Bioengineering

Bachelor of Science (BS)

Rated one of the top 10 bioengineering undergraduate programs in the country, Bioengineering at Berkeley is a multidisciplinary major intended for academically strong students who excel in the physical sciences, mathematics, and biology. Coursework provides a strong foundation in engineering and the biological sciences, with the freedom to explore a variety of topics and specialize in advanced areas of research. All students benefit from intensive group design work, either through a senior capstone project (http://bioeng.berkeley.edu/undergrad/capstone) or through independent research in faculty laboratories. The major features small, specialized upper division courses and direct interaction with faculty.

The stimulating environment of Berkeley offers a wealth of opportunity for learning, research, service, and community involvement, and provides dedicated students the knowledge and skills to become the next leaders in bioengineering.

Bachelor of Science (BS), 120 units

Course of Study Overview

The Department offers one Bioengineering major, with several concentrations. For detailed descriptions of these concentrations, please see the department's website (http://bioeng.berkeley.edu/undergrad/program/concentrations) .

- Biomaterials, Biomechanics and Cell Tissue Engineering
- Biomedical Devices
- Computational Bioengineering
- Biomedical Imaging
- Premed
- Synthetic Biology

Admission to the Major

Prospective undergraduates of the College of Engineering will apply for admission to a specific program in the College. For further information, please see the College of Engineering's website (http://coe.berkeley.edu/students/prospective-students/admissions.html) .

Admission to Engineering via a Change of College application for current UC Berkeley students is highly unlikely and very competitive as there few, if any, spaces open in the College each year to students admitted to other colleges at UC Berkeley. For further information regarding a Change of College to Engineering, please see the College's website (http://coe.berkeley.edu/students/current-undergraduates/change-of-college) .

Minor Program

The Department offers a minor in Bioengineering that is open to all students who are not majoring in Bioengineering and who have completed the necessary prerequisites for the minor. For further information regarding the prerequisites, please see the Minor Requirements tab on this page.

Joint Major

The Department of Bioengineering also offers a joint major with the Department of Materials Science and Engineering, for students who have an interest in the field of biomaterials. For further information regarding this program, please see the Bioengineering/Materials Science and Engineering joint major (http://guide.berkeley.edu/archive/2014-15/undergraduate/degree-programs/bioengineering-materials-science-engineering-joint-major) page in this Bulletin.

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.

Students are advised to consult the approved concentrations (http://bioeng.berkeley.edu/undergrad/program/concentrations) to identify an appropriate course sequence for bioengineering specialty areas and may also design their own program that meets with the below requirements with permission from their faculty advisor. Regular consultation with an advisor is strongly encouraged. Recommended courses for each concentration can be found on the department's website (http://bioeng.berkeley.edu/undergrad/program/concentrations) .

Summary of Major Requirements

A student's course of study must include:

1. 42 units of upper-division coursework in technical subjects such as engineering, chemistry, physics, integrative biology, molecular and cell biology, mathematics, or statistics. Of these units, at least 22 must be in bioengineering.
2. 45 units of engineering (upper- or lower-division). These units must be from courses that appear on the Bioengineering Topics or Engineering Topics lists.

Lower-division Requirements: 48 units
Engineering Biology Preparation: Two courses
Bioengineering Fundamentals: Two courses
Engineering Topics: Two courses
Bioengineering Lab: One course
Bioengineering Topics: Two courses

Technical Electives: Three courses	
Upper-division Biology Elective: One course	
Bioengineering Design Project or Research: One course	

Lower-division Requirements

Select one course from the following:

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
ENGIN 7	Introduction to Computer Programming for Scientists and Engineers	4
or COMPSCI 61A	The Structure and Interpretation of Computer Programs	
BIO ENG 10	Introduction to Biomedicine for Engineers [2]	4
BIO ENG 24	Aspects of Bioengineering	1
BIO ENG 25	Careers in Biotechnology	1
Total Units		48

1. CHEM 4A and CHEM 112A are intended for students majoring in chemistry or a closely-related field.
2. Junior transfer admits are exempt from completing BIO ENG 10

Engineering Biology Preparation

Select two courses from the following:

ENGIN 45	Properties of Materials	3
EL ENG 20N	Course Not Available	
EL ENG 40	Introduction to Microelectronic Circuits	4
or EL ENG 100	Electronic Techniques for Engineering	
CHEM 120B	Physical Chemistry	3
CHEM C130/ MCELLBI C100A	Biophysical Chemistry: Physical Principles and the Molecules of Life	4
CIV ENG C30/ MEC ENG C85	Introduction to Solid Mechanics	3
COMPSCI 61B	Data Structures	4
or COMPSCI 61BI	Data Structures and Programming Methodology	

Bioengineering Fundamentals

Select one course from the following:

BIO ENG 101	Instrumentation in Biology and Medicine	4
BIO ENG 102	Biomechanics: Analysis and Design	4
BIO ENG 104	Biological Transport Phenomena	4
BIO ENG 110	Biomedical Physiology for Engineers	4
BIO ENG 116	Cell and Tissue Engineering	4
BIO ENG 131	Introduction to Computational Molecular and Cell Biology	4
BIO ENG 150	Introduction of Bionanoscience and Bionanotechnology	4

Engineering Topics

Select two courses from the following:

BIO ENG 192	Senior Design Projects	4
BIO ENG H194	Honors Undergraduate Research	3,4
BIO ENG 196	Undergraduate Design Research	4
CHM ENG 140	Introduction to Chemical Process Analysis	4
CHM ENG 141	Chemical Engineering Thermodynamics	4
CHM ENG 150A	Transport Processes	4
CHM ENG 150B	Transport and Separation Processes	4
CHM ENG 170A	Biochemical Engineering	3
CHM ENG 170B	Biochemical Engineering	3
CHM ENG C170L	Biochemical Engineering Laboratory	3
CHM ENG 171	Transport Phenomena	3
CHM ENG C178	Polymer Science and Technology	3
CIV ENG C30/ MEC ENG C85	Introduction to Solid Mechanics	3
CIV ENG 130N	Mechanics of Structures	3
COMPSCI 61A	The Structure and Interpretation of Computer Programs	4
COMPSCI 61B	Data Structures	4
or COMPSCI 61BI	Data Structures and Programming Methodology	
COMPSCI 170	Efficient Algorithms and Intractable Problems	4
COMPSCI 186	Introduction to Database Systems	4
COMPSCI/ PHYSICS C191	Quantum Information Science and Technology	3
ENGIN 7	Introduction to Computer Programming for Scientists and Engineers	4
ENGIN 45	Properties of Materials	3
ENGIN 115	Engineering Thermodynamics	4
ENGIN 170	Course Not Available	4
ENGIN 190	Course Not Available	4
EL ENG 20N	Course Not Available	4
EL ENG 40	Introduction to Microelectronic Circuits	4
EL ENG 100	Electronic Techniques for Engineering	4
EL ENG 105	Microelectronic Devices and Circuits	4
EL ENG 120	Signals and Systems	4
EL ENG 117	Electromagnetic Fields and Waves	4
EL ENG 120	Signals and Systems	4
EL ENG 126	Probability and Random Processes	4
EL ENG 129	Neural and Nonlinear Information Processing	3
EL ENG 142	Integrated Circuits for Communications	4
EL ENG 143	Microfabrication Technology	4
EL ENG 192	Mechatronic Design Laboratory	4
IND ENG 162	Linear Programming	3
MEC ENG C85/ CIV ENG C30	Introduction to Solid Mechanics	3

MEC ENG 102B	Mechatronics Design	4
MEC ENG 104	Engineering Mechanics II	3
MEC ENG 106	Fluid Mechanics	3
MEC ENG 109	Heat Transfer	3
MEC ENG 118	Introduction to Nanotechnology and Nanoscience	3
MEC ENG 119	Introduction to MEMS (Microelectromechanical Systems)	3
MEC ENG 128	Computer-Aided Mechanical Design	3
MEC ENG 132	Dynamic Systems and Feedback	3
MEC ENG 133	Mechanical Vibrations	3
MEC ENG 167	Microscale Fluid Mechanics	3
MEC ENG 185	Introduction to Continuum Mechanics	3
MAT SCI 102	Bonding, Crystallography, and Crystal Defects	3
MAT SCI 104	Materials Characterization	4
MAT SCI 111	Properties of Electronic Materials	4
MAT SCI 113	Mechanical Behavior of Engineering Materials	3
MAT SCI 151	Polymeric Materials	3
NUC ENG 101	Nuclear Reactions and Radiation	4
NUC ENG 107	Introduction to Imaging	3
NUC ENG 170B	Nuclear Design: Design in Bionuclear, Nuclear Medicine, and Radiation Therapy	3
PHYSICS/ COMPSCI C191	Quantum Information Science and Technology	3
any Bioengineering Topics Course		

Bioengineering Lab

Select one course from the following:

BIO ENG 22 & 22L	Course Not Available and Course Not Available	5
BIO ENG 101	Instrumentation in Biology and Medicine	4
BIO ENG 115	Cell Biology for Engineers	4
BIO ENG 121L	BioMems and BioNanotechnology Laboratory	4
BIO ENG C136L	Laboratory in the Mechanics of Organisms	3
BIO ENG 140L	Synthetic Biology Laboratory	4
BIO ENG C144L	Protein Informatics Laboratory	2
BIO ENG C145L	Introductory Electronic Transducers Laboratory	3
BIO ENG C145M	Introductory Microcomputer Interfacing Laboratory	3
BIO ENG 163L	Molecular and Cellular Biophotonics Laboratory	4
BIO ENG 168L	Practical Light Microscopy	3

Bioengineering Topics

Select two courses from the following:

BIO ENG 101	Instrumentation in Biology and Medicine	4
BIO ENG 102	Biomechanics: Analysis and Design	4
BIO ENG 104	Biological Transport Phenomena	4
BIO ENG 110	Biomedical Physiology for Engineers	4
BIO ENG 111	Functional Biomaterials Development and Characterization	4
BIO ENG 112	Molecular Cell Biomechanics	4
BIO ENG 113	Stem Cells and Technologies	4
BIO ENG 115	Cell Biology for Engineers	4
BIO ENG 116	Cell and Tissue Engineering	4
BIO ENG C117	Structural Aspects of Biomaterials	4
BIO ENG C118	Biological Performance of Materials	4
BIO ENG C119	Orthopedic Biomechanics	4
BIO ENG 121	BioMEMS and Medical Devices	4
BIO ENG 121L	BioMems and BioNanotechnology Laboratory	4
BIO ENG C125	Introduction to Robotics	4
BIO ENG 131	Introduction to Computational Molecular and Cell Biology	4
BIO ENG 132	Genetic Devices	4
BIO ENG 135	Frontiers in Microbial Systems Biology	4
BIO ENG C136L	Laboratory in the Mechanics of Organisms	3
BIO ENG 140L	Synthetic Biology Laboratory	4
BIO ENG C144	Introduction to Protein Informatics	4
BIO ENG C144L	Protein Informatics Laboratory	2
BIO ENG C145L	Introductory Electronic Transducers Laboratory	3
BIO ENG C145M	Introductory Microcomputer Interfacing Laboratory	3
BIO ENG C146	Course Not Available	3
BIO ENG 147	Principles of Synthetic Biology	4
BIO ENG 148	Bioenergy and Sustainable Chemical Synthesis: Metabolic Engineering and Synthetic Biology Approaches	3
BIO ENG 150	Introduction of Bionanoscience and Bionanotechnology	4
BIO ENG 151	Micro/Nanofluidics for Bioengineering and Lab-On-A-Chip	4
BIO ENG 163	Principles of Molecular and Cellular Biophotonics	4
BIO ENG 163L	Molecular and Cellular Biophotonics Laboratory	4
BIO ENG 164	Optics and Microscopy	4
BIO ENG C165	Medical Imaging Signals and Systems	4
BIO ENG 168L	Practical Light Microscopy	3
BIO ENG C181	The Berkeley Lectures on Energy: Energy from Biomass	3
Courses numbered BIO ENG 190A-BIO ENG 190H (courses of 3 units or more)		

Technical Electives

Select three courses from the following:

Pre-med students should take BIOLOGY 1B and CHEM 3B/CHEM 3BL.

BIOLOGY 1B	General Biology Lecture and Laboratory	4
CHEM 3B	Chemical Structure and Reactivity	5
CHEM 120A	Physical Chemistry	3
CHEM 120B	Physical Chemistry	3
CHEM C130/ MCELLBI C100A	Biophysical Chemistry: Physical Principles and the Molecules of Life	4
CHEM 130B	Biophysical Chemistry	3
COMPSCI 61B	Data Structures	4
or COMPSCI 61BL	Data Structures and Programming Methodology	
COMPSCI 70	Discrete Mathematics and Probability Theory	4
MATH 55	Discrete Mathematics	4
MATH 110	Linear Algebra	4
MATH 118	Fourier Analysis, Wavelets, and Signal Processing	4
MATH 127	Mathematical and Computational Methods in Molecular Biology	4

MATH 128A	Numerical Analysis	4
MATH 170	Mathematical Methods for Optimization	4
MCELLBI C100A/ CHEM C130	Biophysical Chemistry: Physical Principles and the Molecules of Life	4
NUSCTX 121	Computational Toxicology	3
PHYSICS 7C	Physics for Scientists and Engineers	4
PHYSICS 110A	Electromagnetism and Optics	4
PHYSICS 112	Introduction to Statistical and Thermal Physics	4
PHYSICS 137A	Quantum Mechanics	4
PHYSICS 177	Principles of Molecular Biophysics	3
PHYSICS C191	Quantum Information Science and Technology	3
PB HLTH 143	Course Not Available	4
STAT 133	Concepts in Computing with Data	3
STAT 134	Concepts of Probability	3
or IND ENG 172	Probability and Risk Analysis for Engineers	
STAT 135	Concepts of Statistics	4
STAT 150	Stochastic Processes	3
Bioengineering Topics class, any Engineering Topics class, or any upper-division Biology Elective		

Upper-division Biology Elective

Select one course from the following:

CHEM C130	Biophysical Chemistry: Physical Principles and the Molecules of Life	4
CHEM 135	Chemical Biology	3
INTEGBI 115	Introduction to Systems in Biology and Medicine	4
INTEGBI 127L	Motor Control with Laboratory	3
INTEGBI 131	General Human Anatomy	3
INTEGBI 132	Survey of Human Physiology	4
INTEGBI 135	The Mechanics of Organisms	4
INTEGBI 148	Comparative Animal Physiology	3
INTEGBI 163	Molecular and Genomic Evolution	3
MCELLBI C100A/ CHEM C130	Biophysical Chemistry: Physical Principles and the Molecules of Life	4
MCELLBI 100B	Biochemistry: Pathways, Mechanisms, and Regulation	4
MCELLBI 102	Survey of the Principles of Biochemistry and Molecular Biology	4
MCELLBI 110	Molecular Biology: Macromolecular Synthesis and Cellular Function	4
MCELLBI 111	Course Not Available	4
MCELLBI/ PLANTBI C112	General Microbiology	4
MCELLBI 130A	Cell and Systems Biology	4
MCELLBI 132	Biology of Human Cancer	4
MCELLBI 133L	Physiology and Cell Biology Laboratory	4
MCELLBI 136	Physiology	4
MCELLBI 140	General Genetics	4
MCELLBI 140L	Genetics Laboratory	4
MCELLBI/ PLANTBI C145	Course Not Available	4
MCELLBI/ PLANTBI C148	Microbial Genomics and Genetics	4
MCELLBI 150	Molecular Immunology	4
MCELLBI/ NEUROSC C160	Course Not Available	4
MCELLBI 160L	Neurobiology Laboratory	4
MCELLBI 166	Biophysical Neurobiology	3
NEUROSC/ MCELLBI C160	Course Not Available	4
PLANTBI/ MCELLBI C112	General Microbiology	4
PLANTBI/ MCELLBI C145	Course Not Available	4
PLANTBI/ MCELLBI C148	Microbial Genomics and Genetics	4
PLANTBI 185	Techniques in Light Microscopy	3

Bioengineering Design Project or Research

Select one course from the following:

BIO ENG 121L	BioMems and BioNanotechnology Laboratory	4
BIO ENG 140L	Synthetic Biology Laboratory	4
BIO ENG 168L	Practical Light Microscopy	3
BIO ENG 192	Senior Design Projects	4
BIO ENG H194	Honors Undergraduate Research	3,4
BIO ENG 196	Undergraduate Design Research	4

Minor programs are areas of concentration requiring fewer courses than an undergraduate major. These programs are optional, but can provide depth and breadth to a UC Berkeley education. The College of Engineering does not offer additional time to complete a minor, but it is usually possible to finish within the allotted time with careful course planning. Students are encouraged to meet with their ESS Adviser to discuss the feasibility of completing a minor program.

All the engineering departments offer minors. Students may also consider pursuing a minor in another school or college.

General Guidelines

1. All courses taken to fulfill the minor requirements must be taken for graded credit.
2. A minimum overall grade point average (GPA) of 3.0 and a minimum GPA of 3.0 in the prerequisite courses is required for acceptance into the minor program.
3. A minimum grade point average (GPA) of 2.0 is required for courses used to fulfill the minor requirements.
4. No more than one upper-division course may be used to simultaneously fulfill requirements for a student's major and minor programs.
5. Completion of the minor program cannot delay a student's graduation.

Recommended Preparation

The upper division requirements for the BIOE minor require competency in subject matters covered in the following recommended courses.

CHEM 3A	Chemical Structure and Reactivity	3
PHYSICS 7A	Physics for Scientists and Engineers [1]	4
PHYSICS 7B	Physics for Scientists and Engineers [1]	4
MATH 53	Multivariable Calculus	4
MATH 54	Linear Algebra and Differential Equations	4

[1] Students who have already taken PHYSICS 8A and PHYSICS 8B may substitute them for these courses.

Upper-division Minor Requirements

Bioengineering Fundamentals		
Select one course from the following:		
BIO ENG 101	Instrumentation in Biology and Medicine	
BIO ENG 102	Biomechanics: Analysis and Design	
BIO ENG 104	Biological Transport Phenomena	
BIO ENG 110	Biomedical Physiology for Engineers	
BIO ENG 116	Cell and Tissue Engineering	
BIO ENG 131	Introduction to Computational Molecular and Cell Biology	
BIO ENG 150	Introduction of Bionanoscience and Bionanotechnology	
Technical Elective		
Select one upper-division course from the following:		
CHEM 120A	Physical Chemistry	
CHEM 120B	Physical Chemistry	
CHEM C130	Biophysical Chemistry: Physical Principles and the Molecules of Life	
CHEM 130B	Biophysical Chemistry	
or MCELLBI C130	Biophysical Chemistry: Physical Principles and the Molecules of Life	
MATH 110	Linear Algebra	
MATH 118	Fourier Analysis, Wavelets, and Signal Processing	
MATH 127	Mathematical and Computational Methods in Molecular Biology	
MATH 128A	Numerical Analysis	
MATH 170	Mathematical Methods for Optimization	
NUSCTX 121	Computational Toxicology	
PHYSICS 110A	Electromagnetism and Optics	
PHYSICS 112	Introduction to Statistical and Thermal Physics	
PHYSICS 137A	Quantum Mechanics	
PHYSICS 177	Principles of Molecular Biophysics	
PHYSICS C191	Quantum Information Science and Technology	
PB HLTH 143	Course Not Available	
STAT 133	Concepts in Computing with Data	
STAT 134	Concepts of Probability	
or IND ENG 172	Probability and Risk Analysis for Engineers	
STAT 135	Concepts of Statistics	
STAT 150	Stochastic Processes	
Any Bioengineering topics course (see below), any Engineering Topics course (see below), upper-division biology course		
Engineering Topics		
Select one upper-division course from the Engineering Topics list (see below)		4
Bioengineering Topics		
Select two upper-division courses from the Bioengineering Topics list (see below)		8

Engineering Topics

BIO ENG 192	Senior Design Projects	4
CHM ENG 140	Introduction to Chemical Process Analysis	4
CHM ENG 141	Chemical Engineering Thermodynamics	4
CHM ENG 150A	Transport Processes	4
CHM ENG 150B	Transport and Separation Processes	4
CHM ENG 170A	Biochemical Engineering	3
CHM ENG 170B	Biochemical Engineering	3
CHM ENG 170L	Course Not Available	4
CHM ENG 171	Transport Phenomena	3
CHM ENG C178	Polymer Science and Technology	3
CIV ENG C30/ MEC ENG C85	Introduction to Solid Mechanics	3
CIV ENG 130N	Mechanics of Structures	3
COMPSCI 61A	The Structure and Interpretation of Computer Programs	4
COMPSCI 61B	Data Structures	4
or COMPSCI 61BI	Data Structures and Programming Methodology	
COMPSCI 170	Efficient Algorithms and Intractable Problems	4
COMPSCI 186	Introduction to Database Systems	4
COMPSCI/ PHYSICS C191	Quantum Information Science and Technology	3
ENGIN 7	Introduction to Computer Programming for Scientists and Engineers	4
ENGIN 45	Properties of Materials	3
ENGIN 115	Engineering Thermodynamics	4
ENGIN 170	Course Not Available	4
ENGIN 190	Course Not Available	4
EL ENG 20N	Course Not Available	4
EL ENG 40	Introduction to Microelectronic Circuits	4
EL ENG 100	Electronic Techniques for Engineering	4
EL ENG 105	Microelectronic Devices and Circuits	4
EL ENG 120	Signals and Systems	4
EL ENG 117	Electromagnetic Fields and Waves	4
EL ENG 120	Signals and Systems	4
EL ENG 126	Probability and Random Processes	4
EL ENG 129	Neural and Nonlinear Information Processing	3
EL ENG 142	Integrated Circuits for Communications	4
EL ENG 143	Microfabrication Technology	4
EL ENG 192	Mechatronic Design Laboratory	4
IND ENG 162	Linear Programming	3
MEC ENG C85/ CIV ENG C30	Introduction to Solid Mechanics	3
MEC ENG 102B	Mechatronics Design	4
MEC ENG 104	Engineering Mechanics II	3
MEC ENG 106	Fluid Mechanics	3
MEC ENG 109	Heat Transfer	3
MEC ENG 118	Introduction to Nanotechnology and Nanoscience	3

MEC ENG 119	Introduction to MEMS (Microelectromechanical Systems)	3
MEC ENG 128	Computer-Aided Mechanical Design	3
MEC ENG 132	Dynamic Systems and Feedback	3
MEC ENG 133	Mechanical Vibrations	3
MEC ENG 167	Microscale Fluid Mechanics	3
MEC ENG 185	Introduction to Continuum Mechanics	3
MAT SCI 102	Bonding, Crystallography, and Crystal Defects	3
MAT SCI 104	Materials Characterization	4
MAT SCI 111	Properties of Electronic Materials	4
MAT SCI 113	Mechanical Behavior of Engineering Materials	3
MAT SCI 151	Polymeric Materials	3
NUC ENG 101	Nuclear Reactions and Radiation	4
NUC ENG 107	Introduction to Imaging	3
NUC ENG 170B	Nuclear Design: Design in Bionuclear, Nuclear Medicine, and Radiation Therapy	3
PHYSICS/ COMPSCI C191	Quantum Information Science and Technology	3
Any Bioengineering Topics Course		

Bioengineering Topics

BIO ENG 101	Instrumentation in Biology and Medicine	4
BIO ENG 102	Biomechanics: Analysis and Design	4
BIO ENG 104	Biological Transport Phenomena	4
BIO ENG 110	Biomedical Physiology for Engineers	4
BIO ENG 111	Functional Biomaterials Development and Characterization	4
BIO ENG 112	Molecular Cell Biomechanics	4
BIO ENG 113	Stem Cells and Technologies	4
BIO ENG 115	Cell Biology for Engineers	4
BIO ENG 116	Cell and Tissue Engineering	4
BIO ENG C117	Structural Aspects of Biomaterials	4
BIO ENG C118	Biological Performance of Materials	4
BIO ENG C119	Orthopedic Biomechanics	4
BIO ENG 121	BioMEMS and Medical Devices	4
BIO ENG 121L	BioMems and BioNanotechnology Laboratory	4
BIO ENG C125	Introduction to Robotics	4
BIO ENG 131	Introduction to Computational Molecular and Cell Biology	4
BIO ENG 132	Genetic Devices	4
BIO ENG 135	Frontiers in Microbial Systems Biology	4
BIO ENG C136L	Laboratory in the Mechanics of Organisms	3
BIO ENG 140L	Synthetic Biology Laboratory	4
BIO ENG C144	Introduction to Protein Informatics	4
BIO ENG C144L	Protein Informatics Laboratory	2
BIO ENG C145L	Introductory Electronic Transducers Laboratory	3
BIO ENG C145M	Introductory Microcomputer Interfacing Laboratory	3
BIO ENG C146	Course Not Available	3
BIO ENG 147	Principles of Synthetic Biology	4
BIO ENG 148	Bioenergy and Sustainable Chemical Synthesis: Metabolic Engineering and Synthetic Biology Approaches	3
BIO ENG 150	Introduction of Bionanoscience and Bionanotechnology	4
BIO ENG 151	Micro/Nanofluidics for Bioengineering and Lab-On-A-Chip	4
BIO ENG 163	Principles of Molecular and Cellular Biophotonics	4
BIO ENG 163L	Molecular and Cellular Biophotonics Laboratory	4
BIO ENG 164	Optics and Microscopy	4
BIO ENG C165	Medical Imaging Signals and Systems	4
BIO ENG 168L	Practical Light Microscopy	3
BIO ENG C181	The Berkeley Lectures on Energy: Energy from Biomass	3
Courses numbered BIO ENG 190A-BIO ENG 190H (courses of 3 units or more)		

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	MATH 1B	4
BIO ENG 10		4	CHEM 3A & 3AL	5
Reading and Composition course from List A		4	ENGIN 7	4
MATH 1A		4	BIO ENG 24 or 25 (this requirement can be fulfilled any time)	1
BIO ENG 24 or 25 (this requirement can be fulfilled any time)		1	PHYSICS 7A	4
		17		**18**
				Sophomore
	Fall	**Units**	**Spring**	**Units**
Engineering/Biology Preparation course		3	BIOLOGY 1A & 1AL	5
MATH 53		4	Engineering/ Biology Preparation course	3
PHYSICS 7B		4	MATH 54	4
Reading and Composition course from List B		4		
		15		**12**
				Junior
	Fall	**Units**	**Spring**	**Units**
Bioengineering Fundamentals course		4	Biongineering Fundamentals course	4
Humanities/Social Sciences course		3-4	Technical Elective	3
Engineering Topics course		3	Upper-division Biology elctive	3
Technical Elective		4	BIO ENG 100 or Humanities/ Social Sciences course w/ ethics content	3-4
		14-15		**13-14**
				Senior
	Fall	**Units**	**Spring**	**Units**
Bioengineering Lab course		4	Bioengineering Topics course	4
Bioengineering Topics course		4	Engineering Topics course	4
Technical Elective		3	Bioengineering Design Project or Research	4
Humanities/Social Sciences course		3-4	Humanities/ Social Sciences course	3-4
		14-15		**15-16**

Total Units: 118-122

Mission

The guiding principles of curriculum development in Bioengineering (BioE) are defined in our workload policy as follows: “The Department of Bioengineering will expand the knowledge base in bioengineering through teaching and cross-disciplinary research. Department faculty will be encouraged to develop and teach a modern bioengineering curriculum, to provide hands-on research opportunities for students, and

to provide one-on-one mentor advising to ensure that students select the best combination of coursework to meet their academic goals."

Since our founding in 1998, the BioE faculty have been working to create an integrated, comprehensive program. Much thought has been put into the question: "what does every bioengineer need to know?" The faculty have been engaged in considerable dialog over the years about what needs to be included, in what order, and how to do so in a reasonable time frame. Balancing depth with breadth has been the key challenge, and we have now reached a turning point where the pieces are coming together to form a coherent bioengineering discipline.

Learning Goals for the Major

1. Describe the fundamental principles and methods of engineering
2. Understand the physical, chemical, and mathematical basis of biology
3. Appreciate the different scales of biological systems
4. Apply the physical sciences and mathematics in an engineering approach to biological systems
5. Effectively communicate scientific and engineering data and ideas, both orally and in writing
6. Demonstrate the values of cooperation, teamwork, social responsibility and lifelong learning necessary for success in the field
7. Design a bioengineering solution to a problem of technical, scientific or societal importance
8. Demonstrate advanced knowledge in a specialized field of bioengineering

Bioengineering provides an array of programmatic and individual advising services. Each student is required to consult with a faculty adviser each semester. Our dedicated Bioengineering Undergraduate Affairs Officer is available through appointments or drop-in times to consult on topics such as course selection, degree requirements, concentration selection, and achieving personal and academic goals. Further advising support is available from staff in the Engineering Student Services Office.

Advising Staff and Hours

Undergraduate Adviser:
Cindy Manly-Fields
Phone: 510-642-5860
cmanly@berkeley.edu
306C Stanley Hall
Monday: 9:00am-11:45am
Tuesday-Friday: 9:00am-11:45am; Drop-ins 1:15pm-4:00pm

Summer Biodesign Immersion Experience

UC Berkeley Bioengineering offers an NIH-sponsored summer program using clinical immersion to identify areas where BioE innovation is needed. Summer payroll is provided for the 8-week program which includes intensive needs-finding training and clinical immersion, guest speakers from industry and non-profits, hands-on development and use of biomedical technology, and both oral and written technical communication.

Current UC Berkeley Bioengineering Juniors and Seniors are eligible to apply, with preference given to individuals who either will be enrolled in BIO ENG 192 or who have just completed BIO ENG 192 .

For further information, please see the program's website (http://bioeng.berkeley.edu/biodesign) .

Bioengineering

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.