Bioengineering

Overview

Bioengineering applies engineering principles and practices to living things in order to solve some of the most challenging problems that face the world today. In Bioengineering, also known as Biomedical Engineering, work is concentrated on high-impact applications instrumentation, molecular and cellular engineering, and computational biosciences that will bring about major advances in medicine and the life sciences.

Our Ph.D. and Master of Translational Medicine (http://uctranslationalmedicine.org/) (MTM) programs are conducted in partnership with UC San Francisco, one of the premier medical and health sciences schools in the world. The joint Ph.D. program (http://bioegrad.berkeley.edu/) was founded in 1983 and has grown to become one of the top-ranked doctoral degrees in the nation, offering students a robust set of resources on both campuses. The MTM is a one-year professional master's degree, focused on training talented individuals seeking to speed medical technologies from the lab to clinical use.

UC Berkeley also offers the Master of Engineering in Bioengineering (http://bioeng.berkeley.edu/meng/), a one-year professional master's degree designed for students focused on careers in industry.

All programs are supported by the UC Berkeley Department of Bioengineering, anchored by exceptional faculty, strong ties to other departments on campus, and close collaborations with other institutions. The Department continues to expand with new faculty, staff, facilities, and research programs.

Undergraduate Programs

Bioengineering (http://guide.berkeley.edu/undergraduate/degree-programs/bioengineering/): BS, Minor
Bioengineering/Materials Science and Engineering (http://guide.berkeley.edu/undergraduate/degree-programs/bioengineering-materials-science-engineering-joint-major/): BS (Joint Major)

Graduate Programs

Bioengineering (http://guide.berkeley.edu/graduate/degree-programs/bioengineering/): MEng, PhD (Joint PhD, in cooperation with UCSF)
Translational Medicine (http://guide.berkeley.edu/graduate/degree-programs/translational-medicine/): MTM (in cooperation with UCSF)

Bioengineering

Expand all course descriptions [+]Collapse all course descriptions [-]

BIO ENG 10 Introduction to Biomedicine for Engineers 4 Units

Terms offered: Fall 2023, Fall 2022, Fall 2021
This course is intended for lower division students interested in acquiring a foundation in biomedicine with topics ranging from evolutionary biology to human physiology. The emphasis is on the integration of engineering applications to biology and health. The specific lecture topics and exercises will include the key aspects of genomics and proteomics as well as topics on plant and animal evolution, stem cell biomedicine, and tissue regeneration and replacement. Medical physiology topics include relevant engineering aspects of human brain, heart, musculoskeletal, and other systems.
Introduction to Biomedicine for Engineers: Read More [+]
Objectives & Outcomes

Student Learning Outcomes: The goal is for undergraduate engineering students to gain sufficient biology and human physiology fundamentals so that they are better prepared to study specialized topics, e.g., biomechanics, imaging, computational biology, tissue engineering, biomonitoring, drug development, robotics, and other topics covered by upper division and graduate courses in UC Berkeley departments of Molecular and Cell Biology, Integrative Biology, Bioengineering, Electrical Engineering and Computer Science, Mechanical Engineering, and courses in the UC San Francisco Division of Bioengineering.

Rules & Requirements

Prerequisites: MATH 1A or MATH 16A or another introductory calculus course (can be taken concurrently)

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructors: Conboy, Kumar, Johnson

Introduction to Biomedicine for Engineers: Read Less [-]

BIO ENG 11 Engineering Molecules 1 3 Units

Terms offered: Spring 2024, Spring 2023, Spring 2022
This course focuses on providing students with a foundation in organic chemistry and biochemistry needed to understand contemporary problems in synthetic biology, biomaterials and computational biology.
Engineering Molecules 1: Read More [+]
Objectives & Outcomes

Course Objectives: The goal of this course is to give students the background in organic chemistry and biochemistry needed understand problems in synthetic biology, biomaterials and molecular imaging. Emphasis is on basic mechanisms

Student Learning Outcomes: Students will learn aspects of organic and biochemistry required to begin the rational manipulation and/or design of biological systems and the molecules they are comprised of.

Rules & Requirements

Prerequisites: CHEM 3A

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Engineering Molecules 1: Read Less [-]

BIO ENG 24 Freshmen Seminar 1 Unit

Terms offered: Spring 2022, Spring 2021, Fall 2020
The Berkeley Seminar Program has been designed to provide new students with the opportunity to explore an intellectual topic with a faculty member in a small-seminar setting. Berkeley seminars are offered in all campus departments, and topics vary from department to department and semester to semester.
Freshmen Seminar: Read More [+]
Rules & Requirements

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 1 hour of seminar per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Final Exam To be decided by the instructor when the class is offered.

Freshmen Seminar: Read Less [-]

BIO ENG 25 Careers in Biotechnology 1 Unit

Terms offered: Spring 2024, Spring 2023, Spring 2022
This introductory seminar is designed to give freshmen and sophomores an opportunity to explore specialties related to engineering in the pharmaceutical/biotech field. A series of one-hour seminars will be presented by industry professionals, professors, and researchers. Topics may include biotechnology and pharmaceutical manufacturing; process and control engineering; drug inspection process; research and development; compliance and validation; construction process for a GMP facility; project management; and engineered solutions to environmental challenges. This course is of interest to students in all areas of engineering and biology, including industrial engineering and manufacturing, chemical engineering, and bioengineering.
Careers in Biotechnology: Read More [+]
Rules & Requirements

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 1 hour of seminar per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

Careers in Biotechnology: Read Less [-]

BIO ENG 26 Introduction to Bioengineering 1 Unit

Terms offered: Fall 2023, Fall 2022, Fall 2021
This introductory seminar is designed to give freshmen and sophomores a glimpse of a broad selection of bioengineering research that is currently underway at Berkeley and UCSF. Students will become familiar with bioengineering applications in the various concentration areas and see how engineering principles can be applied to biological and medical problems.
Introduction to Bioengineering: Read More [+]
Objectives & Outcomes

Course Objectives: This course is designed to expose students to current research and problems in bioengineering. As a freshman/ sophomore class, its main purpose is to excite our students about the possibilities of bioengineering and to help them to choose an area of focus.

Student Learning Outcomes: This course demonstrates the rapid pace of new technology and the need for life-long learning (2). In addition, the course, because of its state-of-the-art research content, encourages our students to explore new horizons (3).

Hours & Format

Fall and/or spring: 15 weeks - 1 hour of seminar per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

Instructors: T. Johnson, H. Lam

Introduction to Bioengineering: Read Less [-]

BIO ENG 98 Supervised Independent Group Studies 1 - 4 Units

Terms offered: Fall 2023, Fall 2022, Fall 2021
Organized group study on various topics under the sponsorship of a member of the Bioengineering faculty.
Supervised Independent Group Studies: Read More [+]
Rules & Requirements

Prerequisites: Consent of instructor

Credit Restrictions: Enrollment is restricted; see the Introduction to Courses and Curricul a section of this catalog.

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 1-4 hours of directed group study per week

Summer: 8 weeks - 1-4 hours of directed group study per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

Supervised Independent Group Studies: Read Less [-]

BIO ENG 99 Supervised Independent Study and Research 1 - 4 Units

Terms offered: Spring 2020, Fall 2019, Spring 2019
Supervised independent study for lower division students.
Supervised Independent Study and Research: Read More [+]
Rules & Requirements

Prerequisites: Freshman or sophomore standing and consent of instructor

Credit Restrictions: Enrollment is restricted; see the Introduction to Courses and Curricula section of this catalog.

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 1-4 hours of independent study per week

Summer:
8 weeks - 1.5-7.5 hours of independent study per week
10 weeks - 1.5-6 hours of independent study per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

Supervised Independent Study and Research: Read Less [-]

BIO ENG 100 Ethics in Science and Engineering 3 Units

Terms offered: Spring 2024, Fall 2023, Spring 2022
The goal of this semester course is to present the issues of professional conduct in the practice of engineering, research, publication, public and private disclosures, and in managing professional and financial conflicts. The method is through historical didactic presentations, case studies, presentations of methods for problem solving in ethical matters, and classroom debates on contemporary ethical issues. The faculty will be drawn from national experts and faculty from religious studies, journalism, and law from the UC Berkeley campus.
Ethics in Science and Engineering: Read More [+]

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructors: Lam, Hayley

Ethics in Science and Engineering: Read Less [-]

BIO ENG 101 Instrumentation in Biology and Medicine 4 Units

Terms offered: Spring 2024, Spring 2023, Spring 2022
This course teaches the fundamental principles underlying modern sensing and control instrumentation used in biology and medicine. The course takes an integrative analytic and hands-on approach to measurement theory and practice by presenting and analyzing example instruments currently used for biology and medical research, including EEG, ECG, pulsed oximeters, Complete Blood Count (CBC), etc.
Instrumentation in Biology and Medicine: Read More [+]

Objectives & Outcomes

Course Objectives: Students should understand the architecture and design principles of modern biomedical sensor data-acquisition (sensor-DAQ) systems. They should understand how to choose the appropriate biomedical sensor, instrumentation amplifier, number of bits, sampling rate, anti-aliasing filter, and DAQ system. They will learn how to design a low-noise instrumentation amplifier circuit. They should understand the crucial importance of suppressing 60 Hz and other interferences to acquire high quality low-level biomedical signals. They should understand the design principles of building, debugging.

Student Learning Outcomes: Students will achieve knowledge and skills in biomedical signal acquisition. They will be assessed in their success with the Course Objectives through tests, homeworks, and laboratories. In particular, the tests will ensure that the students have absorbed the theoretical concepts. The laboratories will provide assessment of learning practical skills (e.g., building an ECG circuit).

Rules & Requirements

Prerequisites: EECS 16A, EECS 16B, MATH 53, MATH 54, PHYSICS 7A, and PHYSICS 7B; or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Conolly

Instrumentation in Biology and Medicine: Read Less [-]

BIO ENG 102 Biomechanics: Analysis and Design 4 Units

Terms offered: Fall 2023, Fall 2022, Spring 2022
This course introduces, develops and applies the methods of continuum mechanics to biomechanical phenomena abundant in biology and medicine. It is intended for upper level undergraduate students who have been exposed to vectors, differential equations, and undergraduate course(s) in physics and certain aspects of modern biology.
Biomechanics: Analysis and Design: Read More [+]
Objectives & Outcomes

Course Objectives: This course introduces, develops and applies scaling laws and the methods of continuum mechanics to biomechanical phenomena related to tissue or organ levels. It is intended for upper level undergraduate students who have been exposed to vectors, differential equations, and undergraduate course(s) in physics and certain aspects of modern biology.
Topics include:

- Biosolid mechanics
- Stress, strain, constitutive equation
- Vector and tensor math
- Equilibrium
- Extension, torsion, bending, buckling
- Material properties of tissues

Student Learning Outcomes: The course will equip the students with a deep understanding of principles of biomechanics. The intuitions gained in this course will help guide the analysis of design of biomedical devices and help the understanding of biological/medical phenomena in health and disease.
The students will develop insight, skills and tools in quantitative analysis of diverse biomechanical systems and topics, spanning various scales from cellular to tissue and organ levels.

Rules & Requirements

Prerequisites: MATH 53, MATH 54, and PHYSICS 7A

Credit Restrictions: Students will receive no credit for BIO ENG 102 after completing MEC ENG C85.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Mofrad

Biomechanics: Analysis and Design: Read Less [-]

BIO ENG 103 Engineering Molecules 2 4 Units

Terms offered: Fall 2023, Fall 2022, Fall 2021
Thermodynamic and kinetic concepts applied to understanding the chemistry and structure of biomolecules (proteins, membranes, DNA, and RNA) and their thermodynamic and kinetic features in the crowded cellular environment. Topics include entropy, bioenergetics, free energy, chemical potential, reaction kinetics, enzyme kinetics, diffusion and transport, non-equilibrium systems, and their connections to the cellular environment.
Engineering Molecules 2: Read More [+]
Objectives & Outcomes

Course Objectives: (1) To introduce the basics of thermodynamics and chemical kinetics for molecular to cellular biological systems; (2) To give students an understanding of biological size and timescales illustrated through computational exercises on model problems in physical biology.

Student Learning Outcomes: students will be able to (1) relate statistical thermodynamics and chemical kinetics to analyze molecular and cellular behavior beyond the ideal gas and Carnot cycle.

Rules & Requirements

Prerequisites: PHYSICS 7A, PHYSICS 7B, MATH 1A, MATH 1B, MATH 53, and MATH 54; and BIOLOGY 1A or BIO ENG 11

Credit Restrictions: Students will receive no credit for Bioengineering 103 after completing Chemistry 120B, or Molecular Cell Biology C100A/Chemistry C130.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Head-Gordon

Engineering Molecules 2: Read Less [-]

BIO ENG 104 Biological Transport Phenomena 4 Units

Terms offered: Spring 2024, Spring 2023, Spring 2022
The transport of mass, momentum, and energy are critical to the function of living systems and the design of medical devices. Biological transport phenomena are present at a wide range of length scales: molecular, cellular, organ (whole and by functional unit), and organism. This course develops and applies scaling laws and the methods of continuum mechanics to biological transport phenomena over a range of length and time scales. The course is intended for undergraduate students who have taken a course in differential equations and an introductory course in physics. Students should be familiar with basic biology; an understanding of physiology is useful, but not assumed.
Biological Transport Phenomena: Read More [+]
Rules & Requirements

Prerequisites: MATH 53, MATH 54, and PHYSICS 7A

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Johnson

Biological Transport Phenomena: Read Less [-]

BIO ENG 105 Engineering Devices 1 4 Units

Terms offered: Fall 2022, Fall 2021, Fall 2020
This course provides students with an introduction to medical device design through fundamentals of circuit design/analysis, signal processing, and instrumentation development from concept to market. Important concepts will include impulse responses of systems, op-amps, interference, and noise; the origin of biological signals and recording mechanisms; and design considerations including sensitivity, accuracy, and market potential. This course is designed to be an introduction to these tools and concepts to prepare students to engage deeply and mindfully with device design in their future courses
Engineering Devices 1: Read More [+]
Objectives & Outcomes

Course Objectives: # To prepare students to engage in upper division device design work
Establish a foundational understanding of biomedical device electronics, signal acquisition, sampling, and reconstruction
To learn quantitative approaches to analyze biomedical signals
Reinforce mathematical principles including linear algebra, differential equations
Establish proficiency in the use of MATLAB as a tool for analyzing biomedical data

Student Learning Outcomes: To give students the mathematical and physical tools required to engage in device design.

Rules & Requirements

Prerequisites: MATH 53, PHYSICS 7A, and PHYSICS 7B

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Moriel Vandsburger

Engineering Devices 1: Read Less [-]

BIO ENG C106A Introduction to Robotics 4 Units

Terms offered: Fall 2023, Fall 2022, Fall 2021, Fall 2020, Fall 2019
This course is an introduction to the field of robotics. It covers the fundamentals of kinematics, dynamics, control of robot manipulators, robotic vision, sensing, forward & inverse kinematics of serial chain manipulators, the manipulator Jacobian, force relations, dynamics, & control. We will present techniques for geometric motion planning & obstacle avoidance. Open problems in trajectory generation with dynamic constraints will also be discussed. The course also presents the use of the same analytical techniques as manipulation for the analysis of images & computer vision. Low level vision, structure from motion, & an introduction to vision & learning will be covered. The course concludes with current applications of robotics.
Introduction to Robotics: Read More [+]
Rules & Requirements

Prerequisites: Familiarity with linear algebra at the level of EECS 16A/ EECS 16B or Math 54. Experience coding in python at the level of COMPSCI 61A. Preferred: experience developing software at the level of COMPSCI 61B and experience using Linux

Credit Restrictions: Students will receive no credit for Electrical Engineering and Computer Science C106A/Bioengineering C106A after completing EE C106A/BioE C125, Electrical Engineering 206A, or Electrical Engineering and Computer Science 206A.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 3 hours of laboratory per week

Summer: 8 weeks - 6 hours of lecture, 2 hours of discussion, and 6 hours of laboratory per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Alternative to final exam.

Instructor: Sastry

Also listed as: EECS C106A/MEC ENG C106A

Introduction to Robotics: Read Less [-]

BIO ENG C106B Robotic Manipulation and Interaction 4 Units

Terms offered: Spring 2024, Spring 2023, Spring 2022, Spring 2021, Spring 2020, Spring 2019
The course is a sequel to EECS/BIOE/MEC106A/EECSC206A, which covers the mathematical fundamentals of robotics including kinematics, dynamics and control as well as an introduction to path planning, obstacle avoidance, and computer vision. This course will present several areas of robotics and active vision, at a deeper level and informed by current research. Concepts will include the review at an advanced level of robot control, the kinematics, dynamics and control of multi-fingered hands, grasping and manipulation of objects, mobile robots: including non-holonomic motion planning and control, path planning, Simultaneous Localization And Mapping (SLAM), and active vision. Additional research topics covered at the instructor's discretion.
Robotic Manipulation and Interaction: Read More [+]
Rules & Requirements

Prerequisites: EECS C106A / BIO ENG C106A / MEC ENG C106A / EECS C206A or an equivalent course. A strong programming background, knowledge of Python and Matlab, and some coursework in feedback controls (such as EL ENG C128 / MEC ENG C134) are also useful. Students who have not taken the prerequisite course should have a strong programming background, knowledge of Python and Matlab, and exposure to linear algebra, Lagrangian dynamics, and feedback controls at the intermediate level. EECS C106A

Credit Restrictions: Students will receive no credit for Electrical Engineering and Computer Science C106B/Bioengineering C106B after completing Electrical Engineering C106B/Bioengineering C125B, Electrical Engineering 206B, or Electrical Engineering and Computer Science 206B.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Alternative to final exam.

Instructor: Sastry

Also listed as: EECS C106B/MEC ENG C106B

Robotic Manipulation and Interaction: Read Less [-]

BIO ENG 110 Biomedical Physiology for Engineers 4 Units

Terms offered: Spring 2024, Spring 2023, Spring 2022
This course introduces students to the physiology of human organ systems, with an emphasis on quantitative problem solving, engineering-style modeling, and applications to clinical medicine.
Biomedical Physiology for Engineers: Read More [+]
Objectives & Outcomes

Course Objectives: This 15-week course will introduce students to the principles of medical physiology, with a strong emphasis on quantitative problem solving, the physiological basis of human disease, and applications to biomedical devices and prostheses.

Student Learning Outcomes: Students will be exposed to the basic physiological systems which govern the function of each organ system, examples of diseases in which these systems go awry, and medical devices which have been developed to correct the deficits.

Rules & Requirements

Prerequisites: BIO ENG 10; and BIO ENG 11 or BIOLOGY 1A; and MATH 54 recommended

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Kumar

Biomedical Physiology for Engineers: Read Less [-]

BIO ENG 111 Functional Biomaterials Development and Characterization 4 Units

Terms offered: Spring 2024, Spring 2023, Spring 2022
This course is intended for upper level engineering undergraduate students interested in the development of novel functional proteins and peptide motifs and characterization of their physical and biological properties using various instrumentation tools in quantitative manners. The emphasis of the class is how to develop novel proteins and peptide motifs, and to characterize their physical and biological functions using various analytical tools in quantitative manners.
Functional Biomaterials Development and Characterization: Read More [+]
Objectives & Outcomes

Course Objectives: To provide students with basic and extended concepts for the development of the functional proteins and their characterization for various bioengineering and biomedical purposes.

Student Learning Outcomes: Upon completing the course, the student should be able:
1.
To understand the directed evolution processes of functional proteins.
2.
To identify the natural protein products from proteomic database.
3.
To design various experiments to characterize the new protein products.
4.
To develop novel functional proteins and characterize their properties.
5.
To understand basic concepts and instrumentation of protein characterization tools.

Rules & Requirements

Prerequisites: CHEM 1A or CHEM 4A; BIO ENG 11 or BIOLOGY 1A; and BIO ENG 103

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: SW Lee

Functional Biomaterials Development and Characterization: Read Less [-]

BIO ENG C112 Molecular Biomechanics and Mechanobiology of the Cell 4 Units

Terms offered: Spring 2023, Spring 2022, Spring 2021, Spring 2020
This course applies methods of statistical continuum mechanics to subcellar biomechanical phenomena ranging from nanoscale (molecular) to microscale (whole cell and cell population) biological processes at the interface of mechanics, biology, and chemistry.
Molecular Biomechanics and Mechanobiology of the Cell: Read More [+]
Objectives & Outcomes

Course Objectives: This course, which is open to senior undergraduate students or graduate students in diverse disciplines ranging from engineering to biology to chemistry and physics, is aimed at exposing students to subcellular biomechanical phenomena spanning scales from molecules to the whole cell.

Student Learning Outcomes: The students will develop tools and skills to (1) understand and analyze subcelluar biomechanics and transport phenomena, and (2) ultimately apply these skills to novel biological and biomedical applications

Rules & Requirements

Prerequisites: BIO ENG 102; or MEC ENG C85 / CIV ENG C30; or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Alternative to final exam.

Instructor: Mofrad

Also listed as: MEC ENG C115

Molecular Biomechanics and Mechanobiology of the Cell: Read Less [-]

BIO ENG 114 Cell Engineering 4 Units

Terms offered: Fall 2023, Fall 2022, Fall 2021
This course will teach the main concepts and current views on key attributes of animal cells (somatic, embryonic, pluripotent, germ-line; with the focus on mammalian cells), will introduce theory of the regulation of cell function, methods for deliberate control of cell properties and resulting biomedical and bioengineering technologies.
Cell Engineering: Read More [+]
Objectives & Outcomes

Course Objectives: The goal of this course to establish fundamental understanding of cell engineering technologies and of the key biological paradigms, upon which cell engineering is based, with the focus on biomedical applications of cell engineering.

Student Learning Outcomes: At the completion of this course students will understand how bioengineering technologies address the deliberate control of cell properties (and how this advances biomedicine); and students will learn the main concepts and current views on key attributes of animal cells (somatic, embryonic, pluripotent, germ-line; with the focus on mammalian cells).

Rules & Requirements

Prerequisites: BIOLOGY 1A or BIO ENG 11; or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 2 hours of discussion per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Conboy

Cell Engineering: Read Less [-]

BIO ENG 115 Tissue Engineering Lab 4 Units

Terms offered: Fall 2023, Spring 2023, Fall 2022
This class provides a conceptual and practical understanding of cell and tissue bioengineering that is vital for careers in medicine, biotechnology, and bioengineering. Students are introduced to cell biology laboratory techniques, including immunofluorescence, quantitative image analysis, protein quantification, protein expression, gene expression, and cell culture.
Tissue Engineering Lab: Read More [+]
Objectives & Outcomes

Course Objectives: The goal of this course to provide students with conceptual and practical understanding of cell and tissue bioengineering.

Student Learning Outcomes: At the completion of this course, students will learn key cellular bioengineering laboratory techniques, will develop a conceptual and theoretical understanding of the reliability and limitations of these techniques and will enhance their skills in quantitative data analysis, interpretation and integration.

Rules & Requirements

Prerequisites: BIO ENG 11, BIO ENG 114 or BIO ENG 202, or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 4 hours of laboratory and 2 hours of lecture per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Alternative to final exam.

Instructor: Conboy

Tissue Engineering Lab: Read Less [-]

BIO ENG C117 Structural Aspects of Biomaterials 4 Units

Terms offered: Spring 2023, Fall 2020, Spring 2019
This course covers the basic design, materials selection, stress analysis and clinical case studies for load-bearing
medical devices. Implant applications include orthopedics, dentistry and cardiology reconstructive surgery. FDA
regulatory requirements and intellectual property issues are discussed. Case studies of medical devices
elucidating the trade-offs in structural function and clinical performance are presented. Ongoing challenges with
personalized implantable devised are addressed. This is a project-based course.
Structural Aspects of Biomaterials: Read More [+]
Rules & Requirements

Prerequisites: MEC ENG 108, BIO ENG 102, MAT SCI 113 or equivalent

Credit Restrictions: Students will receive no credit for Mechanical Engineering C117 after completing Mechanical Engineering C215/ Bioengineering C222.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Alternative to final exam.

Instructor: Pruitt

Also listed as: MEC ENG C117

Structural Aspects of Biomaterials: Read Less [-]

BIO ENG C118 Biological Performance of Materials 4 Units

Terms offered: Fall 2023, Fall 2022, Fall 2021
This course is intended to give students the opportunity to expand their knowledge of topics related to biomedical materials selection and design. Structure-property relationships of biomedical materials and their interaction with biological systems will be addressed. Applications of the concepts developed include blood-materials compatibility, biomimetic materials, hard and soft tissue-materials interactions, drug delivery, tissue engineering, and biotechnology.
Biological Performance of Materials: Read More [+]
Objectives & Outcomes

Course Objectives: The course is separated into four parts spanning the principles of synthetic materials and surfaces, principles of biological materials, biological performance of materials and devices, and state-of-the-art materials design. Students are required to attend class and master the material therein. In addition, readings from the clinical, life and materials science literature are assigned. Students are encouraged to seek out additional reference material to complement the readings assigned. A mid-term examination is given on basic principles (parts 1 and 2 of the outline). A comprehensive final examination is given as well. The purpose of this course is to introduce students to problems associated with the selection and function of biomaterials. Through class lectures and readings in both the physical and life science literature, students will gain broad knowledge of the criteria used to select biomaterials, especially in devices where the material-tissue or material-solution interface dominates performance. Materials used in devices for medicine, dentistry, tissue engineering, drug delivery, and the biotechnology industry will be addressed.

This course also has a significant design component (~35%). Students will form small teams (five or less) and undertake a semester-long design project related to the subject matter of the course. The project includes the preparation of a paper and a 20 minute oral presentation critically analyzing a current material-tissue or material-solution problem. Students will be expected to design improvements to materials and devices to overcome the problems identified in class with existing materials.

Student Learning Outcomes:
Apply math, science & engineering principles to the understanding of soft materials, surface chemistry, DLVO theory, protein adsorption kinetics, viscoelasticity, mass diffusion, and molecular (i.e., drug) delivery kinetics.

•
Design experiments and analyze data from the literature in the context of the class design project.
Apply core concepts in materials science to solve engineering problems related to the selection biomaterials, especially in devices where the material-tissue or material-solution interface dominates performance.
Develop an understanding of the social, safety and medical consequences of biomaterial use and regulatory issues associated with the selection of biomaterials in the context of the silicone breast implant controversy and subsequent biomaterials crisis.
Work independently and function on a team, and develop solid communication skills (oral, graphic & written) through the class design project.
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Understanding of the origin of surface forces and interfacial free energy, and how they contribute to the development of the biomaterial interface and ultimately biomaterial performance.

Rules & Requirements

Prerequisites: MAT SCI 45 and BIO ENG 103 are required. BIO ENG 102 and BIO ENG 104 are strongly recommended

BIO ENG C119 Orthopedic Biomechanics 4 Units

Terms offered: Fall 2023, Fall 2022, Fall 2020
Statics, dynamics, optimization theory, composite beam theory, beam-on-elastic foundation theory, Hertz contact theory, and materials behavior. Forces and moments acting on human joints; composition and mechanical behavior of orthopedic biomaterials; design/analysis of artificial joint, spine, and fracture fixation prostheses; musculoskeletal tissues including bone, cartilage, tendon, ligament, and muscle; osteoporosis and fracture-risk predication of bones; and bone adaptation. MATLAB-based project to integrate the course material.
Orthopedic Biomechanics: Read More [+]
Rules & Requirements

Prerequisites: MEC ENG C85 / CIV ENG C30 or BIO ENG 102 (concurrent enrollment OK). Proficiency in MatLab or equivalent. Prior knowledge of biology or anatomy is not assumed

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of laboratory per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Keaveny

Also listed as: MEC ENG C176

Orthopedic Biomechanics: Read Less [-]

BIO ENG 121 BioMEMS and Medical Devices 4 Units

Terms offered: Fall 2023, Fall 2022, Fall 2021
Biophysical and chemical principles of biomedical devices, bionanotechnology, bionanophotonics, and biomedical microelectromechanical systems (BioMEMS). Topics include basics of nano- and microfabrication, soft-lithography, DNA arrays, protein arrays, electrokinetics, electrochemical, transducers, microfluidic devices, biosensor, point of care diagnostics, lab-on-a-chip, drug delivery microsystems, clinical lab-on-a-chip, advanced biomolecular probes, etc.
BioMEMS and Medical Devices: Read More [+]
Rules & Requirements

Prerequisites: CHEM 3A; PHYSICS 7A and PHYSICS 7B; and BIO ENG 104 or equivalent transport course

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Alternative to final exam.

Instructors: Lee, Streets

BioMEMS and Medical Devices: Read Less [-]

BIO ENG 121L BioMems and BioNanotechnology Laboratory 4 Units

Terms offered: Spring 2024, Spring 2023, Fall 2022
Students will become familiar with BioMEMS and Lab-on-a-Chip research. Students will design and fabricate their own novel micro- or nano-scale device to address a specific problem in biotechnology using the latest micro- and nano-technological tools and fabrication techniques. This will involve an intensive primary literature review, experimental design, and quantitative data analysis. Results will be presented during class presentations and at a final poster symposium.
BioMems and BioNanotechnology Laboratory: Read More [+]
Objectives & Outcomes

Course Objectives: Students will become familiar with research associated with BioMEMS and Lab-on-a-Chip technologies. Students will gain experience in using creative design to solve a technological problem. Students will learn basic microfabrication techniques. Working in engineering teams, students will learn how to properly characterize a novel device
by choosing and collecting informative metrics. Students will design and carry out carefully controlled experiments that will result in the analysis of quantitative data.

Student Learning Outcomes: Students will learn how to critically read BioMEMS and Lab-on-a-Chip primary literature. Students will learn how to use AutoCAD software to design microscale device features. Students will gain hands-on experience in basic photolithography and soft lithography. Students will get experience with a variety of fluid loading interfaces and
microscopy techniques. Students will learn how to design properly controlled uantitative experiments. Students will gain experience in presenting data to their peers in the form of powerpoint presentations and also at a poster symposium.

Rules & Requirements

Prerequisites: BIO ENG 104; and BIO ENG 121 (can be taken concurrently)

Credit Restrictions: Students will receive no credit for 121L after taking 221L.

Hours & Format

Fall and/or spring: 15 weeks - 6 hours of laboratory and 2 hours of lecture per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Alternative to final exam.

Instructor: Liepmann

BioMems and BioNanotechnology Laboratory: Read Less [-]

BIO ENG 124 Basic Principles of Drug Delivery 3 Units

Terms offered: Fall 2023, Fall 2021, Fall 2020
This course focuses on providing students with the foundations needed to understand contemporary literature in drug delivery. Concepts in organic chemistry, biochemistry, and physical chemistry needed to understand current problems in drug delivery are emphasized.
Basic Principles of Drug Delivery: Read More [+]
Objectives & Outcomes

Course Objectives: The goal of this course is to give students the ability to understand problems in drug delivery. Emphasis is placed on the design and synthesis of new molecules for drug delivery.

Student Learning Outcomes: At the completion of this course students should be able to design new molecules to solve drug delivery problems.

Rules & Requirements

Prerequisites: BIO ENG 11 or CHEM 3B; BIO ENG 103 and BIO ENG 104

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Murthy

Basic Principles of Drug Delivery: Read Less [-]

BIO ENG C125 Introduction to Robotics 4 Units

Terms offered: Fall 2017, Fall 2016, Fall 2015
An introduction to the kinematics, dynamics, and control of robot manipulators, robotic vision, and sensing. The course covers forward and inverse kinematics of serial chain manipulators, the manipulator Jacobian, force relations, dynamics, and control. It presents elementary principles on proximity, tactile, and force sensing, vision sensors, camera calibration, stereo construction, and motion detection. The course concludes with current applications of robotics in active perception, medical robotics, and other areas.
Introduction to Robotics: Read More [+]
Rules & Requirements

Prerequisites: EL ENG 120 or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Bajcsy

Formerly known as: Electrical Engineering C125/Bioengineering C125

Also listed as: EL ENG C106A

Introduction to Robotics: Read Less [-]

BIO ENG C125B Robotic Manipulation and Interaction 4 Units

Terms offered: Spring 2017, Spring 2016
This course is a sequel to Electrical Engineering C106A/Bioengineering C125, which covers kinematics, dynamics and control of a single robot. This course will cover dynamics and control of groups of robotic manipulators coordinating with each other and interacting with the environment. Concepts will include an introduction to grasping and the constrained manipulation, contacts and force control for interaction with the environment. We will also cover active perception guided manipulation, as well as the manipulation of non-rigid objects. Throughout, we will emphasize design and human-robot interactions, and applications to applications in manufacturing, service robotics, tele-surgery, and locomotion.
Robotic Manipulation and Interaction: Read More [+]
Rules & Requirements

Prerequisites: EECS C106A / BIO ENG C125 or consent of the instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Alternative to final exam.

Instructors: Bajcsy, Sastry

Also listed as: EL ENG C106B

Robotic Manipulation and Interaction: Read Less [-]

BIO ENG 131 Introduction to Computational Molecular and Cell Biology 4 Units

Terms offered: Fall 2018, Fall 2017, Fall 2016
Topics include computational approaches and techniques to gene structure and genome annotation, sequence alignment using dynamic programming, protein domain analysis, RNA folding and structure prediction, RNA sequence design for synthetic biology, genetic and biochemical pathways and networks, UNIX and scripting languages, basic probability and information theory. Various "case studies" in these areas are reviewed; web-based computational biology tools will be used by students and programming projects will be given. Computational biology research connections to biotechnology will be explored.
Introduction to Computational Molecular and Cell Biology: Read More [+]
Objectives & Outcomes

Course Objectives: To introduce the biological databases and file formats commonly used in computational biology. (2) To familiarize students with the use of Unix scripting languages in bioinformatics workflows. (3) To introduce common algorithms for sequence alignment, RNA structure prediction, phylogeny and clustering, along with fundamentals of probability, information theory and algorithmic complexity analysis.

Student Learning Outcomes: Students will be able to use knowledge from the lectures and lab sessions to write simple programs to parse bioinformatics file formats and execute basic algorithms, to analyze algorithmic complexity, to navigate and (for simple cases) set up biological databases containing biological data (including sequences, genome annotations and protein structures), and to use basic statistics to interpret results of compbio analyses.

Rules & Requirements

Prerequisites: BIO ENG 11 or BIOLOGY 1A (may be taken concurrently); plus a programming course (ENGIN 7 or COMPSCI 61A)

Credit Restrictions: Students will receive no credit for BIO ENG 131 after completing BIO ENG 231. A deficient grade in BIO ENG 131 may be removed by taking BIO ENG C131.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1.5 hours of laboratory per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Holmes

Introduction to Computational Molecular and Cell Biology: Read Less [-]

BIO ENG C131 Introduction to Computational Molecular and Cell Biology 4 Units

Terms offered: Fall 2023, Fall 2022, Fall 2021, Fall 2020
This class teaches basic bioinformatics and computational biology, with an emphasis on alignment, phylogeny, and ontologies. Supporting foundational topics are also reviewed with an emphasis on bioinformatics topics, including basic molecular biology, probability theory, and information theory.
Introduction to Computational Molecular and Cell Biology: Read More [+]
Rules & Requirements

Prerequisites: BioE 11 or Bio 1A (may be taken concurrently), plus a programming course (ENGIN 7 or CS 61A)

Credit Restrictions: Students will receive no credit for BIO ENG C131 after completing BIO ENG 131, BIO ENG C131, or BIO ENG C131. A deficient grade in BIO ENG C131 may be removed by taking BIO ENG C131, or BIO ENG C131.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Holmes

Also listed as: CMPBIO C131

Introduction to Computational Molecular and Cell Biology: Read Less [-]

BIO ENG 134 Genetic Design Automation 4 Units

Terms offered: Fall 2023, Fall 2022, Fall 2021
Genetic Design Automation is the use of software to design and manage genetics experiments. This course introduces the interface between object-oriented programming and wetlab synthetic biology in a hands-on manner. Through a series of programming assignments, each student will build a computer program that automatically designs experiments starting from a formal specification. They will then independently build a new software module of their own design to augment the basic platform
Genetic Design Automation: Read More [+]
Objectives & Outcomes

Course Objectives: (1) To develop the skill of translating experimental design into computer code, (2) Develop familiarity with state-of-the-art infrastructure for wetlab automation, (3) Develop proficiency in software development

Student Learning Outcomes: students will be able to (1) Describe molecular biology entities and operations in terms of data structures, (2) Develop moderately-sized computer programs, (3) Write tests and benchmarking suites for biological algorithms (4) Explore different algorithmic approaches to problems and assess their relative merits and efficiencies, (5) Develop proficiency in conceiving and implementing software projects of their own design as they relate to biological problems

Rules & Requirements

Prerequisites: COMPSCI 61B, BIO ENG 11 and BIO ENG 103

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: J. Christopher Anderson

Genetic Design Automation: Read Less [-]

BIO ENG 135 Frontiers in Microbial Systems Biology 4 Units

Terms offered: Spring 2024, Spring 2022, Spring 2021
This course is aimed at graduate and advanced undergraduate students from the (bio) engineering and chemo-physical sciences interested in a research-oriented introduction to current topics in systems biology. Focusing mainly on two well studied microbiological model systems--the chemotaxis network and Lambda bacteriophage infection--the class systematically introduces key concepts and techniques for biological network deduction, modelling, analysis, evolution, and synthetic network design. Students analyze the impact of approaches from the quantitative sciences--such as deterministic modelling, stochastic processes, statistics, non-linear dynamics, control theory, information theory, graph theory, etc.--on understanding biological processes, including (stochastic) gene regulation, signalling, network evolution, and synthetic network design. The course aims to identify unsolved problems and discusses possible novel approaches while encouraging students to develop ideas to explore new directions in their own research.
Frontiers in Microbial Systems Biology: Read More [+]
Rules & Requirements

Prerequisites: Upper division standing with background in differential equations and probability. Coursework in molecular and cell biology or biochemistry recommended

Credit Restrictions: Students will receive no credit for 135 after taking 235.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructors: Arkin, Bischofs-Pfeifer, Wolf

Frontiers in Microbial Systems Biology: Read Less [-]

BIO ENG C136L Laboratory in the Mechanics of Organisms 3 Units

Terms offered: Spring 2015, Spring 2014, Spring 2013, Spring 2012
Introduction to laboratory and field study of the biomechanics of animals and plants using fundamental biomechanical techniques and equipment. Course has a series of rotations involving students in experiments demonstrating how solid and fluid mechanics can be used to discover the way in which diverse organisms move and interact with their physical environment. The laboratories emphasize sampling methodology, experimental design, and statistical interpretation of results. Latter third of course devoted to independent research projects. Written reports and class presentation of project results are required.
Laboratory in the Mechanics of Organisms: Read More [+]
Rules & Requirements

Prerequisites: INTEGBI 135 or consent of instructor. For Electrical Engineering and Computer Sciences students: EL ENG 105, EL ENG 120 or COMPSCI 184

Credit Restrictions: Students will receive no credit for C135L after taking 135L.

Hours & Format

Fall and/or spring: 15 weeks - 6 hours of laboratory, 1 hour of discussion, and 1 hour of fieldwork per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Formerly known as: Integrative Biology 135L

Also listed as: EL ENG C145O/INTEGBI C135L

Laboratory in the Mechanics of Organisms: Read Less [-]

BIO ENG C137 Designing for the Human Body 4 Units

Terms offered: Fall 2019, Fall 2018, Fall 2017
The course provides project-based learning experience in understanding product design, with a focus on the human body as a mechanical machine. Students will learn the design of external devices used to aid or protect the body. Topics will include forces acting on internal materials (e.g., muscles and total replacement devices), forces acting on external materials (e.g., prothetics and crash pads), design/analysis of devices aimed to improve or fix the human body, muscle adaptation, and soft tissue injury. Weekly laboratory projects will incorporate EMG sensing, force plate analysis, and interpretation of data collection (e.g., MATLAB analysis) to integrate course material to better understand contemporary design/analysis/problems.
Designing for the Human Body: Read More [+]
Objectives & Outcomes

Course Objectives: The purpose of this course is twofold:

- to learn the fundamental concepts of designing devices to interact with the human body;
- to enhance skills in mechanical engineering and bioengineering by analyzing the behavior of various complex biomedical problems;
- To explore the transition of a device or discovery as it goes from “benchtop to bedside”.

Student Learning Outcomes: RELATIONSHIP OF THE COURSE TO ABET PROGRAM OUTCOMES
(a) an ability to apply knowledge of mathematics, science, and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(d) an ability to function on multi-disciplinary teams
(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(i) a recognition of the need for, and an ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Working knowledge of design considerations for creating a device to protect or aid the human body, force transfer and distribution, data analysis, and FDA approval process for new devices. Understanding of basic concepts in orthopaedic biomechanics and the ability to apply the appropriate engineering concepts to solve realistic biomechanical problems, knowing clearly the assumptions involved. Critical analysis of current literature and technology.

Rules & Requirements

Prerequisites: PHYSICS 7A, MATH 1A, and MATH 1B. Proficiency in MatLab or equivalent. Prior knowledge of biology or anatomy is not assumed

Credit Restrictions: There will be no credit given for MEC ENG C178 / BIO ENG C137 after taking MEC ENG 178.

Hours & Format

Fall and/or spring: 15 weeks - 1-3 hours of lecture per week

BIO ENG 140L Synthetic Biology Laboratory 4 Units

Terms offered: Spring 2024, Spring 2023, Spring 2022
This laboratory course is designed as an introduction to research in synthetic biology, a ground-up approach to genetic engineering with applications in bioenergy, heathcare, materials science, and chemical production. In this course, we will design and execute a real research project. Each student will be responsible for designing and constructing components for the group project and then performing experiments to analyze the system. In addition to laboratory work, we will have lectures on methods and design concepts in synthetic biology including an introduction to Biobricks, gene synthesis, computer modeling, directed evolution, practical molecular biology, and biochemistry.
Synthetic Biology Laboratory: Read More [+]
Objectives & Outcomes

Course Objectives: Designing and interpreting biological experiments
Learning how to plan, coordinate, and implement a genetic engineering project in a group format
To master the wetlab techniques of synthetic biology

Student Learning Outcomes: Students will be able to examine analytical data, interpret controls, and make decisions about next steps.
Students will be able to perform synthetic biology experiments including reagent preparation, DNA manipulation, analytical methods, and microbiological techniques.
Students will be able to understand responsible conduct expectations for wetlab experimentalists.
Students will be able to understand the techniques and protocols used in synthetic biology.
Students will be able to work within a team and develop communication skills.

Rules & Requirements

Prerequisites: BIO ENG 11 or BIOLOGY 1A

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of lecture and 6 hours of laboratory per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Anderson

Synthetic Biology Laboratory: Read Less [-]

BIO ENG C142 Machine Learning, Statistical Models, and Optimization for Molecular Problems 4 Units

Terms offered: Spring 2024, Spring 2023
An introduction to mathematical optimization, statistical models, and advances in machine learning for the physical sciences. Machine learning prerequisites are introduced including local and global optimization, various statistical and clustering models, and early meta-heuristic methods such as genetic algorithms and artificial neural networks. Building on this foundation, current machine learning techniques are covered including deep learning artificial neural networks, Convolutional neural networks, Recurrent and long short term memory (LSTM) networks, graph neural networks, decision trees.
Machine Learning, Statistical Models, and Optimization for Molecular Problems: Read More [+]
Objectives & Outcomes

Course Objectives: To build on optimization and statistical modeling to the field of machine learning techniques
To introduce the basics of optimization and statistical modeling techniques relevant to chemistry students
To utilize these concepts on problems relevant to the chemical sciences.

Student Learning Outcomes: Students will be able to understand the landscape and connections between numerical optimization, stand-alone statistical models, and machine learning techniques, and its relevance for chemical problems

Rules & Requirements

Prerequisites: MATH 53 and MATH 54; CHEM 120A or CHEM 120B or BIO ENG 103

Credit Restrictions: Students will receive no credit for BIO ENG C142 after completing BIO ENG 142. A deficient grade in BIO ENG C142 may be removed by taking BIO ENG 142.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Alternate method of final assessment during regularly scheduled final exam group (e.g., presentation, final project, etc.).

Instructor: Teresa Head-Gordon

Formerly known as: Bioengineering C142/Chemistry C142

Also listed as: CHEM C142

Machine Learning, Statistical Models, and Optimization for Molecular Problems: Read Less [-]

BIO ENG 143 Computational Methods in Biology 4 Units

Terms offered: Fall 2011, Fall 2010, Fall 2009
An introduction to biophysical simulation methods and algorithms, including molecular dynamics, Monte Carlo, mathematical optimization, and "non-algorithmic" computation such as neural networks. Various case studies in applying these areas in the areas of protein folding, protein structure prediction, drug docking, and enzymatics will be covered. Core Specialization: Core B (Informatics and Genomics); Core D (Computational Biology); BioE Content: Biological.
Computational Methods in Biology: Read More [+]

Rules & Requirements

Prerequisites: MATH 53 and MATH 54. Programming experience preferred but not required

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 2 hours of laboratory per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Head-Gordon

Computational Methods in Biology: Read Less [-]

BIO ENG 144 Introduction to Protein Informatics 4 Units

Terms offered: Spring 2017, Fall 2008, Fall 2007
This course will introduce students to the bioinformatics algorithms used by biologists to identify homologs, construct multiple sequence alignments, predict protein structure, estimate phylogenetic trees, identify orthologs, predict protein-protein interaction, and build hidden Markov models. The focus is on the algorithms used, and on the sources of various types of errors in these methods.
Introduction to Protein Informatics: Read More [+]

Objectives & Outcomes

Course Objectives: This course is designed to provide a theoretical framework for protein sequence and structure analysis using bioinformatics software tools. Students completing this course will be prepared for subsequent in-depth studies in bioinformatics, for algorithm development, and for the use of bioinformatics methods for biological discovery. It is aimed at two populations: students in the life sciences who need to become expert users of bioinformatics tools, and students in engineering and mathematics/computer science who wish to become the developers of the next generation of bioinformatics methods. As virtually all the problems in this field are very complex, there are many opportunities for research and development of new methods.

Student Learning Outcomes: Students completing this course are likely to find several potential areas of research of interest, which they may want to work on as independent study projects during undergraduate work, or take on as Master’s or Ph.D. thesis topics for advanced work.

Rules & Requirements

Prerequisites: Prior coursework in algorithms. No prior coursework in biology is required. This course includes no programming projects and prior experience in programming is not required

Credit Restrictions: BioE 244 or BioE C244L/PMB C244

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Sjolander

Formerly known as: Bioengineering C144/Plant and Microbial Biology C144

Introduction to Protein Informatics: Read Less [-]

BIO ENG 144L Protein Informatics Laboratory 3 Units

Terms offered: Fall 2008

This course is intended to provide hands-on experience with a variety of bioinformatics tools, web servers, and databases that are used to predict protein function and structure. This course will cover numerous bioinformatics tasks including: homolog detection using BLAST and PSI-BLAST, hidden Markov model construction and use, multiple sequence alignment, phylogenetic tree construction, ortholog identification, protein structure prediction, active site prediction, cellular localization, protein-protein interaction and phylogenomic analysis. Some minimal programming/scripting skills (e.g., Perl or Python) are required to complete some of the labs.

Protein Informatics Laboratory: Read More [+]

Rules & Requirements

Prerequisites: One upper-division course in molecular biology or biochemistry (e.g., MCELLBI C100A / CHEM C130 or equivalent); and Python programming (e.g. COMPSCI 61A) and experience using command-line tools in a Unix environment

Credit Restrictions: Bio Eng 244L or Bio Eng C244L/PMB C244L

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of laboratory and 2 hours of lecture per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Sjolander

Formerly known as: Bioengineering C144L/Plant and Microbial Biology C144L

Protein Informatics Laboratory: Read Less [-]

BIO ENG 145 Introduction to Machine Learning for Computational Biology 4 Units

Terms offered: Spring 2024, Spring 2023, Spring 2022

Genome-scale experimental data and modern machine learning methods have transformed our understanding of biology. This course investigates classical approaches and recent machine learning advances in genomics including:

1)Computational models for genome analysis

2)Applications of machine learning to high throughput biological data

3)Machine learning for genomic data in health

This course builds on existing skills to introduce methodologies for probabilistic modeling, statistical learning, and dimensionality reduction, while grounding these methods in understanding genomic information.

Introduction to Machine Learning for Computational Biology: Read More [+]

Objectives & Outcomes

Course Objectives: This course aims to equip students with a foundational understanding of computational and machine learning techniques used in genomics and computational biology.

Student Learning Outcomes: Students completing this course should have a better understanding of some of the challenges in machine learning as applied to biology

Students completing this course should have stronger programming skills.

Students completing this course should have the ability to apply simple statistical and machine learning techniques to complex genomics data

Rules & Requirements

Prerequisites: Bio 1A or BioE 11, Math 54, CS61B; CS70 or Math 55 recommended

Credit Restrictions: Students will receive no credit for BIO ENG 145 after completing BIO ENG 245. A deficient grade in BIO ENG 145 may be removed by taking BIO ENG 245.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Alternative to final exam.

Instructor: Lareau

Introduction to Machine Learning for Computational Biology: Read Less [-]

BIO ENG C145L Introductory Electronic Transducers Laboratory 3 Units

Terms offered: Fall 2014, Fall 2013, Fall 2012
Laboratory exercises exploring a variety of electronic transducers for measuring physical quantities such as temperature, force, displacement, sound, light, ionic potential; the use of circuits for low-level differential amplification and analog signal processing; and the use of microcomputers for digital sampling and display. Lectures cover principles explored in the laboratory exercises; construction, response and signal to noise of electronic transducers and actuators; and design of circuits for sensing and controlling physical quantities.
Introductory Electronic Transducers Laboratory: Read More [+]
Hours & Format

Fall and/or spring: 15 weeks - 2 hours of lecture and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Derenzo

Also listed as: EL ENG C145L

Introductory Electronic Transducers Laboratory: Read Less [-]

BIO ENG C145M Introductory Microcomputer Interfacing Laboratory 3 Units

Terms offered: Spring 2013, Spring 2012, Spring 2011
Laboratory exercises constructing basic interfacing circuits and writing 20-100 line C programs for data acquisition, storage, analysis, display, and control. Use of the IBM PC with microprogrammable digital counter/timer, parallel I/O port. Circuit components include anti-aliasing filters, the S/H amplifier, A/D and D/A converters. Exercises include effects of aliasing in periodic sampling, fast Fourier transforms of basic waveforms, the use of the Hanning filter for leakage reduction, Fourier analysis of the human voice, digital filters, and control using Fourier deconvolution. Lectures cover principles explored in the lab exercises and design of microcomputer-based systems for data acquisitions, analysis and control.
Introductory Microcomputer Interfacing Laboratory: Read More [+]
Rules & Requirements

Prerequisites: EE 16A & 16B

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of lecture and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Derenzo

Also listed as: EL ENG C145M

Introductory Microcomputer Interfacing Laboratory: Read Less [-]

BIO ENG C146 Data Science for Biology 3 Units

Terms offered: Spring 2024, Fall 2022, Spring 2007, Spring 2005
Biology has become a data science! This lab course aims for student curiosity to drive hands-on
case studies and coding projects about biological applications of data science. The course design
supports students' development of fundamental and transferable computational and statistical
skills for critically thinking about and using data in biology. Ethical considerations are
interwoven throughout. This course offers projects with multiple levels of sophistication and
complexity, enabling participation for students with varying levels of experience.
Data Science for Biology: Read More [+]
Objectives & Outcomes

Course Objectives: Students will become empowered to use basic coding approaches to access, work with, and
analyze biological data
Students will learn how to appropriately apply statistical tests to biological data
Students will learn how to select and evaluate methods and tools for data analysis
Students will understand how to grapple with the ethical considerations of biological data

Rules & Requirements

Prerequisites: Biology 1A; Biology 1B (can be taken concurrently); Data C8 or equivalent statistics and programming experience

Hours & Format

Fall and/or spring: 15 weeks - 4 hours of laboratory per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Alternate method of final assessment during regularly scheduled final exam group (e.g., presentation, final project, etc.).

Instructors: Brenner, Eisen

Also listed as: MCELLBI C146/PLANTBI C146

Data Science for Biology: Read Less [-]

BIO ENG 147 Principles of Synthetic Biology 4 Units

Terms offered: Fall 2023, Fall 2021, Fall 2020
The field of synthetic biology is quickly emerging as potentially one of the most important and profound ways by which we can understand and manipulate our physical world for desired purposes. In this course, the field and its natural scientific and engineering basis are introduced. Relevant topics in cellular and molecular biology and biophysics, dynamical and engineering systems, and design and operation of natural and synthetic circuits are covered in a concise manner that then allows the student to begin to design new biology-based systems.
Principles of Synthetic Biology: Read More [+]
Objectives & Outcomes

Course Objectives: (1) To introduce the basics of Synthetic Biology, including quantitative cellular network characterization and modeling, (2) to introduce the principles of discovery and genetic factoring of useful cellular activities into reusable functions for design, (3) to inculcate the principles of biomolecular system design and diagnosis of designed systems, and (4) to illustrate cutting-edge applications in Synthetic Biology and to enhance skull sin analyzing and designing synthetic biological applications.

Student Learning Outcomes: The goals of this course are to enable students to: (1) design simple cellular circuitry to meet engineering specification using both rational/model-based and library-based approaches, (2) design experiments to characterize and diagnose operation of natural and synthetic biomolecular network functions, and (3) understand scientific, safety and ethical issues of synthetic biology.

Rules & Requirements

Prerequisites: MATH 53 and MATH 54; and BIO ENG 103 or consent of instructor

Credit Restrictions: Students will receive no credit for 147 after taking 247.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Alternative to final exam.

Instructor: Arkin

Principles of Synthetic Biology: Read Less [-]

BIO ENG 148 Bioenergy and Sustainable Chemical Synthesis: Metabolic Engineering and Synthetic Biology Approaches 3 Units

Terms offered: Fall 2023, Fall 2022, Fall 2020
This course will cover metabolic engineering and the various synthetic biology approaches for optimizing pathway performance. Use of metabolic engineering to produce biofuels and general "green technology" will be emphasized since these aims are currently pushing these fields. The course is meant to be a practical guide for metabolic engineering and the related advances in synthetic biology as well the related industrial research and opportunities.
Bioenergy and Sustainable Chemical Synthesis: Metabolic Engineering and Synthetic Biology Approaches: Read More [+]
Objectives & Outcomes

Course Objectives: (1) Learn the common engineered metabolic pathways for biofuel biosynthesis
(2) analytical methods
(3) synthetic biology approaches
(4) Industry technologies and opportunities

Student Learning Outcomes: Students will learn (1) the common pathways used for biofuel synthesis and framework for the biosynthesis of specialty chemicals, (2) analytical methods for quantitative measurements of metabolic pathways, (3) synthetic biology approaches for increasing overall pathway performance, and how to (4) utilize available online resources for culling information from large data sources.

Rules & Requirements

Prerequisites: CHEM 3A and BIO ENG 103

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Dueber

Bioenergy and Sustainable Chemical Synthesis: Metabolic Engineering and Synthetic Biology Approaches: Read Less [-]

BIO ENG C149 Computational Functional Genomics 4 Units

Terms offered: Fall 2023
This course provides a survey of the computational analysis of genomic data, introducing the material through lectures on biological concepts and computational methods, presentations of primary literature, and practical bioinformatics exercises. The emphasis is on measuring the output of the genome and its regulation. Topics include modern computational and statistical methods for analyzing data from genomics experiments: high-throughput RNA sequencing data, single-cell data, and other genome-scale measurements of biological processes. Students will perform original analyses with Python and command-line tools.
Computational Functional Genomics: Read More [+]
Objectives & Outcomes

Course Objectives: This course aims to equip students with practical proficiency in bioinformatics analysis of genomic data, as well as understanding of the biological, statistical, and computational underpinnings of this field.

Student Learning Outcomes: Students completing this course should have stronger programming skills, practical proficiency with essential bioinformatics methods that are applicable to genomics research, understanding of the statistics underlying these methods, and awareness of key aspects of genome function and challenges in the field of genomics.

Rules & Requirements

Prerequisites: MATH 54 or EECS 16A/B; COMPSCI 61A or equivalent Python course; BIOENG 11 or BIOLOGY 1A; and BIOENG 131. Introductory statistics or data science is recommended

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Alternative to final exam.

Instructor: Lareau

Also listed as: CMPBIO C149

Computational Functional Genomics: Read Less [-]

BIO ENG 150 Introduction of Bionanoscience and Bionanotechnology 4 Units

Terms offered: Fall 2023, Fall 2021, Fall 2020
This course is intended for the bioengineering or engineering undergraduate students interested in acquiring a background in recent development of bio-nanomaterials and bio-nanotechnology. The emphasis of the class is to understand the properties of biological basis building blocks, their assembly principles in nature, and their application to build functional materials and devices.
Introduction of Bionanoscience and Bionanotechnology: Read More [+]
Objectives & Outcomes

Course Objectives: I.
Basic building blocks and governing forces: This part is intended to enhance the understanding of the structures and properties of biological basic building blocks and their governing forces to assemble the biological materials. This part covers the chemical structures of amino acids, ribonucleic acids, hydrocarbonates, and lipids, and their physical properties depending on the chemical and physical structures. In addition, governing forces (hydrogen bonding, ionic interaction, van der Waals interaction, hydrophobic interactions, etc) to assemble the basic building blocks to form nanostructures will be covered. Tools and methodologies to analyze the chemical structure of the molecules will be introduced. Quantitative analysis of the properties of biological basic building blocks will also be addressed.
II.
Case study of the molecular level structures of biological materials. This part is intended to study the examples of biological molecules to enhance understanding the assembly principle of biological materials, including collagens, keratins, spider webs, silks, bio-adhesives as protein based robust materials, bones, sea shells, diatoms, sponges, and, other biominerals as hierarchical nanostructures, and butterfly wings and insect eyes, other periodic structures for optical applications. Through the case study, we will learn how natural materials are designed to solve the challenging problem to be faced in the natural environments and exploit their design principle to develop novel functional materials and devices.
III.
Case study of the artificial nanomaterials and devices inspired by biological nature. This part is intended to enhance understanding the recently developed nanostructures and devices to mimic the natural biological materials and organisms. Hybrid functional nanomaterials and devices, such as biological basic building blocks conjugated with inorganic nanocomponents, such as quantum dots, nanowires, nanotubes will be discussed to fabricate various devices including, bio-sensor, bio-nano electronic materials and devices, bio-computing. Nano medicine and bio imaging will also be covered.
The goal is for the bioengineering students to gain sufficient chemical and physical aspects of biological materials through the case study of spider webs, silks, sea shells, diatoms, bones, and teeth, as well as recently developed self-assembled nanostructures inspired by nature.

Student Learning Outcomes: This course is intended for the undergraduate students interested in acquiring a background of recent development of bio-nanomaterials and bio-nanotechnology focused on the materials point of view. Through this course, students will understand the assembly principle of biological materials and their application in bio-nanotechnology.

Rules & Requirements

Prerequisites: BIO ENG 11 or BIOLOGY 1A; and CHEM 1A

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

BIO ENG 151 Micro/Nanofluidics for Bioengineering and Lab-On-A-Chip 4 Units

Terms offered: Spring 2015, Spring 2014, Spring 2013
Introduction and in-depth treatment of theory relevant to fluid flow in microfluidic and nanofluidic systems supplemented by critical assessment of recent applications drawn from the literature. Topics include low Reynolds Number flow, mass transport including diffusion phenomena, and emphasis on electrokinetic systems and bioanalytical applications of said phenomena.
Micro/Nanofluidics for Bioengineering and Lab-On-A-Chip: Read More [+]
Objectives & Outcomes

Course Objectives: We will study mass and momentum transport phenomena of microscale and nanoscale flow devices. Throughout the course, we will place an emphasis on bioanalytical microfluidic system applications where electrophoresis, electroosmosis, molecular diffusion, and/or Brownian motion effects dominate. Successful completion of the course will prepare students to design micro/nanofluidic engineering solutions, as well as critically assess academic and industrial developments in these areas.
The course is an introduction to the physicochemical dynamics associated with fluid flow in nanoscale and microscale devices for graduate students and advance undergraduate students. The course has been created in response to the active field of microfluidics and nanofluidics, as well as the associated interest from industry, government, and academic research groups. The course provides an theoretical treatment of micro/nanofluidic phenomena that complements the well-established laboratory and research content offered in the Department.

Student Learning Outcomes: 1.
To introduce students to the governing principles of fluid flow in microfluidic and nanofluidic regimes, with emphasis on phenomena relevant to bioanalytical devices.
2.
To provide students with an understanding of scaling laws that define the performance of microfluidic and nanofluidic systems.
3.
To provide students with a detailed investigation of applications that do and do not benefit from miniaturization.
4.
To give students adequate didactic background for critical assessment of literature reports and conference presentations regarding advances in the topical areas of microfluidics and nanofluidics.

Rules & Requirements

Prerequisites: BIO ENG 11 or CHEM 3B; BIO ENG 104, MEC ENG 106, or consent of instructor

Credit Restrictions: Students will receive no credit for 151 after taking 251.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Herr

Micro/Nanofluidics for Bioengineering and Lab-On-A-Chip: Read Less [-]

BIO ENG 153 Biotechnology Entrepreneurship: Impact, History, Therapeutics R&D, Entrepreneurship & Careers 2 Units

Terms offered: Spring 2024, Spring 2023, Spring 2021
This course is designed for students interested in an introduction to the biotechnology entrepreneurship, biotherapeutics R and D, and careers in the industry. Students should be interested in the impact of biotechnology on medicine and society, the history of the field (including individual scientists, entrepreneurs and companies), key methodologies, therapeutic product classes, entrepreneurship and innovation within the life sciences.Students will learn principles of drug and biologics discovery, development and commercialization, and will be exposed to the range of careers in the biopharmaceutical industry. Students should be considering careers in the biopharmaceutical and life sciences fields.
Biotechnology Entrepreneurship: Impact, History, Therapeutics R&D, Entrepreneurship & Careers: Read More [+]
Objectives & Outcomes

Course Objectives: To educate students on biopharmaceutical company entrepreneurship and innovation through team-based hands on virtual company creation
To educate students on careers in the biopharmaceutical industry
To educate students on the history of the field and industry, including key methodologies, technologies, scientists, entrepreneurs, and companies
To foster understanding and appreciation for the medical and societal impact of the biopharmaceutical field and industry
To introduce the key steps in the process of discovery, development and commercialization of novel therapeutics

Student Learning Outcomes: Entrepreneurship principles, including those defined by the Lean Launchpad approach (including the Business Model Canvas, the Minimum Viable Product and Customer Discovery).
The history of the biotech industry
The impact of the biopharmaceutical industry on medicine and society
The methods, product technologies and development methodologies that have driven the evolution of the field
The nature of the ecosystem and specific careers in the biopharmaceutical industry
The product design and development process (with a focus on biotherapeutics), including opportunities and challenges

Rules & Requirements

Prerequisites: Consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of lecture per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Alternative to final exam.

Instructor: Kirn

Biotechnology Entrepreneurship: Impact, History, Therapeutics R&D, Entrepreneurship & Careers: Read Less [-]

BIO ENG C157 Nanomaterials in Medicine 3 Units

Terms offered: Fall 2022, Fall 2021, Fall 2020
Nanomedicine is an emerging field involving the use of nanoscale materials for therapeutic and diagnostic purposes. Nanomedicine is a highly interdisciplinary field involving chemistry, materials science, biology and medicine, and has the potential to make major impacts on healthcare in the future. This upper division course is designed for students interested in learning about current developments and future trends in nanomedicine. The overall objective of the course is to introduce major aspects of nanomedicine including the selection, design and testing of suitable nanomaterials, and key determinants of therapeutic and diagnostic efficacy. Organic, inorganic and hybrid nanomaterials will be discussed in this course.
Nanomaterials in Medicine: Read More [+]
Objectives & Outcomes

Course Objectives: To identify an existing or unmet clinical need and identify a nanomedicine that can provide a solution
To learn about chemical approaches used in nanomaterial synthesis and surface modification.
To learn how to read and critique the academic literature.
To understand the interaction of nanomaterials with proteins, cells, and biological systems.

Rules & Requirements

Prerequisites: MAT SCI 45 or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Messersmith

Also listed as: MAT SCI C157

Nanomaterials in Medicine: Read Less [-]

BIO ENG 163 Principles of Molecular and Cellular Biophotonics 4 Units

Terms offered: Fall 2022, Fall 2018, Fall 2017
This course provides undergraduate and graduate bioengineering students with an opportunity to increase their knowledge of topics in the emerging field of biophotonics with an emphasis on fluorescence spectroscopy, biosensors and devices for optical imaging and detection of biomolecules. This course will cover the photophysics and photochemistry of organic molecules, the design and characterization of biosensors and their applications within diverse environments.
Principles of Molecular and Cellular Biophotonics: Read More [+]
Rules & Requirements

Prerequisites: CHEM 3A and PHYSICS 7B; and BIO ENG 102 or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Alternative to final exam.

Instructor: Marriott

Principles of Molecular and Cellular Biophotonics: Read Less [-]

BIO ENG 163L Molecular and Cellular Biophotonics Laboratory 4 Units

Terms offered: Spring 2024, Spring 2023, Spring 2022
This course provides undergraduate and graduate bioengineering students with an opportunity to acquire essential experimental skills in fluorescence spectroscopy and the design, evaluation, and optimization of optical biosensors for quantitative measurements of proteins and their targets. Groups of students will be responsible for the research, design, and development of a biosensor or diagnostic device for the detection, diagnosis, and monitoring of a specific biomarker(s).
Molecular and Cellular Biophotonics Laboratory: Read More [+]
Rules & Requirements

Prerequisites: BIO ENG 163 (may be taken concurrently)

Credit Restrictions: Students will receive no credit for Bioengineering 163L after taking Bioengineering 263L.

Hours & Format

Fall and/or spring: 15 weeks - 6 hours of laboratory and 2 hours of discussion per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Marriott

Molecular and Cellular Biophotonics Laboratory: Read Less [-]

BIO ENG 164 Optics and Microscopy 4 Units

Terms offered: Fall 2010, Fall 2009, Fall 2008
This course teaches fundamental principles of optics and examines contemporary methods of optical microscopy for cells and molecules. Students will learn how to design simple optical systems, calculate system performance, and apply imaging techniques including transmission, reflection, phase, and fluorescence microscopy to investigate biological samples. The capabilities of optical microscopy will be compared with complementary techniques including electron microscopy, coherence tomography, and atomic force microscopy. Students will also be responsible for researching their final project outside of class and presenting a specific application of modern microscopy to biological research as part of an end-of-semester project.
Optics and Microscopy: Read More [+]
Rules & Requirements

Prerequisites: PHYSICS 7A and PHYSICS 7B; or PHYSICS 8A and PHYSICS 8B

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Fletcher

Optics and Microscopy: Read Less [-]

BIO ENG C165 Medical Imaging Signals and Systems 4 Units

Terms offered: Fall 2023, Fall 2022, Fall 2021
Biomedical imaging is a clinically important application of engineering, applied mathematics, physics, and medicine. In this course, we apply linear systems theory and basic physics to analyze X-ray imaging, computerized tomography, nuclear medicine, and MRI. We cover the basic physics and instrumentation that characterizes medical image as an ideal perfect-resolution image blurred by an impulse response. This material could prepare the student for a career in designing new medical imaging systems that reliably detect small tumors or infarcts.
Medical Imaging Signals and Systems: Read More [+]
Rules & Requirements

Prerequisites: Prerequisites are introductory level skills in Python/Matlab; and either EECS 16A, EECS 16B, and EL ENG 120; or MATH 54, BIO ENG 105, and BIO ENG 101

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Conolly

Also listed as: EL ENG C145B

Medical Imaging Signals and Systems: Read Less [-]

BIO ENG 166 Biomedical Imaging Systems II: Targeted Molecular Imaging in Disease 4 Units

Terms offered: Spring 2024, Spring 2023, Spring 2022
This course is designed as an introduction to the growing world of molecular imaging in medicine and research. The course is divided into five modules based on common imaging modalities (optical imaging, ultrasound methods, radiography, nuclear imaging, and magnetic resonance approaches). Within each module the fundamental physics and engineering behind each modality, corresponding methods for targeted molecular imaging including contrast mechanisms and probe design, and signal and image processing algorithms are covered. Homework assignments will utilize imaging data from either clinical or research studies in order to provide training in MATLAB based image analysis techniques.
Biomedical Imaging Systems II: Targeted Molecular Imaging in Disease: Read More [+]
Objectives & Outcomes

Course Objectives: Discuss limitations to each targeted approach including non-specific binding, unbound probe clearance, signal decay, etc.
Discuss the design of targeted molecular contrast agents for each modality across myriad biological applications
Establish a foundational understanding of MRI (multi-spectral), PET/SPECT, Ultrasound (including photo-acoustic imaging), and emerging methods including MPI
Establish proficiency in the use of MATLAB as a tool for analyzing biomedical imaging data
Reinforce mathematical principles relevant to image analysis including linear algebra, convolution and differential equations
To discuss imaging ethics in the context of data interpretation
To expose students interested in biomedical research or clinical practice to fundamentals of modern imaging methods and interpretation
To learn quantitative approaches to analyze biomedical images (includes pharmacokinetic models, attenuation correction, cross modality registration, etc.)

Student Learning Outcomes: Analyze imaging data derived from imaging studies using commonly utilized image processing techniques
Critically evaluate scientific publications in the molecular imaging space.

Understand the devices, techniques and protocols used for in vivo imaging in research and clinical settings

Rules & Requirements

Prerequisites: BIO ENG C165 or BIO ENG 163; and BIO ENG 101 plus BIO ENG 105 or EECS 16A plus EECS 16B

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Vandsburger

Biomedical Imaging Systems II: Targeted Molecular Imaging in Disease: Read Less [-]

BIO ENG 168L Practical Light Microscopy 3 Units

Terms offered: Fall 2023, Fall 2022, Fall 2021
This laboratory course is designed for students interested in obtaining practical hands-on training in optical imaging and instrumentation. Using a combination of lenses, cameras, and data acquisition equipment, students will construct simple light microscopes that introduce basic concepts and limitations important in biomedical optical imaging. Topics include compound microscopes, Kohler illumination, Rayleigh two-point resolution, image contrast including dark-field and fluorescence microscopy, and specialized techniques such as fluorescence recovery after photobleaching (FRAP). Intended for students in both engineering and the sciences, this course will emphasize applied aspects of optical imaging and provide a base of practical skill and reference material that students can leverage in their own research or in industry.
Practical Light Microscopy: Read More [+]
Hours & Format

Fall and/or spring: 15 weeks - 2 hours of lecture and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Fletcher

Practical Light Microscopy: Read Less [-]

BIO ENG 171 Interface Between Neuroethology & Neural Engineering 3 Units

Terms offered: Spring 2023, Spring 2021
The course will provide students with an overview of the tight interface between neural engineering and neuroethological approaches in the field of neuroscience. This course will also discuss the concepts of causal manipulations, such as the control of brain circuits using optics and genetic engineering. Lastly, students will also inquire and discuss what discoveries have yet to be made and how neuroethological approaches can inform neural engineering designs that will revolutionize the future of neural medicine.
Interface Between Neuroethology & Neural Engineering: Read More [+]
Objectives & Outcomes

Course Objectives: Understand the close interface between studies of the nervous system and technology

Student Learning Outcomes: The course will review the utilization, development and implementation of a wide diversity of neural engineering technologies to the study of the brain. Students will discuss the bidirectional road between the two approaches.
The overreaching goal of this course is to expose student interested in neural engineering to the remarkable history of neuroethological approaches that have been a foundation of discoveries in the field.

Rules & Requirements

Prerequisites: BIO ENG 105; and BIO ENG 101 or EECS 16A and EECS 16B; or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Yartsev

Interface Between Neuroethology & Neural Engineering: Read Less [-]

BIO ENG C181 The Berkeley Lectures on Energy: Energy from Biomass 3 Units

Terms offered: Fall 2015, Fall 2014, Fall 2013
After an introduction to the different aspects of our global energy consumption, the course will focus on the role of biomass. The course will illustrate how the global scale of energy guides the biomass research. Emphasis will be placed on the integration of the biological aspects (crop selection, harvesting, storage and distribution, and chemical composition of biomass) with the chemical aspects to convert biomass to energy. The course aims to engage students in state-of-the-art research.
The Berkeley Lectures on Energy: Energy from Biomass: Read More [+]
Rules & Requirements

Prerequisites: Chemistry 1B or Chemistry 4B, Mathematics 1B, Biology 1A

Repeat rules: Course may be repeated for credit under special circumstances: Repeatable when topic changes with consent of instructor.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructors: Bell, Blanch, Clark, Smit, C. Somerville

Also listed as: CHEM C138/CHM ENG C195A/PLANTBI C124

The Berkeley Lectures on Energy: Energy from Biomass: Read Less [-]

BIO ENG 190 Special Topics in Bioengineering 1 - 4 Units

Terms offered: Spring 2024, Fall 2023, Spring 2023
This course covers current topics of research interest in bioengineering. The course content may vary from semester to semester.
Special Topics in Bioengineering: Read More [+]
Rules & Requirements

Prerequisites: Consent of instructor

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 1-4 hours of lecture per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Special Topics in Bioengineering: Read Less [-]

BIO ENG 192 Senior Design Projects 5 Units

Terms offered: Spring 2024, Fall 2021, Fall 2020
This semester-long course introduces students to bioengineering project-based learning in small teams, with a strong emphasis on need-based solutions for real medical and research problems through prototype solution selection, design, and testing. The course is designed to provide a "capstone" design experience for bioengineering seniors. The course is structured around didactic lectures and a textbook, from which assigned readings will be drawn, and supplemented by additional handouts, readings, and lecture material.
Senior Design Projects: Read More [+]
Rules & Requirements

Prerequisites: Senior standing

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of lecture and 2 hours of discussion per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam not required.

Instructor: Herr

Senior Design Projects: Read Less [-]

BIO ENG H194 Honors Undergraduate Research 3 or 4 Units

Terms offered: Fall 2019, Fall 2018, Spring 2016
Supervised research. Students who have completed 3 or more upper division courses may pursue original research under the direction of one of the members of the staff. May be taken a second time for credit only. A final report or presentation is required. A maximum of 4 units of this course may be used to fulfill the research or technical elective requirement or in the Bioengineering program.
Honors Undergraduate Research: Read More [+]
Rules & Requirements

Prerequisites: Upper division technical GPA 3.3 or higher and consent of instructor and adviser

Repeat rules: Course may be repeated for credit up to a total of 8 units.

Hours & Format

Fall and/or spring: 15 weeks - 3-4 hours of independent study per week

Summer:
8 weeks - 1.5-7.5 hours of independent study per week
10 weeks - 1.5-9 hours of independent study per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam not required.

Honors Undergraduate Research: Read Less [-]

BIO ENG 195 Bioengineering Department Seminar 1 Unit

Terms offered: Prior to 2007
This weekly seminar series invites speakers from the bioengineering community, as well as those in related fields, to share their work with our department and other interested parties on the Berkeley campus. The series includes our annual Bioengineering Distinguished Lecture and Rising Star lecture.
Bioengineering Department Seminar: Read More [+]
Objectives & Outcomes

Course Objectives: •
To introduce students to bioengineering research as it is performed at Berkeley and at other institutions
•
To give students opportunities to connect their own work to work in the field overall
•
To give students an opportunity to meet with speakers who can inform and contribute to their post-graduation career paths

Student Learning Outcomes: To introduce students to the breadth of bioengineering research, both here at Berkeley and at other institutions, and help them to connect their work here at Berkeley to the field overall.

Rules & Requirements

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 1 hour of seminar per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

Instructor: Faculty

Bioengineering Department Seminar: Read Less [-]

BIO ENG 196 Undergraduate Design Research 2 - 4 Units

Terms offered: Fall 2019, Fall 2018, Fall 2017
Supervised research. This course will satisfy the Bioengineering Design project/research requirement. Students with junior or senior status may pursue research under the direction of one of the members of the staff. A final report or presentation is required. For Bioengineering majors, the following policies apply: A maximum of 8 units of graded research units (BIO ENG H194 and/or BIO ENG 196) can be counted towards the Upper Division Technical Topics unit requirement. A maximum of 4 graded research units can be used towards the Upper Division Bioengineering Unit requirement. There is no limit to the number of letter-graded research units that can be applied to the 48 Engineering Unit requirement.
Undergraduate Design Research: Read More [+]
Rules & Requirements

Prerequisites: Junior or senior status, consent of instructor and faculty adviser

Repeat rules: Course may be repeated for credit up to a total of 8 units.

Hours & Format

Fall and/or spring: 15 weeks - 2-4 hours of independent study per week

Summer: 10 weeks - 3-9 hours of independent study per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Letter grade. Alternative to final exam.

Undergraduate Design Research: Read Less [-]

BIO ENG 198 Directed Group Study for Advanced Undergraduates 1 - 4 Units

Terms offered: Fall 2022, Fall 2021, Spring 2021
Group study of a selected topic or topics in bioengineering, usually relating to new developments.
Directed Group Study for Advanced Undergraduates: Read More [+]
Rules & Requirements

Prerequisites: Upper division standing and good academic standing. (2.0 grade point average and above)

Credit Restrictions: Enrollment is restricted; see the Introduction to Courses and Curricula section of this catalog.

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 1-4 hours of directed group study per week

Summer:
6 weeks - 2.5-10 hours of directed group study per week
8 weeks - 1.5-7.5 hours of directed group study per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

Directed Group Study for Advanced Undergraduates: Read Less [-]

BIO ENG 199 Supervised Independent Study 1 - 4 Units

Terms offered: Fall 2021, Spring 2021, Fall 2020
Supervised independent study.
Supervised Independent Study: Read More [+]
Rules & Requirements

Credit Restrictions: Enrollment is restricted; see the Introduction to Courses and Curricul a section of this catalog.

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 0 hours of independent study per week

Summer:
6 weeks - 2.5-10 hours of independent study per week
8 weeks - 1.5-7.5 hours of independent study per week
10 weeks - 1.5-6 hours of independent study per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

Supervised Independent Study: Read Less [-]

BIO ENG 200 The Graduate Group Introductory Seminar 1 Unit

Terms offered: Fall 2023, Fall 2022, Fall 2021
An introduction to research in bioengineering including specific case studies and organization of this rapidly expanding and diverse field.
The Graduate Group Introductory Seminar: Read More [+]
Rules & Requirements

Prerequisites: Enrollment in PhD Program in Bioengineering or consent of instructor

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 1 hour of seminar per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

The Graduate Group Introductory Seminar: Read Less [-]

BIO ENG 201 Responsible Conduct in Bioengineering Research and in Practice 1 Unit

Terms offered: Spring 2024, Spring 2023, Spring 2022
This course will explore ethical issues likely to be faced by a bioengineer, and consider them in the context of responsible engineering. The content of the class is designed considering the NSF Standards of Ethical Conduct and the NIH Ethical Guidelines & Regulations in mind, and to serve as the Responsible Conduct of Research training for our PhD program.
Responsible Conduct in Bioengineering Research and in Practice: Read More [+]
Objectives & Outcomes

Course Objectives: The content of the class is designed considering the NSF Standards of Ethical Conduct and the NIH Ethical Guidelines & Regulations in mind, and to serve as the Responsible Conduct of Research training for our PhD program.

Student Learning Outcomes: To prepare bioengineering PhD students to perform their research and design responsibly.

Rules & Requirements

Prerequisites: Open only to Bioengineering graduate students

Hours & Format

Fall and/or spring: 10 weeks - 1 hour of lecture per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

Instructor: Terry Johnson

Responsible Conduct in Bioengineering Research and in Practice: Read Less [-]

BIO ENG 202 Cell Engineering 4 Units

Terms offered: Fall 2023, Fall 2022, Fall 2021
This course will teach the main concepts and current views on key attributes of animal cells (somatic, embryonic, pluripotent, germ-line; with the focus on mammalian cells), will introduce theory of the regulation of cell function, methods for deliberate control of cell properties and resulting biomedical and bioengineering technologies.
Cell Engineering: Read More [+]
Objectives & Outcomes

Course Objectives: The goal of this course to establish fundamental understanding of cell engineering technologies and of the key biological paradigms, upon which cell engineering is based, with the focus on biomedical applications of cell engineering.

Student Learning Outcomes: At the completion of this course students will understand how bioengineering technologies address the deliberate control of cell properties (and how this advances biomedicine); and students will learn the main concepts and current views on key attributes of animal cells (somatic, embryonic, pluripotent, germ-line; with the focus on mammalian cells).

Rules & Requirements

Prerequisites: BIOLOGY 1A or BIO ENG 11; or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 2 hours of discussion per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructor: Conboy

Cell Engineering: Read Less [-]

BIO ENG 203 Tissue Engineering lab 4 Units

Terms offered: Prior to 2007
This class provides a conceptual and practical understanding of cell and tissue bioengineering that is vital for careers in medicine, biotechnology, and bioengineering. Students are introduced to cell biology laboratory techniques, including immunofluorescence, quantitative image analysis, protein quantification, protein expression, gene expression, and cell culture.
Tissue Engineering lab: Read More [+]
Objectives & Outcomes

Course Objectives: The goal of this course to provide students with conceptual and practical understanding of cell and tissue bioengineering.

Student Learning Outcomes: At the completion of this course, students will learn key cellular bioengineering laboratory techniques, will develop a conceptual and theoretical understanding of the reliability and limitations of these techniques and will enhance their skills in quantitative data analysis, interpretation and integration.

Rules & Requirements

Prerequisites: BIO ENG 114 or BIO ENG 202, or BIO ENG 11; or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 9 hours of laboratory and 1 hour of lecture per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructor: Conboy

Tissue Engineering lab: Read Less [-]

BIO ENG C208 Biological Performance of Materials 4 Units

Terms offered: Fall 2023, Fall 2022, Fall 2021
This course is intended to give students the opportunity to expand their knowledge of topics related to biomedical materials selection and design. Structure-property relationships of biomedical materials and their interaction with biological systems will be addressed. Applications of the concepts developed include blood-materials compatibility, biomimetic materials, hard and soft tissue-materials interactions, drug delivery, tissue engineering, and biotechnology.
Biological Performance of Materials: Read More [+]
Objectives & Outcomes

Course Objectives: The course is separated into four parts spanning the principles of synthetic materials and surfaces, principles of biological materials, biological performance of materials and devices, and state-of-the-art materials design. Students are required to attend class and master the material therein. In addition, readings from the clinical, life and materials science literature are assigned. Students are encouraged to seek out additional reference material to complement the readings assigned. A mid-term examination is given on basic principles (parts 1 and 2 of the outline). A comprehensive final examination is given as well. The purpose of this course is to introduce students to problems associated with the selection and function of biomaterials. Through class lectures and readings in both the physical and life science literature, students will gain broad knowledge of the criteria used to select biomaterials, especially in devices where the material-tissue or material-solution interface dominates performance. Materials used in devices for medicine, dentistry, tissue engineering, drug delivery, and the biotechnology industry will be addressed.

This course also has a significant design component (~35%). Students will form small teams (five or less) and undertake a semester-long design project related to the subject matter of the course. The project includes the preparation of a paper and a 20 minute oral presentation critically analyzing a current material-tissue or material-solution problem. Students will be expected to design improvements to materials and devices to overcome the problems identified in class with existing materials.

Student Learning Outcomes: Work independently and function on a team, and develop solid communication skills (oral, graphic & written) through the class design project.

- Develop an understanding of the social, safety and medical consequences of biomaterial use and regulatory issues associated with the selection of biomaterials in the context of the silicone breast implant controversy and subsequent biomaterials crisis.
- Design experiments and analyze data from the literature in the context of the class design project.
- Understanding of the origin of surface forces and interfacial free energy, and how they contribute to the development of the biomaterial interface and ultimately biomaterial performance.
- Apply math, science & engineering principles to the understanding of soft materials, surface chemistry, DLVO theory, protein adsorption kinetics, viscoelasticity, mass diffusion, and molecular (i.e., drug) delivery kinetics.
- Apply core concepts in materials science to solve engineering problems related to the selection biomaterials, especially in devices where the material-tissue or material-solution interface dominates performance.

Rules & Requirements

Prerequisites: MAT SCI 45; and CHEM C130 / MCELLBI C100A or

BIO ENG C209 Advanced Orthopedic Biomechanics 4 Units

Terms offered: Fall 2023, Fall 2022, Fall 2020
Students will learn the application of engineering concepts including statics, dynamics, optimization theory, composite beam theory, beam-on-elastic foundation theory, Hertz contact theory, and materials behavior. Topics will include forces and moments acting on human joints; composition and mechanical behavior of orthopedic biomaterials; design/analysis of artificial joint, spine, and fracture fixation prostheses; musculoskeletal tissues including bone, cartilage, tendon, ligament, and muscle; osteoporosis and fracture-risk predication of bones; and bone adaptation. Students will be challenged in a MATLAB-based project to integrate the course material in an attempt to gain insight into contemporary design/analysis/problems.
Advanced Orthopedic Biomechanics: Read More [+]
Objectives & Outcomes

Course Objectives: The purpose of this course is twofold:

- to learn the fundamental concepts of orthopaedic biomechanics;
- to enhance skills in mechanical engineering and bioengineering by analyzing the mechanical behavior of various complex biomedical problems.

Student Learning Outcomes: Working knowledge of various engineering concepts such as composite beam theory, beam-on-elastic-foundation theory, Hertz contact theory and MATLAB-based optimization design analysis. Understanding of basic concepts in orthopaedic biomechanics and the ability to apply the appropriate engineering concepts to solve realistic biomechanical problems, knowing clearly the assumptions involved.

Rules & Requirements

Prerequisites: ME C85/CE C30 or Bio Eng 102; concurrent enrollment OK. Proficiency in MatLab or equivalent. Prior knowledge of biology or anatomy is not assumed

Credit Restrictions: Students will not receive credit for this course if they have taken ME C176/Bio E C119.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 1 hour of laboratory per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructors: O'Connell, Keaveny

Also listed as: MEC ENG C210

Advanced Orthopedic Biomechanics: Read Less [-]

BIO ENG 211 Cell and Tissue Mechanotransduction 3 Units

Terms offered: Fall 2023, Fall 2018, Fall 2017
This course will focus on biophysical and bioengineering aspects of mechanotransduction, the process through which living cells sense and respond to their mechanical environment. Students will learn how mechanical inputs to cells influence both subcellular biochemistry and whole-cell behavior. They will also study newly-engineered technologies for force manipulation and measurement in living cells, and synthetic strategies to control the mechanics and chemistry of the extracellular matrix. Finally, students will learn about the role of mechanotransduction in selected human organ systems and how these mechanisms may go awry in the setting of the disease. Instruction will feature lectures, discussions, analysis of relevant research papers, assembly of a literature review and a research proposal, and an oral presentation.
Cell and Tissue Mechanotransduction: Read More [+]
Rules & Requirements

Prerequisites: Undergraduate cell biology or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructor: Kumar

Cell and Tissue Mechanotransduction: Read Less [-]

BIO ENG C212 Heat and Mass Transport in Biomedical Engineering 3 Units

Terms offered: Spring 2008, Fall 2007, Spring 2006, Spring 2005
Fundamental processes of heat and mass transport in biological systems; organic molecules, cells, biological organs, whole animals. Derivation of mathematical models and discussion of experimental procedures. Applications to biomedical engineering.
Heat and Mass Transport in Biomedical Engineering: Read More [+]
Rules & Requirements

Prerequisites: 106 and 109 (106 and 109 may be taken concurrently)

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Formerly known as: Mechanical Engineering 212

Also listed as: MEC ENG C212

Heat and Mass Transport in Biomedical Engineering: Read Less [-]

BIO ENG C213 Fluid Mechanics of Biological Systems 3 Units

Terms offered: Fall 2023, Spring 2019, Spring 2016
Fluid mechanical aspects of various physiological systems, the circulatory, respiratory, and renal systems. Motion in large and small blood vessels. Pulsatile and peristaltic flows. Other biofluidmechanical flows: the ear, eye, etc. Instrumentation for fluid measurements in biological systems and for medical diagnosis and applications. Artificial devices for replacement of organs and/or functions, e.g. blood oxygenators, kidney dialysis machines, artificial hearts/circulatory assist devices.
Fluid Mechanics of Biological Systems: Read More [+]
Rules & Requirements

Prerequisites: 106 or equivalent; 265A or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructors: Berger, Liepmann

Also listed as: MEC ENG C213

Fluid Mechanics of Biological Systems: Read Less [-]

BIO ENG C214 Advanced Tissue Mechanics 3 Units

Terms offered: Spring 2018, Spring 2017, Spring 2015
The goal of this course is to provide a foundation for characterizing and understanding the mechanical behavior of load-bearing tissues. A variety of mechanics topics will be introduced, including anisotropic elasticity and failure, cellular solid theory, biphasic theory, and quasi-linear viscoelasticity (QLV) theory. Building from this theoretical basis, we will explore the constitutive behavior of a wide variety of biological tissues. After taking this course, students should have sufficient background to independently study the mechanical behavior of most biological tissues. Formal discussion section will include a seminar series with external speakers.
Advanced Tissue Mechanics: Read More [+]
Rules & Requirements

Prerequisites: 102A, 176, 185; graduate standing or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Also listed as: MEC ENG C214

Advanced Tissue Mechanics: Read Less [-]

BIO ENG C215 Molecular Biomechanics and Mechanobiology of the Cell 4 Units

Terms offered: Spring 2023, Spring 2022, Spring 2021, Spring 2020
This course develops and applies scaling laws and the methods of continuum and statistical mechanics to understand micro- and nano-scale mechanobiological phenomena involved in the living cell with particular attention the nucleus and the cytoskelton as well as the interactions of the cell with the extracellular matrix and how these interactions may cause changes in cell architecture and biology, consequently leading to functional adaptation or pathological conditions.
Molecular Biomechanics and Mechanobiology of the Cell: Read More [+]
Objectives & Outcomes

Course Objectives: This course, which is open to graduate students in diverse disciplines ranging from engineering to biology to chemistry and physics, is aimed at exposing students to subcellular biomechanical phenomena spanning scales from molecules to the whole cell.

Student Learning Outcomes: The students will develop tools and skills to (1) understand and analyze subcelluar biomechanics and transport phenomena, and (2) ultimately apply these skills to novel biological and biomedical applications.

Rules & Requirements

Prerequisites: MATH 54, PHYSICS 7A; BIO ENG 102 or MEC ENG C85; or instructor’s consent

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructor: Mofrad

Also listed as: MEC ENG C216

Molecular Biomechanics and Mechanobiology of the Cell: Read Less [-]

BIO ENG C216 Macromolecular Science in Biotechnology and Medicine 4 Units

Terms offered: Spring 2024, Spring 2023, Spring 2022
Overview of the problems associated with the selection and function of polymers used in biotechnology and medicine. Principles of polymer science, polymer synthesis, and structure-property-performance relationships of polymers. Particular emphasis is placed on the performance of polymers in biological environments. Interactions between macromolecular and biological systems for therapy and diagnosis. Specific applications will include drug delivery, gene therapy, tissue engineering, and surface engineering.
Macromolecular Science in Biotechnology and Medicine: Read More [+]
Rules & Requirements

Prerequisites: BIO ENG 115. Open to seniors with consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructor: Healy

Also listed as: MAT SCI C216

Macromolecular Science in Biotechnology and Medicine: Read Less [-]

BIO ENG C217 Biomimetic Engineering -- Engineering from Biology 3 Units

Terms offered: Fall 2017, Spring 2014, Fall 2010
Study of nature's solutions to specific problems with the aim of determining appropriate engineering analogs. Morphology, scaling, and design in organisms applied to engineering structures. Mechanical principles in nature and their application to engineering devices. Mechanical behavior of biological materials as governed by underlying microstructure, with the potential for synthesis into engineered materials. Trade-offs between redundancy and efficiency. Students will work in teams on projects where they will take examples of designs, concepts, and models from biology and determine their potential in specific engineering applications.
Biomimetic Engineering -- Engineering from Biology: Read More [+]
Rules & Requirements

Prerequisites: Graduate standing in engineering or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructor: Dharan

Also listed as: INTEGBI C217/MEC ENG C217

Biomimetic Engineering -- Engineering from Biology: Read Less [-]

BIO ENG C218 Stem Cells and Directed Organogenesis 3 Units

Terms offered: Spring 2015, Spring 2014, Spring 2013
This course will provide an overview of basic and applied embryonic stem cell (ESC) biology. Topics will include early embryonic development, ESC laboratory methods, biomaterials for directed differentiation and other stem cell manipulations, and clinical uses of stem cells.
Stem Cells and Directed Organogenesis: Read More [+]
Rules & Requirements

Prerequisites: Consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 6 hours of laboratory and 1 hour of lecture per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructor: Conboy

Also listed as: MCELLBI C237

Stem Cells and Directed Organogenesis: Read Less [-]

BIO ENG C219 Protein Engineering 3 Units

Terms offered: Fall 2015, Fall 2014, Fall 2010
An in-depth study of the current methods used to design and engineer proteins. Emphasis on how strategies can be applied in the laboratory. Relevant case studies presented to illustrate method variations and applications. Intended for graduate students.
Protein Engineering: Read More [+]
Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructor: Tullman-Ercek

Also listed as: CHM ENG C270

Protein Engineering: Read Less [-]

BIO ENG 220L Cells and Biomaterials Laboratory 4 Units

Terms offered: Prior to 2007
The objective of this course is to teach graduate students the essential laboratory techniques in the design and characterization and analysis of cells and biomaterials. The course will cover basics on synthetic biomaterials and native matrix, cellular responses to biomaterials, three-dimensional culture, and tissue engineering. The course includes a lecture and a laboratory section each week. There will be a midterm exam, final exam, and a tissue engineering group project.
Cells and Biomaterials Laboratory: Read More [+]
Rules & Requirements

Prerequisites: Cell and tissue engineering; upper division cell biology course or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of lecture and 6 hours of laboratory per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructor: Li

Cells and Biomaterials Laboratory: Read Less [-]

BIO ENG 221 Advanced BioMEMS and Bionanotechnology 4 Units

Terms offered: Fall 2023, Fall 2022, Fall 2021
Biophysical and chemical principles of biomedical devices, bionanotechnology, bionanophotonics, and biomedical microelectromechanical systems (BioMEMS). Topics include basics of nano-& microfabrication, soft-lithography, DNA arrays, protein arrays, electrokinetics, electrochemical transducers, microfluidic devices, biosensor, point of care diagnostics, lab-on-a-chip, drug delivery microsystems, clinical lab-on-a-chip, advanced biomolecular probes, biomolecular spectroscopy, and etc.
Advanced BioMEMS and Bionanotechnology: Read More [+]
Rules & Requirements

Prerequisites: Chemistry 3A, Physics 7A and 7B, Electrical Engineering 143 or equivalent

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Summer:
6 weeks - 7.5 hours of lecture per week
8 weeks - 5.5 hours of lecture per week
10 weeks - 4.5 hours of lecture per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructor: L. Lee

Advanced BioMEMS and Bionanotechnology: Read Less [-]

BIO ENG 221L BioMEMS and BioNanotechnology Laboratory 4 Units

Terms offered: Spring 2024, Spring 2023, Fall 2022
Students will become familiar with BioMEMS and Lab-on-a-Chip research. Students will design and fabricate their own novel micro- or nano-scale device to address a specific problem in biotechnology using the latest micro- and nano-technological tools and fabrication techniques. This will involve an intensive primary literature review, experimental design, and quantitative data analysis. Results will be presented during class presentations and at a final poster symposium.
BioMEMS and BioNanotechnology Laboratory: Read More [+]
Objectives & Outcomes

Course Objectives: Students will become familiar with research associated with BioMEMS and Lab-on-a-Chip technologies. Students will gain experience in using creative design to solve a technological problem. Students will learn basic microfabrication techniques. Working in engineering teams, students will learn how to properly characterize a novel device
by choosing and collecting informative metrics. Students will design and carry out carefully controlled experiments that will result in the analysis of quantitative data.

Student Learning Outcomes: Students will learn how to critically read BioMEMS and Lab-on-a-Chip primary literature. Students will learn how to use AutoCAD software to design microscale device features. Students will gain hands-on experience in basic photolithography and soft lithography. Students will get experience with a variety of fluid loading interfaces and
microscopy techniques. Students will learn how to design properly controlled uantitative experiments. Students will gain experience in presenting data to their peers in the form of powerpoint presentations and also at a poster symposium.

Rules & Requirements

Prerequisites: BIO ENG 104, BIO ENG 221, and/or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 6 hours of laboratory and 2 hours of lecture per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructors: Liepmann, Streets

BioMEMS and BioNanotechnology Laboratory: Read Less [-]

BIO ENG C222 Advanced Structural Aspects of Biomaterials 4 Units

Terms offered: Spring 2023, Fall 2020, Spring 2019
This course covers the structure and mechanical functions of load bearing tissues and their replacements. Biocompatibility of biomaterials and host response to structural implants are examined. Quantitative treatment of biomechanical issues and constitutive relationships of materials are covered in order to design implants for structural function. Material selection for load bearing applications including reconstructive surgery, orthopedics, dentistry, and cardiology are addressed.
Advanced Structural Aspects of Biomaterials: Read More [+]
Rules & Requirements

Credit Restrictions: Students should not receive credit if they've taken ME ME C117 or Bio Eng C117.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Also listed as: MEC ENG C215

Advanced Structural Aspects of Biomaterials: Read Less [-]

BIO ENG C223 Polymer Engineering 3 Units

Terms offered: Fall 2023, Fall 2021, Fall 2019
This course provides an overview of engineering polymers and an introduction to polymer physics. The molecular variables that play a role in structural performance of polymer systems are examined. The assessment of structural behavior of macromolecules and engineering polymers are addressed for functional design in broad applications including medical devices as well as product design. Environmental impact and novel applications of plastics are evaluated.
Polymer Engineering: Read More [+]
Rules & Requirements

Prerequisites: MECENG 108, BIOENG 102, MATSCI 113 or equivalent

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Also listed as: MEC ENG C223

Polymer Engineering: Read Less [-]

BIO ENG 224 Basic Principles of Drug Delivery 3 Units

Terms offered: Fall 2023, Fall 2021, Fall 2020
This course focuses on providing students with the foundations needed to understand contemporary literature in drug delivery. Concepts in organic chemistry, biochemistry, and physical chemistry needed to understand current problems in drug delivery are emphasized.
Basic Principles of Drug Delivery: Read More [+]
Objectives & Outcomes

Course Objectives: The goal of this course is to give students the ability to understand problems in drug delivery. Emphasis is placed on the design and synthesis of new molecules for drug delivery.

Student Learning Outcomes: At the completion of this course students should be able to design new molecules to solve drug delivery problems.

Rules & Requirements

Prerequisites: BIO ENG 11 or CHEM 3B; BIO ENG 103; and BIO ENG 104

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructor: Murthy

Basic Principles of Drug Delivery: Read Less [-]

BIO ENG 225 Biomolecular Structure Determination 3 Units

Terms offered: Spring 2023, Spring 2021, Spring 2020
The detailed, atomic-level structure of biomolecules is at the basis of our understanding of many biochemical processes. The knowledge of these 3D structures has provided fundamental insights in the organization and inner workings of the living cell and has directly impacted the daily lives of many through the development of novel therapeutic agents. This graduate level course is designed to provide students with an in-depth understanding of
crystallography for macromolecular structure determination.
The underlying theory, computational approaches, and practical considerations for each step in the process will be discussed.
Biomolecular Structure Determination: Read More [+]
Objectives & Outcomes

Course Objectives: (1) Introduce students to the atomic structure of macromolecules,
2) review methods for structure determination, (3) describe the basic theory of diffraction, and (4) provide students with a detailed knowledge of macromolecular crystallography. At the end of the course students will have a solid theoretical and practical understanding of how macromolecular structures are determined to atomic resolution using crystallographic methods. The application of the method to problems in biomolecular engineering will be reviewed.

Student Learning Outcomes: The students will be able to (1) interpret diffraction data to determine reciprocal and real space parameters, (2) plan diffraction experiments, (3) use computational methods to solve the crystallographic phase problem (an inverse problem), (4) interpret complex 3-dimensional maps to build atomic models, (5) determine which optimization methods are appropriate for obtaining a refined, validated model, and (6) apply the knowledge to the engineering of biomolecules.

Rules & Requirements

Prerequisites: Consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructor: Paul Adams

Biomolecular Structure Determination: Read Less [-]

BIO ENG C230 Implications and Applications of Synthetic Biology 3 Units

Terms offered: Spring 2007
Explore strategies for maximizing the economic and societal benefits of synthetic biology and minimizing the risks; create "seedlings" for future research projects in synthetic biology at UC Berkeley; increase multidisciplinary collaborations at UC Berkeley on synthetic biology; and introduce students to a wide perspective of SB projects and innovators as well as policy, legal, and ethical experts.
Implications and Applications of Synthetic Biology: Read More [+]
Rules & Requirements

Prerequisites: Consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructors: Arkin, Keasling

Also listed as: CHM ENG C295L

Implications and Applications of Synthetic Biology: Read Less [-]

BIO ENG 231 Introduction to Computational Molecular and Cellular Biology 4 Units

Terms offered: Fall 2018, Fall 2017, Fall 2016
Topics include computational approaches and techniques to gene structure and genome annotation, sequence alignment using dynamic programming, protein domain analysis, RNA folding and structure prediction, RNA sequence design for synthetic biology, genetic and biochemical pathways and networks, UNIX and scripting languages, basic probability and information theory. Various "case studies" in these areas are reviewed and web-based computational biology tools will be used by students and programming projects will be given.
Introduction to Computational Molecular and Cellular Biology: Read More [+]
Rules & Requirements

Prerequisites: BIO ENG 11 or BIOLOGY 1A (may be taken concurrently); and a programming course (ENGIN 7 or COMPSCI 61A)

Credit Restrictions: Students will receive no credit for BIO ENG 231 after completing BIO ENG 131, or BIO ENG C231. A deficient grade in BIO ENG 231 may be removed by taking BIO ENG C231, or BIO ENG C231.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1.5 hours of laboratory per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructor: Holmes

Introduction to Computational Molecular and Cellular Biology: Read Less [-]

BIO ENG C231 Introduction to Computational Molecular and Cell Biology 4 Units

Terms offered: Fall 2023, Fall 2022, Fall 2021, Fall 2020
This class teaches basic bioinformatics and computational biology, with an emphasis on alignment, phylogeny, and ontologies. Supporting foundational topics are also reviewed with an emphasis on bioinformatics topics, including basic molecular biology, probability theory, and information theory.
Introduction to Computational Molecular and Cell Biology: Read More [+]
Rules & Requirements

Prerequisites: BIO ENG 11 or BIOLOGY 1A (may be taken concurrently); and a programming course (ENGIN 7 or COMPSCI 61A)

Credit Restrictions: Students will receive no credit for BIO ENG C231 after completing BIO ENG 231. A deficient grade in BIO ENG C231 may be removed by taking BIO ENG 231, or BIO ENG 231.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructor: Holmes

Also listed as: CMPBIO C231

Introduction to Computational Molecular and Cell Biology: Read Less [-]

BIO ENG 232 Genetic Devices 4 Units

Terms offered: Spring 2018, Fall 2014, Fall 2013
This graduate-level course is a comprehensive survey of genetic devices. These DNA-based constructs are comprised of multiple "parts" that together encode a higher-level biological behavior and perform useful human-defined functions. Such constructs are the engineering target for most projects in synthetic biology. Included within this class of constructs are genetic circuits, sensors, biosynthetic pathways, and microbiological functions.
Genetic Devices: Read More [+]
Objectives & Outcomes

Course Objectives: (1) To introduce the basic biology and engineering principles for constructing genetic devices including biochemical devices, microbiological devices, genetic circuits, eukaryotic devices, and developmental devices, (2) To familiarize students with current literature examples of genetic devices and develop literature searching skills; (3) To develop the students' ability to apply computational tools to the design of genetic devices.

Student Learning Outcomes: Students will be able to (1) use mathematical models to describe the dynamics of genetic devices, (2) comprehend and evaluate publications related to any type of genetic device, (3) perform a thorough literature search, (4) evaluate the technical plausibility of a proposed genetic device, (5) analyze a design challenge and propose a plausible solution to it in the form of a genetic device, and (6) assess any ethical or safety issues associated with a proposed genetic device.

Rules & Requirements

Prerequisites: ENGIN 7 or COMPSCI 61A; MATH 54; CHEM 3A; and BIO ENG 103

Credit Restrictions: Students will receive no credit for 232 after taking 132.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructor: Anderson

Genetic Devices: Read Less [-]

BIO ENG 235 Frontiers in Microbial Systems Biology 4 Units

Terms offered: Spring 2024, Spring 2022, Spring 2021
This course is aimed at graduate and advanced undergraduate students from the (bio) engineering and chemo-physical sciences interested in a research-oriented introduction to current topics in systems biology. Focusing mainly on two well studied microbiological model systems--the chemotaxis network and Lambda bacteriophage infection--the class systematically introduces key concepts and techniques for biological network deduction, modelling, analysis, evolution and synthetic network design. Students analyze the impact of approaches from the quantitative sciences--such as deterministic modelling, stochastic processes, statistics, non-linear dynamics, control theory, information theory, graph theory, etc.--on understanding biological processes, including (stochastic) gene regulation, signalling, network evolution, and synthetic network design. The course aims identify unsolved problems and discusses possible novel approaches while encouraging students to develop ideas to explore new directions in their own research.
Frontiers in Microbial Systems Biology: Read More [+]

Rules & Requirements

Prerequisites: Designed for graduates with background in differential equations and probability. Course work in molecular cell biology or biochemistry helpful

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructors: Arkin, Bischofs-Pfeifer, Wolf

Frontiers in Microbial Systems Biology: Read Less [-]

BIO ENG C237 Adv Designing for the Human Body 4 Units

Terms offered: Fall 2019, Fall 2018, Fall 2017
The course provides project-based learning experience in understanding product design, with a focus on the human body as a mechanical machine. Students will learn the design of external devices used to aid or protect the body. Topics will include forces acting on internal materials (e.g., muscles and total replacement devices), forces acting on external materials (e.g., prothetics and crash pads), design/analysis of devices aimed to improve or fix the human body, muscle adaptation, and soft tissue injury. Weekly laboratory projects will incorporate EMG sensing, force plate analysis, and interpretation of data collection (e.g., MATLAB analysis) to integrate course material to better understand contemporary design/analysis/problems.
Adv Designing for the Human Body: Read More [+]

Objectives & Outcomes

Course Objectives: The purpose of this course is twofold:

- to learn the fundamental concepts of designing devices that interact with the human body;
- to enhance skills in mechanical engineering and bioengineering by analyzing the behavior of various complex biomedical problems;
- To explore the transition of a device or discovery as it goes from “benchtop to bedside”.
- Three separate written projects evaluating devices that interact with the body. Projects will focus on 1) biomechanical analysis, 2) FDA regulations and procedures, and 3) design lifecycle.

Student Learning Outcomes: Working knowledge of design considerations for creating a device to protect or aid the human body, force transfer and distribution, data analysis, and FDA approval process for new devices. Understanding of basic concepts in orthopaedic biomechanics and the ability to apply the appropriate engineering concepts to solve realistic biomechanical problems, knowing clearly the assumptions involved. Critical analysis of current literature and technology.

Rules & Requirements

Prerequisites: Proficiency in MatLab or equivalent. Prior knowledge of biology or anatomy is not assumed

Credit Restrictions: There will be no credit given for MEC ENG C178 / BIO ENG C137 after taking MEC ENG 178.

Hours & Format

Fall and/or spring: 15 weeks - 1-3 hours of lecture per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructor: O'Connell

Also listed as: MEC ENG C278

Adv Designing for the Human Body: Read Less [-]

BIO ENG 241 Probabilistic Modeling in Computational Biology 4 Units

Terms offered: Spring 2023, Spring 2022, Spring 2021
This course covers applications of probabilistic modeling to topics in bioinformatics, with an emphasis on literature study and novel tool development. Areas covered vary from year to year but typically include finite-state Markov models as models of point substitution processes; graphical models and dynamic programming; basic coalescent theory; grammar theory; birth-death processes and the Thorne-Kishino-Felsenstein model of indels; general PDE methods and applications to continuous-state models; the Chinese restaurant process in population genetics and ecology; data compression algorithms; general techniques including conjugate priors, MCMC, and variational methods.
Probabilistic Modeling in Computational Biology: Read More [+]
Objectives & Outcomes

Course Objectives: To introduce the most commonly used statistical models and associated inference techniques for the analysis and organization of biological sequences, with a focus on models based on evolutionary theory.

Student Learning Outcomes: Students will be familiar with the bioinformatics literature and underyling theory for discrete Markov processes, Bayesian networks, stochastic grammars, birth-death processes, Chinese restaurant processes, data compression algorithms, and related methods such as dynamic programming and MCMC.

Rules & Requirements

Prerequisites: Recommended preparation: MATH 53 (multivariable calculus), MATH 54 (linear algebra), MATH 126 (partial differential equations); or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructor: Holmes

Probabilistic Modeling in Computational Biology: Read Less [-]

BIO ENG C242 Machine Learning, Statistical Models, and Optimization for Molecular Problems 4 Units

Terms offered: Spring 2024, Spring 2023
An introduction to mathematical optimization, statistical models, and advances in machine learning for the physical sciences. Machine learning prerequisites are introduced including local and global optimization, various statistical and clustering models, and early meta-heuristic methods such as genetic algorithms and artificial neural networks. Building on this foundation, current machine learning techniques are covered including deep learning artificial neural networks, Convolutional neural networks, Recurrent and long short term memory (LSTM) networks, graph neural networks, decision trees.
Machine Learning, Statistical Models, and Optimization for Molecular Problems: Read More [+]
Objectives & Outcomes

Course Objectives: To build on optimization and statistical modeling to the field of machine learning techniques
To introduce the basics of optimization and statistical modeling techniques relevant to chemistry students
To utilize these concepts on problems relevant to the chemical sciences.

Student Learning Outcomes: Students will be able to understand the landscape and connections between numerical optimization, stand-alone statistical models, and machine learning techniques, and its relevance for chemical problems.

Rules & Requirements

Prerequisites: Math 53 and Math 54; Chem 120A or 120B or BioE 103; or consent of intructor

Credit Restrictions: Students will receive no credit for BIO ENG C242 after completing BIO ENG 242. A deficient grade in BIO ENG C242 may be removed by taking BIO ENG 242.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructor: Teresa Head-Gordon

Formerly known as: Bioengineering C242/Chemistry C242

Also listed as: CHEM C242

Machine Learning, Statistical Models, and Optimization for Molecular Problems: Read Less [-]

BIO ENG 243 Computational Methods in Biology 4 Units

Terms offered: Fall 2011, Fall 2010, Fall 2009
An introduction to biophysical simulation methods and algorithms, including molecular dynamics, Monte Carlo, mathematical optimization, and "non-algorithmic" computation such as neural networks. Various case studies in applying these areas in the areas of protein folding, protein structure prediction, drug docking, and enzymatics will be covered. Core Specialization: Core B (Informatics and Genomics); Core D (Computational Biology); Bioengineering Content: Biological.
Computational Methods in Biology: Read More [+]

Rules & Requirements

Prerequisites: MATH 53 and MATH 54; and programming experience preferred but not required

Credit Restrictions: Students will receive no credit for 243 after taking 143.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 2 hours of laboratory per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructor: Head-Gordon

Computational Methods in Biology: Read Less [-]

BIO ENG 244 Introduction to Protein Informatics 4 Units

Terms offered: Spring 2017, Fall 2008, Fall 2007
This course will introduce students to the bioinformatics algorithms used by biologists to identify homologs, construct multiple sequence alignments, predict protein structure, estimate phylogenetic trees, identify orthologs, predict protein-protein interaction, and build hidden Markov models. The focus is on the algorithms used, and on the sources of various types of errors in these methods. This class includes no programming, and no programming background is required.
Introduction to Protein Informatics: Read More [+]

Objectives & Outcomes

Course Objectives: This course is designed to provide a theoretical framework for protein sequence and structure analysis using bioinformatics software tools. Students completing this course will be prepared for subsequent in-depth studies in bioinformatics, for algorithm development, and for the use of bioinformatics methods for biological discovery. It is aimed at two populations: students in the life sciences who need to become expert users of bioinformatics tools, and students in engineering and mathematics/computer science who wish to become the developers of the next generation of bioinformatics methods. As virtually all the problems in this field are very complex, there are many opportunities for research and development of new methods.

Student Learning Outcomes: Students completing this course are likely to find several potential areas of research of interest, which they may want to work on as independent study projects during undergraduate work, or take on as Master’s or Ph.D. thesis topics for advanced work.

Rules & Requirements

Prerequisites: Prior coursework in algorithms (e.g., COMPSCI 170) is highly recommended. The class does not include programming, and no prior programming experience is required, although students need to be comfortable reading and writing pseudocode (precise text descriptions of algorithms

Credit Restrictions: BioE 144 or previous BioE/PMB C144

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructor: Sjolander

Formerly known as: Bioengineering C244/Plant and Microbial Biology C244

Introduction to Protein Informatics: Read Less [-]

BIO ENG 244L Protein Informatics Laboratory 3 Units

Terms offered: Prior to 2007
This course is intended to provide hands-on experience with a variety of bioinformatics tools, web servers and databases that are used to predict protein function and structure. This course will cover numerous bioinformatics tasks including: homolog detection using BLAST and PSI-BLAST, hidden Markov model construction and use, multiple sequence alignment, phylogenetic tree construction, ortholog identification, protein structure prediction, active site prediction, cellular localization, protein-protein interaction and phylogenomic analysis. Some minimal programming/scripting skills (e.g., Perl or Python) are required to complete some of the labs.
Protein Informatics Laboratory: Read More [+]
Rules & Requirements

Prerequisites: One upper-division course in molecular biology or biochemistry (e.g., MCELLBI C100A/CHEM C130). Python programming (e.g., COMPSCI 61A) and experience using command-line tools in a Unix environment

Credit Restrictions: BioE 144L or BioE C144L/PMB C144L

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of laboratory and 2 hours of lecture per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructor: Sjolander

Formerly known as: Bioengineering C244L/Plant and Microbial Biology C244L

Protein Informatics Laboratory: Read Less [-]

BIO ENG 245 Introduction to Machine Learning for Computational Biology 4 Units

Terms offered: Spring 2024, Spring 2023, Spring 2022
Genome-scale experimental data and modern machine learning methods have transformed our understanding of biology.This course investigates classical approaches and recent machine learning advances in genomics including:
1)Computational models for genome analysis.
2)Applications of machine learning to high throughput biological data.
3)Machine learning for genomic data in health.
This course builds on existing skills to introduce methodologies for probabilistic modeling, statistical learning, and dimensionality reduction, while grounding these methods in understanding genomic information.
Introduction to Machine Learning for Computational Biology: Read More [+]
Objectives & Outcomes

Course Objectives: This course aims to equip students with a foundational understanding of computational and machine learning techniques used in genomics and computational biology.

Student Learning Outcomes: Students completing this course should have a better understanding of some of the challenges in machine learning as applied to biology
Students completing this course should have stronger programming skills.
Students completing this course should have the ability to apply simple statistical and machine learning techniques to complex genomics data

Rules & Requirements

Prerequisites: Bio 1A or BioE 11, Math 54, CS61B; CS70 or Math 55 recommended

Credit Restrictions: Students will receive no credit for BIO ENG 245 after completing BIO ENG 145.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructor: Lareau

Introduction to Machine Learning for Computational Biology: Read Less [-]

BIO ENG 247 Principles of Synthetic Biology 4 Units

Terms offered: Fall 2023, Fall 2021, Fall 2020
The field of synthetic biology is quickly emerging as potentially one of the most important and profound ways by which we can understand and manipulate our physical world for desired purposes. In this course, the field and its natural scientific and engineering basis are introduced. Relevant topics in cellular and molecular biology and biophysics, dynamical and engineering systems, and design and operation of natural and synthetic circuits are covered in a concise manner that then allows the student to begin to design new biology-based systems.
Principles of Synthetic Biology: Read More [+]
Objectives & Outcomes

Course Objectives: (1) To introduce the basics of Synthetic Biology, including quantitative cellular network characterization and modeling, (2) to introduce the principles of discovery and genetic factoring of useful cellular activities into reusable functions for design, (3) to inculcate the principles of biomolecular system design and diagnosis of designed systems, and (4) to illustrate cutting-edge applications in Synthetic Biology and to enhance skull sin analyzing and designing synthetic biological applications.

Student Learning Outcomes: The goals of this course are to enable students to: (1) design simple cellular circuitry to meet engineering specification using both rational/model-based and library-based approaches, (2) design experiments to characterize and diagnose operation of natural and synthetic biomolecular network functions, and (3) understand scientific, safety and ethical issues of synthetic biology.

Rules & Requirements

Prerequisites: MATH 53, MATH 54, and BIO ENG 103; or consent of instructor

Credit Restrictions: Students will receive no credit for 247 after taking 147.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructor: Arkin

Principles of Synthetic Biology: Read Less [-]

BIO ENG 248 Bioenergy and Sustainable Chemical Synthesis: Metabolic Engineering and Synthetic Biology Approaches 3 Units

Terms offered: Fall 2023, Fall 2022, Fall 2020
This course will cover metabolic engineering and the various synthetic biology approaches for optimizing pathway performance. Use of metabolic engineering to produce biofuels and general "green technology" will be emphasized since these aims are currently pushing these fields. The course is meant to be a practical guide for metabolic engineering and the related advances in synthetic biology as well the related industrial research and opportunities.
Bioenergy and Sustainable Chemical Synthesis: Metabolic Engineering and Synthetic Biology Approaches: Read More [+]
Rules & Requirements

Prerequisites: CHEM 3A; and MCELLBI C100A/CHEM C130A or equivalent

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructor: Dueber

Bioenergy and Sustainable Chemical Synthesis: Metabolic Engineering and Synthetic Biology Approaches: Read Less [-]

BIO ENG C249 Computational Functional Genomics 4 Units

Terms offered: Fall 2023
This course provides a survey of the computational analysis of genomic data, introducing the material through lectures on biological concepts and computational methods, presentations of primary literature, and practical bioinformatics exercises. The emphasis is on measuring the output of the genome and its regulation. Topics include modern computational and statistical methods for analyzing data from genomics experiments: high-throughput RNA sequencing data, single-cell data, and other genome-scale measurements of biological processes. Students will perform original analyses with Python and command-line tools.
Computational Functional Genomics: Read More [+]

Objectives & Outcomes

Course Objectives: This course aims to equip students with practical proficiency in bioinformatics analysis of genomic data, as well as understanding of the biological, statistical, and computational underpinnings of this field.

Student Learning Outcomes: Students completing this course should have stronger programming skills, practical proficiency with essential bioinformatics methods that are applicable to genomics research, understanding of the statistics underlying these methods, and awareness of key aspects of genome function and challenges in the field of genomics.

Rules & Requirements

Prerequisites: Math 54 or EECS 16A/B; CS 61A or another course in python; BioE 11 or Bio 1a; and BioE 131. Introductory statistics or data science is recommended

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructor: Lareau

Also listed as: CMPBIO C249

Computational Functional Genomics: Read Less [-]

BIO ENG C250 Nanomaterials in Medicine 3 Units

Terms offered: Fall 2022, Fall 2021, Fall 2020
The course is designed for graduate students interested in the emerging field of nanomedicine. The course will involve lectures, literature reviews and proposal writing. Students will be required to formulate a nanomedicine research project and write an NIH-style proposal during the course. The culmination of this project will involve a mock review panel in which students will serve as peer reviewers to read and evaluate the proposals.
Nanomaterials in Medicine: Read More [+]

Objectives & Outcomes

Course Objectives: To review the current literature regarding the use of nanomaterials in medical applications; (2) To describe approaches to nanomaterial synthesis and surface modification; (3) To understand the interaction of nanomaterials with proteins, cells and biological systems; (4) To familiarize students with proposal writing and scientific peer review.

Student Learning Outcomes: Students should be able to (1) identify the important properties of metal, polymer and ceramic nanomaterials used in healthcare; (2) understand the role of size, shape and surface chemistry of nanomaterials in influencing biological fate and performance; (3) understand common methods employed for surface modification of nanomaterials; (4) comprehend the range of cell-nanomaterial interactions and methods for assaying these interactions; (5) read and critically review the scientific literature relating to nanomedicine; (6) formulate and design an experimental nanomedicine research project; (7) understand the principles of the peer review system.

Rules & Requirements

Prerequisites: Graduate Standing

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructor: Messersmith

Also listed as: MAT SCI C250

Nanomaterials in Medicine: Read Less [-]

BIO ENG 251 Micro/Nanofluidics for Bioengineering and Lab-On-A-Chip 4 Units

Terms offered: Spring 2015, Spring 2014, Spring 2013
Introduction and in-depth treatment of theory relevant to fluid flow in microfluidic and nanofluidic systems supplemented by critical assessment of recent applications drawn from the literature. Topics include low Reynolds Number flow, mass transport including diffusion phenomena, and emphasis on electrokinetic systems and bioanalytical applications of said phenomena.
Micro/Nanofluidics for Bioengineering and Lab-On-A-Chip: Read More [+]
Objectives & Outcomes

Course Objectives: The course is an introduction to the physicochemical dynamics associated with fluid flow in nanoscale and microscale devices for graduate students and advance undergraduate students. The course has been created in response to the active field of microfluidics and nanofluidics, as well as the associated interest from industry, government, and academic research groups. The course provides an theoretical treatment of micro/nanofluidic phenomena that complements the well-established laboratory and research content offered in the Department.
We will study mass and momentum transport phenomena of microscale and nanoscale flow devices. Throughout the course, we will place an emphasis on bioanalytical microfluidic system applications where electrophoresis, electroosmosis, molecular diffusion, and/or Brownian motion effects dominate. Successful completion of the course will prepare students to design micro/nanofluidic engineering solutions, as well as critically assess academic and industrial developments in these areas.

Student Learning Outcomes: 1.
To introduce students to the governing principles of fluid flow in microfluidic and nanofluidic regimes, with emphasis on phenomena relevant to bioanalytical devices.
2.
To provide students with an understanding of scaling laws that define the performance of microfluidic and nanofluidic systems.
3.
To provide students with a detailed investigation of applications that do and do not benefit from miniaturization.
4.
To give students adequate didactic background for critical assessment of literature reports and conference presentations regarding advances in the topical areas of microfluidics and nanofluidics.

Rules & Requirements

Prerequisites: BIO ENG 11 or CHEM 3B; and BIO ENG 104 or MEC ENG 106; or consent of instructor

Credit Restrictions: Students will receive no credit for 251 after taking 151.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructor: Herr

Micro/Nanofluidics for Bioengineering and Lab-On-A-Chip: Read Less [-]

BIO ENG 252 Clinical Need-Based Therapy Solutions 2 Units

Terms offered: Fall 2023, Fall 2022, Fall 2021
Students will be introduced to clinical areas with unmet needs, be introduced to the current standard of care or state of the art solutions for those needs, and learn to methodically conceptualize potential alternatives. The course will emphasize interaction between students and subject matter experts in these clinical areas and in the related fields of medtech and biotech innovation. Open innovative ideas from students are encouraged during the course.
Clinical Need-Based Therapy Solutions: Read More [+]
Objectives & Outcomes

Course Objectives: (1) To expose students to clinical areas with major unmet need; (2) Expose students to current state of the art in therapy solutions for the above clinical need; (3) Stimulate innovation concept targeting high-impact clinical needs

Student Learning Outcomes: Students will be able to (1) Immerse in an enabling innovation environment stemming from the solution ideas by the students and mentor faculties; (2) Obtain potential avenues to enable capstone projects, UCSF collaborations, SBIR, etc.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of lecture per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructor: Hossiany

Clinical Need-Based Therapy Solutions: Read Less [-]

BIO ENG 253 Biotechnology Entrepreneurship: Impact, History, Therapeutics R&D, Entrepreneurship & Careers 2 Units

Terms offered: Spring 2024, Spring 2023, Spring 2021
This course is designed for students interested in an introduction to the biotechnology entrepreneurship, biotherapeutics R and D, and careers in the industry. Students should be interested in the impact of biotechnology on medicine and society, the history of the field (including individual scientists, entrepreneurs and companies), key methodologies, therapeutic product classes, entrepreneurship and innovation within the life sciences. Students will learn principles of drug and biologics discovery, development and commercialization, and will be exposed to the range of careers in the biopharmaceutical industry. Students should be considering careers in the biopharmaceutical and life sciences fields.
Biotechnology Entrepreneurship: Impact, History, Therapeutics R&D, Entrepreneurship & Careers: Read More [+]

Objectives & Outcomes

Course Objectives: To educate students on careers in the biopharmaceutical industry
To educate students on the history of the field and industry, including key methodologies, technologies, scientists, entrepreneurs, and companies
To foster understanding and appreciation for the medical and societal impact of the biopharmaceutical field and industry
To introduce the key steps in the process of discovery, development and commercialization of novel therapeutics
o educate students on biopharmaceutical company entrepreneurship and innovation through team-based hands on virtual company creation

Student Learning Outcomes: Entrepreneurship principles, including those defined by the Lean Launchpad approach (including the Business Model Canvas, the Minimum Viable Product and Customer Discovery)
The history of the biotech industry
The impact of the biopharmaceutical industry on medicine and society
The methods, product technologies and development methodologies that have driven the evolution of the field
The nature of the ecosystem and specific careers in the biopharmaceutical industry
The product design and development process (with a focus on biotherapeutics), including opportunities and challenges

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of lecture per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructor: Kirn

Biotechnology Entrepreneurship: Impact, History, Therapeutics R&D, Entrepreneurship & Careers: Read Less [-]

BIO ENG C261 Medical Imaging Signals and Systems 4 Units

Terms offered: Fall 2023, Fall 2022, Fall 2021
Biomedical imaging is a clinically important application of engineering, applied mathematics, physics, and medicine. In this course, we apply linear systems theory and basic physics to analyze X-ray imaging, computerized tomography, nuclear medicine, and MRI. We cover the basic physics and instrumentation that characterizes medical image as an ideal perfect-resolution image blurred by an impulse response. This material could prepare the student for a career in designing new medical imaging systems that reliably detect small tumors or infarcts.
Medical Imaging Signals and Systems: Read More [+]

Objectives & Outcomes

Course Objectives: •
understand how 2D impulse response or 2D spatial frequency transfer function (or Modulation Transfer Function) allow one to quantify the spatial resolution of an imaging system.
•
understand 2D sampling requirements to avoid aliasing
•
understand 2D filtered backprojection reconstruction from projections based on the projection-slice theorem of Fourier Transforms
•
understand the concept of image reconstruction as solving a mathematical inverse problem.
•
understand the limitations of poorly conditioned inverse problems and noise amplification
•
understand how diffraction can limit resolution---but not for the imaging systems in this class
•
understand the hardware components of an X-ray imaging scanner
•
•
understand the physics and hardware limits to spatial resolution of an X-ray imaging system
•
understand tradeoffs between depth, contrast, and dose for X-ray sources
•
understand resolution limits for CT scanners
•
understand how to reconstruct a 2D CT image from projection data using the filtered backprojection algorithm
•
understand the hardware and physics of Nuclear Medicine scanners
•
understand how PET and SPECT images are created using filtered backprojection
•
understand resolution limits of nuclear medicine scanners
•
understand MRI hardware components, resolution limits and image reconstruction via a 2D FFT
•
understand how to construct a medical imaging scanner that will achieve a desired spatial resolution specification.

Student Learning Outcomes: •
students will be tested for their understanding of the key concepts above
•
undergraduate students will apply to graduate programs and be admitted
•
students will apply this knowledge to their research at Berkeley, UCSF

BIO ENG 263 Principles of Molecular and Cellular Biophotonics 4 Units

Terms offered: Fall 2022, Fall 2018, Fall 2017
Topics in the emerging field of biophotonics with an emphasis on fluorescence spectroscopy, biosensors, and devices for optical imaging and detection of biomolecules. The course will cover the photophysics and photochemistry of organic molecules, the design and characterization of biosensors, and their applications within diverse environments, ranging from the detection of single molecules in vitro and in cells to studies of detection, diagnosis, and monitoring of specific health conditions and disease.
Principles of Molecular and Cellular Biophotonics: Read More [+]
Rules & Requirements

Prerequisites: 102 or consent of instructor, and Chemistry 3A and Physics 7B

Credit Restrictions: Students will receive no credit for 263 after taking 163.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructor: Marriott

Principles of Molecular and Cellular Biophotonics: Read Less [-]

BIO ENG 263L Molecular and Cellular Biophotonics Laboratory 4 Units

Terms offered: Spring 2024, Spring 2023, Spring 2022
This course provides undergraduate and graduate bioengineering students with an opportunity to acquire essential experimental skills in fluorescence spectroscopy and the design, evaluation, and optimization of optical biosensors for quantitative measurements of proteins and their targets. Groups of students will be responsible for the research, design, and development of a biosensor or diagnostic device for the detection, diagnosis, and monitoring of a specific biomarker(s).
Molecular and Cellular Biophotonics Laboratory: Read More [+]
Rules & Requirements

Prerequisites: BIO ENG 263; experience in a research lab; and consent of instructor

Credit Restrictions: Students will receive no credit for 263L after taking 163L.

Hours & Format

Fall and/or spring: 15 weeks - 6 hours of laboratory and 2 hours of discussion per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructor: Marriott

Molecular and Cellular Biophotonics Laboratory: Read Less [-]

BIO ENG C265 Principles of Magnetic Resonance Imaging 4 Units

Terms offered: Spring 2023, Spring 2021, Spring 2020, Spring 2019
Fundamentals of MRI including signal-to-noise ratio, resolution, and contrast as dictated by physics, pulse sequences, and instrumentation. Image reconstruction via 2D FFT methods. Fast imaging reconstruction via convolution-back projection and gridding methods and FFTs. Hardware for modern MRI scanners including main field, gradient fields, RF coils, and shim supplies. Software for MRI including imaging methods such as 2D FT, RARE, SSFP, spiral and echo planar imaging methods.
Principles of Magnetic Resonance Imaging: Read More [+]
Objectives & Outcomes

Course Objectives: Graduate level understanding of physics, hardware, and systems engineering description of image formation, and image reconstruction in MRI. Experience in Imaging with different MR Imaging systems. This course should enable students to begin graduate level research at Berkeley (Neuroscience labs, EECS and Bioengineering), LBNL or at UCSF (Radiology and Bioengineering) at an advanced level and make research-level contribution

Rules & Requirements

Prerequisites: EL ENG 120 or BIO ENG C165/EL ENG C145B or consent of instructor

Credit Restrictions: Students will receive no credit for Bioengineering C265/El Engineering C225E after taking El Engineering 265.

Repeat rules: Course may be repeated for credit under special circumstances: Students can only receive credit for 1 of the 2 versions of the class,BioEc265 or EE c225e, not both

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructors: Conolly, Vandsburger

Also listed as: EL ENG C225E/NUC ENG C235

Principles of Magnetic Resonance Imaging: Read Less [-]

BIO ENG 266 Biomedical Imaging Systems II: Targeted Molecular Imaging in Disease 4 Units

Terms offered: Spring 2024, Spring 2023, Spring 2022
This course is designed as an introduction to the growing world of molecular imaging in medicine and research. The course is divided into five modules based on common imaging modalities (optical imaging, ultrasound methods, radiography, nuclear imaging, and magnetic resonance approaches). Within each module the fundamental physics and engineering behind each modality, corresponding methods for targeted molecular imaging including contrast mechanisms and probe design, and signal and image processing algorithms are covered. Homework assignments will utilize imaging data from either clinical or research studies in order to provide training in MATLAB based image analysis techniques.
Biomedical Imaging Systems II: Targeted Molecular Imaging in Disease: Read More [+]
Objectives & Outcomes

Course Objectives: Discuss limitations to each targeted approach including non-specific binding, unbound probe clearance, signal decay, etc
Discuss the design of targeted molecular contrast agents for each modality across myriad biological applications
Establish a foundational understanding of MRI (multi-spectral), PET/SPECT, Ultrasound (including photo-acoustic imaging), and emerging methods including MPI
Establish proficiency in the use of MATLAB as a tool for analyzing biomedical imaging data
Reinforce mathematical principles relevant to image analysis including linear algebra, convolution and differential equations
To discuss imaging ethics in the context of data interpretation
To expose students interested in biomedical research or clinical practice to fundamentals of modern imaging methods and interpretation
To learn quantitative approaches to analyze biomedical images (includes pharmacokinetic models, attenuation correction, cross modality registration, etc.)

Student Learning Outcomes: Analyze imaging data derived from imaging studies using commonly utilized image processing techniques
Critically evaluate scientific publications in the molecular imaging space.
Understand the devices, techniques and protocols used for in vivo imaging in research and clinical settings

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructor: Vandsburger

Biomedical Imaging Systems II: Targeted Molecular Imaging in Disease: Read Less [-]

BIO ENG 271 Interface Between Neuroethology & Neural Engineering 3 Units

Terms offered: Spring 2023, Spring 2021
The course will provide students with an overview of the tight interface between neural engineering and neuroethological approaches in the field of neuroscience. This course will also discuss the concepts of causal manipulations, such as the control of brain circuits using optics and genetic engineering. Lastly, students will also inquire and discuss what discoveries have yet to be made and how neuroethological approaches can inform neural engineering designs that will revolutionize the future of neural medicine.
Interface Between Neuroethology & Neural Engineering: Read More [+]
Objectives & Outcomes

Course Objectives: Understand the close interface between studies of the nervous system and technology

Student Learning Outcomes: The course will review the utilization, development and implementation of a wide diversity of neural engineering technologies to the study of the brain. Students will discuss the bidirectional road between the two approaches
The overreaching goal of this course is to expose student interested in neural engineering to the remarkable history of neuroethological approaches that have been a foundation of discoveries in the field.

Rules & Requirements

Prerequisites: BIO ENG 105; and BIO ENG 101 or EECS 16A and EECS 16B; or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructor: Yartsev

Interface Between Neuroethology & Neural Engineering: Read Less [-]

BIO ENG 280 Ethical and Social Issues in Translational Medicine 1 Unit

Terms offered: Spring 2024, Spring 2023, Spring 2022
This class is designed to introduce MTM students to their professional responsibilities
as engineers and translational scientists. By the end of it, students will have
experience communicating their ideas appropriately and effectively to their peers,
their superiors, and those whom they manage or mentor. We will also discuss
methods for having a successful graduate school experience - choosing and working
on a project and preparing to meet post-graduate goals. Finally, some of the ethical
challenges likely to be met by a working bioengineer will be explored.
While this syllabus is meant to be an accurate description of the course and its content,
it may be modified at the instructor’s discretion.
Ethical and Social Issues in Translational Medicine: Read More [+]
Objectives & Outcomes

Course Objectives: Objectives
Communications skills and best practices
Research ethics in translational medicine
Professional development for MTM graduate students

Student Learning Outcomes: MTM students will become aware of ethical issues commonly confronted in
translational medicine and learn how to evaluate and act accordingly. They will also
leave capable of independently considering new ethical issues that arise during their
careers.

Rules & Requirements

Prerequisites: Open only to students in the Masters of Translational Medicine Graduate program

Hours & Format

Fall and/or spring: 15 weeks - 1 hour of lecture per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructors: Johnson, Terry

Ethical and Social Issues in Translational Medicine: Read Less [-]

BIO ENG C280 Introduction to Nano-Science and Engineering 3 Units

Terms offered: Spring 2015, Spring 2013, Spring 2012
A three-module introduction to the fundamental topics of Nano-Science and Engineering (NSE) theory and research within chemistry, physics, biology, and engineering. This course includes quantum and solid-state physics; chemical synthesis, growth fabrication, and characterization techniques; structures and properties of semiconductors, polymer, and biomedical materials on nanoscales; and devices based on nanostructures. Students must take this course to satisfy the NSE Designated Emphasis core requirement.
Introduction to Nano-Science and Engineering: Read More [+]
Rules & Requirements

Prerequisites: Major in physical science such as chemistry, physics, etc., or engineering; consent of advisor or instructor

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructors: Gronsky, S.W. Lee, Wu

Also listed as: MAT SCI C261/NSE C201/PHYSICS C201

Introduction to Nano-Science and Engineering: Read Less [-]

BIO ENG C281 The Berkeley Lectures on Energy: Energy from Biomass 3 Units

Terms offered: Fall 2015, Fall 2014, Fall 2013
After an introduction to the different aspects of our global energy consumption, the course will focus on the role of biomass. The course will illustrate how the global scale of energy guides the biomass research. Emphasis will be places on the integration of the biological aspects (crop selection, harvesting, storage, and distribution, and chemical composition of biomass) with the chemical aspects to convert biomass to energy. The course aims to engage students in state-of-art research.
The Berkeley Lectures on Energy: Energy from Biomass: Read More [+]
Rules & Requirements

Prerequisites: Biology 1A; Chemistry 1B or 4B, Mathematics 1B

Repeat rules: Course may be repeated for credit under special circumstances: Repeatable when topic changes with consent of instructor.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructors: Bell, Blanch, Clark, Smit, C. Somerville

Also listed as: CHEM C238/CHM ENG C295A/PLANTBI C224

The Berkeley Lectures on Energy: Energy from Biomass: Read Less [-]

BIO ENG 282 Model-Based Design of Clinical Therapies 3 Units

Terms offered: Spring 2024, Spring 2023, Spring 2022
Students will learn how to translate a clinically relevant physical system into a governing equation with boundary conditions, and how to use this mathematical model to test and improve the design of medical devices and therapies. Problems of mass, heat, and momentum transport; the interaction of electromagnetic fields with materials (including tissue); and the mechanics of fluids and solids will be explored.
Model-Based Design of Clinical Therapies: Read More [+]
Objectives & Outcomes

Course Objectives: •
Develop skills in translating physical problem statement into quantitative applied math construction
•
Emphasis will be on constructing problems statements into mathematical equations and boundary conditions.

Student Learning Outcomes: •
Use quantitative applied math construction to estimate dominant parameters or dimensionless groups in cutting-edge, industry-relevant problem statements
•
Students become well-versed in quantitative analysis of real life products and therapeutic applications

Rules & Requirements

Prerequisites: Calculus (MATH 54); BIO ENG 104 (preferred but not required); and/or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructor: Syed Hossiany

Model-Based Design of Clinical Therapies: Read Less [-]

BIO ENG 290 Advanced Topics in Bioengineering 1 - 4 Units

Terms offered: Spring 2024, Fall 2023, Spring 2023
This course covers current topics of research interest in bioengineering. The course content may vary from semester to semester.
Advanced Topics in Bioengineering: Read More [+]
Rules & Requirements

Prerequisites: Consent of instructor

Credit Restrictions: One hour of lecture per week per unit.

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 1-4 hours of lecture per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Advanced Topics in Bioengineering: Read Less [-]

BIO ENG C290D Advanced Technical Communication: Proposals, Patents, and Presentations 3 Units

Terms offered: Spring 2018, Spring 2016, Spring 2012, Spring 2011
This course will help the advanced Ph.D. student further develop critically important technical communication traits via a series of lectures, interactive workshops, and student projects that will address the structure and creation of effective research papers, technical reports, patents, proposals, business plans, and oral presentations. One key concept will be the emphasis on focus and clarity--achieved through critical thinking regarding objectives and context. Examples will be drawn primarily from health care and bioengineering multidisciplinary applications.
Advanced Technical Communication: Proposals, Patents, and Presentations: Read More [+]
Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

Instructors: Keaveny, Pruitt

Also listed as: MEC ENG C290X

Advanced Technical Communication: Proposals, Patents, and Presentations: Read Less [-]

BIO ENG 291 Project Management for Translational Medicine 2 Units

Terms offered: Not yet offered
This course emphasizes practical examples of medical innovation projects. The classroom pedagogy draws on industry professionals sharing real-world experiences. The goal is twofold: first, for students to get a better appreciation for why health innovation projects need to be managed differently to successfully navigate the clinical world; second, to gain familiarity with specific aspects and topics in medical product development that need to be done for successful implementation. Some speakers will provide insights into relevant careers in project management for medical technology.
Project Management for Translational Medicine: Read More [+]
Hours & Format

Fall and/or spring: 15 weeks - 2 hours of lecture per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructor: Rodriguez

Project Management for Translational Medicine: Read Less [-]

BIO ENG 296 MTM Capstone Project 3 Units

Terms offered: Spring 2016, Fall 2015, Spring 2015
Members of the MTM Program Committee will help design several capstone projects in collaboration with clinical, academic, and/or industry partners, aiming to incorporate emerging technologies, industry requirements, and the potential for significant economic or social impact with regard to medicine and health care. All projects will be designed and vetted by the MTM Program Committee and in consultation with the MTM Advisory Board. For each selected project, an Academic Senate member from the Department of Bioengineering or BTS will serve as research adviser.
MTM Capstone Project: Read More [+]
Objectives & Outcomes

Course Objectives: The objective of the one year professional MTM program is to develop engineering leaders who can synthesize the technical, environmental, economic, and social issues involved in the design and operation of complex engineering devices, systems, and organizations. Students will develop and demonstrate this skill at synthesis through the capstone project.

Student Learning Outcomes: Projects will provide practical instruction and experience in solving real problems in translational medicine, and it is anticipated that some will lead to innovations with commercial potential. This experience, undertaken by each student as a member of a team and marked by extensive interaction with faculty, peers, and industry partners, enables the student to integrate the leadership and technical dimensions of the professional MTM curriculum.

Rules & Requirements

Prerequisites: Graduate status in the MTM program

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 9-9 hours of independent study per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Instructors: Li, Song

MTM Capstone Project: Read Less [-]

BIO ENG 297 Bioengineering Department Seminar 1 Unit

Terms offered: Spring 2024, Fall 2023, Spring 2023
This weekly seminar series invites speakers from the bioengineering community, as well as those in related fields, to share their work with our department and other interested parties on the Berkeley campus. The series includes our annual Bioengineering Distinguished Lecture and Rising Star lecture.
Bioengineering Department Seminar: Read More [+]
Objectives & Outcomes

Course Objectives: •
To introduce students to bioengineering research as it is performed at Berkeley and at other institutions
•
To give students opportunities to connect their own work to work in the field overall
•
To give students an opportunity to meet with speakers who can inform and contribute to their post-graduation career paths

Student Learning Outcomes: To introduce students to the breadth of bioengineering research, both here at Berkeley and at other institutions, and help them to connect their work here at Berkeley to the field overall.

Rules & Requirements

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 1 hour of seminar per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

Instructor: Faculty

Bioengineering Department Seminar: Read Less [-]

BIO ENG 298 Group Studies, Seminars, or Group Research 1 - 8 Units

Terms offered: Spring 2024, Fall 2023, Spring 2023
Advanced studies in various subjects through special seminars on topics to be selected each year. Informal group studies of special problems, group participation in comprehensive design problems, or group research on complete problems for analysis and experimentation.
Group Studies, Seminars, or Group Research: Read More [+]
Rules & Requirements

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 1-8 hours of directed group study per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

Group Studies, Seminars, or Group Research: Read Less [-]

BIO ENG 299 Individual Study or Research 1 - 12 Units

Terms offered: Summer 2024 Second 6 Week Session, Spring 2024, Fall 2023
Investigations of advanced problems in bioengineering.
Individual Study or Research: Read More [+]
Rules & Requirements

Prerequisites: Graduate standing

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 0 hours of independent study per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

Individual Study or Research: Read Less [-]

BIO ENG N299 Individual Study or Research 1 - 6 Units

Terms offered: Summer 2013 10 Week Session, Summer 2012 10 Week Session, Summer 2009 10 Week Session
Investigations of advanced problems in bioengineering.
Individual Study or Research: Read More [+]
Rules & Requirements

Prerequisites: Graduate standing

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Summer:
6 weeks - 2.5-15 hours of independent study per week
8 weeks - 2-11.5 hours of independent study per week

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

Individual Study or Research: Read Less [-]

BIO ENG 301 Teaching Techniques for Bioengineering 1 Unit

Terms offered: Fall 2022, Fall 2021, Fall 2020
Weekly seminars and discussions of effective teaching techniques. Use of educational objectives, alternative forms of instruction, and special techniques for teaching key concepts and techniques in bioengineering. Course is intended to orient new graduate student instructors to teaching in the Bioengineering department at Berkeley.
Teaching Techniques for Bioengineering: Read More [+]
Rules & Requirements

Prerequisites: Graduate standing

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 1 hour of seminar per week

Additional Details

Subject/Course Level: Bioengineering/Professional course for teachers or prospective teachers

Grading: Offered for satisfactory/unsatisfactory grade only.

Instructor: Johnson

Teaching Techniques for Bioengineering: Read Less [-]