

BIOMEDICAL ENGINEERING, BACHELOR OF SCIENCE

College of Engineering

The Biomedical Engineering Undergraduate Major

The Biomedical Engineering Bachelor of Science 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. | | |
| <i>Mathematics</i> | | |
| 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 | |
| <i>Physics</i> | | |
| PHY 009A | Classical Physics | 5 |
| or PHY 009HA | Honors Physics | |
| PHY 009B | Classical Physics | 5 |
| PHY 009C | Classical Physics | 5 |
| <i>Chemistry</i> | | |
| 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 |

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| or CHE 118B | Organic Chemistry for Health & Life Sciences | |
| <i>Engineering</i> | | |
| ENG 006 | Engineering Problem Solving | 4 |
| ENG 017 | Circuits I | 4 |
| or ENG 017V | Circuits I | |
| <i>Biological Science</i> | | |
| BIS 002A | Introduction to Biology: Essentials of Life on Earth | 5 |
| <i>Biomedical Engineering</i> | | |
| 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: | | |
| 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 | |
| or NAS 005V | 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 | | |
| <i>Engineering</i> | | |
| ENG 100 | Electronic Circuits & Systems | 3-5 |
| or EEC 100 | Circuits II | |
| ENG 105 | Thermodynamics | 4 |
| ENG 190 | Professional Responsibilities of Engineers | 3 |
| <i>Biomedical Engineering</i> | | |
| 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. | | |
| <i>Science Electives</i> | | |
| To be chosen according to specialization: | | 7 |

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| 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 | |
| <i>Engineering Electives</i> | | |
| 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 (Discontinued for fall 2026)** | |
| 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 (Discontinued for spring 2026)** | |
| ECH 161A | (Discontinued for winter 2024)** | |
| ECH 161B | (Discontinued for spring 2024)** | |
| 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 | |

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| 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 | |
| <i>Additional Elective Policies</i> ¹ | | |
| <i>Upper Division Composition Requirement</i> | | |
| 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 | |

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| 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 |

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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.

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Course(s) discontinued; see your advisor for course options.