Biomedical Engineering

Mailing Address:
Richard and Loan Hill Department of Biomedical Engineering (MC 063)
851 South Morgan Street
Chicago, IL 60607-7052

Contact Information:
Campus Location: 218 SEO
(312) 996–2335
gradbioe@uic.edu
bioe.uic.edu

Administration:
Head of the Department: Thomas Royston
Director of Graduate Studies: David Eddington

Program Codes:
20FS0408MS (MS)
20FS0408PHD (PhD)

The Richard and Loan Hill Department of Biomedical Engineering offers graduate programs leading to Master of Science and Doctor of Philosophy degrees in Biomedical Engineering and Bioinformatics, and participates in the Medical Scientist Training Program. The Interdepartmental Concentration in Neuroscience is also available to doctoral students. Areas of study include Cell and Tissue Engineering, Neural Engineering and Rehabilitation, Bioinformatics and Genomics, Medical Imaging, Biomechanics, Biomaterials and Nanobiomolecular Engineering.

Admission and Degree Requirements

- MS in Biomedical Engineering
- PhD in Biomedical Engineering
- MD/MS in Biomedical Engineering

BIOE 402. Medical Technology Assessment. 2 or 3 hours.
Bioentrepreneur course. Assessment of medical technology in the context of commercialization. Objectives, competition, market share, funding, pricing, manufacturing, growth, and intellectual property; many issues unique to biomedical products. Course Information: 2 undergraduate hours. 3 graduate hours. Prerequisite(s): Junior standing or above and consent of the instructor.

BIOE 403. Quality Assurance for Medical Products. 2 or 3 hours.
Requirements for current good manufacturing practices and quality assurance in the design and manufacture of medical devices. Course Information: 2 undergraduate hours. 3 graduate hours. Prerequisite(s): BIOE 250; and junior standing or above; or consent of the instructor.

BIOE 405. Atomic and Molecular Nanotechnology. 3 or 4 hours.
Nanoscale structures and phenomena. Simulation methods for nano systems, and molecular assemblies. Molecular building blocks, scanning probe and atomic force microscopy, quantum mechanical phenomena. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): Senior standing or above. Recommended background: Engineering or physical science major.

BIOE 407. Pattern Recognition I. 3 or 4 hours.
The design of automated systems for detection, recognition, classification and diagnosis. Parametric and nonparametric decision-making techniques. Applications in computerized medical and industrial image and waveform analysis. Course Information: Same as ECE 407. 3 undergraduate hours. 4 graduate hours. Prerequisite(s): ECE 341 or BIOE 339 or IE 342 or STAT 381.

BIOE 408. Medical Product Development. 2 or 3 hours.
Bioentrepreneur course. Major stages of medical product development (investigative, feasibility, development, commercialization, maturation and growth), regulatory issues, product performance, failure mode and effect analysis, hazard analysis. Course Information: 2 undergraduate hours. 3 graduate hours. Prerequisite(s): Junior standing or above and consent of the instructor.

BIOE 410. FDA and ISO Requirements for the Development and Manufacturing of Medical Devices. 3 or 4 hours.
FDA Performance Standard for General Medical Devices for manufacturing and development engineers. Product requirement definition, design control, hazard analysis, failure mode and effect analysis, regulatory submission, product tests, ISO 9001. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): BIOS 100 and BIOE 250. Recommended background: Junior standing or above.

BIOE 415. Biomechanics. 3 or 4 hours.
Continuum mechanics of cells, tissues and organs. Statics and force balances; stress, strain and constitutive relations; equilibrium, universal solutions and inflation; finite deformation; nonlinear problems; finite element methods. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): BIOE 310.

BIOE 421. Biomedical Imaging. 3 or 4 hours.
Introduction to engineering and scientific principles associated with X-ray, magnetic resonance, ultrasound, computed tomographic and nuclear imaging. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): MATH 210 and PHYS 142.

BIOE 422. Magnetic Resonance Imaging. 3 or 4 hours.
Fundamental priciples of magnetic resonance imaging (MRI) from a signal processing perspective. Focus on image acquisition, formation, and analysis. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): BIOE 310 or ECE 310; and junior standing or above; or consent of the instructor.

BIOE 423. Biomedical Imaging Laboratory. 2 hours.
Acquisition and processing of biomedical imaging data. Relaxation time-based magnetic resonance imaging, motion sensitive magnetic resonance imaging, computed tomography, ultrasound, nuclear medicine imaging and optical imaging. Course Information: Extensive computer use required. Prerequisite(s): Credit or concurrent registration in BIOE 421.

BIOE 430. Bioinstrumentation and Measurements I. 3 or 4 hours.
Theory and application of instrumentation used for physiological and medical measurements. Characteristics of physiological variables, signal conditioning devices and transducers. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): BIOS 100 and ECE 115 or ECE 210; and BIOE 310.

BIOE 431. Bioinstrumentation and Measurement Laboratory. 2 hours.
Practical experience in the use of biomedical instrumentation for physiological measurements. Course Information: Prerequisite(s): Credit or concurrent registration in BIOE 430.

BIOE 432. Bioinstrumentation and Measurements II. 3 or 4 hours.
Principles of bioinstrumentation for the assessment of physiological function and therapeutic intervention. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): BIOE 430.

BIOE 433. Bioinstrumentation and Measurements II Laboratory. 1 hour.
Laboratory experiments using instruments to assess physiological function. Course Information: Prerequisite(s): Credit or concurrent registration in BIOE 432.

BIOE 439. Biostatistics II. 4 hours.
Statistical treatment of data, model estimation, and inference are treated in a framework of biological experiments and attributes of data generated from such experiments. Course Information: Credit is not given for BIOE 439 if the student has credit for BSTT 400. Extensive computer use required. Prerequisite(s): MATH 210 and CS 109 and BIOE 339; and consent of the instructor. Recommended background: Knowledge of MATLab.

BIOE 450. Molecular Biophysics of the Cell. 4 hours.
Introduction to force, time energies at nanometer scales; Boltzmann distribution; hydrodynamic drag; Brownian motions; DNA, RNA protein structure and function; sedimentation; chemical kinetics; general aspects of flexible polymers. Course Information: Same as PHYS 450. Prerequisite(s): PHYS 245 or the equivalent; or approval of the department.

BIOE 452. Biocontrol. 3 or 4 hours.
Considers the unique characteristics of physiological systems using the framework of linear systems and control theory. Static and dynamic operating characteristics, stability, and the relationship of pathology to control function. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): BIOE 310.

BIOE 455. Introduction to Cell and Tissue Engineering. 3 or 4 hours.
Foundation of cell and tissue engineering covering cell technology, construct technology, and cell-substrate interactions. Emphasis in emerging trends and technologies in tissue engineering. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): CME 260; and BIOS 443 or BIOS 452.

BIOE 456. Cell and Tissue Engineering Laboratory. 2 hours.
Includes polymer scaffold fabrication, microstamping biomolecules, cellular adhesion and proliferation assays, and immo/fluorescent tagging. Course Information: Prerequisite(s): Credit or concurrent registration in BIOE 455; or consent of the instructor.

BIOE 460. Materials in Bioengineering. 3 or 4 hours.
Analysis and design considerations of problems associated with prostheses and other implanted biomedical devices. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): CME 260; and BIOS 220 or BIOS 240 or BIOS 286 or CHEM 234.

BIOE 465. Metabolic Engineering. 3 or 4 hours.
Quantitative descriptions of biochemical networks; modeling, control, and design of metabolic pathways to achieve industrial and medical goals. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): BIOE 310 or ECE 310 or ME 312; or consent of the instructor.

BIOE 470. Bio-Optics. 3 or 4 hours.
Physical principles and instrumentation relevant to the use of light in biomedical research. Several current and developing clinical applications are explored. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): PHYS 142.

BIOE 471. Biomedical Optical Imaging. 3 or 4 hours.
Fundamentals of light-matter interactions, geometric optics, nonlinear optics, ultra-fast lasers, photodetectors, light microscopy, supper-resolution imaging, photoacoustic tomography, optical coherence tomography, functional optical imaging. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): PHYS 142 and BIOS 100.

BIOE 472. Models of the Nervous System. 3 or 4 hours.
Mathematical models of neural excitation and nerve conduction, stochastic models and simululation of neuronal activity, models of neuron pools and information processing, models of specific neural networks. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): BIOE 310; and credit or concurrent registration in BIOS 484.

BIOE 475. Neural Engineering I: Introduction to Hybrid Neural Systems. 3 or 4 hours.
Modeling and design of functional neural interfaces for in vivo and in vitro applications, electrodes and molecular coatings, neural prostheses and biopotential control of robotics. Course Information: Same as BIOS 475. 3 undergraduate hours. 4 graduate hours. Prerequisite(s): BIOE 472; or consent of the instructor.

BIOE 476. Neural Engineering I Laboratory. 2 hours.
Hands-on experience with computational and experimental models of engineered neural systems, with emphasis on neuroprostheses and biosensors. Course Information: Animals used in instruction. Prerequisite(s): Credit or concurrent registration in BIOE 475.

BIOE 480. Introduction to Bioinformatics. 3 or 4 hours.
Computational analysis of genomic sequences and other high throughput data. Sequence alignment, dynamic programming, database search, protein motifs, cDNA expression array, and structural bioinformatics. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): BIOS 100 and CS 109.

BIOE 481. Bioinformatics Laboratory. 2 hours.
How to use bioinformatics tools, including sequence alignment methods such as Blast, Fasta, and Pfam, as well as structural bioinformatics tools, such as Rasmol and CastP. Course Information: Extensive computer use required. Prerequisite(s): Credit or concurrent registration in BIOE 480; and senior standing or above; and consent of the instructor.

BIOE 482. Introduction to Optimization Methods in Bioinformatics. 3 or 4 hours.
The objectives are to provide the students with a basis for understanding principles of the optimization methods and an insight on how these methods are used in bioinformatics. Course Information: 3 undergraduate hours. 4 graduate hours. Extensive computer use required. Prerequisite(s): BIOS 100 and CS 201 and MATH 310.

BIOE 483. Molecular Modeling in Bioinformatics. 3 or 4 hours.
Basic structural and dynamics tools in protein structure prediction, structure comparison, function prediction, Monte Carlo and molecular dynamics simulations. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): Grade of B or better in BIOE 480.

BIOE 485. Nanobiosensors. 3 or 4 hours.
Fabrication and principles of operation for nanostructures used for biological sensing and analysis. Optical and electrical properties, use of biomolecules as active sensing elements. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): BIOS 100 and BIOE 205 and PHYS 141 and PHYS 142.

BIOE 494. Special Topics in Bioengineering. 1-4 hours.
Special topics to be arranged. Course Information: May be repeated. Students may register in more than one section per term. Prerequisite(s): Consent of the instructor.

BIOE 496. Undergraduate Senior Design Thesis I. 0-8 hours.
Applying engineering design methodology to a large scale biomedical engineering design problem. Technical reports and presentations, literature survey and undergraduate thesis. Course Information: May be repeated. Credit is not given for BIOE 496 to students enrolled in any degree program in the College of Engineering. Extensive computer use required. Prerequisite(s): Approval of the Department.

BIOE 497. Undergraduate Senior Design Thesis II. 0-8 hours.
Applying engineering design methodology to a large scale biomedical engineering design problem. Technical reports and presentations, literature survey and undergraduate thesis. Course Information: Credit is not given for BIOE 497 to students enrolled in any degree program in the College of Engineering. Extensive computer use required. Prerequisite(s): Approval of the Department.

BIOE 500. Interfacial Biosystems Engineering. 4 hours.
Advanced and detailed exposition of the fundamentals of biological systems using quantitative approaches. Areas of concentration include bioinformatics, cell and tissue engineering, and neuroengineering. Course Information: Prerequisite(s): BIOS 442.

BIOE 504. Emerging Medical Technologies. 3 hours.
Investigates new and emerging medical technologies following the technical due diligence process, a methodical evaluation of strengths, weaknesses, opportunities and threats of the identified technology. Course Information: Prerequisite(s): BIOE 401 or BIOE 402 or BIOE 403 or the BIOE 494 equivalent.

BIOE 505. NanoBioTechnology. 4 hours.
Nanotechnology theory and applications in biology and medicine. Molecular simulations, combinatorial chemistry. Nanoscale structures, molecular building blocks, integrated nano-bio complexes. Positional and self-assembly, self-replication. Course Information: Recommended background: Engineering or physical sciences.

BIOE 510. Drug Transport in the Central Nervous System. 4 hours.
Introduction to convective and diffusive transport of macromolecules with special attention to drug transport and biochemical reactions in the central nervous system. Course Information: Prerequisite(s): Graduate standing; and consent of the instructor.

BIOE 514. Biotransport. 4 hours.
Diffusion and flow in living systems. Blood rheology and flow. Microcirculation, oxygen transport, diffusive transport across membranes. Membrane structure; water, and ion flows, active transport. Course Information: Same as CHE 514. Prerequisite(s): CHE 410 or consent of the instructor.

BIOE 515. Mechanics of the Human Spine. 4 hours.
Biomechanics as applied to the human spine. Spinal loading. Experimentation methods and modelling of intact ligamentous spine. Nature and treatment of adolescent idiopathic scoliosis. Thoracolumbar injuries. Course Information: Prerequisite(s): BIOE 415 or the equivalent.

BIOE 518. Advanced Drug Delivery Systems. 2 or 3 hours.
Controlled drug delivery systems utilizing polymers, synthesis of different types of devices, and the delivery expected from these devices, and mathematical modeling of delivery systems. Course Information: Same as BPS 518. Prerequisite(s): Consent of the instructor.

BIOE 521. Imaging Systems for Biological Tissues. 4 hours.
Examination of major imaging systems using ionizing and nonionizing energy for characterization of biological tissues and physiological lesions. Course Information: Prerequisite(s): BIOE 420.

BIOE 522. Principles of Polymeric Science and Engineering. 3 hours.
Intermediate polymer science, thermodynamics of polymer solutions, phase separations, MW determination, crystallization, elasticity, kinetics and processing. Course Information: Same as BPS 522. Prerequisite(s): MATH 220 or consent of the instructor.

BIOE 523. Haptics. 4 hours.
Hands-on course on fundamental concepts of haptics technology applied to medical visualization, simulation, and training. Course Information: Same as BVIS 523. Extensive computer use required. Recommended Background: Basic computer programming experience. Class Schedule Information: To be properly registered, students must enroll in one Lecture-Discussion and one Laboratory.

BIOE 525. Physiological and Cellular Effects of Biomechanical Forces. 4 hours.
Discuss how biomechanical forces are generated, the impact the forces have on cells and tissues, plus methods for studying them. Mechanisms by which cells may sense forces and transduce this information to the nucleus are also covered. Prerequisite(s): Consent of the instructor.

BIOE 530. Statistics and Machine Learning for Bioengineering and Bioinformatics. 4 hours.
Probability theory, parameter estimation, hypothesis testing, experimental design and power analysis for bioengineering problems. Supervised and unsupervised machine learning, dimensionality reduction, biological system model evaluation. Course Information: Extensive computer use required. Prerequisite(s): MATH 310 or the equivalent. Recommended background: Programming skills with Matlab or R.

BIOE 532. Advanced Biological Systems Analysis. 4 hours.
Numerical integration, inversion, optimization, Markov chains, deconvolution and singular value decomposition applied to problems in conservation balances , diffusion and reaction networks, metabolic flux analysis, cell signaling, bio-image analysis. Course Information: Extensive computer use required. Prerequisite(s: MATH 310; or consent of the instructor. Recommended background: Working knowledge of Matlab.

BIOE 540. Biological Signal Analysis. 4 hours.
Analysis of signals of biological origin. Transient signals, stability and control, probabilities and stochastic processes, signal modeling, estimation and filtering, medical applications. Course Information: Previously listed as BIOE 440. Extensive computer use required.

BIOE 548. Micro and Nanotechnology for Biomedical Applications. 4 hours.
This course covers selected topics in micro- and nano-technology underlying biomedical applications; topics include: microfabrication and nanofabrication; microfluidic processes; neuroMEMS; nanoscale structures as functional bio-interfaces. Prerequisite(s): PHYS 244.

BIOE 550. Principles of Cell and Tissue Engineering. 4 hours.
Introduction to tissue engineering. Presents principles of biomedical, biochemical, and biomaterials science applied to tissue engineered organ replacements, implantable medical devices, and drug delivery systems. Course Information: Prerequisite(s): BIOS 442 or BIOS 443; and CEMM 260. Recommended background: A course in cell biology.

BIOE 552. Advanced Biocontrol. 4 hours.
Modeling and analysis of physiological systems including such topics as adaptive control, statistical analysis error signal analysis and the characteriszation of individual neural control elements. Course Information: Prerequisite(s): BIOE 452.

BIOE 560. Processing and Properties of Structural Biomaterials. 4 hours.
Considers the inter-relationships between atomic bonding, atomic/molecular structure and material processing to provide a fundamental understanding of the properties and performance of advanced biomaterials. Course Information: Prerequisite(s): CEMM 260. Recommended background: Credit in BIOE 460.

BIOE 562. Biomedical Implants in Orthopedics and Dentistry. 4 hours.
Advanced aspects of implant design, including biomaterials, surface coatings, biomechanics, corrosion, tribocorrosion, failure mechanisms, implant monitoring, clinical and regulatory concerns, critical review of current research. Course Information: Same as ME 562. Prerequisite(s): BIOE 460.

BIOE 575. Neural Engineering II - Neural Coding. 4 hours.
Analytical techniques and models used to assess and predict neural activity. Emphasis on information coding in sensory systems. Course Information: Prerequisite(s): Consent of the instructor. Recommended background: Working knowledge of Matlab.

BIOE 576. Sensory Prostheses Engineering. 4 hours.
Existing and emerging prosthetic devices for sensory systems damaged by trauma or disease. Physiology, technology, and information flow in hybrid systems. Visual, auditory, neuromuscular, haptic, olfactory, sensory substitution. Course Information: Prerequisite(s): BIOE 475; or consent of the instructor.

BIOE 579. Neural and Neuromuscular Prostheses. 4 hours.
Neuromuscular electrical stimulation for ambulation by paraplegics, of upper limb in tetraplegics, of vocal cord and breathing functions, stimulation of bladder, cochlea, retina, and visual cortex. Course Information: Prerequisite(s): Consent of the instructor.

BIOE 580. Principles of Bioinformatics. 4 hours.
Bioinformatics analysis of sequence, phylogeny, and molecular structure. Focus on probabilistic models and algorithms, as well as structural analysis. Course Information: Extensive computer use required. Prerequisite(s): BIOE 480; and graduate or professional standing; or consent of the instructor. Recommended background: Exposure to biochemistry, molecular biology, or evolution.

BIOE 582. Computational Functional Genomics. 4 hours.
Modern statistical and computational methods relevant to functional genomics. Cell function, gene regulation and protein expression. Microarray technology and use; cluster analysis; prediction of protein function. Course Information: Prerequisite(s): BIOE 480. Recommended background: Basic knowledge of probability, statistics, vector algebra, calculus and cell biology.

BIOE 590. Internship in Bioengineering. 1-4 hours.
Current clinical practice experience in a health care setting culminating in a written and oral report. Course Information: Satisfactory/Unsatisfactory grading only. Prerequisite(s): BIOE 430 and BIOE 431 and BIOE 479.

BIOE 594. Advanced Special Topics in Bioengineering. 1-4 hours.
Systematic review of selected topics in bioengineering theory and practice. Subjects vary from year to year. Course Information: May be repeated. Students may register in more than one section per term. Prerequisite(s): Consent of the instructor.

BIOE 595. Seminar on Bioengineering. 0-1 hours.
Recent innovations in bioengineering theory and practice presented by invited speakers, faculty and graduate students. Course Information: Satisfactory/Unsatisfactory grading only. May be repeated. Students who are presenting seminars should register for 1 hour, others for 0 hour.

BIOE 596. Independent Study. 1-5 hours.
Research on special problems not included in thesis research. Course Information: May be repeated. Students may register in more than one section per term. Prerequisite(s): Consent of the instructor.

BIOE 598. Masters Thesis Research. 0-16 hours.
Research in M.S. thesis project. Course Information: Satisfactory/Unsatisfactory grading only. May be repeated. Students may register in more than one section per term.

BIOE 599. Ph.D. Thesis Research. 0-16 hours.
Research in Ph.D. thesis project. Course Information: Satisfactory/Unsatisfactory grading only. May be repeated. Students may register in more than one section per term.