# Bioengineering

The Department of Bioengineering offers a Master of Engineering (MEng) in Bioengineering, PhD in Bioengineering, and a Master of Translational Medicine (MTM). The PhD and MTM are operated in partnership with UC San Francisco, and degrees are granted jointly by UCSF and UC Berkeley.

## Master of Engineering (http://bioeng.berkeley.edu/meng/) (MEng)

The Master of Engineering is a one-year master's degree with a strong emphasis on engineering and entrepreneurship designed for students planning to move directly into industry after completing the program.

## Doctor of Philosophy (http://bioegrad.berkeley.edu/) (PhD)

The PhD in Bioengineering is granted jointly by Berkeley and UCSF, two of the top public universities in the world in engineering and health sciences. Our interdisciplinary program combines the outstanding resources in biomedical and clinical sciences at UCSF with the excellence in engineering, physical, and life sciences at Berkeley.

Administered by the Department of Bioengineering at UC Berkeley and the Department of Bioengineering and Therapeutic Sciences at UCSF, all students in the program are simultaneously enrolled in the graduate divisions of both the San Francisco and Berkeley campuses and are free to take advantage of courses and research opportunities on both campuses. The program awards the PhD in Bioengineering degree from both campuses.

For a full list of our core faculty, visit this page (https://bioegrad.berkeley.edu/faculty/).

## Admission to the Master of Engineering

Please see more information on the department website (http://bioeng.berkeley.edu/meng/).

## Admission to the Master of Translational Medicine

Please see more information about the MTM Program (http://guide.berkeley.edu/graduate/degree-programs/translational-medicine/#admissionstext).

## Admission to the Doctor of Philosophy

Please see detailed guidelines and instructions on the graduate program website (http://bioegrad.berkeley.edu/prospectivegrads/admissions/).

## Admission to the University

### Minimum Requirements for Admission

The following minimum requirements apply to all graduate programs and will be verified by the Graduate Division:

1. A bachelor's degree or recognized equivalent from an accredited institution;
2. A grade point average of B or better (3.0);
3. If the applicant has completed a basic degree from a country or political entity (e.g., Quebec) where English is not the official language, adequate proficiency in English to do graduate work, as evidenced by a TOEFL score of at least 90 on the iBT test, 570 on the paper-and-pencil test, or an IELTS Band score of at least 7 on a 9-point scale (note that individual programs may set higher levels for any of these); and
4. Sufficient undergraduate training to do graduate work in the given field.

### Applicants Who Already Hold a Graduate Degree

The Graduate Council views academic degrees not as vocational training certificates, but as evidence of broad training in research methods, independent study, and articulation of learning. Therefore, applicants who already have academic graduate degrees should be able to pursue new subject matter at an advanced level without the need to enroll in a related or similar graduate program.

Programs may consider students for an additional academic master's or professional master's degree only if the additional degree is in a distinctly different field.

Applicants admitted to a doctoral program that requires a master's degree to be earned at Berkeley as a prerequisite (even though the applicant already has a master's degree from another institution in the same or a closely allied field of study) will be permitted to undertake the second master's degree, despite the overlap in field.

The Graduate Division will admit students for a second doctoral degree only if they meet the following guidelines:

1. Applicants with doctoral degrees may be admitted for an additional doctoral degree only if that degree program is in a general area of knowledge distinctly different from the field in which they earned their original degree. For example, a physics PhD could be admitted to a doctoral degree program in music or history; however, a student with a doctoral degree in mathematics would not be permitted to add a PhD in statistics.
2. Applicants who hold the PhD degree may be admitted to a professional doctorate or professional master's degree program if there is no duplication of training involved.

Applicants may apply only to one single degree program or one concurrent degree program per admission cycle.

### Required Documents for Applications

1. **Transcripts:** Applicants may upload *unofficial* transcripts with your application for the departmental initial review. *If the applicant is admitted,* then *official* transcripts of all college-level work will be required. Official transcripts must be in sealed envelopes as issued by the school(s) attended. If you have attended Berkeley, upload your unofficial transcript with your application for the departmental initial review. *If you are admitted,* an official transcript with evidence of degree conferral *will not* be required.
2. **Letters of recommendation:** Applicants may request online letters of recommendation through the online application system. Hard copies of recommendation letters must be sent directly to the program, not the Graduate Division.
3. **Evidence of English language proficiency:** All applicants who have completed a basic degree from a country or political entity in which the official language is not English are required to submit official evidence of English language proficiency. This applies to institutions from Bangladesh, Burma, Nepal, India, Pakistan, Latin America, the Middle East, the People's Republic of China, Taiwan, Japan,

Korea, Southeast Asia, most European countries, and Quebec (Canada). However, applicants who, at the time of application, have already completed at least one year of full-time academic course work with grades of B or better at a US university may submit an official transcript from the US university to fulfill this requirement. The following courses will not fulfill this requirement:

- courses in English as a Second Language,
- courses conducted in a language other than English,
- courses that will be completed after the application is submitted, and
- courses of a non-academic nature.

If applicants have previously been denied admission to Berkeley on the basis of their English language proficiency, they must submit new test scores that meet the current minimum from one of the standardized tests. Official TOEFL score reports must be sent directly from Educational Test Services (ETS). The institution code for Berkeley is 4833. Official IELTS score reports must be sent electronically from the testing center to University of California, Berkeley, Graduate Division, Sproul Hall, Rm 318 MC 5900, Berkeley, CA 94720. TOEFL and IELTS score reports are only valid for two years.

### Where to Apply

Visit the Berkeley Graduate Division application page (http://grad.berkeley.edu/admissions/apply/).

## Curriculum

In general, the program of study includes a major and a minor field of study. Due to the wide variety of topics included in bioengineering and the variety of student interests, major and minor subfields will be chosen by the student in consultation with their primary graduate adviser, taking into account the student's prior training, research interests, and career goals. Students who already hold a master's or other professional degree (MD, DDS, or DVM) may not be required to complete minor coursework.

Sixteen semester units of graduate-level coursework must be taken in the major field and 8 units of upper division or graduate coursework in the minor field, excluding seminars and research. The course requirements are designed to develop a strong and useful knowledge base in both biology and engineering. Students must also enroll in two graduate seminar courses and complete two semester or three quarter units in ethics.

## Laboratory Rotations

Students should perform three 12-week rotations in different graduate group faculty laboratories during the first year. The objective of the research rotation is to allow students to become familiar with different areas of research, learn new experimental techniques, obtain experience in unique research laboratories, and ultimately to identify a lab in which to conduct dissertation research. The research being performed during a rotation may correspond to the initial stages of a thesis project or may be on an entirely different topic.

## Teaching

Anticipating future careers which may include teaching, all graduate students participate in undergraduate instruction by serving as a Graduate Student Instructor for at least one semester.

## Qualifying Examination

An oral qualifying examination must be taken in the spring of the second year or the fall of the third year. In this examination, students demonstrate their ability to recognize research problems of fundamental importance, to propose appropriate experimental approaches to address these problems and to display comprehensive knowledge of their disciplinary area and related subjects.

## Dissertation Work

After advancing to candidacy, a student meets each fall semester with his or her thesis committee to discuss the dissertation project, to review results, and to chart directions for their third and subsequent years. In the final years in the program, students complete a dissertation based on original laboratory research. It generally takes five and a half years to complete the doctoral program.

Please see the graduate program website for more details. (http://bioegrad.berkeley.edu/currentgrads/program/)

## Core Requirements

Please visit the Bioengineering Department (https://bioeng.berkeley.edu/meng/degree-requirements/) website (http://bioeng.berkeley.edu/meng/degree-requirements/) for an overview of core MEng degree requirements.

## Concentrations

Students earning this degree will choose a track (concentration) of coursework in one of these seven fields. Please follow the links below to see the requirements for each track:

- Bioinformatics and Computational Biology (https://bioeng.berkeley.edu/meng/meng-track-compbio/)
- Biomedical Engineering Design (https://bioeng.berkeley.edu/meng/meng-track-design/)
- Biomedical Imaging (https://bioeng.berkeley.edu/meng/meng-track-imaging/)
- Biomaterials and Devices (https://bioeng.berkeley.edu/meng/meng-track-materials-devices/)
- General Bioengineering and Entrepreneurship (https://bioeng.berkeley.edu/meng/meng-track-general/)
- Mechanobiology (https://bioeng.berkeley.edu/meng/meng-track-mechanobiology/)
- Synthetic Biology (https://bioeng.berkeley.edu/meng/meng-track-synbio/)

## Bioengineering

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

## BIO ENG 200 The Graduate Group Introductory Seminar 1 Unit

Terms offered: Fall 2021, Fall 2020, Fall 2019
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 2022, Spring 2020, Spring 2019
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 2022, Fall 2021, Fall 2020
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 2022, Fall 2021, Fall 2020
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 2022, Fall 2020, Fall 2019
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 2018, Fall 2017, Fall 2016
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: Spring 2019, Spring 2016, Spring 2014
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 2022, Spring 2021, Spring 2020, Spring 2019
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 2022, Spring 2021, Spring 2020, Spring 2019
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 2022, Fall 2021, Fall 2020
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: Fall 2022, Spring 2022, Fall 2021
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: Fall 2020, Spring 2019, Spring 2018
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 2021, Fall 2019, Fall 2017
A survey of the structure and mechanical properties of advanced engineering polymers. Topics include rubber elasticity, viscoelasticity, mechanical properties, yielding, deformation, and fracture mechanisms of various classes of polymers. The course will discuss degradation schemes of polymers and long-term performance issues. The class will include polymer applications in bioengineering and medicine.
Polymer Engineering: Read More [+]
**Rules & Requirements**

**Prerequisites:** Civil Engineering 130, Engineering 45

**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 2021, Fall 2020, Fall 2019
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 2021, Spring 2020, Spring 2019
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 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 2022, Spring 2021, Spring 2020

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 2022, Spring 2021, Spring 2020
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: Not yet offered
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

**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

**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 2022, Spring 2021, Spring 2020

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 2021, Fall 2020, Fall 2019

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 2022, Fall 2020, Fall 2018

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 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 2022, Fall 2021, Fall 2020
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 2021, Spring 2020, Spring 2019
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 2022, Fall 2021, Fall 2020
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 2022, Spring 2020, Spring 2019
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 2021, Spring 2020, Spring 2019, Spring 2017
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 2022, Spring 2021
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 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 2022, Spring 2021, Spring 2020
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 2022, Spring 2021, Spring 2020
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: Fall 2022, Spring 2022, Fall 2021
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 295 Bringing Biomedical Devices to Market 3 Units

Terms offered: Spring 2017
Engineering design is the process by which an idea is generated, developed, constructed, tested, and managed. Typical bioengineering courses often focus on idea conception and construction. True engineering design integrates not only these two essential elements, but also the process of evaluating, planning, and testing a product. This course highlights the context and value of product development: the formalized process bridging the gap between device proof-of-concept and an FDA approved biomedical product in the marketplace. Instructor led lectures and student led case studies and exercises will form the core of the coursework.
Bringing Biomedical Devices to Market: Read More [+]
**Objectives & Outcomes**

**Course Objectives:** To provide students with a fundamental understanding of the biomedical device R&D pathway including: design proof-of-concept, design input/output, design verification and validation, and regulatory approval.

- To give graduates the tools to be leaders in the medtech/biotech industry with a clear understanding of the design development process.
- To give students the opportunity to apply and implement the strategies learned in concurrent leadership and capstone coursework

**Student Learning Outcomes:** Students will gain an understanding of:

- Biomedical Device Design & Development
- Design Risk Analysis
- Design Documentation
- Verification & Validation Testing
- FDA Design Control
- Quality Systems (cGMP)
- Regulatory Clearance/Approval Strategy
- Device Commercialization Pathways

**Rules & Requirements**

**Prerequisites:** Engineering 271 or equivalent recommended

**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:** H. Lam, S. Patel

Bringing Biomedical Devices to Market: 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: Fall 2022, Spring 2022, Fall 2021
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: Fall 2022, Spring 2022, Fall 2021
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: Fall 2022, Summer 2022 Second 6 Week Session, Spring 2022
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 [-]