Department of Biomedical Engineering

Zoran Nenadic, Department Chair
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http://www.eng.uci.edu/dept/bme (http://www.eng.uci.edu/dept/bme/)

Biomedical engineering combines engineering expertise with medical needs for the enhancement of health care. It is a branch of engineering in which knowledge and skills are developed and applied to define and solve problems in biology and medicine. Students choose the biomedical engineering field to be of service to people, for the excitement of working with living systems, and to apply advanced technology to the complex problems of medical care. Biomedical engineers may be called upon to design instruments and devices, to bring together knowledge from many sources to develop new procedures, or to carry out research to acquire knowledge needed to solve new problems.

During the last 20 years, we have witnessed unprecedented advances in engineering, medical care, and the life sciences. The combination of exploding knowledge and technology in biology, medicine, the physical sciences, and engineering, coupled with the changes in the way health care will be delivered in the next century, provide a fertile ground for biomedical engineering. Biomedical engineering, at the confluence of these fields, has played a vital role in this progress. Traditionally, engineers have been concerned with inanimate materials, devices, and systems, while life scientists have investigated biological structure and function. Biomedical engineers integrate these disciplines in a unique way, combining the methodologies of the physical sciences and engineering with the study of biological and medical problems. The collaboration between engineers, physicians, biologists, and physical scientists is an integral part of this endeavor and has produced many important discoveries in the areas of artificial organs, artificial implants, and diagnostic equipment.

The Department offers a B.S. in Biomedical Engineering (BME), a four-year engineering curriculum accredited by the Engineering Accreditation Commission of ABET (http://www.abet.org/), http://www.abet.org. This program prepares students for a wide variety of careers in Biomedical Engineering in industry, hospitals, and research laboratories or for further education in graduate school.

The Department also offers a B.S. in Biomedical Engineering: Premedical (BMEP), a four-year engineering curriculum taken with required premedical courses. It is one of many majors that can serve as preparation for further training in medical, veterinary, or allied health professions. It is also suitable for students interested in pursuing graduate work in Biomedical Engineering and other biomedical areas such as physiology, neurosciences, and bioinformatics. The curriculum has less engineering content but more biological sciences and chemistry course work than the Biomedical Engineering major. The undergraduate major in Biomedical Engineering: Premedical is not designed to be accredited, therefore is not accredited by ABET.

Areas of graduate study and research include biophotonics, biomedical nanoscale systems, biomedical computational technologies, and tissue engineering.

- Biomedical Engineering, B.S.
- Biomedical Engineering, M.S.
- Biomedical Engineering, Minor
- Biomedical Engineering, Ph.D.
- Biomedical Engineering: Premedical, B.S.

Faculty

Kyriacos Athanasiou, Ph.D. Columbia University, *Henry Samueli Chair in Engineering and Director of DELTAi (Directing Engineering and Life Science Translational Advances at Irvine) and Distinguished Professor of Biomedical Engineering* (understanding and enhancing the healing processes of musculoskeletal tissues as well as the body's cartilaginous tissues, effecting translation of engineering innovations to clinical use, especially in terms of instruments and devices)

Elliot L. Botvinick, Ph.D. University of California, San Diego, *Professor of Surgery; Biomedical Engineering*

Gregory Brewer, Ph.D. University of California, San Diego, *Adjunct Professor of Biomedical Engineering* (neuronal networks, decoding brain learning and memory, brain-inspired computing, Alzheimer's disease, brain aging, neuron cell culture)

James P. Brody, Ph.D. Princeton University, *Associate Professor of Biomedical Engineering* (bioinformatics, micro-nanoscale systems)

Zhongping Chen, Ph.D. Cornell University, *Professor of Biomedical Engineering; Otolaryngology; Surgery* (biomedical optics, optical coherence tomography, bioMEMS, biomedical devices)

Naomi Chesler, Ph.D. Harvard-MIT Division of Health Sciences and Technology, *Director of The Edwards Lifesciences Center for Advanced Cardiovascular Technology and Professor of Biomedical Engineering* (cardiovascular mechanobiology and biomechanics; engineering education; diversity, equity, and inclusion in STEM)

Bernard H. Choi, Ph.D. University of Texas at Austin, *Professor of Surgery; Biomedical Engineering*

Michelle Digman, Ph.D. University of Illinois at Chicago, *Associate Professor of Biomedical Engineering; Developmental and Cell Biology* (biophotonics, fluorescence Spectroscopy and microscopy, nano-scale imaging, mechanotransduction, cancer cell migration, fluorescence lifetime and metabolic mapping)

Fangyuan Ding, Ph.D. École Normale Supérieure de Paris, *Assistant Professor of Biomedical Engineering; Developmental and Cell Biology; Pharmaceutical Sciences* (quantitative single molecule biology and engineering, systems biology, nucleic-acid based therapies, single cell research tool developments)

Timothy L. Downing, Ph.D. University of California, Berkeley, *Associate Professor of Biomedical Engineering; Microbiology and Molecular Genetics* (stem cells and tissue engineering, regenerative biology, cell programming, epigenomics, mechanobiology)

Anthony J. Durkin, Ph.D. University of Texas at Austin, *Associate Professor of Biomedical Engineering* (spatial frequency domain imaging, wide field functional imaging, quantitative near-infrared spectroscopy of superficial tissues, chemometrics, fluorescence spectroscopy, quantitative spectral imaging)

Enrico Gratton, Ph.D. University of Rome, *Distinguished Professor of Biomedical Engineering; Developmental and Cell Biology; Physics and Astronomy* (design of new fluorescence instruments, protein dynamics, single molecule, fluorescence microscopy, photon migration in tissues)

Anna Grosberg, Ph.D. California Institute of Technology, *Associate Professor of Biomedical Engineering; Chemical and Biomolecular Engineering* (computational modeling of biological systems, biomechanics, cardiac tissue engineering)

Jered Haun, Ph.D. University of Pennsylvania, *Associate Professor of Biomedical Engineering; Chemical and Biomolecular Engineering; Materials Science and Engineering* (nanotechnology, molecular engineering, computational simulations, targeted drug delivery, clinical cancer detection)

Elliot E. Hui, Ph.D. University of California, Berkeley, *Associate Professor of Biomedical Engineering* (microscale tissue engineering, bioMEMS, cell-cell interactions, global health diagnostics)

Tibor Juhasz, Ph.D. Attila József University, *Professor of Ophthalmology; Biomedical Engineering*

Arash Kheradvar, Ph.D. California Institute of Technology, *Professor of Biomedical Engineering; Electrical Engineering and Computer Science; Mechanical and Aerospace Engineering* (cardiac mechanics, cardiovascular devices, cardiac imaging)

Michelle Khine, Ph.D. University of California, Berkeley, *Professor of Biomedical Engineering; Electrical Engineering and Computer Science* (development of novel nano- and micro-fabrication technologies and systems for single cell analysis, stem cell research, in-vitro diagnostics)

Christine King, Ph.D. University of California, Irvine, *Assistant Professor of Teaching of Biomedical Engineering* (engineering and STEM education, active learning, wireless health systems, rehabilitation, brain-computer interfaces, robotics)

Frithjof Kruggel, M.D. Ludwig Maximilian University of Munich, *Professor of Biomedical Engineering* (biomedical signal and image processing, anatomical and functional neuroimaging in humans, structure-function relationship in the human brain)

Abraham P. Lee, Ph.D. University of California, Berkeley, *Chancellor's Professor of Biomedical Engineering; Mechanical and Aerospace Engineering* (integrated point-of-care diagnostics, engineered "theranostic" vesicles and particles, active cell sorting microdevices, microphysiological microsystems, and high throughput droplet bioassays)

Chang C. Liu, Ph.D. Scripps Research Institute, *Professor of Biomedical Engineering; Chemistry; Molecular Biology and Biochemistry* (genetic engineering, directed evolution, synthetic biology, chemical biology)

Wendy F. Liu, Ph.D. Johns Hopkins University, *Professor of Biomedical Engineering; Chemical and Biomolecular Engineering; Molecular Biology and Biochemistry; Pharmaceutical Sciences* (biomaterials, microdevices in cardiovascular engineering, cell-cell and cell-micro-environment interactions, cell functions and controls)

Beth A. Lopour, Ph.D. University of California, Berkeley, *Associate Professor of Biomedical Engineering* (computational neuroscience, signal processing, mathematical modeling, epilepsy, translational research)

Joshua Mauney, Ph.D. Tufts University, *Jerry D. Choate Presidential Chair in Urology Tissue and Engineering and Associate Professor of Urology; Biomedical Engineering*

Thomas Milner, Ph.D. University of Arizona, *Director of Beckman Laser Institute and Medical Clinic and Professor of Biomedical Engineering*

Zoran Nenadic, D.Sc. Washington University, *William J. Link Department Chair and Professor of Biomedical Engineering; Electrical Engineering and Computer Science* (adaptive biomedical signal processing, control algorithms for biomedical devices, brain-machine interfaces, modeling and analysis of biological neural networks)

Ronke Olabisi, Ph.D. University of Wisconsin-Madison, *Associate Professor of Biomedical Engineering* (orthopedic tissue engineering and regenerative medicine for injury, aging, disease, and space flight)

Pia Oomen, Ph.D. Eindhoven University of Technology, *Assistant Professor of Biomedical Engineering* (cardiovascular biomechanics, electrophysiology growth & remodeling, patient-specific modeling)

Daryl Preece, Ph.D. University of Glasgow, *Assistant Professor of Biomedical Engineering* (nano-optics, neuro-photonics, optical forces and mechanotransduction, singular optics, and biophotonics)

William C. Tang, Ph.D. University of California, Berkeley, *Professor of Biomedical Engineering; Chemical and Biomolecular Engineering; Electrical Engineering and Computer Science; Materials Science and Engineering* (micro-electro-mechanical systems (MEMS) nanoscale engineering for biomedical applications, microsystems integration, microimplants, microbiomechanics, microfluidics)

Liangzhong (Shawn) Xiang, Ph.D. South China Normal University, *Associate Professor of Biomedical Engineering; Radiological Sciences*

Affiliate Faculty

Tayloria Adams, Ph.D. Michigan Technological University, *Assistant Professor of Chemical and Biomolecular Engineering; Biomedical Engineering* (dielectrophoresis, microfluidic devices, stem cells, biomarker development, cell membrane biophysics, cell sorting)

Alpesh N. Amin, M.D. M.B.A. Northwestern University, *Department Chair and Thomas and Mary Cesario Endowed Chair in Medicine and Professor of Medicine; Biomedical Engineering; Clinical Pharmacy Practice; Paul Merage School of Business; Population Health and Disease Prevention; Radiological Sciences*

Herdeline Ann Ardoña, Ph.D. John Hopkins University, *Assistant Professor of Chemical and Biomolecular Engineering; Biomedical Engineering; Chemistry* (biomaterials, self-assembly, optoelectronics, stimuli-responsive materials, in vitro tissue models, biosensors)

Pierre F. Baldi, Ph.D. California Institute of Technology, *Director of the Institute for Genomics and Bioinformatics and Distinguished Professor of Computer Science; Biological Chemistry; Biomedical Engineering; Mathematics* (artificial intelligence and machine learning, biomedical informatics, databases and data mining, environmental informatics, statistics and statistical theory)

Kevin T. Beier, Ph.D. Harvard University, *Assistant Professor of Physiology and Biophysics; Biomedical Engineering; Neurobiology and Behavior; Pharmaceutical Sciences* (neuroscience, neural circuits, neural plasticity, molecular neuroscience, behavior, technique development, viral-genetic)

Bruce Blumberg, Ph.D. University of California, Los Angeles, *Professor of Developmental and Cell Biology; Biomedical Engineering; Environmental Health Sciences* (gene regulation by nuclear hormone receptors in vertebrate development physiology, endocrine disruption)

Andrew Browne, M.D., Ph.D. University of Cincinnati, *Health Sciences Assistant Clinical Professor of Ophthalmology; Biomedical Engineering*

Peter J. Burke, Ph.D. Yale University, *Professor of Electrical Engineering and Computer Science; Biomedical Engineering; Materials Science and Engineering* (nano-electronics, bio-nanotechnology)

Hung Cao, Ph.D. University of Texas at Arlington, *Associate Professor of Electrical Engineering and Computer Science; Biomedical Engineering* (MEMS, sensors, implants, heart disease, neurological disease, wireless biomedical systems)

Dan M. Cooper, M.D. University of California, San Francisco, *Senior Associate Dean, Clinical Translational Science and Associate Vice Chancellor, Clinical Translational Research and Professor of Pediatrics; Biomedical Engineering; Pharmaceutical Sciences*

Nancy A. Da Silva, Ph.D. California Institute of Technology, *Professor of Chemical and Biomolecular Engineering; Biomedical Engineering* (molecular biotechnology, metabolic engineering and synthetic biology, eukaryotic expression systems, biorenewable chemicals)

Hamid Djalilian, M.D. University of Minnesota, *Professor of Otolaryngology; Biomedical Engineering*

James Earthman, Ph.D. Stanford University, *Professor of Materials Science and Engineering; Biomedical Engineering* (biomaterials, compositionally complex materials, nanocrystalline alloys, quantitative percussion diagnostics, deformation and damage processes)

Rahim Esfandyarpour, Ph.D. Stanford University, *Assistant Professor of Electrical Engineering and Computer Science; Biomedical Engineering* (nanotechnology and nanoscience, flexible electronics, MEMS and NEMS fabrication and modeling, stretchable and wearable bio devices, translational micro/nanotechnologies, biological and chemical sensors, microfluidics, microelectronics circuits and systems, physiological monitoring, Internet of Things (IOT) bio devices, technology development for personalized/precision medicine, and Point of Care (POC) diagnostics)

Gregory R.D. Evans, M.D. University of Southern California, *Bruce F. Connell Endowed Chair in Plastic Surgery and Department Chair and Professor of Plastic Surgery; Biomedical Engineering; Surgery*

Lisa Flanagan, Ph.D. University of California, San Diego, *Professor of Neurology; Anatomy and Neurobiology; Biomedical Engineering*

Ron D. Frostig, Ph.D. University of California, Los Angeles, *Professor of Neurobiology and Behavior; Biomedical Engineering*

Zhibin Guan, Ph.D. University of North Carolina at Chapel Hill, *Professor of Chemistry; Biomedical Engineering; Chemical and Biomolecular Engineering; Materials Science and Engineering* (chemical biology, organic and synthetic, polymer, materials, nanoscience)

Gultekin Gulsen, Ph.D. Bogazici University, *Associate Professor of Radiological Sciences; Biomedical Engineering; Electrical Engineering and Computer Science; Physics and Astronomy*

Ranjan Gupta, M.D. Albany Medical College, *Professor of Orthopaedic Surgery; Anatomy and Neurobiology; Biomedical Engineering*

Payam Heydari, Ph.D. University of Southern California, *UCI Chancellor's Professor of Electrical Engineering and Computer Science; Biomedical Engineering* (design and analysis of analog, radio-frequency, millimeter-wave and terahertz integrated circuits)

Frank P.K. Hsu, M.D. University of Maryland, College Park, *Department Chair of Physical Medicine and Rehabilitation and Professor of Neurological Surgery; Biomedical Engineering; Otolaryngology*

Lan Huang, Ph.D. University of Florida, *Professor of Physiology and Biophysics; Biological Chemistry; Biomedical Engineering; Pharmaceutical Sciences* (proteomics, mass spectrometry, structural biology, chemical biology, proteasome biology, protein-protein interactions, protein complexes)

Christopher C. Hughes, Ph.D. University of London, *Director of Edwards Lifesciences Center for Advanced Cardiovascular Technology and Professor of Molecular Biology and Biochemistry; Biomedical Engineering* (tissue engineering, growth and patterning of blood vessels)

Kei Igarashi, Ph.D. University of Tokyo, *Associate Professor of Anatomy and Neurobiology; Biomedical Engineering*

James V. Jester, Ph.D. University of Southern California, *Jack H. Skirball Endowed Chair in Ophthalmology Research and Professor of Ophthalmology; Biomedical Engineering*

Joyce H. Keyak, Ph.D. University of California, San Francisco, *Professor of Radiological Sciences; Biomedical Engineering; Mechanical and Aerospace Engineering*

Baruch D. Kuppermann, M.D., Ph.D. University of Miami, *California Institute of Technology, Director, Gavin Herbert Eye Institute; Roger F. Steinart, M.D., Endowed Chair in Ophthalmology and Department Chair and Professor of Ophthalmology; Biomedical Engineering*

Young Jik Kwon, Ph.D. University of Southern California, *Professor of Pharmaceutical Sciences; Biomedical Engineering; Chemical and Biomolecular Engineering; Molecular Biology and Biochemistry* (gene therapy, drug delivery, cancer-targeted therapeutics, artificially-induced cellular vesicles, multi-modal therapies)

Arthur D. Lander, Ph.D. University of California, San Francisco, *Donald Bren Professor and Professor of Developmental and Cell Biology; Biomedical Engineering; Logic and Philosophy of Science* (systems biology of development, pattern formation, growth control)

Guann-Pyng Li, Ph.D. University of California, Los Angeles, *Director of the UCI Division of the California Institute for Telecommunications and Information Technology (Calit2), Director of the Integrated Nanosystems Research Facility and Professor of Electrical Engineering and Computer Science; Biomedical Engineering* (micro/nano technology for sensors and actuators, internet of things (IoT), smart manufacturing, biomedical devices and millimeter wave wireless communication)

Han Li, Ph.D. University of California, Los Angeles, *Associate Professor of Chemical and Biomolecular Engineering; Biomedical Engineering* (metabolic engineering, synthetic biology, biomanufacturing renewable chemicals, protein engineering)

John S. Lowengrub, Ph.D. Courant Institute of Mathematical Sciences, *Chancellor's Professor of Mathematics; Biomedical Engineering* (applied and computational mathematics, mathematical and computational biology)

Ray Luo, Ph.D. University of Maryland, College Park, *Professor of Molecular Biology and Biochemistry; Biomedical Engineering; Chemical and Biomolecular Engineering; Materials Science and Engineering* (protein structure, noncovalent associations involving proteins)

John Middlebrooks, Ph.D. University of California, San Francisco, *Professor of Otolaryngology; Biomedical Engineering; Cognitive Sciences; Neurobiology and Behavior*

Sabee Y. Molloi, Ph.D. University of Wisconsin-Madison, *Professor of Radiological Sciences; Biomedical Engineering; Electrical Engineering and Computer Science*

Jogeshwar Mukherjee, Ph.D. Jodhpur National University, *Professor in Residence of Radiological Sciences; Biomedical Engineering*

J. Stuart Nelson, Ph.D. University of California, Irvine, *Professor of Surgery; Biomedical Engineering*

Qing Nie, Ph.D. Ohio State University, *Director of the NSF-Simons Center for Multiscale Cell Fate Research and Distinguished Professor of Mathematics; Biomedical Engineering; Developmental and Cell Biology* (applied and computational mathematics, mathematical and computational biology)

Brian Paegel, Ph.D. University of California, Berkeley, *Associate Dean of Research and Professor of Pharmaceutical Sciences; Biomedical Engineering; Chemistry* (chemical biology, drug discovery, drug discovery, miniaturization, evolution)

Pranav Patel, M.D. Saint Louis University, *Chief, Division of Cardiology; Director of Cardiac Catheterization Laboratory and Cardiac Care Unit (CCU) and Health Sciences Associate Clinical Professor of Medicine; Biomedical Engineering*

Medha Pathak, Ph.D. University of California, Berkeley, *Assistant Professor of Physiology and Biophysics; Biomedical Engineering* (piezo1, ion channels, stem cells, neural stem cells, differentiation, development, mechanical forces, matrix, environment)

Eric Potma, Ph.D. University of Groningen, *Professor of Chemistry; Biomedical Engineering; Electrical Engineering and Computer Science* (analytical, chemical biology, physical chemistry and chemical physics)

David J. Reinkensmeyer, Ph.D. University of California, Berkeley, *Professor of Anatomy and Neurobiology; Biomedical Engineering; Mechanical and Aerospace Engineering; Physical Medicine and Rehabilitation*

Terence Sanger, M.D. Harvard Medical School, *Vice President and Chief Scientific Officer for Children's Hospital Orange County and Professor of Electrical Engineering and Computer Science; Biomedical Engineering*

Phillip C-Y Sheu, Ph.D. University of California, Berkeley, *Professor of Electrical Engineering and Computer Science; Biomedical Engineering; Computer Science* (semantic computing, robotic computing, artificial intelligence, biomedical computing, multimedia computing)

Xiaoyu Shi, Ph.D. University of California, Davis, *Assistant Professor of Chemistry; Biomedical Engineering; Developmental and Cell Biology* (super-resolution microscopy)

Andrei M. Shkel, Ph.D. University of Wisconsin-Madison, *Professor of Mechanical and Aerospace Engineering; Biomedical Engineering; Electrical Engineering and Computer Science* (design and advanced control of micro-electro-mechanical systems (MEMS); high precision micro-machined gyroscopes; MEMS-enhanced optical systems, tools and prosthetic appliances; electromechanical and machine-information systems integration)

Seunghyun Sim, Ph.D. The University of Tokyo, Japan, *Assistant Professor of Chemistry; Biomedical Engineering; Chemical and Biomolecular Engineering* (chemical biology, organic and synthetic, polymer, materials and nanoscience)

Zuzanna S. Siwy, Ph.D. Silesian University of Technology, *Professor of Physics and Astronomy; Biomedical Engineering; Chemistry*

Quinton Smith, Ph.D. John Hopkins University, *Assistant Professor of Chemical and Biomolecular Engineering; Biomedical Engineering* (pluripotent stem cells, regenerative medicine, organoids, microfluidics, tissue engineering)

Ramesh Srinivasan, Ph.D. Tulane University, *Professor of Cognitive Sciences; Biomedical Engineering* (perception, attention, decision-making, cognitive and clinical neuroscience)

Julian F. Thayer, Ph.D. New York University, *Distinguished Professor of Psychological Science; Biomedical Engineering* (health psychology, psychopathology, health disparities, heart rate variability, emotions, stress)

Peter Tseng, Ph.D. University of California, Los Angeles, *Associate Professor of Electrical Engineering and Computer Science; Biomedical Engineering* ((bio) Micro-Electro-Mechanical systems, wearable technology, materials-by-design, bioelectromagnetism, nanotechnology)

Vasan Venugopalan, Sc.D. Massachusetts Institute of Technology, *Department Chair and Professor of Chemical and Biomolecular Engineering; Biomedical Engineering; Mechanical and Aerospace Engineering; Surgery* (laser-generated thermal, mechanical and radiative transport processes for application in medical diagnostics, imaging, therapeutics, biotechnology)

Szu-Wen Wang, Ph.D. Stanford University, *Professor of Chemical and Biomolecular Engineering; Biomedical Engineering* (bioinspired materials, immunomodulatory materials, nanoparticle vaccines, therapeutics, protein engineering, drug delivery)

H. Kumar Wickramasinghe, Ph.D. University of London, *Henry Samueli Endowed Chair in Engineering and Professor Emeritus of Electrical Engineering and Computer Science; Biomedical Engineering; Materials Science and Engineering* (nanoscale measurements and characterization, scanning probe microscopy, storage technology, nano-bio measurement technology)

Brian J-F Wong, M.D. Johns Hopkins University, *Professor of Otolaryngology; Biomedical Engineering*

Xiangmin Xu, Ph.D. Vanderbilt University, *Chancellor's Professor of Anatomy and Neurobiology; Biomedical Engineering; Computer Science*

Albert Fan Yee, Ph.D. University of California, Berkeley, *Professor Emeritus of Chemical and Biomolecular Engineering; Biomedical Engineering*

Fan-Gang Zeng, Ph.D. Syracuse University, *Director of Hearing Research and Professor of Otolaryngology; Anatomy and Neurobiology; Biomedical Engineering; Cognitive Sciences*

Zhuoli Zhang, M.D., Ph.D. Xi'an Jiaotong University School of Medicine, *Professor of Radiological Sciences; Biomedical Engineering; Pathology and Laboratory Medicine*

Weian Zhao, Ph.D. McMaster University, *Professor of Pharmaceutical Sciences; Biological Chemistry; Biomedical Engineering; Chemical and Biomolecular Engineering* (stem cell therapy, diagnostics, biosensors, immunotherapy, single-cell analysis)

Courses

BME 1. Introduction to Biomedical Engineering. 3 Units.
Introduction to the central topics of biomedical engineering. Offers a perspective on bioengineering as a discipline in a seminar format. Principles of problem solving, design, engineering inventiveness, entrepreneurship, information access, communication, ethics, teamwork, and social responsibility are emphasized.

(Design units: 1)

Restriction: Biomedical Engineering Majors have first consideration for enrollment. Biomedical Engr: Premedical Majors have first consideration for enrollment.

BME 3. Engineering Innovations in Treating Diabetes. 4 Units.
Innovations in diabetes treatment from the 1800s until the present: purification of insulin, measuring and control of blood glucose, recombinant DNA, clinical trials, and ethics. Solving optimization problems in engineering with Excel.

(II and VA).

BME 50A. Cell and Molecular Engineering. 4 Units.
Molecular, structural, genetic, biophysical, and cellular principles of life and bioengineering. Introduction to molecular bioengineering, genetic engineering, synthetic biology, and cell biology. Applications to genetic and biomolecular design.

(Design units: 1)

Prerequisite: CHEM 1C or CHEM H2C

Restriction: Biomedical Engineering Majors have first consideration for enrollment. Chemical Engineering Majors have first consideration for enrollment. Materials Science and Engr Majors have first consideration for enrollment.

BME 50B. Cell and Molecular Engineering. 4 Units.
Physiological function from a cellular, molecular, and biophysical perspective. Introduction to genetics, structure and function of cells and tissues, cell cycle control, cancer, and immunology.

(Design units: 1)

Prerequisite: BME 50A

Restriction: Biomedical Engineering Majors have first consideration for enrollment. Chemical Engineering Majors have first consideration for enrollment.

BME 60A. Engineering Analysis/Design: Data Acquisition. 4 Units.
Fundamentals of LabVIEW programming, basics of computer-based experimentation, establishing interface between computer and data acquisition instrumentation, signal conditioning basics. Materials fee.

(Design units: 2)

Prerequisite: PHYS 7D

Restriction: Biomedical Engineering Majors have first consideration for enrollment. Biomedical Engr: Premedical Majors have first consideration for enrollment.

BME 60B. Engineering Analysis/Design: Data Analysis. 4 Units.
Overview of MATLAB; numeric, cell, and structure arrays; file management; plotting and model building; solving linear algebraic equations; signal and image processing. Materials fee.

(Design units: 1)

Prerequisite or corequisite: MATH 3A

Restriction: Biomedical Engineering Majors have first consideration for enrollment. Biomedical Engr: Premedical Majors have first consideration for enrollment.

BME 60C. Engineering Analysis/Design: Computer-Aided Design. 4 Units.
Introduction to SolidWorks and Computer-Aided Design software; design; analysis; rapid prototyping; visualization and presentation; manufacturing planning. Materials fee.

(Design units: 2)

Prerequisite or corequisite: BME 1

Restriction: Biomedical Engineering Majors have first consideration for enrollment. Biomedical Engr: Premedical Majors have first consideration for enrollment.

BME 60D. Engineering Analysis/Design: Finite-Element Simulation. 4 Units.
Introduction to finite-element simulation; fundamentals of Multiphysics simulation;.

(Design units: 2)

Prerequisite: BME 60B and BME 60C

BME 110A. Biomechanics I. 4 Units.
Introduction to statics and dynamics. Topics include rigid bodies, analysis of structures, forces in beams, moments of inertia, friction, kinetics, work, and energy.

(Design units: 1)

Corequisite: BME 60B
Prerequisite: PHYS 7C and MATH 3A and MATH 3D and BME 60B

Restriction: Biomedical Engineering Majors have first consideration for enrollment. Biomedical Engr: Premedical Majors have first consideration for enrollment. Materials Science and Engr Majors have first consideration for enrollment.

BME 110B. Biomechanics II. 4 Units.
Introduction to biomechanics from subcellular to tissue levels. Introduction to stress, strain, and constitutive laws of cells and tissues. Emphasis is placed on biosolids. Introduction to elastic and viscoelastic behaviors with emphasis on the standard linear model of viscoelasticity.

(Design units: 1)

Prerequisite: BME 110A

Restriction: Biomedical Engineering Majors have first consideration for enrollment. Biomedical Engr: Premedical Majors have first consideration for enrollment. Materials Science and Engr Majors have first consideration for enrollment.

BME 110C. Biomechanics III. 4 Units.
Introduction to human biomechanics with emphasis on cardiovascular biomechanics and biofluid mechanics.

(Design units: 0)

Prerequisite: BME 110B

Restriction: Biomedical Engineering Majors have first consideration for enrollment.

BME 111. Design of Biomaterials. 4 Units.
Natural and synthetic polymeric materials. Metal and ceramics implant materials. Mechanical properties, degradation, surface characterization, and design of materials. Wound repair, blood clotting, foreign body response, biocompatibility of material. Artificial organs and medical devices. Government regulations.

(Design units: 3)

Corequisite: BME 50B or BIO SCI 99
Prerequisite: (BME 50B or BIOL 99) and CHEM 1C

Restriction: Biomedical Engineering Majors have first consideration for enrollment. Biomedical Engr: Premedical Majors have first consideration for enrollment. Materials Science and Engr Majors have first consideration for enrollment.

BME 114. Genetic Engineering and Synthetic Biology. 4 Units.
Exploring how biological function can be engineered and "synthesized" from the DNA level up.

(Design units: 0)

Prerequisite: (CHEM 1C or CHEM H2C) and MATH 3D and BME 50A and BME 50B

Restriction: Biomedical Engineering Majors have first consideration for enrollment.

BME 120. Sensory Motor Systems. 4 Units.
A quantitative and systems approach to understanding physiological systems. Systems covered include the nervous and musculoskeletal systems.

(Design units: 2)

Prerequisite: (BME 60B or EECS 10 or EECS 12 or CEE 20 or MAE 10) and MATH 3D and PHYS 7D

Restriction: Biomedical Engineering Majors have first consideration for enrollment. Biomedical Engr: Premedical Majors have first consideration for enrollment. Materials Science and Engr Majors have first consideration for enrollment.

BME 121. Quantitative Physiology: Organ Transport Systems. 4 Units.
A quantitative and systems approach to understanding physiological systems. Systems covered include the cardiopulmonary, circulatory, and renal systems.

(Design units: 1)

Prerequisite: (BME 60B or EECS 10 or EECS 12 or CEE 20 or MAE 10) and MATH 3D and BME 150 and BME 110A

Restriction: Biomedical Engineering Majors have first consideration for enrollment. Biomedical Engr: Premedical Majors have first consideration for enrollment. Chemical Engineering Majors have first consideration for enrollment.

BME 130. Biomedical Signals and Systems. 4 Units.
Analysis of analog and digital biomedical signals; Fourier Series expansions; difference and differential equations; convolutions. System models: discrete-time and continuous-time linear time-invariant systems; Laplace and Fourier transforms. Analysis of signals and systems using computer programs.

(Design units: 1)

Corequisite: BME 60B
Prerequisite: BME 60B and (MATH 3A or ICS 6N) and MATH 3D. Recommended: STAT 8.

Restriction: Biomedical Engineering Majors have first consideration for enrollment. Biomedical Engr: Premedical Majors have first consideration for enrollment.

BME 132. Introduction to Computational Biology. 4 Units.
The use of theories and methods based on computer science, mathematics, and physics in molecular biology and biochemistry. Basics in biomolecular modeling. Analysis of sequence and structural data of biomolecules. Analysis of biomolecular functions.

Prerequisite: MATH 2D or MATH 3A or STAT 7 or STAT 8

Same as BIOL M123, CS 183.

Concurrent with MBB 223 and BME 232.

BME 135. Photomedicine. 4 Units.
Studies the use of optical and engineering-based systems (laser-based) for diagnosis, treating diseases, manipulation of cells and cell function. Physical, optical, and electro-optical principles are explored regarding molecular, cellular, organ, and organism applications.

(Design units: 0)

Prerequisite: PHYS 3C or PHYS 7D

Same as BIOL D130.

Restriction: Biomedical Engineering Majors have first consideration for enrollment.

BME 136. Engineering Medical Optics. 4 Units.
Principles of optics and photonics, integration of optical components into systems and devices, and analysis of physiological signals obtained from Biophotonics measurements.

(Design units: 3)

Prerequisite: PHYS 7E or PHYS 3C

Restriction: Biomedical Engineering Majors have first consideration for enrollment. Biomedical Engr: Premedical Majors have first consideration for enrollment.

Concurrent with BME 251.

BME 137. Introduction to Biomedical Imaging. 4 Units.
Introduction to imaging modalities widely used in medicine and biology, including X-ray, computed tomography (CT), nuclear medicine (PET and SPET), ultrasonic imaging, magnetic resonance imaging (MRI), optical tomography, imaging contrast, imaging processing, and complementary nature of the imaging modalities.

(Design units: 1)

Prerequisite: BME 130 or EECS 50 or EECS 150

Restriction: Biomedical Engineering Majors have first consideration for enrollment.

BME 138. Spectroscopy and Imaging of Biological Systems. 4 Units.
Principles of spectroscopy; absorption; molecular orbitals; multiphoton transitions; Jablonski diagram; fluorescence anisotropy; fluorescence decay; quenching; FRET; excited state reactions; solvent relaxations; instruments; microscopy: wide field, LSM, TPE; fluorescent probes, fluctuations spectroscopy; optical resolution and super-resolution; CARS and SHG microscopy.

(Design units: 1)

Prerequisite: (MATH 3A or ICS 6N) and MATH 3D. Recommended: STAT 8.

Restriction: Biomedical Engineering Majors have first consideration for enrollment. Biomedical Engr: Premedical Majors have first consideration for enrollment.

Concurrent with BME 238.

BME 140. Design of Biomedical Electronics. 4 Units.
Analog and digital circuits in bioinstrumentation. AC and DC circuit analysis, design and construction of filter and amplifiers using operational amplifier, digitization of signals and data acquisition, bioelectrical signals, design and construction of ECG instrument, bioelectrical signal measurement and analysis. Materials fee.

(Design units: 3)

Prerequisite: BME 60A and BME 130

Restriction: Biomedical Engineering Majors have first consideration for enrollment.

BME 142. Microfabrication. 4 Units.
Essentials of photolithography, soft-lithography, microfabrication, Microelectromechanical Systems (MEMS), BioMEMS; applications in biomedical engineering.

(Design units: 2)

Restriction: Biomedical Engineering Majors have first consideration for enrollment.

BME 147. Microfluidics and Lab-on-a-Chip. 4 Units.
Introduction to principles of microfluidics and state-of-the-art micro Total Analysis Systems (uTAS). Lab-on-a-Chip for bimolecular assays with device design principles for microscale sample preparation, flow transport, bimolecular manipulation, separation and detection, and the technologies for integrating these devices into microsystems.

(Design units: 1)

Prerequisite: BME 110C

Restriction: Biomedical Engineering Majors have first consideration for enrollment.

BME 148. Microimplants. 4 Units.
Essential concepts of biomedical implants at the micro scale. Design, fabrication, and applications of several microimplantable devices including cochlear, retinal, neural, and muscular implants.

(Design units: 1)

Prerequisite: BME 111

Restriction: Biomedical Engineering Majors have first consideration for enrollment.

BME 150. Biotransport Phenomena. 4 Units.
Fundamentals of heat and mass transfer, similarities in the respective rate equations. Emphasis on practical application of fundamental principles.

(Design units: 0)

Corequisite: BME 60B or ENGRCEE 20.
Prerequisite: (BME 60B or CEE 20) and MATH 3D and CHEM 1C and PHYS 7E and MATH 2D

Restriction: Biomedical Engineering Majors have first consideration for enrollment. Biomedical Engr: Premedical Majors have first consideration for enrollment.

BME 160. Tissue Engineering. 4 Units.
Quantitative analysis of cell and tissue functions. Emerging developments in stem cell technology, biodegradable scaffolds, growth factors, and others important in developing clinical products. Applications of bioengineering.

(Design units: 2)

Prerequisite: (BME 50B or BIOL 99) and BME 111 and BME 121 and BME 150

Restriction: Biomedical Engineering Majors have first consideration for enrollment. Biomedical Engr: Premedical Majors have first consideration for enrollment. Chemical Engineering Majors have first consideration for enrollment.

BME 161. Introduction to Modern Bioengineering Tools. 4 Units.
A broad picture of diverse modern bioengineering tools, including genetic engineering and its risks to society, how to sequence DNA/RNA molecules with single base resolution, how to manipulate small biomolecules one at a time.

Prerequisite: (BME 50A and BME 50B) or (BIOL 97 and BIOL 98 and BIOL 99)

Restriction: Biomedical Engineering Majors have first consideration for enrollment. Biomedical Engr: Premedical Majors have first consideration for enrollment.

BME 170. Biomedical Engineering Laboratory. 4 Units.
Measurement and analysis of biological systems using engineering tools and techniques. Laboratory experiments involve living systems with the emphasis on measuring physiological parameters. Materials fee.

(Design units: 1)

Prerequisite: BME 50B and BME 120 and BME 130

Restriction: Biomedical Engineering Majors have first consideration for enrollment.

BME 171. Cell and Tissue Engineering Laboratory. 4 Units.
Techniques in molecular, cellular, and tissue engineering. Topics include bacterial and mammalian cell culture, DNA cloning and gene transfer, fabrication of biomaterial scaffolds, and immunassays and microscopy techniques for cell-based assays.

(Design units: 0)

Prerequisite: BME 160

Restriction: Biomedical Engineering Majors have first consideration for enrollment. Biomedical Engr: Premedical Majors have first consideration for enrollment.

BME 179. Biomedical Engineering Design: Addressing Unmet Clinical Needs. 1 Unit.
Introduction to unmet clinical needs identification and evaluation in biomedical engineering design.

Restriction: Biomedical Engineering Majors have first consideration for enrollment. Biomedical Engr: Premedical Majors have first consideration for enrollment. School of Engineering students have first consideration for enrollment.

BME 180A. Biomedical Engineering Design. 3 Units.
Design strategies, techniques, tools, and protocols commonly encountered in biomedical engineering; industrial design experience in group projects; ethics, economic analysis, and FDA product approval. Materials fee.

(Design units: 3)

Prerequisite: (BME 60B or MAE 10 or EECS 10) and (BME 60C or MAE 52 or EECS 31L) and (BME 140 or MAE 106 or EECS 170B). BME 180A, BME 180B, and BME 180C must be taken in the same academic year.

Grading Option: In progress only.

Restriction: Seniors only. Biomedical Engineering Majors only.

BME 180B. Biomedical Engineering Design. 3 Units.
Design strategies, techniques, tools, and protocols commonly encountered in biomedical engineering; industrial design experience in group projects; ethics, economic analysis, and FDA product approval. Materials fee.

(Design units: 3)

Prerequisite: BME 180A. BME 180A, BME 180B, and BME 180C must be taken in the same academic year.

Grading Option: In progress only.

Restriction: Seniors only. Biomedical Engineering Majors only.

BME 180C. Biomedical Engineering Design. 3 Units.
Design strategies, techniques, tools, and protocols commonly encountered in biomedical engineering; industrial design experience in group projects; ethics, economic analysis, and FDA product approval. Materials fee.

(Design units: 3)

Prerequisite: BME 180B. BME 180A, BME 180B, and BME 180C must be taken in the same academic year.

Restriction: Seniors only. Biomedical Engineering Majors only.

BME 195. Special Topics in Biomedical Engineering. 1-4 Units.
Studies in selected areas of Biomedical Engineering. Topics addressed vary each quarter.

(Design units: 1-4)

Prerequisite: Prerequisites vary.

Repeatability: Unlimited as topics vary.

BME 197. Seminars in Biomedical Engineering. 2 Units.
Presentation of advanced topics and reports of current research efforts in Biomedical Engineering.

(Design units: 1-2)

Restriction: Seniors only. Biomedical Engineering Majors have first consideration for enrollment.

Concurrent with BME 298.

BME 198. Biomedical Engineering Internship. 2-12 Units.
Students majoring in BME may receive credit for an approved internship, working at a company under the supervision of an industry mentor and a faculty advisor. Enables students to gain valuable experience in a professional setting and enhance their skills.

Grading Option: Pass/no pass only.

Repeatability: May be taken for credit 3 times.

BME 199. Individual Study. 1-4 Units.
Independent research conducted in the lab of a biomedical engineering core faculty member. A formal written report of the research conducted is required at the conclusion of the quarter.

(Design units: 1-4)

Repeatability: May be taken for credit for 8 units.

BME 199P. Individual Study. 1-4 Units.
Supervised independent reading, research, or design for undergraduate Engineering majors. Students taking individual study for design credit are to submit a written paper to the instructor and to the Undergraduate Student Affairs Office in the School of Engineering.

(Design units: 1-4)

Grading Option: Pass/no pass only.

Repeatability: May be repeated for credit unlimited times.

BME 201P. Biomedical Big Data. 4 Units.
Analysis and visualization of large biomedical datasets. Topics covered include cloud computing, learning Structured Query Language (SQL), database normalization and joins, using Google's BigQuery, using the statistical analysis package R, machine learning algorithms, application of machine learning for classification problems.

Restriction: Master of Engineering students only. Graduate students only.

BME 202P. Biomedical Imaging and Biophotonics. 4 Units.
Designed as a subfield of optical imaging and biophotonics as it applies to their applications to basic lifesciences and in vivo imaging to diagnose disease. Topics span all of of the areas of biophotonics and techniques.

Restriction: Master of Engineering students only. Graduate students only.

BME 203P. Digital Health. 4 Units.
Digital health is the convergence of genomics and technology to radically change the way health and medicine is practiced. Explores the history of healthcare in the U.S., its current status, and the future of digital health.

Restriction: Master of Engineering students only. Graduate students only.

BME 204P. Personalized Medical Devices. 4 Units.
Introduces students to fundamental aspects of medical devices and discusses therapeutic as well as diagnostic devices. Basic aspects of microfluidics and biology critical to personalized medical systems are studied. Typical FDA approval pathways for medical devices are presented.

Restriction: Master of Engineering students only.

BME 210. Molecular and Cellular Engineering. 4 Units.
Engineering of physiological function at the genetic, cellular, and tissue scales. Topics include cloning and genetic engineering, extracellular matrix biomaterials, principles of regenerative medicine and tissue engineering, and experimental design.

Restriction: Graduate students only.

BME 210P. Molecular and Cellular Engineering. 4 Units.
Engineering of physiological function at the genetic, cellular, and tissue scales. Topics include cloning and genetic engineering, extracellular matrix biomaterials, principles of regenerative medicine and tissue engineering, and experimental design.

Restriction: Master of Engineering students only. Graduate students only.

BME 211. Microscale Tissue Engineering. 4 Units.
Engineering of physiological function at the scale of individual cells. Topics include cell micropatterning, microfluidic tissue culture, engineering the cellular microenvironment, and microphysiological systems.

Restriction: Graduate students only.

BME 211P. Microscale Tissue Engineering. 4 Units.
Engineering of physiological function at the scale of individual cells. Topics include cell micropatterning, microfluidic tissue culture, engineering the cellular microenvironment, and microphysiological systems.

Restriction: Master of Engineering students only. Graduate students only.

BME 212. Cardiovascular Mechanobiology. 4 Units.
Advanced topics in cellular engineering and mechanobiology, with focus on the cardiovascular system. Tools and techniques used to manipulate and measure mechanical forces at the molecular, cellular, tissue, and organ levels, and their applications in cardiovascular devices and tissue engineering.

Restriction: Graduate students only.

BME 212P. Cardiovascular Mechanobiology. 4 Units.
Advanced topics in cellular engineering and mechanobiology, with focus on the cardiovascular system. Tools and techniques used to manipulate and measure mechanical forces at the molecular, cellular, tissue, and organ levels, and their applications in cardiovascular devices and tissue engineering.

Restriction: Master of Engineering students only. Graduate students only.

BME 213. Systems Cell and Developmental Biology. 4 Units.
Introduces concepts needed to understand cell and developmental biology at the systems level, i.e., how the parts (molecules) work together to create a complex output. Emphasis on using mathematical/computational modeling to expand/modify insights provided by intuition.

Same as DEVB 232.

Restriction: Graduate students only.

BME 215. Linking Modeling and Experiments in Bioengineering. 4 Units.
Overview of modeling based on experimental techniques in bioengineering. Construct and evaluate models of varying complexity and to relate them to experimental data.

Prerequisite: BME 220 and BME 221. BME 220 with a grade of B- or better. BME 221 with a grade of B- or better

Restriction: Graduate students only.

BME 220. Sensory Motor Systems. 4 Units.
A quantitative and systems approach to understanding physiological systems. Systems covered include the nervous and musculoskeletal systems.

Restriction: Graduate students only.

BME 220P. Sensory Motor Systems. 4 Units.
A quantitative and systems approach to understanding physiological systems. Systems covered include the nervous and musculoskeletal systems.

Restriction: Master of Engineering students only. Graduate students only.

BME 221. Organ Transport Systems. 4 Units.
A quantitative and systems approach to understanding physiological systems. Systems covered include the cardiopulmonary, circulatory, and renal systems.

Restriction: Graduate students only.

BME 221P. Organ Transport Systems. 4 Units.
Applies engineering models and mathematics to understand human physiology in order to understand the physiology. Covers the pulmonary, cardiac, and cardiovascular systems focusing on transport phenomena.

Restriction: Master of Engineering students only. Graduate students only.

BME 222. Biofluid Mechanics . 4 Units.
Introduces principles of biofluid mechanics in a research oriented scheme and approaches a wide spectrum of biofluid related problems in human body and solutions that involves engineering concepts.

Restriction: Graduate students only.

BME 230A. Applied Engineering Mathematics I. 4 Units.
Analytical techniques applied to engineering problems in transport phenomena, process dynamics and control, and thermodynamics.

BME 230B. Applied Engineering Mathematics II. 4 Units.
Focuses on biomedical system identification. Includes fundamental techniques of model building and testing such as formulation, solution of governing equations, sensitivity theory, identifiability theory, and uncertainty analysis.

Restriction: Graduate students only.

BME 230P. Introduction to Machine Learning. 4 Units.
Introduces fundamental concepts in programming and machine learning. The goal is to provide an accessible introduction to the field of machine learning and related techniques for students with a wide variety of engineering degrees.

Same as ENGR 230P, CEE 230P, EECS 230P, MAE 230P.

Restriction: Master of Engineering students only.

BME 232. Introduction to Computational Biology. 4 Units.
The use of theories and methods based on computer science, mathematics, and physics in molecular biology and biochemistry. Basics in biomolecular modeling. Analysis of sequence and structural data of biomolecules. Analysis of biomolecular functions.

Same as MBB 223.

Restriction: Graduate students only.

Concurrent with BIOL M123 and CS 183 and BME 132.

BME 233. Dynamic Systems in Biology and Medicine. 4 Units.
Introduces principles of system theory to analyze biological, biochemical, physiological, and bioengineering systems. Analytical and computational tools are used to model and analyze dynamic systems such as population, neuronal and heart dynamics, biochemical and physiological systems, oxygen diffusion and similar.

Restriction: Graduate students only.

BME 233P. Dynamic Systems in Biology and Medicine. 4 Units.
Introduces the elements of system theory, and applies these principles to analyze biomedical, chemical, social, and engineering systems. Using analytical and computational tools to model and analyze various dynamic systems.

Restriction: Master of Engineering students only. Graduate students only.

BME 234. Neuroimaging Data Analysis. 4 Units.
Knowledge and understanding of recent techniques for the analysis of healthy and pathological structure and function in neuroimaging data.

Restriction: Graduate students only.

BME 234P. Neuroimaging Data Analysis. 4 Units.
Knowledge and understanding of recent techniques for the analysis of healthy and pathological structure and function in neuroimaging data.

Restriction: Master of Engineering students only. Graduate students only.

BME 235. Analysis of Neural Time Series. 4 Units.
Hands-on introduction to techniques for the analysis of neural time series data, with a primary focus on the electroencephalogram (EEG). Topics may include the physiological basis of EEG, time-frequency analysis, spatial filtering, and methods of assessing connectivity.

Same as COGS 235.

Restriction: Graduate students only.

BME 238. Spectroscopy and Imaging of Biological Systems. 4 Units.
Principles of spectroscopy; absorption; molecular orbitals; multiphoton transitions; Jablonski diagram; fluorescence anisotropy; fluorescence decay; quenching; FRET; excited state reactions; solvent relaxations; instruments; microscopy: wide field, LSM, TPE; fluorescent probes, fluctuations spectroscopy; optical resolution and super-resolution; CARS and SHG microscopy.

Restriction: Graduate students only.

Concurrent with BME 138.

BME 238P. Spectroscopy and Imaging of Biological Systems. 4 Units.
Principles of spectroscopy; absorption; molecular orbitals; multiphoton transitions; Jablonski diagram; fluorescence anisotropy; fluorescence decay; quenching; FRET; excited state reactions; solvent relaxations; instruments; microscopy: wide field, LSM, TPE; fluorescent probes, fluctuations spectroscopy; optical resolution and super-resolution; CARS and SHG microscopy.

Restriction: Master of Engineering students only. Graduate students only.

BME 240. Introduction to Clinical Medicine for Biomedical Engineering. 4 Units.
An introduction to clinical medicine for graduate students in biomedical engineering. Lectures and rotations through nephology, gastroenterology, pulmonary, and critical care cardiology.

Restriction: Graduate students only. Biomedical Engineering Majors only.

BME 240P. Introduction to Clinical Medicine for Biomedical Engineering. 4 Units.
An introduction to clinical medicine for graduate students in biomedical engineering. Lectures and rotations through nephology, gastroenterology, pulmonary, and critical care cardiology.

Restriction: Master of Engineering students only. Graduate students only.

BME 251. Engineering Medical Optics. 4 Units.
Principles of optics and photonics, integration of optical components into systems and devices, and analysis of physiologic signals obtained from Biophotonics measurements.

Restriction: Graduate students only.

Concurrent with BME 136.

BME 251P. Engineering Medical Optics. 4 Units.
Principles of optics and photonics, integration of optical components into systems and devices, and analysis of physiologic signals obtained from Biophotonics measurements.

Restriction: Master of Engineering students only. Graduate students only.

BME 255. Cardiovascular Devices. 4 Units.
Cardiovascular implants, the science around those, regulatory affairs, and cardiovascular device market and related business opportunities. Students form practice startups around a clinical unmet need and use their knowledge from the course to plan it accordingly.

Restriction: Graduate students only.

BME 260P. Microfluids and Lab-on-a-Chip. 4 Units.
Introduction to microfluidics and state-of-the-art micro Total Analysis Systems (uTAS). Lab-on-a-Chip for biomolecular assays with device design principles for microscale sample preparation, flow transport, biolmolecular manipulation, separation and detection, and the technologies for integrating these devices into microsystems.

Restriction: Master of Engineering students only. Graduate students only.

BME 262. Microimplants. 4 Units.
Essential concepts of biomedical implants at the micro scale. Design, fabrication, and applications of several microimplantable devices including cochlear, retinal, neural, and muscular implants.

Restriction: Graduate students only.

BME 262P. Microimplants. 4 Units.
Essential concepts of biomedical implants at the micro scale. Design, fabrication, and applications of several microimplantable devices including cochlear, retinal, neural, and muscular implants.

Restriction: Master of Engineering students only. Graduate students only.

BME 290. Critical Thinking and Writing. 4 Units.
Critical thinking and writing are essential ingredients for success in scientific research. Examines examples from the scientific literature to extract principles of good scientific reasoning, experimental design, and writing.

Restriction: Graduate students only. Biomedical Engineering Majors only.

BME 295. Special Topics in Biomedical Engineering. 1-4 Units.
Studies in selected areas of Biomedical Engineering. Topics addressed vary each quarter.

Prerequisite: Prerequisites vary.

Repeatability: Unlimited as topics vary.

BME 295P. Special Topics in Biomedical Engineering. 4 Units.
Studies in selected areas of Biomedical Engineering. Topics addressed vary each quarter.

Prerequisite: Prerequisites vary.

Repeatability: Unlimited as topics vary.

Restriction: Graduate students only. Master of Engineering students only.

BME 296. Master of Science Thesis Research. 1-16 Units.
Individual research or investigation conducted in the pursuit of preparing and completing the thesis required for the M.S. in Engineering.

Repeatability: May be repeated for credit unlimited times.

Restriction: Graduate students only.

BME 297. Doctor of Philosophy Dissertation Research. 1-16 Units.
Individual research or investigation conducted in the pursuit of preparing and completing the dissertation required for the Ph.D. in Engineering.

Repeatability: May be repeated for credit unlimited times.

BME 298. Seminars in Biomedical Engineering. 2 Units.
Presentation of advanced topics and reports of current research efforts in biomedical engineering. Designed for graduate students in the Biomedical Engineering program.

Grading Option: Satisfactory/unsatisfactory only.

Repeatability: Unlimited as topics vary.

Concurrent with BME 197.

BME 299. Individual Research. 1-16 Units.
Individual research or investigation under the direction of an individual faculty.

Repeatability: May be repeated for credit unlimited times.