Bioengineering (BIO ENG)

Courses

BIO ENG 10 Introduction to Biomedicine for Engineers 4 Units
This course is intended for lower division students interested in acquiring a foundation in biomedicine with topics ranging from evolutionary biology to human physiology. The emphasis is on the integration of engineering applications to biology and health. The goal is for undergraduate engineering students to gain sufficient biology and human physiology fundamentals so that they are better prepared to study specialized topics, e.g., biomechanics, imaging, computational biology, tissue engineering, biomonitoring, drug development, robotics, and other topics covered by upper division and graduate courses in UC Berkeley departments of Molecular and Cell Biology, Integrative Biology, Bioengineering, Electrical Engineering and Computer Science, Mechanical Engineering, and courses in the UC San Francisco Division of Bioengineering. The specific lecture topics and exercises will include the key aspects of genomics and proteomics as well as topics on plant and animal evolution, stem cell biomedicine, and tissue regeneration and replacement. Medical physiology topics include relevant engineering aspects of human brain, heart, musculoskeletal, and other systems.
Hours & Format

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

Instructors: Conboy, Kumar

BIO ENG 24 Aspects of Bioengineering 1 Unit
This introductory seminar is designed to give freshmen and sophomores a glimpse of a broad selection of bioengineering research that is currently underway at Berkeley and UCSF. Students will become familiar with bioengineering applications in the various concentration areas and see how engineering principles can be applied to biological and medical problems.
Rules & Requirements

Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

BIO ENG 25 Careers in Biotechnology 1 Unit
This introductory seminar is designed to give freshmen and sophomores an opportunity to explore specialties related to engineering in the pharmaceutical/biotech field. A series of one-hour seminars will be presented by industry professionals, professors, and researchers. Topics may include biotechnology and pharmaceutical manufacturing; process and control engineering; drug inspection process; research and development; compliance and validation; construction process for a GMP facility; project management; and engineered solutions to environmental challenges. This course is of interest to students in all areas of engineering and biology, including industrial engineering and manufacturing, chemical engineering, and bioengineering.
Rules & Requirements

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

BIO ENG 84 Sophomore Seminar 1 or 2 Units
Sophomore seminars are small interactive courses offered by faculty members in departments all across the campus. Sophomore seminars offer opportunity for close, regular intellectual contact between faculty members and students in the crucial second year. The topics vary from department to department and semester to semester. Enrollment limited to 15 sophomores.
Rules & Requirements

Prerequisites: At discretion of instructor

Repeat rules: Course may be repeated for credit as topic varies. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring:
5 weeks - 3-6 hours of seminar per week
10 weeks - 1.5-3 hours of seminar per week
15 weeks - 1-2 hours of seminar per week

Summer:
6 weeks - 2.5-5 hours of seminar per week
8 weeks - 1.5-3.5 hours of seminar and 2-4 hours of seminar per week

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

Grading/Final exam status: The grading option will be decided by the instructor when the class is offered. Final exam required.

BIO ENG 98 Supervised Independent Group Studies 1 - 4 Units
Organized group study on various topics under the sponsorship of a member of the Bioengineering faculty.
Rules & Requirements

Prerequisites: Consent of instructor

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

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

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

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

BIO ENG 99 Supervised Independent Study and Research 1 - 4 Units
Supervised independent study for lower division students.
Rules & Requirements

Prerequisites: Freshman or sophomore standing and consent of instructor

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

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

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

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

BIO ENG 100 Ethics in Science and Engineering 3 Units
The goal of this semester course is to present the issues of professional conduct in the practice of engineering, research, publication, public and private disclosures, and in managing professional and financial conflicts. The method is through historical didactic presentations, case studies, presentations of methods for problem solving in ethical matters, and classroom debates on contemporary ethical issues. The faculty will be drawn from national experts and faculty from religious studies, journalism, and law from the UC Berkeley campus.
Hours & Format

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

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

Instructor: Head-Gordon

BIO ENG 101 Instrumentation in Biology and Medicine 4 Units
This course teaches the fundamental principles underlying modern sensing and control instrumentation used in biology and medicine. The course takes an integrative analytic and hands-on approach to measurement theory and practice by presenting and analyzing example instruments currently used for biology and medical research, including EEG, ECG, pulsed oximeters, Complete Blood Count (CBC), etc.
Rules & Requirements

Prerequisites: Electrical Engineering 100, Mathematics 53, 54, PHYSICS 7A (http://guide.berkeley.edu/search/?P=PHYSICS%207A)-7B, or consent of instructor

Hours & Format

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

Instructor: Conolly

BIO ENG 102 Biomechanics: Analysis and Design 4 Units
This course introduces, develops and applies the methods of continuum mechanics to biomechanical phenomena abundant in biology and medicine. It is intended for upper level undergraduate students who have been exposed to vectors, differential equations, and undergraduate course(s) in physics and certain aspects of modern biology.
Objectives Outcomes

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

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

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

Rules & Requirements

Prerequisites: MATH 53 (http://guide.berkeley.edu/search/?P=MATH%2053), 54; PHYSICS 7A (http://guide.berkeley.edu/search/?P=PHYSICS%207A)

Hours & Format

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

Instructor: Mofrad

BIO ENG 104 Biological Transport Phenomena 4 Units
The transport of mass, momentum, and energy are critical to the function of living systems and the design of medical devices. Biological transport phenomena are present at a wide range of length scales: molecular, cellular, organ (whole and by functional unit), and organism. This course develops and applies scaling laws and the methods of continuum mechanics to biological transport phenomena over a range of length and time scales. The course is intended for undergraduate students who have taken a course in differential equations and an introductory course in physics. Students should be familiar with basic biology; an understanding of physiology is useful, but not assumed.
Rules & Requirements

Prerequisites: Mathematics 53, 54, and PHYSICS 7A (http://guide.berkeley.edu/search/?P=PHYSICS%207A)

Hours & Format

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

Instructor: Johnson

BIO ENG 110 Biomedical Physiology for Engineers 4 Units
This course introduces students to the physiology of human organ systems, with an emphasis on quantitative problem solving, engineering-style modeling, and applications to clinical medicine. The course will begin with a review of basic principles of cellular physiology, including membrane transport and electrophysiology, and then take a system-by-system approach to the physiology of various organ systems, including the cardiovascular, pulmonary, renal, and endocrine systems. Throughout, the course will feature extensive discussions of clinical conditions associated with dysfunction in specific physiological processes as well as the role of medical devices and prostheses. This course is geared towards upper-division bioengineering students who wish to solidify their foundation in physiology, especially in preparation for a career in clinical medicine or the biomedical device industry.
Rules & Requirements

Prerequisites: 10, BIOLOGY 1A (http://guide.berkeley.edu/search/?P=BIOLOGY%201A); MATH 54 (http://guide.berkeley.edu/search/?P=MATH%2054) (may be taken concurrently)

Hours & Format

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

Instructor: Kumar

BIO ENG 111 Functional Biomaterials Development and Characterization 4 Units
This course is intended for upper level engineering undergraduate students interested in the development of novel functional proteins and peptide motifs and characterization of their physical and biological properties using various instrumentation tools in quantitative manners.
Rules & Requirements

Prerequisites: Chemistry 1A or 4A, BIOLOGY 1A (http://guide.berkeley.edu/search/?P=BIOLOGY%201A) and 1AL, Molecular and Cell Biology C100A/Chemistry C130 or Molecular Cell Biology 102

Hours & Format

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

Instructor: SW Lee

BIO ENG 112 Molecular Cell Biomechanics 4 Units
This course develops and applies scaling laws and the methods of continuum and statistical mechanics to biomechanical phenomena over a range of length scales, from molecular to cellular levels. It is intended for senior undergraduate students who have been exposed to differential equations, mechanics, and certain aspects of modern biology.
Rules & Requirements

Prerequisites: Mathematics 54, PHYSICS 7A (http://guide.berkeley.edu/search/?P=PHYSICS%207A), 102, or consent of instructors

Hours & Format

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

Instructor: Mofrad

BIO ENG C112 Molecular Biomechanics and Mechanobiology of the Cell 4 Units
This course applies methods of statistical continuum mechanics to subcellar biomechanical phenomena ranging from nanoscale (molecular) to microscale (whole cell and cell population) biological processes at the interface of mechanics, biology, and chemistry.
Objectives Outcomes

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

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

Rules & Requirements

Prerequisites: MATH 54 (http://guide.berkeley.edu/search/?P=MATH%2054); PHYSICS 7A (http://guide.berkeley.edu/search/?P=PHYSICS%207A); BioE102 or MEC85 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/Undergraduate

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

Instructor: Mofrad

Also listed as: MEC ENG C115

BIO ENG 113 Stem Cells and Technologies 4 Units
This course will teach the main concepts and current views on key attributes of embryonic stem cells (ESC), will introduce theory of their function in embryonic development, methods of ESC derivation, propagation, and characterization, and will discuss currently developing stem cell technologies.
Rules & Requirements

Prerequisites: 10 and BIOLOGY 1A (http://guide.berkeley.edu/search/?P=BIOLOGY%201A), or consent of instructor

Hours & Format

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

Instructor: Conboy

BIO ENG 115 Cell Biology for Engineers 4 Units
This course aims to provide a practical understanding of the nature of cell and tissue biology research. Students will be introduced to cell biology techniques as applied to cells and tissues including immunofluorescence, image analysis, protein quantification, protein expression, gene expression, and cell culture. The course culminates with a group project which synthesizes literature review, experimental design, implementation, troubleshooting, and analysis of results.
Objectives Outcomes

Course Objectives: • To introduce a variety of basic cellular biology laboratory techniques, and develop a conceptual and theoretical understanding of the reliability and limitations of these tools.
• To support students in developing a research question, defining project goals and designing experiments that can be addressed within the constraints of the course.
• To engage students in applying their knowledge and research to others in professional activities such as presentations and papers.

Student Learning Outcomes: Students will gain an understanding of:
• Laboratory safety issues
• Appropriate methods for documenting laboratory procedures
• Phase contrast microscopy
• Fluorescent microscopy
• Image processing
• Cell culture
• Protein quantification, SDS-PAGE, and Western blotting
• Isolation and quantification of mRNA from cells
• RT-PCR
• Data analysis
• Experimental design

Rules & Requirements

Prerequisites: MCB 102 or MCB C100A/CHEM C130 (http://guide.berkeley.edu/search/?P=CHEM%20C130), 110, or 130 or equivalent recommended, or consent of instructor

Hours & Format

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

Instructor: Lam

BIO ENG 116 Cell and Tissue Engineering 4 Units
The goal of tissue engineering is to fabricate substitutes to restore tissue structure and functions. Understanding cell function in response to environmental cues will help us to establish design criteria and develop engineering tools for tissue fabrication. This course will introduce the basic concepts and approaches in the field, and train students to design and engineer biological substitutes. Lectures will be based on the textbook, the reference books and recent literature. Discussion sections will include the discussion of current literature and issues related to course content, homework, exams, and projects. Homework includes quantitative analysis, essay questions, and literature research. There will be a midterm exam, final exam, and a design project (presentation and paper). The final project will be a group project (three to four students) or independent project (required for graduate students). The topic will be chosen by each group and approved by instructor/GSIs.
Rules & Requirements

Prerequisites: 102 and Chemistry C130/Molecular and Cell Biology C100A or equivalent recommended, or consent of instructor

Hours & Format

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

Instructor: Li

BIO ENG C117 Structural Aspects of Biomaterials 4 Units
This course covers the structure and mechanical functions of load bearing tissues and their replacements. Natural and synthetic load-bearing biomaterials for clinical applications are reviewed. Biocompatibility of biomaterials and host response to structural implants are examined. Quantitative treatment of biomechanical issues and constitutive relationships of tissues are covered in order to design biomaterial replacements for structural function. Material selection for load bearing applications including reconstructive surgery, orthopedics, dentistry, and cardiology are addressed. Mechanical design for longevity including topics of fatigue, wear, and fracture are reviewed. Case studies that examine failures of devices are presented. This course includes a teaching/design laboratory component that involves design analysis of medical devices and outreach teaching to the public community. Several problem-based projects are utilized throughout the semester for design analysis. In addition to technical content, this course involves rigorous technical writing assignments, oral communication skill development and teamwork.
Rules & Requirements

Prerequisites: BIOLOGY 1A (http://guide.berkeley.edu/search/?P=BIOLOGY%201A), Engineering 45, Civil and Environmental Engineering 130 or 130N or Bioengineering 102, and Engineering 190

Hours & Format

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

Instructor: Pruitt

Also listed as: MEC ENG C117

BIO ENG C118 Biological Performance of Materials 4 Units
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.
Rules & Requirements

Prerequisites: Engineering 45; Chemisty C130/Mollecular Cell Biology C100A or Engineering 115 or equivalent; Bioengineering 102 & Bioengineering 104 recommended

Hours & Format

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

Instructor: Healy

Also listed as: MAT SCI C118

BIO ENG C119 Orthopedic Biomechanics 4 Units
Statics, dynamics, optimization theory, composite beam theory, beam-on-elastic foundation theory, Hertz contact theory, and materials behavior. Forces and moments acting on human joints; composition and mechanical behavior of orthopedic biomaterials; design/analysis of artificial joint, spine, and fracture fixation prostheses; musculoskeletal tissues including bone, cartilage, tendon, ligament, and muscle; osteoporosis and fracture-risk predication of bones; and bone adaptation. MATLAB-based project to integrate the course material.
Rules & Requirements

Prerequisites: Civil and Environmental Engineering 130 or 130N

Hours & Format

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

Instructor: Keaveny

Also listed as: MEC ENG C176

BIO ENG 121 BioMEMS and Medical Devices 4 Units
Biophysical and chemical principles of biomedical devices, bionanotechnology, bionanophotonics, and biomedical microelectromechanical systems (BioMEMS). Topics include basics of nano- and microfabrication, soft-lithography, DNA arrays, protein arrays, electrokinetics, electrochemical, transducers, microfluidic devices, biosensor, point of care diagnostics, lab-on-a-chip, drug delivery microsystems, clinical lab-on-a-chip, advanced biomolecular probes, etc.
Rules & Requirements

Prerequisites: Chemistry 3A; PHYSICS 7A (http://guide.berkeley.edu/search/?P=PHYSICS%207A) and 7B

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/Undergraduate

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

Instructor: L. Lee

BIO ENG 121L BioMems and BioNanotechnology Laboratory 4 Units
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.
Rules & Requirements

Prerequisites: 102 or 104; 22/22L or Molecular and Cell Biology C100A/Chemistry C130 or equivalent

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

Hours & Format

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

Instructors: L. Lee, Dueck

BIO ENG 124 Basic Principles of Drug Delivery 3 Units
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.
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

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: CHEM 3A (http://guide.berkeley.edu/search/?P=CHEM%203A) and MCB C100A/CHEM C130 (http://guide.berkeley.edu/search/?P=CHEM%20C130)

Hours & Format

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

Instructor: Murthy

BIO ENG 125B Robotic Manipulation and Interaction 4 Units
This course is a sequel to Electrical Engineering C106A/Bioengineering C125, which covers kinematics, dynamics and control of a single robot. This course will cover dynamics and control of groups of robotic manipulators coordinating with each other and interacting with the environment. Concepts will include an introduction to grasping and the constrained manipulation, contacts and force control for interaction with the environment. We will also cover active perception guided manipulation, as well as the manipulation of non-rigid objects. Throughout, we will emphasize design and human-robot interactions, and applications to applications in manufacturing, service robotics, tele-surgery, and locomotion.
Rules & Requirements

Prerequisites: Electrical Engineering C106A/Bioengineering C125 or consent of the instructor

Hours & Format

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

Instructors: Bajcsy, Sastry

Also listed as: EL ENG C106B

BIO ENG C125 Introduction to Robotics 4 Units
An introduction to the kinematics, dynamics, and control of robot manipulators, robotic vision, and sensing. The course covers forward and inverse kinematics of serial chain manipulators, the manipulator Jacobian, force relations, dynamics, and control. It presents elementary principles on proximity, tactile, and force sensing, vision sensors, camera calibration, stereo construction, and motion detection. The course concludes with current applications of robotics in active perception, medical robotics, and other areas.
Rules & Requirements

Prerequisites: EE 120 or equivalent, consent of instructor

Hours & Format

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

Instructor: Bajcsy

Formerly known as: Electrical Engineering C125/Bioengineering C125

Also listed as: EL ENG C106A

BIO ENG 131 Introduction to Computational Molecular and Cell Biology 4 Units
Topics include computational approaches and techniques to gene structure and genome annotation, sequence alignment using dynamic programming, protein domain analysis, RNA folding and structure prediction, RNA sequence design for synthetic biology, genetic and biochemical pathways and networks, UNIX and scripting languages, basic probability and information theory. Various "case studies" in these areas are reviewed; web-based computational biology tools will be used by students and programming projects will be given. Computational biology research connections to biotechnology will be explored.
Rules & Requirements

Prerequisites: Mathematics 53 and BIOLOGY 1A (http://guide.berkeley.edu/search/?P=BIOLOGY%201A) (may be taken concurrently)

Credit Restrictions: Students will receive no credit for 131 after taking 231.

Hours & Format

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

Instructor: Holmes

BIO ENG 132 Genetic Devices 4 Units
This senior-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.
Rules & Requirements

Prerequisites: Engineering 7 or Computer Science 61A, Mathematics 54, Chemistry 3A, and Chemistry C130/Molecular and Cell Biology C100A

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

Hours & Format

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

Instructor: Anderson

BIO ENG 135 Frontiers in Microbial Systems Biology 4 Units
This course is aimed at graduate and advanced undergraduate students from the (bio) engineering and chemo-physical sciences interested in a research-oriented introduction to current topics in systems biology. Focusing mainly on two well studied microbiological model systems--the chemotaxis network and Lambda bacteriophage infection--the class systematically introduces key concepts and techniques for biological network deduction, modelling, analysis, evolution, and synthetic network design. Students analyze the impact of approaches from the quantitative sciences--such as deterministic modelling, stochastic processes, statistics, non-linear dynamics, control theory, information theory, graph theory, etc.--on understanding biological processes, including (stochastic) gene regulation, signalling, network evolution, and synthetic network design. The course aims to identify unsolved problems and discusses possible novel approaches while encouraging students to develop ideas to explore new directions in their own research.
Rules & Requirements

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

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

Hours & Format

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

Instructors: Arkin, Bischofs-Pfeifer, Wolf

BIO ENG C136L Laboratory in the Mechanics of Organisms 3 Units
Introduction to laboratory and field study of the biomechanics of animals and plants using fundamental biomechanical techniques and equipment. Course has a series of rotations involving students in experiments demonstrating how solid and fluid mechanics can be used to discover the way in which diverse organisms move and interact with their physical environment. The laboratories emphasize sampling methodology, experimental design, and statistical interpretation of results. Latter third of course devoted to independent research projects. Written reports and class presentation of project results are required.
Rules & Requirements

Prerequisites: Integrative Biology 135 or consent of instructor; for Electrical Engineering and Computer Science students, Electrical Engineering 105, 120 or Computer Science 184

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

Hours & Format

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

Formerly known as: Integrative Biology 135L

Also listed as: EL ENG C145O/INTEGBI C135L

BIO ENG 140L Synthetic Biology Laboratory 4 Units
This laboratory course is designed as an introduction to research in synthetic biology, a ground-up approach to genetic engineering with applications in bioenergy, heathcare, materials science, and chemical production. In this course, we will design and execute a real research project. Each student will be responsible for designing and constructing components for the group project and then performing experiments to analyze the system. In addition to laboratory work, we will have lectures on methods and design concepts in synthetic biology including an introduction to Biobricks, gene synthesis, computer modeling, directed evolution, practical molecular biology, and biochemistry.
Rules & Requirements

Prerequisites: Molecular biology, basic chemistry and biochemistry, and differential equations; 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/Undergraduate

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

Instructor: Anderson

BIO ENG 143 Computational Methods in Biology 4 Units
An introduction to biophysical simulation methods and algorithms, including molecular dynamics, Monte Carlo, mathematical optimization, and "non-algorithmic" computation such as neural networks. Various case studies in applying these areas in the areas of protein folding, protein structure prediction, drug docking, and enzymatics will be covered. Core Specialization: Core B (Informatics and Genomics); Core D (Computational Biology); BioE Content: Biological.
Rules & Requirements

Prerequisites: MATH 53 (http://guide.berkeley.edu/search/?P=MATH%2053) and Math 54; programming experience preferred but not required

Hours & Format

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

Instructor: Head-Gordon

BIO ENG C144 Introduction to Protein Informatics 4 Units
This course will introduce students to the fundamentals of molecular biology, and to the bioinformatics tools and databases used for the prediction of protein function and structure. It is designed to impart both a theoretical understanding of popular computational methods, as well as some experience with protein sequence analysis methods applied to real data. This class includes no programming, and no programming background is required.
Hours & Format

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

Instructor: Sjolander

Also listed as: PLANTBI C144

BIO ENG C144L Protein Informatics Laboratory 3 Units
This course is intended to introduce students to a variety of bioinformatics techniques that are used to predict protein function and structure. It is designed to be taken concurrently with C144 (which provides the theoretical foundations for the methods used in the laboratory class), although students can petition to take this laboratory course separately. No programming is performed in this class, and no prior programming experience is required.
Rules & Requirements

Prerequisites: Bioengineering C144/Plant and Microbial Biology C144

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/Undergraduate

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

Instructor: Sjolander

Also listed as: PLANTBI C144L

BIO ENG C145L Introductory Electronic Transducers Laboratory 3 Units
Laboratory exercises exploring a variety of electronic transducers for measuring physical quantities such as temperature, force, displacement, sound, light, ionic potential; the use of circuits for low-level differential amplification and analog signal processing; and the use of microcomputers for digital sampling and display. Lectures cover principles explored in the laboratory exercises; construction, response and signal to noise of electronic transducers and actuators; and design of circuits for sensing and controlling physical quantities.
Hours & Format

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

Instructor: Derenzo

Also listed as: EL ENG C145L

BIO ENG C145M Introductory Microcomputer Interfacing Laboratory 3 Units
Laboratory exercises constructing basic interfacing circuits and writing 20-100 line C programs for data acquisition, storage, analysis, display, and control. Use of the IBM PC with microprogrammable digital counter/timer, parallel I/O port. Circuit components include anti-aliasing filters, the S/H amplifier, A/D and D/A converters. Exercises include effects of aliasing in periodic sampling, fast Fourier transforms of basic waveforms, the use of the Hanning filter for leakage reduction, Fourier analysis of the human voice, digital filters, and control using Fourier deconvolution. Lectures cover principles explored in the lab exercises and design of microcomputer-based systems for data acquisitions, analysis and control.
Rules & Requirements

Prerequisites: 40, COMPSCI 61B (http://guide.berkeley.edu/search/?P=COMPSCI%2061B) or a working knowledge of ANSI C programming or consent of instructor

Hours & Format

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

Instructor: Derenzo

Also listed as: EL ENG C145M

BIO ENG 147 Principles of Synthetic Biology 4 Units
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.
Rules & Requirements

Prerequisites: MATH 53 (http://guide.berkeley.edu/search/?P=MATH%2053) and 54; Molecular and Cell Biology C100A/Chemistry C130; or consent of instructor

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

Hours & Format

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

Instructor: Arkin

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

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

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

Rules & Requirements

Prerequisites: Chemistry 3A and Molecular and Cell Biology C100A/Chemistry C130A or equivalent

Hours & Format

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

Instructor: Dueber

BIO ENG 150 Introduction of Bionanoscience and Bionanotechnology 4 Units
This course is intended for the bioengineering or engineering undergraduate students interested in acquiring a background in recent development of bio-nanomaterials and bio-nanotechnology. The emphasis of the class is to understand the properties of biological basis building blocks, their assembly principles in nature, and their application to build functional materials and devices. The goal is for the bioengineering students to gain sufficient chemical and physical aspects of biological materials through the case study of spider webs, silks, sea shells, diatoms, bones, and teeth, as well as recently developed self-assembled nanostructures inspired by nature. The course covers the structures and properties of amino acids, DNAs, sugars, lipids, and their natural and artifical assembly structures. It also covers nanoscale inorganic materials used to develop nano medicines, bio-imaging, bio-sensors, bioelectronics, and machinery.
Rules & Requirements

Prerequisites: BIOLOGY 1A (http://guide.berkeley.edu/search/?P=BIOLOGY%201A) and Chemistry 1A

Hours & Format

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

Instructor: S. W. Lee

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

Prerequisites: Chemistry 3B, PHYSICS 7B (http://guide.berkeley.edu/search/?P=PHYSICS%207B), Bioengineering 102 or Mechanical Engineering 106 or consent of instructor

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

Hours & Format

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

Instructor: Herr

BIO ENG 163 Principles of Molecular and Cellular Biophotonics 4 Units
This course provides undergraduate and graduate bioengineering students with an opportunity to increase their knowledge of topics in the emerging field of biophotonics with an emphasis on fluorescence spectroscopy, biosensors and devices for optical imaging and detection of biomolecules. This course will cover the photophysics and photochemistry of organic molecules, the design and characterization of biosensors and their applications within diverse environments.
Rules & Requirements

Prerequisites: 102 or consent of instructor, Chemistry 3A, and PHYSICS 7B (http://guide.berkeley.edu/search/?P=PHYSICS%207B)

Hours & Format

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

Instructor: Marriott

BIO ENG 163L Molecular and Cellular Biophotonics Laboratory 4 Units
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).
Rules & Requirements

Prerequisites: Bioengineering 163L; experience in a research lab and consent of instructor

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

Hours & Format

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

Instructor: Marriott

BIO ENG 164 Optics and Microscopy 4 Units
This course teaches fundamental principles of optics and examines contemporary methods of optical microscopy for cells and molecules. Students will learn how to design simple optical systems, calculate system performance, and apply imaging techniques including transmission, reflection, phase, and fluorescence microscopy to investigate biological samples. The capabilities of optical microscopy will be compared with complementary techniques including electron microscopy, coherence tomography, and atomic force microscopy. Students will also be responsible for researching their final project outside of class and presenting a specific application of modern microscopy to biological research as part of an end-of-semester project.
Rules & Requirements

Prerequisites: PHYSICS 7A (http://guide.berkeley.edu/search/?P=PHYSICS%207A)-7B or 8A-8B or equivalent introductory physics course

Hours & Format

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

Instructor: Fletcher

BIO ENG C165 Medical Imaging Signals and Systems 4 Units
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.
Rules & Requirements

Prerequisites: Electrical Engineering 20 and Engineering 7 or equivalent; Knowledge of Matlab or linear algebra assumed

Hours & Format

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

Instructor: Conolly

Also listed as: EL ENG C145B

BIO ENG 168L Practical Light Microscopy 3 Units
This laboratory course is designed for students interested in obtaining practical hands-on training in optical imaging and instrumentation. Using a combination of lenses, cameras, and data acquisition equipment, students will construct simple light microscopes that introduce basic concepts and limitations important in biomedical optical imaging. Topics include compound microscopes, Kohler illumination, Rayleigh two-point resolution, image contrast including dark-field and fluorescence microscopy, and specialized techniques such as fluorescence recovery after photobleaching (FRAP). Intended for students in both engineering and the sciences, this course will emphasize applied aspects of optical imaging and provide a base of practical skill and reference material that students can leverage in their own research or in industry.
Hours & Format

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

Instructor: Fletcher

BIO ENG C181 The Berkeley Lectures on Energy: Energy from Biomass 3 Units
After an introduction to the different aspects of our global energy consumption, the course will focus on the role of biomass. The course will illustrate how the global scale of energy guides the biomass research. Emphasis will be placed on the integration of the biological aspects (crop selection, harvesting, storage and distribution, and chemical composition of biomass) with the chemical aspects to convert biomass to energy. The course aims to engage students in state-of-the-art research.
Rules & Requirements

Prerequisites: Chemistry 1B or Chemistry 4B, Mathematics 1B, BIOLOGY 1A (http://guide.berkeley.edu/search/?P=BIOLOGY%201A)

Repeat rules: Repeatable when topic changes with consent of instructor.

Hours & Format

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

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

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

BIO ENG 190 Special Topics in Bioengineering 1 - 4 Units
This course covers current topics of research interest in bioengineering. The course content may vary from semester to semester.
Rules & Requirements

Prerequisites: Consent of instructor

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

BIO ENG 192 Senior Design Projects 4 Units
This semester-long course introduces students to bioengineering project-based learning in small teams, with a strong emphasis on need-based solutions for real medical and research problems through prototype solution selection, design, and testing. The course is designed to provide a "capstone" design experience for bioengineering seniors. The course is structured around didactic lectures, and a textbook, from which assigned readings will be drawn, and supplemented by additional handouts, readings, and lecture material. Where appropriate, the syllabus includes guest lectures from clinicians and practicing engineers from academia and industry. The course includes active learning through organized activities, during which teams will participate in exercises meant to reinforce lecture material through direct application to the team design project.
Rules & Requirements

Prerequisites: Senior standing

Hours & Format

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

Instructor: Herr

BIO ENG H194 Honors Undergraduate Research 3 or 4 Units
Supervised research. Students who have completed 3 or more upper division courses may pursue original research under the direction of one of the members of the staff. May be taken a second time for credit only. A final report or presentation is required. A maximum of 4 units of this course may be used to fulfill the research or technical elective requirement or in the Bioengineering program.
Rules & Requirements

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

Repeat rules: Course may be repeated for a maximum of 8 units.Course may be repeated for a maximum of 8 units.

Hours & Format

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

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

BIO ENG 196 Undergraduate Design Research 4 Units
Supervised research. This course will satisfy the Senior Bioengineering Design project requirement. Students with junior or senior status may pursue research under the direction of one of the members of the staff. May be taken a second time for credit only. A final report or presentation is required.
Rules & Requirements

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

Repeat rules: Course may be repeated for credit once.Course may be repeated for a maximum of 8 units.

Hours & Format

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

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

BIO ENG 198 Directed Group Study for Advanced Undergraduates 1 - 4 Units
Group study of a selected topic or topics in bioengineering, usually relating to new developments.
Rules & Requirements

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

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

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

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

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

BIO ENG 199 Supervised Independent Study 1 - 4 Units
Supervised independent study.
Rules & Requirements

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

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

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

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

Additional Details

Subject/Course Level: Bioengineering/Undergraduate

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

BIO ENG 200 The Graduate Group Introductory Seminar 1 Unit
An introduction to research in bioengineering including specific case studies and organization of this rapidly expanding and diverse field.
Rules & Requirements

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

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

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.

BIO ENG C208 Biological Performance of Materials 4 Units
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.
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: Engineering 45; Chemistry C130/Molecular and Cell Biology C100A or Engineering 115 or equivalent; Bioengineering 102 and 104 recommended

Hours & Format

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

BIO ENG C209 Advanced Orthopedic Biomechanics 4 Units
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.
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

BIO ENG 211 Cell and Tissue Mechanotransduction 3 Units
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.
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

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

BIO ENG C213 Fluid Mechanics of Biological Systems 3 Units
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.
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

BIO ENG C214 Advanced Tissue Mechanics 3 Units
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.
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

BIO ENG C215 Molecular Biomechanics and Mechanobiology of the Cell 4 Units
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.
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 (http://guide.berkeley.edu/search/?P=MATH%2054); PHYSICS 7A (http://guide.berkeley.edu/search/?P=PHYSICS%207A); BioE 102 or ME 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

BIO ENG C216 Macromolecular Science in Biotechnology and Medicine 4 Units
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.
Rules & Requirements

Prerequisites: Bioengineering 115 or equivalent; 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

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

BIO ENG C218 Stem Cells and Directed Organogenesis 3 Units
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.
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: Conboy

Also listed as: MCELLBI C237

BIO ENG C219 Protein Engineering 3 Units
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.
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

BIO ENG 220L Cells and Biomaterials Laboratory 4 Units
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.
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

BIO ENG 221 Advanced BioMEMS and Bionanotechnology 4 Units
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.
Rules & Requirements

Prerequisites: Chemistry 3A, PHYSICS 7A (http://guide.berkeley.edu/search/?P=PHYSICS%207A) and 7B, Electrical Engineering 143 or equivalent

Repeat rules: Students will receive no credit for 221 after taking 121. Course may be repeated for credit when topic changes.

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

BIO ENG 221L BioMEMS and BioNanotechnology Laboratory 4 Units
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.
Rules & Requirements

Prerequisites: 102 or 104; 22/22L or Molecular and Cell Biology C100A/Chemistry C130 or equivalent

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: Dueck, L. Lee

BIO ENG C222 Advanced Structural Aspects of Biomaterials 4 Units
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.
Hours & Format

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

Additional Details

Subject/Course Level: Bioengineering/Graduate

Grading: Letter grade.

Also listed as: MEC ENG C215

BIO ENG C223 Polymer Engineering 3 Units
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.
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

BIO ENG 224 Basic Principles of Drug Delivery 3 Units
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.
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: CHEM 3A (http://guide.berkeley.edu/search/?P=CHEM%203A) and MCB C100A/CHEM C130 (http://guide.berkeley.edu/search/?P=CHEM%20C130)

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

BIO ENG 231 Introduction to Computational Molecular and Cellular Biology 4 Units
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.
Rules & Requirements

Credit Restrictions: Students will receive no credit for 231 after taking 131.

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: Holmes

BIO ENG 232 Genetic Devices 4 Units
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.
Rules & Requirements

Prerequisites: Engineering 7 or Computer Science 61A, Mathematics 54, Chemistry 3A, and Chemistry C130/Molecular and Cell Biology C100A

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

BIO ENG 235 Frontiers in Microbial Systems Biology 4 Units
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.
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

BIO ENG 241 Probabilistic Modeling in Computational Biology 4 Units
This course reviews the statistical and algorithmic foundations of bioinformatics viewed through the lens of paleogenetics, the science of "Jurassic Park", i.e., the reconstruction of ancient genes and genomes by reverse Bayesian inference under various stochastic models of molecular evolution. Such methods, first proposed in the 1960s by Linus Pauling (and others), are now in reach of practical experimentation due to the falling cost of DNA synthesis technology. Applications of these methods are granting insight into the origin of life and of the human species, and may be powerful tools of synthetic biology. Lectures will review the theoretical content; homework and laboratory exercises will involve writing and applying programs for computational reconstruction of ancient protein and DNA sequences and other measurably evolving entities, both biological (e.g., gene families) and otherwise (e.g., natural language).
Rules & Requirements

Prerequisites: Mathematics 53 and 54 or equivalent; Molecular and Cell Biology C100A/C102 or equivalent; programming class 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

BIO ENG 243 Computational Methods in Biology 4 Units
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.
Rules & Requirements

Prerequisites: Mathematics 53 and 54; 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

BIO ENG C244 Introduction to Protein Informatics 4 Units
This course will introduce students to the fundamentals of molecular biology, and to the bioinformatics tools and databases used for the prediction of protein function and structure. It is designed to impart both a theoretical understanding of popular computational methods, as well as some experience with protein sequence analysis methods applied to real data. This class includes no programming, and no programming background required.
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

Also listed as: PLANTBI C244

BIO ENG C244L Protein Informatics Laboratory 3 Units
This course is intended to introduce students to a variety of bioinformatics techniques that are used to predict protein function and structure. It is designed to be taken concurrently with C244 (which provides the theoretical foundations for the methods used in the laboratory class), although students can petition to take this laboratory course separately. No programming is performed in this class, and no prior programming experience is required.
Rules & Requirements

Prerequisites: Bioengineering C244/Plant and Microbial Biology C244

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: Sjolander

Also listed as: PLANTBI C244L

BIO ENG 247 Principles of Synthetic Biology 4 Units
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.
Rules & Requirements

Prerequisites: MATH 53 (http://guide.berkeley.edu/search/?P=MATH%2053) and 54; Molecular and Cell Biology C100A/Chemistry C130; 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

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

Prerequisites: Chemistry 3A and Molecular and Cell Biology C100A/Chemistry 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

BIO ENG C250 Nanomaterials in Medicine 3 Units
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.
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

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

Prerequisites: Chemistry 3B, PHYSICS 7B (http://guide.berkeley.edu/search/?P=PHYSICS%207B), Bioengineering 102, or Mechanical Engineering 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

BIO ENG C261 Medical Imaging Signals and Systems 4 Units
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.
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, the national labs or elsewhere
• students will be hired by companies that create, sell, operate or consult in biomedical imaging

Rules & Requirements

Prerequisites: El Eng 20N and Engineering 7 or equivalent. Knowledge of Matlab or linear algebra assumed

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: Conolly

Also listed as: EL ENG C261

BIO ENG 263 Principles of Molecular and Cellular Biophotonics 4 Units
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.
Rules & Requirements

Prerequisites: 102 or consent of instructor, and Chemistry 3A and PHYSICS 7B (http://guide.berkeley.edu/search/?P=PHYSICS%207B)

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

BIO ENG 263L Molecular and Cellular Biophotonics Laboratory 4 Units
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).
Rules & Requirements

Prerequisites: 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

BIO ENG C265 Principles of Magnetic Resonance Imaging 4 Units
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.
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: Either Electrical Engineering 120 or Bioengineering C165/ Electrical Engineering C145B or consent of instructor

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

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: Lustig, Conolly

Also listed as: EL ENG C225E

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

BIO ENG C280 Introduction to Nano-Science and Engineering 3 Units
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.
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 when topic changes.

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

BIO ENG C281 The Berkeley Lectures on Energy: Energy from Biomass 3 Units
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.
Rules & Requirements

Prerequisites: BIOLOGY 1A (http://guide.berkeley.edu/search/?P=BIOLOGY%201A); Chemistry 1B or 4B, Mathematics 1B

Repeat rules: 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

BIO ENG 290 Advanced Topics in Bioengineering 1 - 4 Units
This course covers current topics of research interest in bioengineering. The course content may vary from semester to semester.
Rules & Requirements

Prerequisites: Consent of instructor

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

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

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.

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

BIO ENG 296 MTM Capstone Project 3 Units
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.
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 when topic changes.

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

BIO ENG 298 Group Studies, Seminars, or Group Research 1 - 8 Units
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.
Rules & Requirements

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

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.

BIO ENG 299 Individual Study or Research 1 - 12 Units
Investigations of advanced problems in bioengineering.
Rules & Requirements

Prerequisites: Graduate standing

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

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.

BIO ENG N299 Individual Study or Research 1 - 6 Units
Investigations of advanced problems in bioengineering.
Rules & Requirements

Prerequisites: Graduate standing

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

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.

BIO ENG 301 Teaching Techniques for Bioengineering 1 Unit
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.
Rules & Requirements

Prerequisites: Graduate standing

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

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