BACHELOR OF SCIENCE IN BIOENGINEERING

http://www.pacific.edu/Academics/Schools-and-Colleges/School-of-Engineering-and-Computer-Science/Academics-/Majors/Bioengineering-.html
Phone: (209) 946-2575
Location: Anderson Hall

Programs Offered

Bachelor of Science in Bioengineering

The Bachelor of Science degree in Bioengineering is offered by the University of the Pacific School of Engineering and Computer Science. Within a few years of graduation, graduates of the Bioengineering program are expected to be able to:

- Apply engineering solutions to biomedical, human health, or biological challenges
- Engage in life-long learning and pursue advanced level studies
- Demonstrate ethical leadership, collaboration, and communication skills in their profession

Student Outcomes

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. An ability to communicate effectively with a range of audiences.
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Bachelor of Science in Bioengineering

Students must complete a minimum of 120 units of academic work in order to earn the bachelor of science in bioengineering. Students must also adhere to the University's graduation requirements for bachelor degrees. A total of 45 units of engineering coursework is required and Cooperative Education is optional.

I. General Education Requirements

For more details, see General Education (https://catalog.pacific.edu/uop/generalinformation/generaleducation/)

Minimum 28 units and 9 courses that include:

A. CORE Seminars (2 courses)

CORE 001	Problem Solving & Oral Comm	3
CORE 002	Writing and Critical Thinking	4

Note: 1) CORE Seminars cannot be taken for Pass/No Credit. ***2)*** Transfer students with 28 or more transfer credits taken after high school are exempt from both CORE seminars.

B. Breadth Requirement (7 courses, at least 3 units each)

At least one course from each of the following areas:

- Artistic Process & Creation
- Civic & Global Responsibility
- Language & Narratives
- Quantitative Reasoning
- Scientific Inquiry
- Social Inquiry
- World Perspectives & Ethics

Note: 1) No more than 2 courses from a single discipline can be used to meet the Breadth Requirement.

C. Diversity and Inclusion Requirement

All students must complete Diversity and Inclusion coursework (at least 3 units)

Note: 1) Diversity and Inclusion courses can also be used to meet the breadth category requirements, or major or minor requirements.

D. Fundamental Skills

Students must demonstrate competence in:

- Writing
- Quantitative Analysis (Math)

Note: 1) Failure to satisfy the fundamental skills requirements by the end of four semesters of full-time study at the University is grounds for academic disqualification.

II. Major Requirements

Mathematics		
MATH 051	Calculus I	4
MATH 053	Calculus II	4
MATH 055	Calculus III	4
MATH 057	Applied Differential Equations I: ODEs	4
Basic Science		
BIOL 061	Principles of Biology	5
Select one of the following:		
CHEM 024	Fundamentals of Chem	
CHEM 025	General Chemistry	
CHEM 027	General Chemistry	
PHYS 053	Principles of Physics I	5
PHYS 055	Principles of Physics II	5
General Engineering		
IDEA 010	Interdisciplinary Design and Success	2
ENGR 020	Engineering Mechanics I (Statics)	3
ENGR 025	Professional Practice Seminar	1
ENGR 030	Engineering and Computing Ethics in Society	3
MECH 015	Mechanical Engineering Graphics	3
Select one of the following:		3-4
COMP 051	Introduction to Computer Science	
COMP 061	Introduction to Programming for Data Science	

ENGR 019	Computer Applications in Engineering	
Bioengineering Core		
BENG 103	Biomaterials	4
BENG 108	Engineering Physiology	5
or BIOL 180	Human Physiology	
BENG 110	Bioinstrumentation and Experimental Design	4
BENG 124	Biomechanics	4
BENG 130	Biotransport	4
Select one of the following:		
BENG 171	Bioelectricity	
or BENG 175	Human/Brain Machine Interface	
BENG 194	Bioengineering Project Proposal	
BENG 195	Senior Project	
ECPE 041	Circuits	
ECPE 041L	Circuits Laboratory	
Technical Electives		
Select three courses, at least one must be a BENG course		6-10
BENG 104	Biomedical Imaging	
BENG 121	Biomedical Signal Processing	
BENG 140	Introduction to Tissue Engineering	
BENG 154	Introduction to Magnetic Resonance Imaging	
BENG 171	Bioelectricity	
BENG 175	Human/Brain Machine Interface	
BIOL 101	Genetics	
BIOL 145	Microbiology	
BIOL 153	Cell Biology	
BIOL 146	Industrial Microbiology	
BIOL 169	Elements of Biochemistry	
BIOL 170	Human Anatomy	
CHEM 121	Organic Chemistry	
CHEM 123	Organic Chemistry	
CHEM 141	Analytical Chemistry	
CHEM 159	Biophysical Chemistry	
COMP 129	Software Engineering	
COMP 135	Human-Computer Interface Design	
COMP 151	Artificial Intelligence	
COMP 153	Computer Graphics	
COMP 155	Computer Simulation	
COMP 157	Design and Analysis of Algorithms	
COMP 162	Data Analytics Programming	
COMP 163	Database Management Systems	
ECPE 071	Digital Design	
ECPE 071L	Digital Design Lab	
ECPE 131	Electronics	
ECPE 141	Advanced Circuits	
ENGR 120	Engineering Mechanics II (Dynamics)	
ENGR 121	Mechanics of Materials	
ENGR 122	Thermodynamics I	
MECH 104	Introduction to Mechatronics	
MECH 150	Heat Transfer	
Cooperative Education Optional		
ENGR 181	Professional Practice	1-16
ENGR 182	Professional Practice	1-16
ENGR 183	Professional Practice	1-16

Bioengineering Courses

BENG 005. Introduction to Bioengineering. 2 Units.
This course introduces students to the various sub-disciplines (medical, chemical, electrical, mechanical, and computation) of bioengineering.

BENG 103. Biomaterials. 4 Units.
This course discusses biomaterials and lays the ground work for topics such as mechanical chemical, and thermal properties of replacement materials and tissues. Implantation of materials in the body are studies studied from the biological point of view. Prerequisites: Completion of all Fundamental Skills; CHEM 24 or CHEM 025 or CHEM 027; BIOL 061 with a "C-" or better.

BENG 104. Biomedical Imaging. 4 Units.
This course discusses major medical imaging modalities in radiology, including X-ray, CT, nuclear medicine, ultrasound, and MRI. Specific contents include physical principle of each imaging modality; instrumentation and data acquisition/image reconstruction strategy, clinical applications and imaging techniques. Prerequisites: MATH 055, PHYS 055, COMP 051 or ENGR 019.

BENG 108. Engineering Physiology. 5 Units.
This course is a lecture and lab-based review of the functions of the major organ systems of vertebrates with emphasis on the human body. Lectures cover basic anatomy, function and regulation of the nervous, endocrine, sensory, muscular, cardiovascular, respiratory, and excretory systems, with the underlying theme of maintaining homeostasis while responding to physiological disturbances. Lab exercises demonstrate basic physiological processes and emphasize techniques of instrument-based data acquisition and data presentation. Prerequisites: Completion of all Fundamental Skills; BIOL 61; CHEM 24 or CHEM 25 all with a "C-" or better or permission of instructor.

BENG 110. Bioinstrumentation and Experimental Design. 4 Units.
Introduction to engineering aspects of the detection, acquisition, processing, and display of signals from living systems; Experimental techniques for measurement of biomedical quantities such as biopotentials, force, pressure, and temperature are discussed. The course introduces statistical analysis including confidence intervals, hypothesis testing, analysis of variance, and linear regression as well as errors in measurement. Use of instruments in the laboratory; a measurement project. Corequisites: BENG 124 or ENGR 121. Prerequisites: MATH 057; ECPE 041 with a “C-” or better.

BENG 121. Biomedical Signal Processing. 4 Units.
Students analyze discrete-time signals and systems using z transforms and Fourier transforms, the fast Fourier transform and its applications, digital filters and their applications and implementation of DSP algorithms using Matlab and Simulink. Also listed as ECPE 121.

BENG 124. Biomechanics. 4 Units.
This course discusses concepts of engineering mechanics including stress, strain, deformation, and analysis of structures with application to biomechanical phenomena over a range of biological length scales. Engineering mechanics concepts are used to evaluate forces and moments acting on human joints, forces in musculoskeletal tissue, material properties of biological tissues, and disease state conditions. Prerequisites: Completion of all Fundamental Skills; ENGR 020 with a “C-“ or better. Prerequisite may be taken concurrently: MATH 057 with a “C-“ or better.

BENG 130. Biotransport. 4 Units.
This course focuses on momentum transport (viscous flow) and mass transport (diffusion and convection) in living systems. The fundamental principles of momentum and mass transfer are explored and laws of conservation applied to develop mathematical descriptions of physiological and engineering systems across a range of length scales. Students develop technical writing skills and learn to use computation fluid dynamics simulation tools. Prerequisites: Completion of all Fundamental Skills; MATH 057; PHYS 053 with a "C-" or better.

BENG 140. Introduction to Tissue Engineering. 4 Units.
Tissue engineering is a multidisciplinary and collaborative field that applies the principles of engineering and biology toward the development of biological substitutes that restore, maintain, and improve tissue function. In this course, there will be an overview of tissue engineering, including discussion of cell sources, cell-material interactions, and assessment of engineering outcome through destructive and nondestructive means with case studies of specific types of tissue engineering including skin, bone, cartilage, bladder, and liver. Finally, ethical standards for different techniques in tissue engineering will be discussed. Prerequisites: Completion of all Fundamental Skills; BIOL 061; BENG 103 all with a "C-" or better or permission of instructor.

BENG 154. Introduction to Magnetic Resonance Imaging. 4 Units.
Introduction to the physics, techniques, and applications of magnetic resonance imaging (MRI) in basic sciences and the clinic. Basics of nuclear magnetic resonance physics, and Fourier transform, MRI hardware, and MR imagining principles including signal generation, detection, and spatial localization techniques. Applications of MRI including tissue relaxometry measurement and diffusion weighted imaging of biological tissues, imagining of anatomy, and function. Prerequisites: Completion of all Fundamental Skills; BENG 104 with a "C-" or better of permission of instructor.

BENG 171. Bioelectricity. 4 Units.
This course provides the student with an understanding of the origins, function, and measurement of electrical potentials and currents within biological tissues, such as nerve, muscle, and heart. Topics include: the bioelectrical properties of ion channels, neurons, the synapse and neuromuscular junction, adaptation and learning in small networks of neurons, the functional organization of bioelectrical systems, and bioelectrical measurement and stimulation of tissues such as the heart and brain. Prerequisites: Completion of all Fundamental Skills; ECPE 041/ECPE 041L; Prerequisite may be taken concurrently: MATH 057 with a "C-" or better.

BENG 175. Human/Brain Machine Interface. 3 Units.
Human/Brain Machine interface (HMI/BMI) is a direct communication pathway between human signals such as heart activity, electro dermal activity, and brain with an external device. Bioelectrical activity can be employed directly to provide information or predict the human alertness, stress level, health or control external devices such as an external keyboard and robotic arm. This topic includes the physiology of generation of human vital signals, designing interface device, and developing offline and real-time computational algorithms for controlling external devices. Prerequisite: Completion of all Fundamental Skills; ENGR 19 or COMP 51 or COMP 61 with a "C-" or better; MATH 53 or COMP 157 with a "C-" or better; and junior standing.

BENG 187. Professional Practice. 1-18 Units.

BENG 191. Independent Study. 1-4 Units.
Special individual projects are undertaken under the direction of one or more faculty members who are knowledgeable in the particular field of study. Permission of department chairperson and faculty members involved.

BENG 194. Bioengineering Project Proposal. 3 Units.
This course provides an introduction to the engineering design process. Students apply basic sciences, mathematics, and engineering topics to meet a stated objective. Students will write a proposal for a comprehensive design project, in which they establish design objectives and criteria, analyze solution alternatives, and synthesize a problem. Consideration for engineering standards, realistic constraints, ethics, and safety is included. Prerequisites: Completion of all Fundamental Skills, Junior or Senior standing, BENG 124 or BENG 103, may be taken concurrently, with a "C-" or better or permission of instructor.

BENG 195. Senior Project. 3 Units.
In this course, students will complete the engineering design process. Students will design and evaluate an engineering solution to an existing problem. Students apply basic sciences, mathematics and engineering topics to implement a solution that meets stated design objectives and criteria. Students will also test prototypes to evaluate design performance. Design documentation and demonstration are required. Includes both written and oral reports and presentations. Prerequisite may be taken concurrently: BENG 194 with a "C-" or better or permission of instructor.

BENG 197. Undergraduate Research. 1-4 Units.
This course is applied or basic research in bioengineering under faculty supervision. Permission of faculty supervisor and department chair. Students must be in good academic standing.

BENG 197D. Undergraduate Research. 1-4 Units.

BENG 202. Biosensor. 3 Units.
This course provides a comprehensive introduction to the basic features of biosensors. Discussion topics include types of most common biological agents and the ways in which they can be interfaced with a variety of transducers to create a biosensor for biomedical applications. The focus is on optical biosensors and systems (e.g. fluorescence spectroscopy, microscopy). Prerequisites: Graduate or blended students in the School of Engineering and Computer Science and BENG 103 with a "C" or better or permission of instructor.

BENG 205. Advanced Biomaterials. 3 Units.
Students study the strategies and fundamental bioengineering design criteria behind the development of cell-based tissue substitutes, artificial skin, muscle, tendons, bone, and extracorporeal systems that use either synthetic materials or hybrid (biological-synthetic) systems. Topics include biocompatibility, biological grafts and bioreactors. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science and BENG 103 with a "C" or better.

BENG 291. Graduate Independent Study. 1-4 Units.
Special individual projects are undertaken under the direction of one or more faculty. Prerequisite: Graduate or blended students in the School of Engineering and Computer Science or permission of instructor.

BENG 293. Special Topics. 1-4 Units.
Special courses are organized and offered from time to time to meet the needs or interests of a group of students.

BENG 297. Graduate Research. 1-4 Units.
Approval by the faculty supervisor and the department chairperson in required. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science or permission of instructor.

BENG 299. Thesis. 1-6 Units.
Minimum of six units is required for Thesis Option students. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science and permission of the research advisor.