BIOENGINEERING (BIOE)

BIOE Class Schedule (https://courses.illinois.edu/schedule/DEFAULT/DEFAULT/BIOE)

Courses

BIOE 100  Bioengineering Freshman Seminar  credit: 1 Hour. (https://courses.illinois.edu/schedule/terms/BIOE/100) Bioengineering Freshman Seminar provides a broad introduction to the field, practice, and curriculum of Bioengineering. The major goals are for students to (1) meet the department faculty, (2) understand the curriculum and the 4-year goals, (3) understand and apply technologies central to the field through individual and group projects, (4) begin independent explorations into technologies in the field, and (5) practice teamwork, technical writing, and presentation. The course is designed for freshman Bioengineering majors. Prerequisite: Bioengineering Freshmen Only.

BIOE 120  Introduction to Bioengineering  credit: 1 Hour. (https://courses.illinois.edu/schedule/terms/BIOE/120) Lectures and discussions of recent trends in bioengineering; topics typically include biological interaction with ultrasound and microwave radiation, modeling, instrumentation, biomaterials, biomechanics, biological heat and mass transfer, and medical imaging techniques.

BIOE 198  Special Topics  credit: 1 to 3 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/198) Subject offerings related to Bioengineering intended to augment the Bioengineering curriculum. Offerings will be at the freshman level. See class schedule or course information websites for topics and prerequisites. May be repeated if topics vary. Prerequisite: Majors only.

BIOE 199  Undergraduate Open Seminar  credit: 1 to 5 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/199) May be repeated.

BIOE 200  Bioengineering Career Immersion  credit: 1 Hour. (https://courses.illinois.edu/schedule/terms/BIOE/200) This course provides exposure to Bioengineering careers through experiences in medicine, industry, and research. Students will observe professional practices to facilitate problem-based discoveries and technology design. Prerequisite: BIOE 120. Majors only.

BIOE 201  Conservation Principles Bioeng  credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/201) Material, energy, charge, and momentum balances in biological problems. Steady-state and transient conservation equations for mass, energy, charge, and momentum will be derived and applied to mathematically analyze physiological systems using basic mathematical principles, physical laws, stoichiometry, and thermodynamic properties. Prerequisite: CHEM 104, MCB 150, and PHYS 211.

BIOE 202  Cell & Tissue Engineering Lab  credit: 2 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/202) Principles of cell biology inherent in tissue engineering design. Lab experience in safely and skillfully manipulating cells of the four tissue types and performing various quantitative analyses on products produced by cells that have differentiated. Prerequisite: MCB 150, and credit or concurrent enrollment in BIOE 206.

BIOE 205  Signals & Systems in Bioengrg  credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/205) Introduction to signals and linear systems with examples from biology and medicine. Linear systems and mathematical models of systems, including differential equations, convolution, Laplace transforms, Fourier series and transforms, and discrete representations. Class examples and coursework apply general techniques to problems in biological signal analysis, including circuits, enzyme kinetics, and physiological system analysis. Use of Matlab and Simulink software to understand more complex systems. Prerequisite: CS 101 and PHYS 212. Concurrent registration in MATH 285 is required.

BIOE 206  Cellular Bioengineering  credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/206) Molecular and cellular biology focusing on instrumentation and measurement techniques: gene expression, translation, and regulation; cellular energetics and enzyme kinetics; membrane transport and cell signaling; cytoskeleton and the cell cycle; cell biology fundamentals emphasizing modern imaging and measurement systems to quantify cellular function. Credit is not given for both BIOE 206 and MCB 252. Prerequisite: MCB 150.


BIOE 297  Individual Study  credit: 1 to 4 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/297) Special project or reading activity. May be repeated in the same or separate terms to a maximum of 12 hours. Prerequisite: Approved written application to department as specified by department or instructor.

BIOE 298  Special Topics  credit: 0 to 4 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/298) Subject offerings of new and developing areas of knowledge in bioengineering intended to augment the existing curriculum. See Class Schedule or departmental course information for topics and prerequisites. May be repeated in the same or separate terms if topics vary to a maximum of 8 hours.

BIOE 301  Introductory Biomechanics  credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/301) Structure and mechanics of biological systems. Statics, dynamics, stress-strain analysis, Newtonian mechanics, and continuum mechanics. Applications to bone, soft tissue, and cells. Prerequisite: PHYS 211.

BIOE 302  Modeling Human Physiology  credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/302) Description, quantification, and modeling of human physiological systems, based on systems fundamentals. Components, relationships, and homeostatic controls of neural, musculoskeletal, respiratory, cardiovascular, endocrine, digestion, and renal-filtration systems. Application of mathematical modeling and MATLAB simulation to further understanding of the systems and relate physiological consequences to changes in environment or component function. Prerequisite: CS 101, BIOE 205, MATH 285, and MCB 252 or BIOE 206.

Information listed in this catalog is current as of 09/2018
BIOE 303 Quantitative Physiology Lab credit: 2 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/303)
Experiments involving the modeling and measurement of animal and human physiology systems. Use of computer simulations to provide mathematical descriptions of physiology behavior. Calibration and validation of models through hands-on experiments. Focus on quantitative measurement of neural, cardiovascular, respiratory, muscular, and endocrine system functions. Prerequisite: Concurrent enrollment in BIOE 302 is allowed.

BIOE 306 Biofabrication Lab credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/306)
Experiments involving design of bioreactors and microfluidic systems, advanced cell culture, and quantitative analysis techniques such as polmerase chain reaction and atomic force microscopy. Laboratory techniques relating to current literature and state of the art in the field of bioengineering. Prerequisite: BIOE 202. Departmental approval required for non-majors.

BIOE 310 Comp Tools Bio Data credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/310)
Fundamental and applied statistics, including probability distributions, parameter estimation, descriptive statistics, hypothesis testing, and linear regression. Statistical methods in genomics including sequence analysis, gene expression data analysis, human genomic variation, regulatory genomics, and cancer genomics. Credit is not given for both BIOE 310 and IE 300. Prerequisites: BIOE 205 and BIOE 206.

BIOE 360 Transport & Flow in Bioengrg credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/360)
Fundamentals of fluid dynamics and mass transport applied to analysis of biological systems. Quantitative understanding of microscopic to macroscopic phenomena in biological systems related to their sensing by imaging techniques. Molecular phenomena in both healthy tissue and disease using examples from cardiovascular problems and cancer using ultrasound, optical and MRI techniques. Credit is not given for both BIOE 360 and any of CHBE 421, CHBE 451, or TAM 335. Prerequisite: BIOE 201, BIOE 220, and MATH 285.

BIOE 380 Biomedical Imaging credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/380)
Same as ECE 380. See ECE 380.

BIOE 397 Individual Study credit: 1 to 4 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/397)
Special project or reading activity. May be repeated up to 8 hours in a term to a maximum of 12 total hours. Prerequisite: Approved written application to department as specified by department or instructor.

BIOE 398 Special Topics credit: 1 to 4 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/398)
Subject offerings of new and developing areas of knowledge in bioengineering intended to augment the existing curriculum. See Class Schedule or departmental course information for topics and prerequisites. May be repeated in the same or separate terms if topics vary to a maximum of 8 hours.

BIOE 414 Biomedical Instrumentation credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/414)
Engineering aspects of the detection, acquisition, processing, and display of signals from living systems; biomedical sensors for measurements of biopotentials, ions and gases in aqueous solution, force, displacement, blood pressure, blood flow, heart sounds, respiration, and temperature; therapeutic and prosthetic devices; medical imaging instrumentation. Same as ECE 414. 3 undergraduate hours. 3 graduate hours. Prerequisite: BIOE 205, ECE 205 or ECE 210.
BIOE 461  Cellular Biomechanics  credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/461)
Same as TAM 461. See TAM 461.

BIOE 467  Biophotonics  credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/467)
Same as ECE 467. See ECE 467.

BIOE 473  Biomaterials Laboratory  credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/473)
Same as MSE 472. See MSE 472.

BIOE 474  Metabolic Engineering  credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/474)
Same as CHBE 474. See CHBE 474.

BIOE 476  Tissue Engineering  credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/476)
Tissue engineering therapies for cell-based, material-based, and therapeutic-based solutions. Stem cells, immunology, and clinical applications. 3 undergraduate hours. 3 graduate hours. Prerequisite: MCB 150 and BIOE 206.

BIOE 477  Imaging and Therapeutic Probes  credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/477)
This course will introduce the principles and prerequisites for clinical (MRI, CT, US, PET-SPECT) and pre-clinical (PAT, Optical) imaging modalities and chemical strategies to develop exogenous probes for the early detection of molecular changes responsible for disease pathogenesis such as cardiovascular, inflammatory, cancer and neurological disorders. We will also discuss in depth the strategies for site-specific delivery of therapeutic agents (chemotherapeutic, thrombolytic, and biologics) with biochemically triggered release mechanisms. The course is designed to teach various aspects of translational medicine from imaging and therapeutic standpoint. Students will be introduced to the fundamentals of various clinical and preclinical imaging modalities, prerequisites for developing probes for these modalities, their application in current clinical practice, and preclinical development in various animal models of cancer, cardiovascular and neurological diseases. We will also briefly explore therapeutic approaches (chemo- and biologics) to these diseases and identify opportunities for personalized preemptive medicine. The course is uniquely tailored for students interested in interdisciplinary translational research with direct clinical focus. 3 undergraduate hours. No graduate credit. Prerequisite: Open to junior or seniors.

BIOE 479  Cancer Nanotechnology  credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/479)
An elective course for graduate students who are interested in learning nanotechnology and its applications in biology and medicine. Key topics include: (1) cancer biology and clinical oncology, (2) fundamentals of nanoscience, (3) principles of nanoscale engineering, (4) major classes of nanoparticles and nanostructures, and (5) nanomedicine - technologies and applications 3 undergraduate hours. No graduate credit. Approved for Letter and S/U grading. Prerequisite: BIOE 206, CHEM 232.

BIOE 480  Magnetic Resonance Imaging  credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/480)
Same as ECE 480. See ECE 480.

BIOE 481  Whole-Body Musculoskel Biomech  credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/481)
Same as ME 481. See ME 481.

BIOE 482  Musculoskel Tissue Mechanics  credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/482)
Same as ME 482. See ME 482.

BIOE 487  Stem Cell Bioengineering  credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/487)
Stem Cell Bioengineering will provide a foundation in the application of engineering approaches for the quantitative analysis of stem cell biology and the translation of stem cells into therapies. There will be 4 main sections of the course; (i) Stem Cell Basics, (ii) Stem Cell Genetics, (iii) Stem Cell Microenvironments, and (iv) Stem Cell Applications. The course will be targeted for first year graduate students and senior-level undergraduate students. The course will use a lecture and discussion format to effectively present relevant information. 3 undergraduate hours. 4 graduate hours. Prerequisite: MCB 150, BIOE 206 or equivalent, and BIOE 476.

BIOE 497  Individual Study  credit: 1 to 4 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/497)
Special project or reading activity. 1 to 4 undergraduate hours. 1 to 4 graduate hours. May be repeated up to 8 hours in a term to a maximum of 12 total hours. Prerequisite: Approved written application to department as specified by department or instructor.

BIOE 498  Special Topics  credit: 1 to 4 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/498)
Subject offerings of new and developing areas of knowledge in bioengineering intended to augment the existing curriculum. See Class Schedule or departmental course information for topics and prerequisites. 1 to 4 undergraduate hours. 1 to 4 graduate hours. May be repeated in the same or separate terms if topics vary to a maximum of 12 hours, but no more than 8 in any one term.

BIOE 499  Senior Thesis  credit: 1 to 5 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/499)
Limited in general to seniors in the curriculum in bioengineering. Any others must have the consent of the head of the department. Each student taking the course must register in a minimum of 5 hours either in one term or divided over two terms. A maximum registration of 10 hours in two terms is permitted. 1 to 5 undergraduate hours. No graduate credit. May be repeated, if topics vary. Prerequisite: Majors only, senior standing.

BIOE 500  Graduate Seminar  credit: 0 or 1 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/500)
Lecture surveying a broad range of Bioengineering topics. 0 or 1 graduate hours. No professional credit. Approved for S/U grading only. May be repeated to a maximum of 2 hours.

BIOE 501  Seminar Discussion  credit: 1 Hour. (https://courses.illinois.edu/schedule/terms/BIOE/501)
Familiarization with reading and discussing academic journals in Bioengineering. Approved for S/U grading only.

BIOE 502  Bioengineering Professionalism  credit: 2 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/502)
Ethical questions and conduct, procedures, and professional standards in the practice of bioengineering. Authorship and mentoring, use of animal and human subjects, conflict of interest, ethical behavior in scientific research, intellectual property, and approval processes for drugs and biomedical devices. 2 graduate hours. No professional credit.

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BIOE 504 Analytical Methods in Bioeng credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/504)
Mathematical concept relating to modeling of physiological and biochemical processes and the instrumentation used to measure those processes. Review of matrix methods, probability, linear systems, and integral transforms. Singular value decomposition, Bayesian decision making, and linear system solutions to ordinary differential equations. Application of concepts to biosensor design and evaluation, tracer kinetic modeling, and filtering and curve-fitting approaches to forward modeling problems. Prerequisite: MATH 285.

BIOE 505 Computational Bioengineering credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/505)
Mathematical and statistical models plus accompanying computational techniques central to many aspects of systems biology and bioengineering research. Theory of supervised and unsupervised learning: linear models; dimension reduction; Monte Carlo computation; analysis of gene expression data and genome sequence data; modeling of gene transcription network signaling pathways. Same as CSE 505. 4 graduate hours. No professional credit. Prerequisite: MATH 400.

BIOE 506 Molecular Biotechniques credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/506)
Introduction to modern biotechnologies for studies on the Central Dogma of Biology (DNA, RNA, and Protein) as well as cellular organelles and cell imaging. In-depth review of traditional established methods and emerging ones, emphasizing high precision, high spatial/temporal resolution, high-throughput, molecular accuracy, sensitivity and real-time imaging. Techniques include single molecule sequencing, super resolution cell imaging, and gene therapeutic methods. Example applications of technology are included through relevant journal articles. 4 graduate hours. No professional credit. Prerequisite: MCB 250.

BIOE 507 Advanced Bioinstrumentation credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/507)
Instrumentation and underlying theory employed in bioengineering. Concepts in the design and operation of sensors, fundamental of optics, basic control theory and systems, digital components, and fundamental principles of medical imaging techniques. Specific knowledge of one biomedical instrument or system will be emphasized including detailed mathematical analysis. Prerequisite: BIOE 504.

BIOE 510 Computational Cancer Biology credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/510)
Mathematical modeling of the process of carcinogenesis as somatic cell evolution. Focus on current research topics in cancer biology using data from next-generation sequencing technologies. Overview of database resources and algorithmic and modeling methods relating to biological problems. 4 graduate hours. No professional credit. Prerequisite: BIOE 206, CS 101, MATH 285.

BIOE 540 Algorithmic Genomic Biology credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/540)
The purpose of the course is to give each student enough background and training in the area of algorithmic genomic biology so that each will be able to do research in this area, and publish papers. The main focus of the course is phylogeny (evolutionary tree) estimation, multiple sequence alignment, and genome-scale phylogenetics, which are problems that present very interesting challenges from a computational and statistical standpoint. Time permitting, we will also discuss computational problems in microbiome analysis, protein function and structure prediction, genome assembly, and even historical linguistics. Students will learn the mathematical and computational foundations in these areas, read the current literature, and do a team research project. The course is designed for doctoral students in computer science, computer engineering, bioengineering, mathematics, and statistics, and does not depend on any prior background in biology. The technical material will depend on discrete algorithms, graph theory, simulations, and probabilistic analysis of algorithms. Same as CS 581. 4 graduate hours. No professional credit. Prerequisite: CS 374 and CS 361/STAT 361, or consent of instructor.

BIOE 550 Seminar Series credit: 1 Hour. (https://courses.illinois.edu/schedule/terms/BIOE/550)
Guest topics will vary, but will typically cover topics of current interest relevant to the bioengineering field. Lecture and discussion on topics relevant to the development, regulatory approval, marketing, and application of systems used in the fields of biomedical imaging, life science research, and pharmaceutical discovery. Emphasis upon case studies on topics that will include regulatory approval, intellectual property, strategy, and technology innovation. 1 graduate hour. No professional credit. Approved for S/U grading only. May be repeated up to 2 hours in separate terms. Prerequisite: For students enrolled in the M.Eng. in Bioengineering degree program.

BIOE 571 Biological Measurement I credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/571)
With special focus on medical imaging, this course will introduce fundamental concepts related to the detection and analysis of biological analytes, biomedical images, and physiological parameters. Topics include signal-to-noise analysis, noise characterization, data aliasing, analog-to-digital conversion, common strategies for noise reduction, exogenous contrast agents and fundamentals of molecular imaging. The fundamental phenomena behind biological measurements such as DNA sequencing, fluorescence microscopy. MRI imaging, OCT imaging, and ultrasound imaging will be discussed along with the factors that influence noise and contrast from the standpoint of fundamental physics, instrumentation/hardware, and post-measurement data/signal processing. 4 graduate hours. No professional credit. Prerequisite: For students enrolled in the M.Eng in Bioengineering degree program.

BIOE 572 Biological Measurement II credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/572)
With special focus on medical imaging, learn about advanced techniques relating to state-of-the-art bioinstrumentation technologies. Topics will broadly include fluorescence, genomic and proteomic diagnostics, biosensors, ultrasound imaging, microscopy and their uses relevant to physiological changes related to major human diseases. 4 graduate hours. No professional credit. Prerequisite: BIOE 571. For students enrolled in the M.Eng in Bioengineering degree program.
BIOE 573 Managing Business Operations  credit: 4 Hours. Introduction to fundamental principles of design, management, and improvement of business operations and product innovations. Strategies and techniques for managing processes, projects, process improvement and new product development. 4 graduate hours. No professional credit. Prerequisite: For students enrolled in the M.Eng in Bioengineering degree program.

BIOE 574 Innovation and Introduction to Financial Decision Making  credit: 4 Hours. Tools, concepts, and analytical frameworks that enhance the ability to define and analyze strategic problems stemming from innovation and technological change, and to identify sources of competitive advantage from both an industry and firm-level perspective. Introduction to financial decision making, including topics in valuation, project analysis and risk-return relationships. 4 graduate hours. No professional credit. Prerequisite: For students enrolled in the M.Eng in Bioengineering degree program only.

BIOE 575 Capstone Project  credit: 6 Hours. Students in the Master of Engineering (M.Eng.) in Bioengineering program will demonstrate their proficiency through a capstone project, where students will work on a translational project to develop solutions for real world problems utilizing principles of design, engineering analysis, and functional operation of engineering systems. Depending on the student's flexibility and availability, capstone projects may include collaboration with other online M.Eng. students on a team-based project, analysis of case studies, or even a self-directed project that directly relates to a specific area of interest or on behalf of their employer. Project presentations and demonstrations may be required at the end of the program. 6 graduate hours. No professional credit. Prerequisite: Proficiency in MATLAB and completion of or concurrent enrollment in core classes required for the Master of Engineering (M.Eng.) in Bioengineering program. Class only available to students in the M.Eng. in Bioengineering degree program.

BIOE 581 MRI Pulse Sequence Design  credit: 3 Hours. Modular approach to pulse sequence programming in magnetic resonance imaging; descriptions of current pulse sequences; RF pulse design; data sampling considerations; k-space acquisition trajectories. Pulse sequence development simulator usage to program, simulate, and reconstruct images from student-designed acquisitions. Prerequisite: ECE 480.

BIOE 582 Stats & Algo in Genomic Bio  credit: 4 Hours. This course will provide students with the practical knowledge of statistical analysis and computational modeling techniques relevant for applications in genomics and systems biology. The focus will be on the fundamental concepts and algorithms for gene finding, genome annotation, sequence alignment, phylogenetic reconstruction, gene expression and network analysis, Genome-Wide Association Studies (GWAS), etc. 4 graduate hours. No professional credit. Prerequisite: STAT 100, MCB 250, MATH 220, CS 101, or equivalent. Restricted to MEng Students only.

BIOE 583 HT Genomic Data Analysis  credit: 4 Hours. The course will provide students with important practical skills for handling genomic big data and analyzing the results of various types of high-throughput sequencing experiments. The focus will be on achieving proficiency in data management and processing based on popular file formats in genomic biology. 4 graduate hours. No professional credit. Prerequisite: STAT 100, MCB 250, CS 101, or equivalent. For students enrolled in the M.Eng in Bioengineering program or with consent of the M.Eng. program.

BIOE 599 Thesis Research  credit: 0 to 16 Hours. Bioengineering graduate thesis research. Approved for S/U grading only. May be repeated.