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 Bioengrgr  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 kinematics, and physiological system analysis. Use of Matlab and Simulink software to understand more complex systems. Prerequisite: CS 101, PHYS 212, and credit or concurrent registration in MATH 285.

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 210  Linear Algebra for Biomedical Data Science  credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/210)
Using analytical and computational tools from linear algebra, students will Solve large systems of linear equations, systems of linear ODEs, and linear PDEs; Analyze large, multivariable datasets to quantify relationships between variables; Decompose complex datasets into simpler representations; Introduce and solve common problems in classification, image processing, and machine learning; Develop a geometric understanding of high-dimensional spaces. Prerequisite: CS 101 and MATH 231. For Bioengineering majors only.

BIOE 220  Bioenergetics  credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/220)

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.

Information listed in this catalog is current as of 04/2020
BIOE 302 Modeling Human Physiology  credit: 3 Hours. ([courses.illinois.edu/schedule/terms/BIOE/302](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.

BIOE 303 Quantitative Physiology Lab  credit: 2 Hours. ([courses.illinois.edu/schedule/terms/BIOE/303](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. ([courses.illinois.edu/schedule/terms/BIOE/306](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 polymerase 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. ([courses.illinois.edu/schedule/terms/BIOE/310](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. ([courses.illinois.edu/schedule/terms/BIOE/360](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 and MATH 285.

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

BIOE 397 Individual Study  credit: 1 to 4 Hours. ([courses.illinois.edu/schedule/terms/BIOE/397](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. ([courses.illinois.edu/schedule/terms/BIOE/398](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. ([courses.illinois.edu/schedule/terms/BIOE/414](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 415 Biomedical Instrumentation Lab  credit: 2 Hours. ([courses.illinois.edu/schedule/terms/BIOE/415](https://courses.illinois.edu/schedule/terms/BIOE/415))
Laboratory to accompany BIOE 414. Use of sensors and medical instrumentation for static and dynamic biological inputs. Measurement of biomedical signals. Same as ECE 415. 2 undergraduate hours. 2 graduate hours. Prerequisite: Credit or concurrent registration in BIOE 414.

BIOE 416 Biosensors  credit: 3 Hours. ([courses.illinois.edu/schedule/terms/BIOE/416](https://courses.illinois.edu/schedule/terms/BIOE/416))
Same as ECE 416. See ECE 416.

BIOE 420 Intro Bio Control Systems  credit: 3 Hours. ([courses.illinois.edu/schedule/terms/BIOE/420](https://courses.illinois.edu/schedule/terms/BIOE/420))
Systems engineering approach to modeling physiological systems to examine natural biological control systems, homeostasis, and control through external medical devices. Introduces open loop and closed loop feedback control; Laplace and Fourier analysis of system behavior; impulse and steady state responses; physiological modeling and system identification; and stability. Includes biological systems for endocrine function, muscle position, neuronal circuits, and cardiovascular function. Mathematical modeling, Matlab and Simulink simulation, and physiological measurements to relate control systems to maintenance of internal environment. 3 undergraduate hours. No graduate credit. Credit is not given for BIOE 420 if credit for AE 353, ECE 486, SE 320, or ME 340 has been earned. Prerequisite: BIOE 302, BIOE 303, BIOE 414, BIOE 415.

BIOE 424 Modeling for Angiogenesis  credit: 3 Hours. ([courses.illinois.edu/schedule/terms/BIOE/424](https://courses.illinois.edu/schedule/terms/BIOE/424))
Introduction to the field of angiogenesis and introduction to growth factor-receptor modeling. Translating experimental observations of vascular formation to mathematical representations. Application of mathematical modeling in MATLAB to angiogenic signaling via model analysis, simulation, and prediction. Case studies and application to regenerative medicine, tumor angiogenesis, anti-angiogenic therapeutics, and other areas (e.g., cardiovascular disease). 3 undergraduate hours. No graduate credit. Prerequisite: BIOE 201, CS 101, MATH 285.

BIOE 430 Intro Synthetic Biology  credit: 3 or 4 Hours. ([courses.illinois.edu/schedule/terms/BIOE/430](https://courses.illinois.edu/schedule/terms/BIOE/430))
Introduction to the field of synthetic biology. Engineering applications of biomolecular systems and cellular capabilities for a variety of application biological background of gene regulation, experimental methods for circuit engineering, and mathematical basis for circuit modeling. Examples in biofuels, biomedicine, and other areas will be discussed. 3 undergraduate hours. 4 graduate hours. Prerequisite: BIOE 206 or MCB 252; and MATH 285.
BIOE 435  
**Senior Design I credit: 2 Hours.** ([courses.illinois.edu/schedule/terms/BIOE/435](https://courses.illinois.edu/schedule/terms/BIOE/435))  
Capstone bioengineering design activity to develop solutions to projects provided by academia, industry, or clinical settings, utilizing principles of design, engineering analysis, and functional operation of engineering systems. Concept-design, safety, human-factors, quality, and Six-Sigma considerations. Initial solution proposals meeting professional technical-writing and communication standards. Concluded in BIOE 436. 2 undergraduate hours. No graduate credit. Prerequisite: BIOE 414, BIOE 415, BIOE 302, and BIOE 303.

BIOE 436  
**Senior Design II credit: 2 Hours.** ([courses.illinois.edu/schedule/terms/BIOE/436](https://courses.illinois.edu/schedule/terms/BIOE/436))  
Continuation of BIOE 435. Design teams finalize concepts, evaluate alternatives, model and analyze solutions, build and test a final product, and present the results professionally to project sponsors. 2 undergraduate hours. No graduate credit. Prerequisite: BIOE 435.

BIOE 460  
**Gene Editing Lab credit: 3 Hours.** ([courses.illinois.edu/schedule/terms/BIOE/460](https://courses.illinois.edu/schedule/terms/BIOE/460))  
The objective of this course is to provide the knowledge and hands-on experience required for both designing and building tools that are necessary to engineer biological systems at the molecular and cellular levels. This particular course will highlight diverse examples of applications in synthetic biology. It will deal with such topics as gene editing, epigenome engineering, regulation of gene expression and synthetic life. Projects will be assigned for small teams. Students will submit a report after completion of each project. Students will have the opportunity to independently design and execute a genetic engineering project and present their project to the class. 3 undergraduate hours. No graduate credit. Prerequisite: BIOE 202 and BIOE 206. For bioengineering undergraduate majors only.

BIOE 461  
**Cellular Biomechanics credit: 4 Hours.** ([courses.illinois.edu/schedule/terms/BIOE/461](https://courses.illinois.edu/schedule/terms/BIOE/461))  
Same as TAM 461. See TAM 461.

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

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

BIOE 476  
**Tissue Engineering credit: 3 Hours.** ([courses.illinois.edu/schedule/terms/BIOE/476](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.** ([courses.illinois.edu/schedule/terms/BIOE/477](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.** ([courses.illinois.edu/schedule/terms/BIOE/479](https://courses.illinois.edu/schedule/terms/BIOE/479))  
An elective course for undergraduate 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.** ([courses.illinois.edu/schedule/terms/BIOE/480](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.** ([courses.illinois.edu/schedule/terms/BIOE/481](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.** ([courses.illinois.edu/schedule/terms/BIOE/482](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.** ([courses.illinois.edu/schedule/terms/BIOE/487](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: BIOE 476.

BIOE 497  
**Individual Study credit: 1 to 4 Hours.** ([courses.illinois.edu/schedule/terms/BIOE/497](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 department chief advisor. Each student taking the course must register in a minimum of 5 hours either in one term or divided over two terms. 1 to 5 undergraduate hours. No graduate credit. May be repeated to a maximum of 10 hours between two semesters. Prerequisite: 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.

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 biomolecular 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: STAT 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, fundamentals 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 531 Principles of Pharmaceutical Technology credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/531)
This is a core course for the pharmaceutical engineering concentration. Drug manufacturing often relies on principles of chemistry, pharmaceutics, and technology. This course will discuss in-depth understanding of compounds and materials to help designers predict and measure compound properties to define and characterize their constitutive behaviors. This course will provide students with an understanding of the principles, strategies, and materials used in the processes of controlled drug delivery systems. Gaining knowledge in ingredient interaction (thermodynamics vs. kinetics) and how the delivery requirements determine the ingredients and the corresponding processing is critical for the success of a pharmaceutical development. This course will first discuss the synthetic approaches to new drug discovery and repurposing followed by introducing the technology methodologies involved in translating a drug compound produced in the lab to an industrial process. It will also focus on topics at the interface between engineering and chemistry and biology covering fundamentals of drug delivery, including physiology, pharmacokinetics/pharmacodynamics, drug diffusion and permeation, and biomaterials used in drug delivery. Controlled release strategies for various administration routes will also be discussed. 4 graduate hours. No professional credit. Prerequisite: Student should have completed courses in advanced math, including linear algebra and differential equations, as well as courses in chemistry and biological sciences. Open to all M.Eng. in Bioengineering students.
BIOE 532  Advanced Pharmaceutical Technology  credit: 4 Hours.  
This is a core course for the pharmaceutical engineering concentration. This course will follow a combination of modular lecture and laboratory-based teaching (lab modules will require students to participate in conducting wet lab experiments followed by calculations). Drug manufacturing often relies on principles of chemistry, pharmaceutics, and technology. Most of the classical pharmaceutical engineering degree programs either do not extensively address newly defined design-based approaches or require long years of work experience to acquire integrated knowledge on pharm-science, relevant regulations and process technology. This knowledge gap on the interface of pharmacy and process technology has been identified independently by WHO and AAPS survey (Lawrence 2017; O’Connor 2016). The goal of this course is to help develop the desired skill sets covering the concepts to adapt technology principles to pharmaceutical and life sciences with topics ranging from process technology in the drug discovery, high throughput characterization and optimization of new chemical entities, solid-state engineering, and intelligent pharmaceutical manufacturing systems. The basic features of common unit operations used in the pharmaceutical industry will be reviewed, including batch reaction, solid-liquid separation, crystallization, drying, mixing, batch distillation and other separation systems. 4 graduate hours. No professional credit. Prerequisite: BIOE 531. Open to all M.Eng. in Bioengineering students.

BIOE 570  Seminar Series  credit: 1 Hour.  
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.  
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.  
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: 3 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. 3 graduate hours. No professional credit. May be repeated for 6 hours in separate semesters. Students in the Master of Engineering program will be required to sign up for BIOE 575 in both the Fall and Spring semesters. 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 576  Innovation and Introduction to Financial Decision Making  credit: 4 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 581  MRI Pulse Sequence Design  credit: 3 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. (https://courses.illinois.edu/schedule/terms/BIOE/583)
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 597  Individual Study  credit: 1 to 8 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/597)
Special project or reading activity. May be repeated. Prerequisite: Approved written application to department as specified by department or instructor.

BIOE 598  Special Topics  credit: 1 to 4 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/598)
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 12 hours, but no more than 8 in any one term.

BIOE 599  Thesis Research  credit: 0 to 16 Hours. (https://courses.illinois.edu/schedule/terms/BIOE/599)
Bioengineering graduate thesis research. Approved for S/U grading only. May be repeated.

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