
ENG 102	Dynamics
ENG 103	Fluid Mechanics
ENG 104	Mechanics of Materials
or ENG 104V	Mechanics of Materials
ENG 104L	Mechanics of Materials Laboratory
ENG 106	Engineering Economics

Additional Elective Policies [1]

Upper Division Composition Requirement

Choose one; grade of C- or better is required:		0-4
UWP 101	Advanced Composition	
or UWP 101V	Advanced Composition	
or UWP 101Y	Advanced Composition	
UWP 102B	Writing in the Disciplines: Biology	
UWP 102E	Writing in the Disciplines: Engineering	
UWP 104A	Writing in the Professions: Business Writing	
or UWP 104AV	Writing in the Professions: Business Writing	
or UWP 104AY	Writing in the Professions: Business Writing	
UWP 104E	Writing in the Professions: Science	

UWP 104F	Writing in the Professions: Health	
or UWP 104FV	Writing in the Professions: Health	
or UWP 104FY	Writing in the Professions: Health	
UWP 104I	Writing in the Professions: Internships	
UWP 104T	Writing in the Professions: Technical Writing	
Passing the Upper Division Composition Exam.		
Upper Division Required Courses Subtotal		75-81
Total Units		**158-162**

[1]

2 units from CHE 118A may be applied towards Science Electives if CHE 118A is also used to satisfy lower division subject credit. 2 units from EEC 100 may be applied towards Engineering Electives if EEC 100 is taken to satisfy upper division subject credit. 1 unit from MAT 027A/BIS 027A and 1 unit from MAT 027B/BIS 027B may be applied to Science Electives.