and aerodynamic properties, as related to the design of harvesting, handling, sorting, and processing equipment. Techniques for measuring and recording physical properties of biological materials. Offered in alternate years. —S. M. McCarthy, Nihin

289A. Selected Topics in Biological Systems Engineering; Animal Systems Engineering (1-5) Variable—1-5 hours. Prerequisite: consent of instructor. Special topics in Animal Systems Engineering. May be repeated for credit when topic differs. —F, W, S (F, W, S)

289B. Selected Topics in Biological Systems Engineering; Aquacultural Engineering (1-5) Variable—1-5 hours. Prerequisite: consent of instructor. Special topics in Aquacultural Engineering. May be repeated for credit when topic differs. —F, W, S (F, W, S)

289C. Selected Topics in Biological Systems Engineering; Forest Systems Engineering (1-5) Variable—1-5 hours. Prerequisite: consent of instructor. Special topics in Forest Systems Engineering. May be repeated for credit when topic differs. —F, W, S (F, W, S)

289D. Selected Topics in Biological Systems Engineering; Energy Systems (1-5) Variable—1-5 hours. Prerequisite: consent of instructor. Special topics in Energy Systems. May be repeated for credit when topic differs. —F, W, S (F, W, S)

289E. Selected Topics in Biological Systems Engineering; Environmental Quality (1-5) Variable—1-5 hours. Prerequisite: consent of instructor. Special topics in Environmental Quality. May be repeated for credit when topic differs. —F, W, S (F, W, S)

289F. Selected Topics in Biological Systems Engineering; Food Engineering (1-5) Variable—1-5 hours. Prerequisite: consent of instructor. Special topics in Food Engineering. May be repeated for credit when topic differs. —F, W, S (F, W, S)

289G. Selected Topics in Biological Systems Engineering; Irrigation and Drainage (1-5) Variable—1-5 hours. Prerequisite: consent of instructor. Special topics in Irrigation and Drainage. May be repeated for credit when topic differs. —F, W, S (F, W, S)

289H. Selected Topics in Biological Systems Engineering; Plant Production and Harvest (1-5) Variable—1-5 hours. Prerequisite: consent of instructor. Special topics in Plant Production and Harvest. May be repeated for credit when topic differs. —F, W, S (F, W, S)

289J. Selected Topics in Biological Systems Engineering; Postharvest Engineering (1-5) Variable—1-5 hours. Prerequisite: consent of instructor. Special topics in Postharvest Engineering. May be repeated for credit when topic differs. —F, W, S (F, W, S)

289K. Selected Topics in Biological Systems Engineering; Sensors and Actuators (1-5) Variable—1-5 hours. Prerequisite: consent of instructor. Special topics in Sensors and Actuators. May be repeated for credit when topic differs. —F, W, S (F, W, S)

290. Seminar (1) Seminar—1 hour. Prerequisite: graduate standing. Weekly seminars on recent advances and selected topics in biological systems engineering. Course theme will change from quarter to quarter. May be repeated for credit. (S/U grading only.)
The minor in Biomedical Engineering is restricted to upper division students. Topics in Biomedical Engineering. (A) Cellular and Molecular Engineering. May be repeated for credit when topic differs. GE credit: SciEng | SE.

98B. Topics in Biomedical Engineering (1-5)
Prerequisite: consent of instructor. Restricted to lower division students. Topics in Biomedical Engineering. (A) Cellular and Molecular Engineering. May be repeated for credit when topic differs. GE credit: SciEng | SE.

99. Special Study for Undergraduates (1-5)
(P/NF grading only) GE credit: SE.
102. Quantitative Cell Biology (4)
Lecture/discussion—4 hours. Prerequisite: Biological Sciences 2A; Chemistry 8B. Open to College of Engineering students. Students applying for this course must demonstrate a strong aptitude in the use and analysis of probability in statistical and experimental contexts. Course is offered only in the Fall, Winter, and Spring quarters. (S.) Facciotti, Revzin

103. Probability and Statistics for Biomedical Engineers (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: C- or better in Mathematics 21D; Engineering 6 (may count as prerequisite). Concepts of probability, random variables, and statistical analysis applied to solving problems in biomedical science. Includes discrete random variables, probability distributions, statistical estimation, hypothesis testing, and confidence intervals. GE credit: SciEng | QL, SE, VL. —(S.) Facciotti

105. Upper Division

109. Biomaterials (4)
Lecture—4 hours. Prerequisite: course 106; Biological Sciences 2A; Chemistry 2C. Restricted to upper division standing. Introduction to the basic techniques in biomolecular engineering. Lectures, laboratory, and assembly, microfluidics and lab-on-a-chip. Weekly laboratory sessions will cover basic techniques of synthetic biology including DNA cloning, bacterial cell culture, gene regulation, protein expression, and data analysis. Offered irregularly. GE credit: SciEng | QL, SE, SL. —(S.) Saiz

110A. Biomedical Engineering Senior Design Experience (3)
Lecture/discussion—1 hour; project—6 hours. Prerequisite: concurrent coursework; course 111 (may be concurrent); consent of instructor. Restricted to senior Biomedical Engineering majors (or by consent of instructor). Application of biotechnology and systems analysis to a design project culminating in the design of a unique solution to a problem. Design may be geared towards current applications in biotechnology or medical technology. Continues in course 110B. (Deferred grading only, pending completion of sequence.) GE credit: SciEng | SE, OL, SL, VL—W. (W.) Pan

110B. Biomedical Engineering Senior Design Experience (3)
Lecture/discussion—1 hour; project—6 hours. Prerequisite: course 110A. Application of biotechnology and systems analysis to a design project culminating in the design of a unique solution to a problem. Design may be geared towards current applications in biotechnology or medical technology. Offered in alternate years. GE credit: SciEng | QL, SE, SL, VL—(S.) Passeri

110L. Biomedical Engineering Senior Design Lab (2)
Laboratory—2 hours; laboratory/discussion—2 hours. Prerequisite: courses 105, 108, 109. Restricted to Biomedical Engineering majors. Lecture—3 hours; discussion—1 hour. Prerequisite: C- or better in course 6; course 20; Mathematics 22B. Restricted to Biomedical Engineering majors only. Mathematical and computational modeling to solve biomedical problems. Topics include stochastic processes and Monte Carlo simulations, and partial differential equations. Introduced to numerical techniques in MATLAB. Offered irregularly. GE credit: SciEng | QL, SE, SL, VL—W. (W.) Tan

111. Biomedical Instrumentation Laboratory (6)
Lecture—4 hours; discussion/labatory—4 hours. Prerequisites: courses 105, and 108; Engineering 100 or Electrical Engineering 100; course 116 or Neurobiology, Physics 101. Open to Biomedical Engineering majors only. Basic biophysical signals and sensors. Topics include analog and digital records using electronic, hydrodynamic, and optical sensors, and medical devices made at cellular, tissue and whole organism level. GE credit: SciEng | SE—F, W. (F, W.) Passeri

116. Physiology for Biomedical Engineers (5)
Lecture—2 hours; discussion—3 hours. Prerequisite: C- or better in Biological Sciences 2A; Physics 9C; Mathematics 22B recommended. Basic human physiology for the nervous, musculoskeletal, cardiovascular, respiratory, gastrointestinal, renal, and endocrine systems. Emphasis on small group design projects and presentaitons in interdisciplinary topics relating biomedical engineering to medical diagnostics and therapeutics. GE credit: SciEng | OL, SE, SL, VL, WE—F—(F.) Silva

117. Analysis of Molecular and Cellular Networks (4)

118. Microelectromechanical Systems (4)
Lecture—2 hours; laboratory—3 hours; discussion—1 hour. Prerequisite: Chemistry 2A; Engineering 17. Restricted to upper division standing in College of Engineering. One restricted to upper division standing in Biomedical Engineering. Introduction to the theory and practice of micro-electromechanical systems (MEMS), including fundamental principles of micro-nano-fabrication, microscale sensing and actuation, self-assembly, microfluidics and lab-on-a-chip. Weekly hands-on laboratory sections are emphasized on implementation and interpretation of MEMS technologies. GE credit: SciEng | SE—S—(S.) Pan

126. Tissue Mechanics (3)
Lecture—2 hours; laboratory/discussion—3 hours. Prerequisite: Exercise Science 103 and/or Engineering 45 and/or consent of instructor. Structural and mechanical properties of biological tissues, including bone, cartilage, ligaments, tendons, nerves, and skeletal muscle. (Same course as Exercise Biology 126.) GE credit: SciEng | QL, QL, SE, SL, WE

140. Protein Engineering (4)

142. Principles and Practices of Biomedical Imaging (4)
Lecture—4 hours. Prerequisite: Mathematics 228, course 108 (may be taken concurrently). Basic physics, engineering principles, and applications of biomedical imaging techniques including x-ray imaging, computed tomography, magnetic resonance imaging, ultrasound, and nuclear imaging. GE credit: SciEng | SE—S. (S.) Cherry

143. Biomolecular Systems Engineering: Synthetic Biology (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: Biological Sciences 2A and Mathematics 22B. Structural, mechanical and dynamic properties of DNA. Topics include DNA structure and their mechanical properties, in vivo topological constraints on DNA, mechanical and thermodynamic equilibria, DNA dynamics, and their roles in normal and pathological biological processes. GE credit: SciEng | SE

151. Mechanics of DNA (3)
Lecture—3 hours. Prerequisite: Biological Sciences 2A and Mathematics 22B. Structural, mechanical and dynamic properties of DNA. Topics include DNA structure and their mechanical properties, in vivo topological constraints on DNA, mechanical and thermodynamic equilibria, DNA dynamics, and their roles in normal and pathological biological processes. GE credit: SciEng | SE

152. Molecular Control of Biosystems (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: Biological Sciences 2A, Physics 9B and Mathematics 228. Fundamentals of molecular biology covering the current methods for quantitative understanding of gene regulation and signal transduction networks at different levels of organization in health and disease. Topics include classic genetic systems, synthetic circuits, and their application in disease and cancer. GE credit: SciEng | OL, SE—S. (S.) Saiz

161A. Biomedical Engineering (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: Biological Sciences 2A; Chemistry 8B. Restricted to upper division standing. Introduction to the fundamental concepts and techniques of biomolecular engineering such as recombinant DNA technology, protein engineering, and molecular diagnostics. Three units of credit for students who have taken course 161S. Offered in alternate years. GE credit: SciEng | QL, SE. —(F.) Tan

161B. Biomedical Engineering Laboratory (3)
Laboratory—4.5 hours; lecture/discussion—1.5 hours. Prerequisite: course 161A or Biological Sciences 101. Introduction to the basic techniques in biomolecular engineering. Lectures, laboratory, and discussion sessions will cover basic techniques of DNA cloning, bacterial cell culture, gene regulation, protein expression, and data analysis. Offered irregularly. GE credit: SciEng | QL, SE, SL
161S. Biomedical Engineering: Brief Course (1)
Lecture. Prerequisite: Basic biology and chemistry. GE credit: SciEng|QL, SE.

162. Introduction to the Biophysics of Molecules and Cells (4)
Lecture—2 hours. Prerequisite: C- or better in Mathematics 22B and Physics 9C. Introduction to fundamental physical mechanisms governing structure and function of bio-macromolecules. Emphasis on a quantitative understanding of the nano- to micrometer scale biomechanical characteristics between and within individual molecules, as well as of their assemblies in particular membranes. GE credit: SciEng|QL, SE, SL, QL.

163. Bioelectricity, Biomechanics, and Signaling Systems (4)
Lecture—3 hours; lecture/discussion—1 hour. Prerequisite: C- or better in Mathematics 22B; course 116 or Neurobiology, Physiology, and Behavior 101. Fundamentals of bioelectricity in cells, the cardiovascular system, and mechanical force generation in muscle. Combination of lecture and projects to provide a learning and hands-on projects using neurons and muscle as microcosms. GE credit: SciEng|QL, SE, SL, VL, QL—S. (S.) Chen/Leiz

167. Biomedical Fluid Mechanics (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: course 106 (may be taken concurrently) or Engineering 103. Basic fluid mechanics, Navier Stokes equations of motion, circulation, respiration and specialized applications including miscellaneous topics such as boundary layer flow. Not open for credit to students who have completed Mechanical Engineering 167C. GE credit: SciEng|QL, SE, SL—S. (S.) Tan

173. Cell and Tissue Engineering (4)
Lecture/discussion—4 hours. Prerequisite: grade of C- or better in courses 106 and 109. Engineering principles to direct cell and tissue behavior and formation. Cell sourcing, controlled delivery of macromolecules, transport within and around biomaterials, bioreactor design, tissue design criteria and outcomes assessment. GE credit: SciEng|QL, SE, SL, WE—F. (F.) Leach

189A. Topics in Biomedical Engineering: Cellular and Molecular Engineering (1-5)
Prerequisite: consent of instructor. Topics in Biomedical Engineering: Cellular and Molecular Engineering. May be repeated if topic differs. Offered irregularly. GE credit: SciEng|QI, SE.

189B. Topics in Biomedical Engineering: Biophysical Sciences (1-5)
Prerequisite: consent of instructor. Topics in Biomedical Engineering: Biomedical Imaging. May be repeated if topic differs. Offered irregularly. GE credit: SciEng|QI.

189C. Topics in Biomedical Engineering: Biomedical Engineering (1-5)
Prerequisite: consent of instructor. Topics in Biomedical Engineering: Biomedical Engineering. May be repeated if topic differs. Offered irregularly. GE credit: SciEng|QI.

190A. Upper Division Seminar in Biomedical Engineering (1)
Seminar—1 hour. Restricted to upper division standing. In depth examination of research topics in a small group setting. Question and answer session with faculty members. May be repeated for credit. (P/NP grading only.) GE credit: SE.

190B. Internship in Biomedical Engineering (1-12)
Internship—3.36 hours. Prerequisite: consent of instructor. Restricted to upper division majors. Super-vised work experience in the Biomedical Engineering field. May be repeated for credit. (P/NP grading only.) GE credit: SE—F, W, S, Su; (F, W, S, Su)

198. Directed Group Study (1-5)
Prerequisite: consent of instructor. May be repeated up to three times. (P/NP grading only.) GE credit: SE—F—W, S, W, F, W, S

199. Special Study for Advanced Undergraduates (1-5)
Prerequisite: consent of instructor. Special study for advanced undergraduates. (P/NP grading only) GE credit: SE.

The Graduate Program in Biomedical Engineering
Doctoral and master’s degrees in Biomedical Engineering are offered through the interdisciplinary Graduate Program in Biomedical Engineering. Please see http://www.bme.ucdavis.edu and Biomedical Engineering (BME) Catalogue page 193 of the catalog for a description of graduate education offerings, requirements, group faculty and research focus.

Graduate
202. Cell and Molecular Biology for Engineers (4)
Lecture/discussion—4 hours. Prerequisite: Biological Sciences 104 or Molecular and Cellular Biology 121. Preparation for research and critical review in the field of cell and molecular biology for biomedical or applied science students. GE credit: SciEng|QI, SE.

204. Physiology for Bioengineers (5)
Lecture—4 hours. Prerequisite: Biological Sciences 1A or equivalent; graduation standing or consent of instructor. Basic human physiology of the nervous, muscular, cardiovascular, respiratory, and renal systems and their interactions; emphasis on the physical and engineering principles governing these systems, including control and transport processes, fluid dynamics, and electrochemistry. (F—F.) Yamada

209. Scientific Integrity for Biomedical Engineers (4)
Lecture—4 hours. Prerequisite: Engineering 45 or equivalent; graduation standing or consent of instructor. Basic human physiology of the nervous, muscular, cardiovascular, respiratory, and renal systems and their interactions; emphasis on the physical and engineering principles governing these systems, including control and transport processes, fluid dynamics, and electrochemistry. (F—F.) Yamada

211. Design of Polynomial Biomaterials and Biological Interfaces (4)
Lecture—4 hours. Prerequisite: Engineering 45 or consent of instructor. Design and analysis of biomaterials. Integration and application of polymer biomaterials. Integration of the principles of polymer science, surface science, materials science and biology. Offered in alternate years. (W—W.) Raveszi

212. Biomedical Heat and Mass Transport Processes (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: Mechanical Engineering 165, Biological Systems Engineering 153 or consent of instructor. Application of principles of heat and mass transfer to biomedical systems related to heat exchange between the biomedical system and its environment, mass transfer across cell membranes and the design and analysis of artificial human organs. (Same course as Mechanical and Aeronautical Engineering 212.) Offered in alternate years. —W. Aldredge

213. Principles and Applications of Biological Sensors (4)
Lecture—4 hours. Prerequisite: Chemistry 2C, Biological sensors based on physical interaction (e.g., enzymes), optical, and affinity detection. Methods for integration of sensing elements with biosensors and miniaturization of biosensors. Offered in alternate years. —F. Revzin

214. Blood Cell Biomechanics (4)

215. Biomedical Fluid Mechanics and Transport Phenomena (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: Engineering 103 or Chemical Engineering 150B or Civil and Environmental Engineering 141. Application of fluid mechanics and transport to biomedical systems. Flow in normal physiological function and pathological conditions. Topics include circulatory and respiratory flows, eddy or flow on cellular processes, transport in the arterial wall and in tumors, and tissue engineering. (Same course as Mechanical and Aeronautical Engineering 215.) Offered irregularly.

216. Advanced Topics in Cellular Engineering (4)
Lecture—4 hours. Prerequisite: course 214 or consent of instructor. Advanced research strategies and technologies used in the study of immune function and inflammation. Static and dynamic measurements of stress, strain, and molecular scale forces in blood and vascular cells, as well as genetic approaches to the study of disease. Offered in alternate years. —F. Simon

217. Mechanobiology in Health and Disease (4)
Lecture/discussion—4 hours. Prerequisite: course 106 or equivalent (e.g., Engineering 103), Biological Sciences 101 or equivalent, Neurobiology, Physiology, and Behavior 101 or equivalent. Principles by which biomechanical forces affect cell and tissue function to impact human health and disease. Emphasis on cardiovascular system: structure and function, biofluid mechanics and nanomechanotransduction, disease mechanisms and research methods. Cartilage, bone and other systems; current topics discussed. —S. Passeri

218. Microsciences (4)
Lecture/discussion—4 hours. Introduction to the theory of physical and chemical principles at the microscopic scale: interpretation of surface tension, microrheological phenomena, micromechanical properties, inter-molecular interactions and micro tribology. (Same course as Electrical and Computer Engineering 2448.)—F. (F.) Pan

222. Cytoskeletal Mechanics (4)
Lecture/discussion—4 hours. Prerequisite: course 202. Current topics in cytoskeletal mechanics including physical properties of the cytoskeleton and motor proteins, molecular force sensor and generator, cyto-skeletal regulation of cell motility and adhesion. Offered in alternate years. —F. (F.) Yamada

233. Multibody Dynamics (4)
Lecture—4 hours. Prerequisite: Engineering 102. Coupled rigid body kinematics/dynamics; reference frames; vector differentiation; configuration and motion constraints; holonomically, generalized speeds; partial velocities; mass, inertia tensor/theorems; angular momenta; generalized forces; comparing Newton/Euler, Lagrange’s, Kane’s methods; computer-aided equation derivation; orientation;
Euler; Rodrigues parameters. (Same course as Mechanical and Aeronautical Engineering 223.)—W. (W.)

225. Spatial Kinematics and Robotics (4)
Lecture—4 hours; laboratory—3 hours. Prerequisite: C Language and course 222. Spatial kinematics, screw theory, spatial mechanisms analysis and synthesis, robot kinematics and dynamics, robot workspace, path planning, robot programming, realtime architecture and software implementation. (Same course as Mechanical and Aeronautical Engineering 225.)—S, Qi

227. Research Techniques in Biomechanics (4)
Lecture—2 hours; laboratory—4 hours; term paper/discussion—1 hour. Prerequisite: consent of instructor, Mathematics 228; Exercise Science 115 recommended. Experimental techniques for biomechanical analysis and visualization of human movement are examined. Techniques evaluated include data acquisition and analysis by computer, force plate analysis, motion analysis, planar- and three-dimensional videography, data reduction and smoothing, body segment parameter determination, electromyography, and biomechanical modeling. (Same course as Mechanical and Aeronautical Engineering 227/Exercise Science 227.)

228. Skeletal Muscle Mechanics: Form, Function, Adaptability (4)
Lecture—4 hours. Prerequisite: basic background in biology, physiology, and engineering; Engineering 35 and 45, Mathematics 21D; Neurobiology, Physiology, and Behavior 101 recommended. Basic structure and function of muscle examined at the microscopic and macroscopic level. Muscle adaptation in response to aging, disease, injury, exercise, and disuse. Analytic models of muscle function are discussed. Offered in alternate years. —F. Hawkins

231. Musculo-Skeletal System Biomechanics (4)
Lecture—4 hours. Prerequisite: Engineering 102. Mechanics of skeletal muscle and mechanical models of muscles, solution of the inverse dynamics problem, theoretical and experimental methods of kinematic and kinetic analysis, computation of intersegmental load and muscle forces, applications to gait analysis and sports biomechanics. (Same course as Mechanical and Aeronautical Engineering 231.)—S.

232. Skeletal Tissue Mechanics (3)
Lecture—3 hours; laboratory—1 hour. Prerequisite: Engineering 104 or equivalent. Analysis of the mechanical properties of the various tissues in the musculoskeletal system, the relationship of these properties to anatomy and histologic structure, and the changes in these properties caused by aging and disuse. The tissues covered include bone, cartilage and synovial fluid, ligament and tendon. (Same course as Mechanical and Aeronautical Engineering 232.)—S. (J.) Fryhie

233. Soft Tissue Mechanics (4)
Lecture—4 hours. Presentation of structure and function of musculoskeletal soft tissues: cartilage, tendon, ligament, meniscus, and intervertebral disc. Instruction in engineering a governing the mechanical behavior of these tissues: viscoelasticity, quasi-linear viscoelasticity, and biphasic theory. Offered in alternate years. —W. Christiansen

239. Advanced Finite Elements and Optimization (4)
Lecture—4 hours. Prerequisite: Engineering 180 or Applied Science 115 or Mathematics 128C. Introduction to advanced finite elements and design optimization, robot kinematics, simulation and modeling of complex mechanical, aerospace and biomedical systems. Application of states of the art in finite elements in optimum design of components under realistic loading conditions and constraints. (Same course as Mechanical Engineering 239.) Offered in alternate years. —(W.) Sarigüel Klin

240. Computational Methods in Nonlinear Mechanics (4)
Lecture—4 hours. Prerequisite: Applied Science Engineering 115 or Mathematics 128B or Engineering 180. Deformation of solids and the motion of fluids treated with state-of-the-art computational methods. Numerical treatment of nonlinear dynamics; classification of coupled problems; applications of finite element methods to mechanical, aeronautical, and biological systems. (Same course as Mechanics and Aeronautical Engineering 240.) Offered in alternate years. —(W.) Sarigüel Klin

241. Introduction to Magnetic Resonance Imaging (3)
Lecture—3 hours. Prerequisite: Physics 9D, Mathematics 21D. Introduction to MR imaging, equipment, methods, medical applications of MRI. Lecture topics: basic principles of MR imaging and nonimaging magnetic resonance. Imaging of the body and diagnostic imaging. (Same course as Mechanical Engineering 240.)—F. (J.)

242. Introduction to Biomedical Imaging (4)
Lecture—4 hours. Prerequisite: Physics 9D and Electrical and Computer Engineering 106 or consent of instructor. Basic physics and engineering principles of medical imaging. Fundamental concepts of linear and non-linear imaging production and interactions with the body and detectors. Major imaging systems: radiography, computed tomography, magnetic resonance, ultrasound, X-ray, and optical microscopy. —F. (R.) Chaudhari

243. Radiation Detectors for Biomedical Applications (4)
Lecture/discussion—3 hours; laboratory—2 hours. Prerequisite: Physics 9D, Mathematics 21D, 228. Radiation detectors and sensors used for biomedical applications. Emphasis on radiation interactions, detection, measurement and use of radiation sensors for imaging. Operating principles of gas, semiconductor, and scintillation detectors. —W. (J.W.) Cherry

246. Magnetic Resonance Technology (3)
Lecture—3 hours. Prerequisite: Physics 9D, Mathematics 21B. Course covers MRI technology at an advanced level with a focus on mathematical descriptions and problem solving. Topics include spin dynamics, signal generation, image reconstruction, pulse sequences, biological basis of T1, T2, 129X, gradient coil design, signal to noise, image artifacts. —F.

251. Medical Image Analysis (4)
Lecture—4 hours. Prerequisite: Electrical and Computer Engineering 106. Techniques for assessing the performance of medical images. Principles of digital image formation and processing. Measures that summarize diagnostic image quality and the performance of human observers viewing those images. Detection and classification of other mathematical observers that may be used to predict performance from system design features. Offered in alternate years. —W. Qi

252. (C) Electromechanical Methods in Biomedical Imaging (4)
Lecture—4 hours. Prerequisite: course 105 or Statistics 120; course 108 or Electrical and Computer Engineering 150A. Analytic tomographic reconstruction from projections and other model-based image reconstruction methods; maximum likelihood and Bayesian methods; applications to CT, PET, and SPECT. (Same course as Electrical and Computer Engineering 205.) Offered in alternate years. —W. Qi

255. Biophotonics in Medicine and the Life Sciences (3)
Lecture—4 hours. Prerequisite: course 101 or Biology 101-105; course 202 highly recommended; graduate standing. Introduction to the science and technology of biomedical optics and photonics, with an overview of applications in medicine and the life sciences. Research is supported by the NSF Center for Biophotonics at UC Davis Medical Center. (Same course as Applied Science 255 and Biophysics 255.) Offered in alternate years.—S. (J.) Chuang

257. Fundamentals of Tissue Optics and Biomedical Applications (5)
Lecture—4 hours; discussion—3 hours; laboratory—3 hours. Fundamentals of optical properties of tissue. Range of optical technologies and their applications to tissue characterization and diagnostics. —S. (J.) Marcu, Wachsmann-Hogiu, Hug

262. Cell and Molecular Biophysics for Bioengineers (4)
Lecture—4 hours. Prerequisite: course 202 or equivalent; graduate standing; undergraduate students by consent of instructor. Introduction to fundamental mechanisms governing the structure, function, and assembly of bio-macromolecules. Emphasis is on a quantitative understanding of the nano-to-microscale interactions between and within individual molecules, as well as of their assemblies and membranes. Not open for credit to students who have completed course 162. —W. (W.) Heinrich

270. Biochemical Systems Theory (4)
Lecture—4 hours. Prerequisite: course 202 concurrently or consent of instructor. Analysis, design, and construction of gene circuits. Modeling strategies, elementary models of design and methods for analyzing designs. Offered in alternate years involving prokaryotic gene circuits to illustrate natural selection, discovery of design principles, and construction of circuits for engineering objectives. —W. (W.) Savageau

271. Gene Circuit Theory (4)
Lecture—4 hours. Prerequisite: course 270 or 202 and consent of instructor. Analysis, design, and construction of gene circuits. Modeling strategies, elementary models of design and methods for analyzing designs. Offered in alternate years involving prokaryotic gene circuits to illustrate natural selection, discovery of design principles, and construction of circuits for engineering objectives. —W. (W.) Savageau

272. Tissue Engineering (3)
Lecture/discussion—3 hours. Prerequisite: Biological Sciences 104 or Molecular and Cellular Biology 121. Based on morphogenetic signals, responding stem cells and extracellular matrix scaffolding. Design and development of tissues for functional restoration of various organs damaged/lost due to cancer, disease and trauma. Fundamentals of morphogenetic signals, responding stem cells and extracellular matrix scaffolding. —W. (J.) Reddi

273. Integrative Tissue Engineering and Technologies (4)
Lecture/discussion—4 hours. Prerequisite: courses 202 and 204 or similar, strongly encourage completion of course 272 although not a prerequisite. Restricted to graduate standing. Engineering principles to direct cell and tissue behavior and formation. Content will include control of morphogenetic molecules, transport within and around biomaterials, examination of mechanical forces of engineered constructs, and current experimental techniques used in the field. —W. (J.) Reddi

281. Acquisition and Analysis of Biomedical Signals (4)
Lecture—3 hours; laboratory—3 hours. Prerequisite: Engineering 100, Statistics 130A. Restricted to upper division engineering students, other graduate students in sciences and engineering, priority given to Biomedical Engineering graduate students. Theoretical applications of linear systems, ordinary and partial differential equations, and probability theory and random processes that describe biological systems and instruments that measure them. Students will be introduced to numerical solution techniques in MATLAB. —W. (W.) Duan
286. Nuclear Imaging in Medicine and Biology (4)
Lecture/discussion—4 hours. Prerequisite: course 243 or consent of instructor. Radioactive decay, interaction of radiation with matter, radionuclide production, radiation detection, digital autoradiography, gamma-camera imaging, single photon emission computed tomography, positron emission tomography and applications of these techniques in biology and medicine. Offered in alternate years. — S. C. Cher

287. Concepts in Molecular Imaging (4)
Lecture—2 hours; lecture/discussion—2 hours; term paper. Prerequisite: Chemistry 2C, Mathematics 21C, Physics 9D, consent of instructor. Current techniques and tools for molecular imaging. Emphasis on learning to apply principles from the physical sciences to imaging problems in medicine and biology. — S. Sultiche

289A. Selected Topics in Biomedical Engineering Research, Systems and Molecular Systems Engineering (1-5)
Variable. Prerequisite: consent of instructor. Selected topics in Cellular and Molecular Systems Engineering. May be repeated for credit when topic differs. — F, W, S. (F, W, S.)

289B. Selected Topics in Biomedical Engineering: Biomedical Imaging (1-5)
Variable. Prerequisite: consent of instructor. Selected topics in Biomedical Imaging. May be repeated for credit when topic differs. — F, W, S. (F, W, S.)

289C. Selected Topics in Biomedical Engineering: Computational Bioengineering (1-5)
Variable. Prerequisite: consent of instructor. Selected topics in Computational Bioengineering. May be repeated for credit when topic differs. — F, W, S. (F, W, S.)

289D. Selected Topics in Biomedical Engineering: Cell and Tissue Biomechanics (1-5)
Variable. Prerequisite: consent of instructor. Selected topics in Cell and Tissue Biomechanics. May be repeated for credit when topic differs. — F, W, S. (F, W, S.)

289E. Selected Topics in Biomedical Engineering: Analysis of Human Movement (1-5)
Variable. Prerequisite: consent of instructor. Selected topics in Analysis of Human Movement. May be repeated for credit when topic differs. — F, W, S. (F, W, S.)

290. Seminar (1)
Seminar—1 hour. Seminar in biomedical engineering. (S/U grading only.)

290C. Graduate Research Conference (1)
Discussion—1 hour. Prerequisite: consent of instructor. Individual and/or group conference on problems, progress, and techniques in biomedical engineering. May be repeated for credit. (S/U grading only.)—F, W, S. (F, W, S.)

298. Directed Group Study (1-5)
Open to graduate students in the Biomedical Engineering Graduate Group, or consent of instructor. Directed group study in Biomedical Engineering. (S/U grading only.)—F, W, S. (F, W, S.)

299. Research (1-12)
(S/U grading only)

Professional

396. Teaching Assistant Training Practicum (1-4)
Prerequisite: graduate standing. May be repeated for credit. (S/U grading only.)—F, W, S. (F, W, S.)

Engineering: Chemical Engineering

(College of Engineering)

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Department Office, 3001 Ghausi Hall 530-752-0400; Fax 530-752-1031; http://cheme.engineering.ucdavis.edu

Faculty

David E. Block, Ph.D., Professor and Endowed Chair (Chemical Engineering; Viticulture and Enology) Academic Senate Distinguished Teaching Award Roger B. Boulton, Ph.D., Professor and Endowed Chair (Chemical Engineering; Viticulture and Enology) Stacie R. Dungan, Ph.D., Professor (Chemical Engineering; Industrial and Technology) Joel El-Far, Ph.D., Professor Academic Senate Distinguished Teaching Award Roland Fuller, Ph.D., Professor Bruce C. Gates, Ph.D., Distinguished Professor Tony L. Kuhl, Ph.D., Professor Academic Senate Distinguished Teaching Award Marjorie L. Longo, Ph.D., Professor Karen A. Mcdonald, Ph.D., Professor Greg Miller, Ph.D., Professor Adam Moule, Ph.D., Associate Professor Alexandra Navrotsky, Ph.D., Distinguished Professor and Endowed Chair (Engineering Materials Science and Engineering; Chemistry; Land, Air and Water Resources) Almert Palazoglu, Ph.D., Professor Ronald J. Phillips, Ph.D., Professor Robert L. Powell, Ph.D., Professor William Ristenpart, Ph.D., Associate Professor Ron Rumerbaugh, Ph.D., Assistant Professor (Chemical Engineering; Viticulture and Enology) Spyros Tsergoulias, Ph.D., Lecturer (Chemical Engineering; Mechanical and Aerospace Engineering) Jason White, Ph.D., Lecturer

Emeriti Faculty

Brian G. Higgins, Ph.D., Professor Emeritus Alan P. Jackman, Ph.D., Professor Emeritus Benjamin J. McCoy, Ph.D., Professor Emeritus Dewey T. Kyu, Ph.D., Professor Emeritus Pietro Levine, Ph.D., Distinguished Professor Academic Senate Distinguished Teaching Award Stephen Whitaker, Ph.D., Professor Emeritus Academic Senate Distinguished Teaching Award

Affiliated Faculty

Lucas Arzola, Ph.D., Assistant Adjunct Professor Cong-Yan Cheng, Ph.D., Adjunct Professor The Department of Chemical Engineering offers two undergraduate programs: Chemical Engineering and Biotechnology.

Mission Statement. To advance, through teaching and research programs, the frontiers of chemical engineering, to educate students with a sense of professionalism and community; and to serve the public of California through outreach efforts.

Honors Program. An Honors Program is available to qualified students in the Chemical Engineering, Biochemical Engineering, and Materials Science and Engineering majors. It is a four-year program designed to challenge the most talented students in these majors. Students invited to participate will take a one-semester honors seminar in their freshman year and will complete all honors courses. In the upper division, students will complete either an honors thesis or a project that might involve local industry (Chemical engineering 194 HA, HB, HC). Students must maintain a grade point average of 3.50 to continue in the program. Successful completion of the Honors Program will be acknowledged on the student's transcript.

Chemical Engineering Undergraduate Program

The Chemical Engineering program is accredited by the Engineering Accreditation Commission of ABET; see http://www.abet.org.

Chemical engineers apply the principles of chemistry and engineering to produce useful commodities, ranging from fuels to polymers. Chemical engineers are increasingly concerned with chemical and engineering processes related to the environment and food production. They work in diverse areas ranging from integrated circuits to integrated waste management. Preparation for a career in chemical engineering requires an understanding of both chemical engineering and chemical principles, proficiency in conceiving, designing, and operating new processes.

The chemical engineering curriculum has been planned to provide a sound knowledge of engineering fundamentals, and to help students to learn to communicate proficiently in writing and oral form.

Students are encouraged to adhere carefully to all prerequisite requirements. The instructor is authorized to drop students from a course for which stated prerequisites have not been completed.

An Honors Program is available to qualified students in the Chemical Engineering major is 156.

Lower Division Required Courses

UNITS

Mathematics 21A:21B:21C:21D................. 16
Mathematics 22A:22B.......................... 9
Physics 9A:9B:9C............................... 15
Chemistry 2A, 2B, 2C or Chemistry 2AH, 2BH, 2CH......................... 15
Chemical Engineering and Materials Science 5, 6, 51, 80.......................... 12
Engineering 45 or 45Y............................ 4
Biotechnology 1 or Biotechnology 1Y or Biological Sciences 2A, 2B, 2C, 2D, 4 or 5
English 3 or University Writing Program 1, 1Y, 1Y, or Comparative Literature 1, 2, 3, or 4, or Native American Studies 5 (grade of C- or better is required)......................... 4

Upper Division Required Courses

Chemistry 110A, 110B, 128A, 128B, 129A ...................................... 16
Chemical Engineering and Materials Science Electives........................................... 8

Choose any upper division courses from the areas of Chemistry (CHE), Chemical Engineering (ECH) or Materials Science and Engineering (EMS). You may receive elective credit up to a maximum of four units for any combination of engineering courses numbered 190C, 192, 198, and 199. Courses may also be selected from the following: Biological Sciences 102, Food Science and Technology 100A, 102A, 102B; Fiber and Polymer Science 150.

Upper Division Composition Requirement

1 or 2 courses from the following (grade of C- or better is required): University Writing Program 102E, 102F, 104A, 104E, 104T