BioE approved Focus & Electives Courses (AY 25/26)*

MSP (Focus area 1): Computation, Modeling and signal processing
SSB (Focus area 2): Synthetic and systems biology
CTD (Focus area 3): Cells, tissues and devices

BioE Focus Area Courses

Instructor	*Quarter offered	Course	Title	Focus	Course description
Dewey	Fall 2025	BIOE 242	Tissue Engineering and Regenerative Medicine	CTD	An introduction to the principles of tissue engineering: interplay and design of cells, biomaterials, and bioactive molecules to assist the body in the repair of damaged tissues. This includes concepts such as examining material fabrication approaches, engineering cells and their behavior, studying tissue microenvironments from diverse organ systems, the role of extracellular matrix in repair, in vitro approaches to tissue engineering, and delivery of bioactive molecules (growth factors, extracellular vesicles, etc.), among others. By the end of this course, students will be able to design and evaluate tissue engineered constructs to repair a specific organ system.
Pruit/Dewey	Spring 2026	BIOE 258	Mechanobiology Methods	CTD	Cell mechanobiology topics including cell structure, mechanical models, and chemo-mechanical signaling. Review and apply methods for controlling and analyzing the biomechanics of cells using traction force microscopy, AFM, micropatterning and cell stimulation. Design and application of methods for quantitative cell mechanobiology.
Stowers	Spring 2027	BIOE 241	Engineering Biomaterials	CTD	This lecture-based course will provide an overview of material structure-property relationships, processing, and characterization techniques for metals, polymers and ceramics. We will discuss the unique design constraints imposed by the human body and discuss strategies to enhance biocompatibility. Throughout the course, emphasis will be placed on applications of biomaterials engineering in medical devices.
Mukherjee	Winter 2026	CHEM 259MM	Gene Therapy		Developing therapies using nucleic acids for human diseases is a high-risk, high-reward endeavor in bioengineering and medicine, with many challenges remaining to be addressed. However, once these obstacles have been overcome and widespread clinical success has been achieved, gene therapy will offer unparalleled opportunities for treating a range of disorders that are currently untreatable by conventional medical practices. This course will explore the field of gene therapy, covering a wide range of topics, including gene delivery, noninvasive reporter gene imaging, genetic editing, clinical trials, and the social and ethical considerations of gene therapy.
Mukherjee	TBD	BIOE 274	Model-guided Engineering of Biological Systems	MSP	This course will introduce students to foundational principles of biological engineering, integrating mechanistic modeling and quantitative analysis with basic molecular and cell biology. Students will be introduced to modeling of biomolecular interactions including protein-ligand binding, gene expression, and regulation of gene networks and metabolic pathways. Fundamental concepts will include rate processes, binding equilibria & kinetics, gene expression modeling, network dynamics, and modeling of coupled mass transport & reaction. At the end of this course, students are expected to have a deep understanding of how these modeling tools provide a uniquely powerful avenue for biological and chemical engineers to study molecular and cellular processes as well as (semi)-predictively engineer these processes to drive cutting-edge advances in the healthcare. Students enrolled in the course will be required to complete a term project involving application of Poisson statistics & the Gillespie algorithm to model a biological process (e.g., gene expression) in a stochastic framework. In addition, Ph.D. students will be expected to implement 4-6 classic papers in biological modeling, reproducing key results, and discussing (by in silico experimentation) how the model might be extended in new directions.
Visell	Winter 2026 (tentative)	BIOE 240	Haptics - Touch Perception, Interaction, and Engineering	MSP	Haptics lies at the intersection of robotics, human-computer interaction, and computational and human perception. The term “haptics” is often used to refer to science and engineering related to the sense of touch. This course introduces human haptics, including sensory specializations and touch perception. It reviews the engineering of electronic technologies for haptic (touch) feedback, emerging technologies, and the design of haptic systems for human-computer interaction, sensory substitution, virtual reality, augmented reality, and other emerging areas. The class involves a mix of readings, hands-on activities, lecture/discussion, and projects. Haptics is a rapidly evolving field, and this course offers us the opportunity to engage with current research through articles, lectures, videos, and our own experiments.
Volkman	Spring 2026	BIOE 244	Introduction to Machine Learning Techniques for Interpretation of Biological Data	MSP	Provides a general introduction to modern Machine Learning techniques with a focus on neural networks with relevance for biological image processing and structural biology applications across scales from the atomic level to organisms. Introductions to relevant concepts in biological image processing and structural biology will be part of the curriculum as well.
Dey	Winter 2026	BIOE 254	Systems Biology	SSB	Applications of engineering tools and methods to solve problems in systems biology. Emphasis is placed on integrative approaches that address multi-scale and multi-rate phenomena in biological regulation. Modeling, optimization, and sensitivity analysis tools are introduced.
Mills	Fall 2025	BIOE 243	Protein Engineering	SSB	Introduces students to current methods and general principles of engineering proteins, with a focus on presenting overall strategies for library generation,screening, and selection such that students can extend approaches to engineering other biomolecules of interest (e.g., nucleic acids).

O'Malley	TBD	BIOE 272	Omics-enabled Biotechnology	SSB	Integrates genomic, transcriptomic, metabolomic, and proteomic approaches to quantify and understand intricate biological systems. Complementary bioinformatics approaches to curate the large datasets associated with these experiments are also discussed. Recent examples from the literature reinforce core concepts, ranging from applications to human health to the environment. By the end of the course, students should be able to design an integrated experiment that capitalizes on these "omics"- based approaches to enhance the scope of their research.
Yeung	AY 26/27	BIOE 250AD/ME225EY	Biological Control	SSB	This course aims to equip students with an understanding of how to use modern control methods to control biological networks and genetic circuits. We will cover the use of H2 and Hoo control methods for biological networks, using classical algebraic Ricatti and modern semi-definite programming methods. We will illustrate how to model insularity or crosstalk in synthetic gene networks, using modern methods developed by working practitioners in the field of synthetic biology and biological control. The course concludes with a treatment of genetic circuit design, using data-driven methods, including sensor fusion, dynamic mode decomposition, and dictionary-based approaches.

BioE Elective Courses

Instructor	*Quarter offered	Course	Title	Focus	Course description
Beyeler		CS 291A	Bionic Vision	ELE	What would the world look like with a bionic eye? This graduate course will introduce students to the multidisciplinary field of bionic vision, with an emphasis on both the computer science and neuroscience of the field. The course will give an overview of current bionic eye technology designed to restore vision to people living with incurable blindness. Students will be exposed to the neuroscience of the human visual system, key engineering concepts for designing a brain-computer interface, and computational principles underlying the encoding of a visual scene into an artificial stimulus that the brain can interpret. We will cover recent advances in theory and applications, and discuss outstanding challenges with existing devices. The course will conclude with a team project giving students the opportunity to gain hands-on experience of working on open problems using methods and tools best suited to their scientific background. The course is targeted to a diverse audience spanning from computer science (neural networks, computer vision, human factors) to psychology (vision, psychophysics) and brain sciences (computational neuroscience, neuroengineering).
Beyeler		PSY 221F	Computational Neuroscience	ELE	Survey of methods in computational neuroscience; single cell methods including Hodgkin-Huxley models, occupation theory, integrate-and-fire models; neural network modeling including linear system theory, nonlinear dynamics, connectionism, Hodgkin-Huxley-like network models, models of synaptic plasticity, methods for generating predicted BOLD signals.
Dressaire		ME 225ED	Bio-inspired Design	ELE	In this course, students will learn how Nature can support the creative design process. Students will study evolutionary adaptation as a source for inspiration, extracting design principles to leverage the functionality, adaptability and robustness of biological systems. To advance student knowledge of biological strategies and facilitate quantitative analysis of the proposed solutions, the course focuses on biologically inspired design in fluids. Over the quarter, the students will learn how biological systems deal with fluids and the bio-inspired design process. The course includes lectures, case studies and hands-on design activities. Final projects will involve a team of students. Each team will select a biological system from our local zoo and define a design problem it solves. The students will then expand their search to learn about relevant biological systems. Students will (1) identify the design principles used by the biological system(s), (2) propose a bio inspired design to achieve the identified function, and (3) produce a demo of the design principle and prepare a pamphlet describing their work to a general audience.
Louis		MCDB 208C	Computational and Systems Biology	ELE	Models of Biochemical and Cellular Systems. Introductory systems-biology approach to model the design and the function of biological systems. Students will develop an intuition about physical concepts that are fundamental to discuss how biological organisms acquire and process information from the environment. Those concepts and tools will cover probabilities and basic dynamical systems theory. Students will build models of processes of increasing complexity, ranging from viral dynamics, bacterial resistance to drugs, the maintenance of homeostatic equilibrium (trp operon), biological oscillators (mitotic clock) and genetic switches underlying cellular decisions (bacteriophage lambda and lac operon).

Marchetti, Dogic, Streichan		PHYS 239	Physical Biology of the Cell	ELE	The role of physics in biology through quantitative measurements and modeling, the organization of a cell, and exemplary quantitative results of biological model systems. The physics of biologically relevant macromolecules, including DNA, RNA and mechanisms of transcription and translation; introduction to protein folding and the role of electrostatics in biology. The physics of the cytoskeleton including beam theory, persistence length, molecular motors, instrumentation used to characterize motor properties, as well as the role of active stresses in cell biology. If time permits, a brief introduction to cell motility and the structure of epithelial tissue.
Miolane		ECE 594N	Biological Shape Analysis	ELE	Geometric transformations, mathematical models of shapes, articulated shapes, shapes of landmarks, curves, surfaces, shape deformations, shape statistics and machine learning, applications to the analysis of shapes of proteins, cells, organs for computational biology and medicine.
Pitenis		MATRL 270	Biomaterials and Biosurfaces	ELE	The first part of this course will explore the fundamentals of natural and artificial biomaterials and biological surfaces (biosurfaces), with an emphasis on surface and contact mechanics. The second part will focus on biosurfaces and delve into molecular-level structure and function. The third part will explore the dynamic interactions between biomaterials and surfaces with the body and designing for biocompatibility.
Saleh		MATRL 272	Mechanical Force and Biomolecules	ELE	In this course, we will explore the field of single-molecule bio-physics, and in particular the role of mechanical force in biomolecular behavior. Mechanical forces are critical to a wide range of biological processes, and modern techniques allow the experimentalist to study those processes by directly measuring forces generated by biomolecules and/or perturbing the system with an applied force. The course will start off with an introduction to the experimental techniques used to apply force to single biomolecules (e.g., optical/magnetic traps, AFM, etc.), with a focus on quantitative calibration approaches. The remainder of the course will cover various aspects of the molecular biophysics of mechanical force, including the linear elasticity of biomolecules; DNA torsional mechanics and topology (twist, writhe); force-induced unfolding and unzipping transitions; and force-generation by motor proteins. Stochastic physical models of molecular behavior (e.g., Langevin, Kramers) will be a theme throughout. The course will draw on recent literature, culminating with student presentations of recently-published papers from the field.
Smith		ECE 594	Measuring and Manipulating Neuronal Activity	ELE	Neuroengineering technology, including optical and electrical methods, for measuring and manipulating neural activity with the resolution to see individual neurons and synapses. Applications to neuroscience research, ML/AI, brain-machine interfaces, and other devices for humans.
Wilson		MCDB 272	Biological Dynamics	ELE	An introduction to mathematical models and computer simulations used to describe and understand time varying biological systems. Learning Objectives: Survey mathematical methods for describing the dependence on time of biological phenomena. Illustrate how to construct mathematical models to gain insights into complex biological systems. Develop working knowledge of a python code base that enables future evaluation of common classes of models applied to the study of biological dynamics.
Only one of the writing courses below may be taken as an elective					
De Tomaso/Kim		MCDB 221	Preparation and Evaluation of Research Proposals and Scientific Presentations	ELE	Instruction in preparation writing, and evaluation of research grant proposals. Overview of federal funding mechanisms, ethics in research, the peer review and proposal evaluation processes, and general strategies in communication of scientific ideas including poster and oral presentations. This course is writing based and includes instruction and guidance on applying to NSF and NIH Pre-Doctoral Fellowships.
Schimmel		EEMB 511	Writing Science	ELE	A hands-on workshop to polish writing skills. Modules focus on story telling to make ideas compelling, streamlining to make writing compact and effective, and developing flow of ideas and paragraphs. Students work on a chapter, paper, or proposal.

*All courses listed subject to change, please confirm in Gold