Bioengineering/ Materials Science and Engineering Joint Major

Bachelor of Science (BS)

The joint major programs are designed for students who wish to undertake study in two areas of engineering in order to qualify for employment in either field or for positions in which competence in two fields is required. These curricula include the core courses in each of the major fields. While they require slightly increased course loads, they can be completed in four years. Both majors are shown on the student's transcript of record.

The Bioengineering/Materials Science and Engineering Joint Major is for students who have a keen interest in the field of biomaterials. Students will study the design and synthesis of novel materials that will define new paradigms in biomaterials from the molecular through macroscopic levels, and will also receive a broad –based learning experience that will include exposure to fundamental courses in engineering and life sciences. This joint major aims to allow the student to understand the interface between the two major fields. Students taking this double major will successfully compete for jobs in the field of biomaterials in academe, industry and government.

Admission to the Joint Major

Admission directly to a joint major is closed to freshmen and junior transfer applicants. Students interested in a joint program may apply to change majors during specific times in their academic progress. Please see the College of Engineering joint majors website (http://engineering.berkeley.edu/academics/majors-minors/joint-majors) for complete details.

In addition to the University, campus, and college requirements, listed on the College Requirements tab, students must fulfill the below requirements specific to their major program.

General Guidelines

1. All technical courses (courses in engineering, mathematics, chemistry, physics, statistics, biological sciences, and computer science) must be taken for a letter grade.
2. No more than one upper-division course may be used to simultaneously fulfill requirements for a student's major and minor programs.
3. A minimum overall grade point average (GPA) of 2.0 is required for all work undertaken at UC Berkeley.
4. A minimum GPA of 2.0 is required for all technical courses taken in satisfaction of major requirements.

For information regarding residence requirements and unit requirements, please see the College Requirements tab.

For a detailed plan of study by year and semester, please see the Plan of Study tab.

Lower-division Requirements

MATH 1A	Calculus	4
MATH 1B	Calculus	4
MATH 53	Multivariable Calculus	4
MATH 54	Linear Algebra and Differential Equations	4
CHEM 1A & 1AL	General Chemistry and General Chemistry Laboratory [1]	4
or CHEM 4A	General Chemistry and Quantitative Analysis	
CHEM 3A & 3AL	Chemical Structure and Reactivity and Organic Chemistry Laboratory [1]	5
or CHEM 112A	Organic Chemistry	
PHYSICS 7A	Physics for Scientists and Engineers	4
PHYSICS 7B	Physics for Scientists and Engineers	4
BIOLOGY 1A & 1AL	General Biology Lecture and General Biology Laboratory	5
BIO ENG 10	Introduction to Biomedicine for Engineers [2]	4
BIO ENG 24	Aspects of Bioengineering	1
ENGIN 7	Introduction to Computer Programming for Scientists and Engineers	4
ENGIN 45	Properties of Materials	3
EL ENG 40	Introduction to Microelectronic Circuits	4

1 CHEM 4A and CHEM 112A are intended for students major in chemistry or a closely-related field.

2 Junior transfer admits are exempt from completing BIO ENG 10

Upper-division Requirements

Please note that technical courses listed below fulfill only one requirement.

BIO ENG 102	Biomechanics: Analysis and Design	4
BIO ENG 104	Biological Transport Phenomena	4
BIO ENG 116	Cell and Tissue Engineering	4
or BIO ENG C117	Structural Aspects of Biomaterials	
or BIO ENG 111	Functional Biomaterials Development and Characterization	
BIO ENG C118	Biological Performance of Materials	4
MAT SCI 102	Bonding, Crystallography, and Crystal Defects	3
MAT SCI 104	Materials Characterization	4
MAT SCI 130	Experimental Materials Science and Design	3
or BIO ENG 115	Cell Biology for Engineers	
or BIO ENG 110	Biomedical Physiology for Engineers	
MAT SCI 151	Polymeric Materials	3
or CHM ENG C17	Polymer Science and Technology	
MCELLBI C100A/ CHEM C130	Biophysical Chemistry: Physical Principles and the Molecules of Life	4
or MCELLBI 102	Survey of the Principles of Biochemistry and Molecular Biology	
BIO ENG 110	Biomedical Physiology for Engineers	4
or BIO ENG 113	Stem Cells and Technologies	
ENGIN 115	Engineering Thermodynamics	4

or CHEM 120B	Physical Chemistry	
Select two courses from the following:		
BIO ENG 121	BioMEMS and Medical Devices	
BIO ENG 150	Introduction of Bionanoscience and Bionanotechnology	
MAT SCI 111	Properties of Electronic Materials	
MAT SCI 112	Corrosion (Chemical Properties)	
MAT SCI 113	Mechanical Behavior of Engineering Materials	3
Upper-division Technical Elective: Select one course from the following:		
BIO ENG 113	Stem Cells and Technologies	
BIO ENG 116	Cell and Tissue Engineering	
BIO ENG C117	Structural Aspects of Biomaterials	
BIO ENG 121	BioMEMS and Medical Devices	
BIO ENG H194	Honors Undergraduate Research	
MAT SCI 103	Phase Transformations and Kinetics	
MAT SCI 111	Properties of Electronic Materials	
MAT SCI 112	Corrosion (Chemical Properties)	
MAT SCI 113	Mechanical Behavior of Engineering Materials	
Engineering Design Project or Research: Select one of the following:		
BIO ENG 121L	BioMems and BioNanotechnology Laboratory	
BIO ENG 140L	Synthetic Biology Laboratory	
BIO ENG 168L	Practical Light Microscopy	
BIO ENG 192	Senior Design Projects	
BIO ENG H194	Honors Undergraduate Research	
BIO ENG 196	Undergraduate Design Research	

Students in the College of Engineering must complete 120 semester units with the following provisions:

1. Completion of the requirements of one Engineering major program (http://coe.berkeley.edu/students/guide/departments) of study.

2. A minimum overall grade point average of 2.000 (C average) and a minimum 2.000 grade point average in upper division technical course work required of the major.

3. The final 30 units must be completed in residence in the College of Engineering on the Berkeley campus in two consecutive semesters.

4. All technical courses (math, science & engineering), required of the major or not, must be taken on a letter graded basis (unless they are only offered P/NP).

5. Entering freshman are allowed a maximum of eight semesters to complete their degree requirements. Entering junior transfers are allowed a maximum of four semesters to complete their degree requirements. Summer terms are optional and do not count toward the maximum. Students are responsible for planning and satisfactorily completing all graduation requirements within the maximum allowable semesters.

Humanities and Social Science Requirement
To promote a rich and varied educational experience outside of the technical requirements for each major, the College of Engineering has a Humanities and Social Sciences breadth requirement, which must be completed to graduate. This requirement is built into all the Engineering programs of study. The requirement includes two approved reading and composition courses and four additional approved courses, within which a number of specific conditions must be satisfied.

1. Complete a minimum of six courses (3 units or more) from the approved Humanities/Social Sciences (H/SS) lists (http://coe.berkeley.edu/hssreq) .

2. Two of the six courses must fulfill the Reading and Composition Requirement. These courses must be taken for a letter grade (C- or better required), and MUST be completed by no later than the end of the sophomore year (4th semester of enrollment). The first half of R&C, the “A” course, must be completed by the end of the freshman year; the second half of R&C, the “B “course, by no later than the end of the sophomore year. For detailed lists of courses that fulfill Reading and Composition requirements, please see the Reading and Composition page (http://guide.berkeley.edu/archive/2014-15/undergraduate/colleges-schools/engineering/reading-composition-requirement) in this bulletin.

3. The four additional courses must be chosen from the H/SS comprehensive list. These courses may be taken on a Pass/Not Passed Basis (P/NP).

4. At least two of the six courses must be upper division (courses numbered 100-196).

5. At least two courses must be from the same department and at least one of the two must be upper division. This is called the *Series requirement. AP tests can be combined with a course to complete the series requirement. For example, AP History (any) combined with an upper division History course would satisfy the series requirement

6. One of the six courses must satisfy the campus American Cultures Requirement. For detailed lists of courses that fulfill American Cultures requirements, please see the American Cultures page (http://guide.berkeley.edu/archive/2014-15/undergraduate/colleges-schools/engineering/american-cultures-requirement) in this bulletin.

7. A maximum of two exams (Advanced Placement, International Baccalaureate, or A-Level) may be used toward completion of the H/SS requirement. Visit this link (http://coe.berkeley.edu/exams)

8. No courses offered by an Engineering department (IEOR, CE, etc.) other than BIOE 100, CS C79, ENGIN 125, ENGIN 130AC, 157AC, ME 191K and ME 191AC may be used to complete H/SS requirements.

9. Courses may fulfill multiple categories. For example, if you complete City and Regional Planning 115 and 118AC that would satisfy the series requirement, the two upper division courses requirement and the American Cultures Requirement.

10. The College of Engineering (COE) uses modified versions of five of the College of Letters and Science (L&S) breadth requirements lists to provide options to our students for completing the Humanities and Social Science requirement. Our requirement is different than that of L & S, so the guidelines posted on the top of each L & S breadth list do NOT apply to COE students.

11. Foreign language courses MAY be used to complete H/SS requirements. L & S does not allow students to use many language courses, so their lists will not include all options open to Engineering students. For a list of language options, visit http://coe.berkeley.edu/FL

*NOTE: for the Series Requirement: The purpose of the series requirement is to provide depth of knowledge in a certain area. Therefore, a two-course sequence not in the same department may be approved by

petition, in cases in which there is a clear and logical connection between the courses involved.

For more detailed information regarding the courses listed below (e.g., elective information, GPA requirements, etc.), please see the Major Requirements tab.

				Freshman
	Fall	Units	Spring	Units
Chemistry: CHEM 1A & CHEM 1AL, or CHEM 4A		4	PHYSICS 7A	4
Reading and Composition course from List A		4	MATH 1B	4
MATH 1A		4	ENGIN 7	4
BIO ENG 24		1	Chemistry: CHEM 3A & CHEM 3AL, or CHEM 112A	5
BIO ENG 10		4		
		17		**17**
				Sophomore
	Fall	**Units**	**Spring**	**Units**
PHYSICS 7B		4	BIOLOGY 1A & 1AL	5
ENGIN 45		3	MATH 54	4
MATH 53		4	Humanities/ Social Sciences course	3-4
Reading and Composition course from List B		4	EL ENG 40	4
		15		**16-17**
				Junior
	Fall	**Units**	**Spring**	**Units**
BIO ENG 102		4	BIO ENG 104	4
CHEM 120B or ENGIN 115		3	BIO ENG 100 or Humanities/ Social Sciences course (with ethics content)	3-4
MCELLBI C100A or 102		4	BIO ENG 110 or 113	4
MAT SCI 102		3	MAT SCI 104	4
		14		**15-16**
				Senior
	Fall	**Units**	**Spring**	**Units**
BIO ENG 110, 115, or MAT SCI 130		3-4	BIO ENG 116, C117, or 111	4
BIO ENG C118		4	MAT SCI 111, 112, 113, BIO ENG 121, or BIO ENG 150	3-4
MAT SCI 111, 112, 113, BIO ENG 121, or BIO ENG 150		3-4	Bioengineering Design Project or Research	4
MAT SCI 151		3	Humanities/ Social Sciences course	3-4
Humanities/Social Sciences course		3-4	Technical Elective	3
		16-19		**17-19**

Total Units: 127-134

Bioengineering/Materials Science and Engineering

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-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, 54; PHYSICS 7A

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

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; MATH 54 (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 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, 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; PHYSICS 7A; 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, 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, 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, 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 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 and MCB C100A/CHEM C130

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 (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 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 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 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 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, 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

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-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

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.