Pritzker School of Molecular Engineering

ime.uchicago.edu

Dean
• Matthew Tirrell

Academic and Student Affairs
• Paul Nealey, Brady W. Dougan Professor in Molecular Engineering and Deputy Director for Education and Outreach
• Rovana Popoff, Senior Associate Dean and Dean of Students
• David Taylor, Associate Dean of Students
• Lisa Abston-Leftridge, Assistant Dean of Students

Faculty
• David Awschalom (http://ime.uchicago.edu/awschalomlab/people/david_awschalom)
• Hannes Bernien (https://ime.uchicago.edu/bernien_lab/hannes_bernien)
• Nicolas Chevrier (https://ime.uchicago.edu/chevrier_group/people/nicolas_chevrier)
• Andrew Cleland (http://ime.uchicago.edu/andrew_cleland)
• Aashish Clerk (https://ime.uchicago.edu/aashish_clerk)
• Juan de Pablo (http://ime.uchicago.edu/de_pablo_lab/people/juan_de_pablo)
• Aaron Esser-Kahn (https://ime.uchicago.edu/esser_kahn_group/people/aaron_esser_kahn)
• Andrew Ferguson (https://ime.uchicago.edu/andrew_ferguson)
• Giulia Galli (https://ime.uchicago.edu/galli_group/people/giulia_galli)
• Supratik Guha (http://ime.uchicago.edu/guha_lab/people/supratik_guha)
• Alex High (https://ime.uchicago.edu/alex_high)
• Jun Huang (http://ime.uchicago.edu/huang_group/people/jun_huang)
• Jeffrey Hubbell (http://ime.uchicago.edu/hubbell_lab/people/jeffrey_hubbell)
• Nancy Kawalek (http://ime.uchicago.edu/nancy_kawalek)
• Chong Liu (https://ime.uchicago.edu/liu_group/people/chong_liu)
• Peter Maurer (https://ime.uchicago.edu/maurer_group/peter_maurer)
• Juan Mendoza (https://ime.uchicago.edu/juan_mendoza)
• Paul Nealey (http://ime.uchicago.edu/nealey_lab/people/paul_nealey)
• Jiwoong Park (https://ime.uchicago.edu/jiwoong_park)
• Shrayesh Patel (https://ime.uchicago.edu/patel_group/people/shrayesh_patel)
• Rama Ranganathan (https://ime.uchicago.edu/rama_ranganathan)
• Stuart Rowan (https://ime.uchicago.edu/rowan_group/people/stuart_rowan)
• James Skinner (https://ime.uchicago.edu/skinner_group/people/james_skinner)
• Melody Swartz (https://ime.uchicago.edu/swartz_group/people/melody_swartz)
• Savas Tay (https://ime.uchicago.edu/savas_tay)
• Matthew Tirrell (http://ime.uchicago.edu/tirrell_lab/people/matthew_tirrell)
• Sihong Wang (https://ime.uchicago.edu/wang_group/sihong_wang)
• Shuolong Yang (https://ime.uchicago.edu/shuolong_yang)
• Tian Zhong (https://ime.uchicago.edu/tian_zhong)

The Pritzker School of Molecular Engineering (PME) is at the forefront of an emerging field. This exciting venture prepares students to combine problem-solving skills with broad expertise in the fundamental sciences to build useful systems from the molecular level up. The PME’s approach to engineering research and education emphasizes analytical and disciplinary integration, rather than the traditional separation of engineering disciplines. As a result, students from diverse scientific backgrounds may collaborate on research projects that involve the incorporation of synthetic molecular building blocks, including electronic, optical, mechanical, chemical, and biological components, into functional systems that will impact technologies from advanced medical therapies to quantum computing.

Established in 2011 by the University of Chicago, in partnership with Argonne National Laboratory (http://www.anl.gov), the PME brings together a growing team of world-class researchers from diverse science and engineering disciplines who take a hands-on approach to mentoring students and cultivating relationships with industrial and academic partners - resulting in exciting discoveries, new technologies, and innovative solutions.
PME researchers conduct much of their work at the William Eckhardt Research Center, one of the largest and most modern accessible nanofabrication facilities in the Midwest, which includes cutting-edge clean rooms, molecular imaging facilities, biomolecular research labs, and a wet-lab for nanofabrication and other materials work. Additionally, Argonne National Laboratory brings important resources to the endeavor, including the Advanced Photon Source (http://www.aps.anl.gov), the Argonne Leadership Computing Facility (http://www.alcf.anl.gov) and the Center for Nanoscale Materials (http://nano.anl.gov).

How to Apply

The Pritzker School of Molecular Engineering welcomes students with diverse academic backgrounds, including all fields of physical, biological and computational sciences, who possess the motivation and background to transcend disciplinary boundaries and pursue research in a bold, problem-focused way. Applicants to the Ph.D. program should have a bachelor’s degree in a STEM field and should provide scores for the GRE general test the TOEFL and IELTS (if not a native English speaker) (https://internationalaffairs.uchicago.edu/page/english-language-requirements). The relevant GRE subject test scores will be considered if submitted, and could strengthen an application, but are not strictly required. Please submit a personal statement of research interests, three recommendation letters, and transcript(s) from all undergraduate and graduate institutions, along with payment of the $90 application fee. Applications are due January 3, 2019 at 11:59 PM central standard time. https://apply-ime.uchicago.edu/apply

Degree Requirements

Graduate students entering the PME Ph.D. program are expected to fulfill a set of course requirements including 3 core courses, 4 in-depth courses in the area relevant to their research field of choice, and 2 broad elective courses. The core and in-depth courses are selected from a portfolio of graduate-level courses, in conjunction with the faculty advisor. These courses are offered by the PME, sister departments (Physics, Chemistry, Biophysics, Computer Science and Biological Sciences), or are developed specifically for PME students. The broad electives are to provide students with the opportunity to acquire skills in leadership, communication, technology development and product design. The hallmark of PME’s Ph.D. program is a highly customized curriculum tailored to each individual student’s needs and inspirations.

The vibrant and diverse research activities pursued by PME faculty members offer students a broad range of research opportunities. First-year students explore these opportunities through a required first-year colloquium, a series of faculty research talks during autumn quarter, and by establishing relationships with individual faculty members. As a highly interdisciplinary environment, there are many opportunities to work with multiple faculty members within the PME and/or with faculty in other partner divisions at the University of Chicago and Argonne National Laboratory (see our website (http://ime.uchicago.edu/partners) for a full list). Every effort will be made to facilitate the matching of each student with one of their preferred advisors by the end of the first term.

Some students may be recommended for a terminal M.S. degree. Such students must have registered full time in the division for a minimum of three quarters and have completed nine courses at the 30000-level or above in STEM departments with grades of C or better (at least two must be research courses with an approved faculty member). In addition, these students may, at the discretion of the Director of Graduate Studies, be required to submit a paper on their research.

To establish candidacy, students are required to develop a research proposal describing the objectives, approaches and expected outcomes of their Ph.D. thesis work. Students will give an oral presentation of their written proposal in front of a faculty review committee for approval. This process should be completed no later than the end of the Winter quarter of the second year.

Pedagogical training is a component of our doctoral education. The PME requires that all graduate students engage in meaningful teaching experiences. Most students will satisfy this requirement by serving as Teaching Assistants. Students can also propose a meaningful teaching equivalent to be approved by the Director of Graduate Studies and the Dean of Students (proposed equivalents must have clearly articulated pedagogical learning goals and objectives).

- Students entering the doctoral program in 2017, 2016, 2015, and 2014 must either complete two quarters as a Teaching Assistant or one quarter as a Teaching Assistant and one approved equivalent.
- Students entering the doctoral program after 2017 must either complete two quarters as a Teaching Assistant or one quarter as a Teaching Assistant and two approved equivalents.

PME graduate students are not expected to complete their teaching requirement in their first year, but may be asked to TA as needed in any year thereafter. While there is some consideration of student preferences in teaching assignments, assignments overall are determined by departmental need.

All students will receive scholarship support from the Pritzker School of Molecular Engineering for the first quarter. Subsequently, PME provides full financial support to all graduate students throughout their graduate study at the PME as long as they remain in good standing.

The PME adopts the residency requirement of the University of Chicago as a part of the degree requirements.
Molecular Engineering Courses

**MENG 30000. Introduction to Emerging Technologies. 100 Units.**
This course will examine five emerging technologies (stem cells in regenerative medicine, quantum computing, water purification, new batteries, etc.) over two weeks each. The first of the two weeks will present the basic science underlying the emerging technology; the second of the two weeks will discuss the hurdles that must be addressed successfully to convert a good scientific concept into a commercial product that addresses needs in the market place.
Instructor(s): Matthew Tirrell, Mustafa Guler
Terms Offered: Autumn
Prerequisite(s): Completion of the general education requirements in mathematics and physical or biological sciences
Equivalent Course(s): MENG 20000

**MENG 30200. Academic/Professional Writing for STEM. 000 Units.**
Equivalent Course(s): BSDG 33000, PHSC 33000

**MENG 31100. Molecular Science and Engineering of Water. 100 Units.**
This course will cover the properties of the water molecule, hydrogen bonding, clusters, supercritical water, condensed phases, solutions, confined and interfacial water, clathrates, and nucleation. In addition, methods of water purification, water splitting and fuel cells, water in atmospheric and climate science, and water in biology, health and medicine will be discussed.
Instructor(s): James Skinner, Chong Liu
Terms Offered: Autumn
Prerequisite(s): MENG 26201 or CHEM 26200 or PHYS 27900 (or concurrent)
Equivalent Course(s): MENG 21100

**MENG 32000. Mathl Methods in Molecular Engineering. 100 Units.**
This course will provide an overview of the general mathematical framework required for the further study of the basic theories (e.g., thermodynamics, quantum mechanics, transport) of molecular engineering. The content of this course mainly includes differential equations, statistics, complex analysis, integral transforms, and stochastic processes, which will be illustrated in the context of common problems in diffusion, heat conduction, particle transfer, and chemical reactions. This course will lay the mathematical foundations for further studies in other courses, as well as for future computational research activities.
Instructor(s): Sihong Wang
Terms Offered: Autumn
Prerequisite(s): Required Math Courses in the Core, Algebra, Calculus, Physics

**MENG 32500. Polymer Physics. 100 Units.**
This course is an advanced introduction to polymer physics taught at a level suitable for senior undergraduates and graduate students in STEM fields. Topics that will be covered include the statistics and conformations of linear chain molecules; polymer brushes; thermodynamics and dynamics of polymers, polymer blends and polymer solutions; phase equilibria; networks, gels, and rubber elasticity; linear viscoelasticity; and thermal and mechanical properties.
Instructor(s): Paul Nealey
Terms Offered: Spring
Prerequisite(s): MENG 22500
Equivalent Course(s): MENG 27300

**MENG 32510. Introduction to Polymer Science. 100 Units.**
This course introduces the basics of polymer materials and their behavior and properties. The course will cover a general overview to polymers, basic terminology and definitions, their classification, and their applications. The mechanistic and kinetic behavior of the major classes of polymerization reactions (step-growth, chain addition, and "living" polymerizations) will be introduced with respect to control over polymer structure/architecture, size, and properties. The course will also discuss polymer properties, polymer thermodynamics, and basic structure-property relationships that provide polymers with their unique characteristics compared to small molecules. Techniques for characterizing the chemical and physical properties of polymer solutions will be introduced, including osmometry, viscometry, and gel permeation chromatography.
Instructor(s): Paul Nealey, Stuart Rowan
Terms Offered: Autumn
Prerequisite(s): MENG 26201 or CHEM 26200
Equivalent Course(s): MENG 22500

**MENG 32520. Polymer Synthesis. 100 Units.**
This course introduces the most important polymerization reactions, focusing on their reaction mechanisms and kinetic aspects. Topics include free radical and ionic chain polymerization, step-growth polymerization, ring-opening, insertion, controlled living polymerization, crosslinking, copolymerization, and chemical modification of preformed polymers.
Instructor(s): Stuart Rowan
Terms Offered: Winter
Prerequisite(s): CHEM 22000 and CHEM 22100
Equivalent Course(s): MENG 27320

**MENG 33000. Thermodynamics and Statistical Mechanics. 100 Units.**
This course will present an overview of thermodynamics and statistical mechanics in the context of molecular engineering applications. Such applications will include prediction of the thermophysical properties of multicomponent gases, solids and liquids, prediction of adsorption processes on surfaces or interfaces, and molecular-level descriptions of synthetic and biological macromolecules in solution. Throughout the course, emphasis will be placed on connecting molecular structure and interactions to measurable macroscopic properties.
Instructor(s): Juan de Pablo
Terms Offered: Autumn
Prerequisite(s): Chemistry 26100-26200 or equivalent or the consent of the instructor
MENG 33300. Quantum Engineering. 100 Units.
Quantum mechanics underlies many areas of modern engineering, including materials science, photonics, electronics, metrology, and information processing. This course explores both the fundamental physics of quantum systems as well as the tools utilized to engineer and control them. Topics to be discussed may include eigenvalues and eigenstates, harmonic oscillators, operators, symmetries, spin, angular momentum, perturbation theory, and time evolution. We will also explore examples of engineered quantum systems. The course will assume that students have prior exposure to quantum mechanics at the intermediate undergraduate level.
Instructor(s): Michael Flatté Terms Offered: Winter
Prerequisite(s): Equivalent to CHEM 26100 or PHYS 23400-23500

MENG 33310. Experimental Techniques and Advanced Instrumentation. 100 Units.
This course aims to provide students with a knowledge of state-of-the-art experimental measurement techniques and laboratory instrumentation for applications in broad scientific research environments, as well as industrial and general engineering practice. Topics include atomic-scale structural and imaging methods, electronic transport in low dimensional matter, magnetic and optical characterization of materials. Basic concepts in electronic measurement such as lock-in amplifiers, spectrum and network analysis, noise reduction techniques, cryogenics, thermometry, vacuum technology, as well as statistical analysis and fitting of data will also be discussed.
Instructor(s): David Awschalom Terms Offered: Spring
Prerequisite(s): PHYS 23400 and PHYS 23500 for undergraduates
Equivalent Course(s): MENG 23310

MENG 33500. Foundations of Quantum Optics. 100 Units.
Quantum optics seeks to illuminate the fundamental quantum mechanics of the interaction of light and matter. These principles can form the basis for quantum technologies in areas such as cryptography, computation, and metrology. This course provides a foundation in the fundamental principles and applications of quantum optics. Topics to be discussed may include Fermi's Golden Rule, interaction of two-level atoms and light, spontaneous emission, Rabi oscillations, classical and non-classical photon statistics, beam splitters, atom cavity interaction, vacuum-Rabi splitting, coherence, entanglement, and teleportation. The course will assume that students are comfortable with single-particle quantum mechanics at the level of a typical introductory graduate-level course.
Instructor(s): Alex High Terms Offered: Winter
Prerequisite(s): PHYS 23400 and PHYS 23500, or CHEM 26100, or equivalent
Equivalent Course(s): MENG 23500

MENG 33600. Quantum Dissipation and Quantum Measurement. 100 Units.
This course provides an introduction to the basic tools and concepts used to describe dissipative quantum systems, where a closed quantum system (described by a Hamiltonian) interacts with a dissipative environment. We will also discuss the basic theory of weak continuous quantum measurements and basic quantum limits to measurement. Applications to quantum optics and quantum information processing and will be stressed. Topics to be discussed may include quantum master equations, stochastic wavefunction evolution (i.e. quantum trajectories), quantum noise, quantum Langevin equations, and path integral approaches. The course will assume that students are comfortable with single-particle quantum mechanics at the level of a typical introductory graduate-level course.
Instructor(s): Aashish Clerk Terms Offered: Spring
Prerequisite(s): PHYS 34100 or Equivalent

MENG 33700. Quantum Computation. 100 Units.
This course provides an introduction to the fundamentals of quantum information to students who have not had training in quantum computing or quantum information theory. Some knowledge of quantum mechanics is expected, including bra-ket notation and the time-dependent form of Schrodinger's equation. Students will learn how to carry out calculations and gain a fundamental grasp of topics that will include some or all of: entanglement, teleportation, quantum algorithms, cryptography, and error correction.
Instructor(s): Andrew Cleland Terms Offered: Winter
Prerequisite(s): PHYS 22100 or equivalent
Equivalent Course(s): MENG 23700

MENG 33710. Synthetic Biology. 100 Units.
The objective of this course is to provide an overview of the fundamentals of synthetic biology by exploration of published and primary literature. Synthetic biology is an interdisciplinary area that involves the application of engineering principles to biology. It aims at the (re-)design and fabrication of biological components and systems that do not already exist in the natural world. Our goal in the course will be to examine how to apply design principles to biological systems. This will require understanding how biological systems operate, what design principles are successful in biology, and a survey of current approaches in the field to tackle these challenges. Topics will include genetic manipulation, pathway engineering, protein design, cellular engineering, and tools for information input and output in biological systems.
Instructor(s): Aaron Esser-Kahn Terms Offered: Spring
Prerequisite(s): Completion of the first two quarters of a Biological Sciences Fundamentals Sequence. MENG 26102, BIOS 20236, and BIOS 20200 are recommended but not required.
Equivalent Course(s): MENG 23710
MENG 33800. Introduction to Nanofabrication. 100 Units.
This course will cover the fundamentals of nanofabrication from a practical viewpoint and will be useful for students planning to pursue research involving semiconductor processing technology, as well as broader topics such as microelectromechanical systems (MEMS), quantum devices, optoelectronics, and microfluidics. This course will cover the theory and practice of lithographic patterning; physical and chemical vapor deposition; reactive plasma etching; wet chemical processing; characterization techniques; and other special topics related to state-of-the-art processes used in the research and development of nanoscale devices. A solid grounding in introductory chemistry and physics is expected.
Instructor(s): Peter Duda Terms Offered: Winter
Prerequisite(s): PHYS 13300 and CHEM 10200, or equivalent
Equivalent Course(s): MENG 23800

MENG 34100-34200. Selected Topics in Molecular Engineering: Molecular/Materials Modelling I-II.
Molecular modeling seeks to develop models and computational techniques for prediction of the structure, thermodynamic properties, and non-equilibrium behaviour of gases, liquids, and solids from knowledge of intermolecular interactions.

MENG 34100. Select Tpcs Molec Engineering: Molecular/Materials Modeling I. 100 Units.
This course will introduce students to the methods of molecular modeling. The topics covered will include an introduction to the origin of molecular forces, a brief introduction to statistical mechanics and ensemble methods, and an introduction to molecular dynamics, Brownian dynamics, and Monte Carlo simulations. The course will also cover elements of advanced sampling techniques, including parallel tempering, umbrella sampling, and other common biased sampling approaches. Course work or research experience is strongly recommended in: (1) elementary programming (e.g., C or C++), and (2) physical chemistry or thermodynamics.
Instructor(s): Andrew Ferguson Terms Offered: Winter
Prerequisite(s): MATH 20100 or PHYS 22100, and MENG 26201 or PHYS 27900 or CHEM 26200
Equivalent Course(s): MENG 24100

MENG 34200. Selected Topics in Molecular Engineering: Molecular/Materials Modeling II. 100 Units.
Quantum mechanical methods, including quantum chemistry, density functional theory (DFT), and many body perturbation theory, for simulating the properties of molecules and materials will be explored in this course. Numerical algorithms and techniques will be introduced that allow for solution of approximate forms of the Schroedinger and Boltzmann Equations that model structural and transport properties of molecules and materials. The coupling of DFT with molecular dynamics will be detailed for determining finite temperature properties. Coupling of DFT with spin Hamiltonians to study dynamical spin correlations in materials will also be described. Examples of the application of quantum mechanical methods to materials for energy conversion and quantum information technologies will be provided.
Instructor(s): Giulia Galli Terms Offered: Spring
Prerequisite(s): PHYS 23400 or CHEM 26100 or instructor consent
Equivalent Course(s): MENG 24200

MENG 34300. The Engineering and Biology of Tissue Repair. 100 Units.
In this course, students will gain an understanding of the science and application of tissue engineering, a field that seeks to develop technologies for restoring lost function in diseased or damaged tissues and organs. The course will first introduce the underlying cellular and molecular components and processes relevant to tissue engineering: extracellular matrices, cell/matrix interactions such as adhesion and migration, growth factor biology, stem cell biology, inflammation, and innate immunity. The course will then discuss current approaches for engineering a variety of tissues, including bone and musculoskeletal tissues, vascular tissues, skin, nerve, and pancreas. Students will be assessed through in-class discussions, take-home assignments and exams, and an end-of-term project on a topic of the student's choice.
Instructor(s): Jeffrey Hubbell Terms Offered: Spring
Prerequisite(s): BIOS 20186 or BIOS 20234
Equivalent Course(s): MENG 24300, MPMM 34300, BIOS 21507
MENG 34310. Cellular Engineering. 100 Units.
Cellular engineering is a field that studies cell and molecule structure-function relationships. It is the development and application of engineering approaches and technologies to biological molecules and cells. This course provides a bridge between engineers and biologists that quantitatively study cells and molecules and develop future clinical applications. Topics include fundamental cell and molecular biology; immunology and biochemistry; receptors, ligands, and their interactions; nanotechnology/biomechanics; enzyme kinetics; molecular probes; cellular and molecular imaging; single-cell genomics and proteomics; genetic and protein engineering; and drug delivery and gene delivery.
Instructor(s): Mustafa Guler Terms Offered: Winter
Prerequisite(s): Completion of the first two quarters of a Biological Sciences Fundamentals Sequence
Equivalent Course(s): BIOS 28700, MENG 24700

MENG 34400. Nanomedicine. 100 Units.
This course focuses on the applications of nanotechnology in medicine. The chemical, physical and biological features of the nanomaterials will be discussed for applications in medicine. A survey of concepts in therapeutic drug delivery methods, diagnostic imaging agents and cell-materials interactions will be discussed.
Instructor(s): Mustafa Guler Terms Offered: Winter
Prerequisite(s): Completion of the first two quarters of a Biological Sciences Fundamentals Sequence

MENG 34500. Microfluidics and Its Applications. 100 Units.
Precision control of fluids at the micrometer scale (hence microfluidics) provides unprecedented capabilities in manipulation and analysis of cells and proteins. Moreover, fluids and particles behave in fundamentally different ways when confined to small dimensions, making microfluidics an interesting topic of basic research. This course aims to provide students with theoretical knowledge and practical skills on the use of microfluidics for the manipulation and analysis of physical, chemical, and biological systems. We will first survey theoretical concepts regarding microfluidics. We will then focus on design considerations and fabrication methods for multi-layer microfluidic chips using PDMS soft-lithography. We will learn how to fabricate, multiplex, and control PDMS membrane valves and integrate them into high-throughput analytical systems. We will survey recent developments in microfluidics and its scientific and industrial applications. Biological systems analysis in cell sorting, culture, cell signaling, single molecule detection, digital nucleic acid and protein quantification, and biosensing are some of the applications we will cover. This course will have a laboratory component where students will design, fabricate, and use microfluidic devices and therefore acquire hands-on skills in microfluidic engineering.
Instructor(s): Savas Tay Terms Offered: Spring
Prerequisite(s): MATH 13300 (or higher), or MATH 13200 (or higher) plus BIOS 20151 or BIOS 20152 or BIOS 20236
Equivalent Course(s): MENG 24500

MENG 34600. Quantitative Systems Biology. 100 Units.
This course aims to provide students with knowledge on the use of modern methods for the analysis, manipulation, and modeling of complex biological systems, and to introduce them to some of the most important applications in quantitative and systems biology. We will first survey theoretical concepts and tools for analysis and modeling of biological systems like biomolecules, gene networks, single cells, and multicellular systems. Concepts from information theory, biochemical networks, control theory, and linear systems will be introduced. Mathematical modeling of biological interactions will be discussed. We will then survey quantitative experimental methods currently used in systems biology. These methods include single cell genomic, transcriptomic, and proteomic analysis techniques, in vivo and in vitro quantitative analysis of cellular and molecular interactions, single molecule methods, live cell imaging, high throughput microfluidic analysis, and gene editing. Finally, we will focus on case studies where the quantitative systems approach made a significant difference in the understanding of fundamental phenomena like signaling, immunity, development, and diseases like infection, autoimmunity, and cancer.
Instructor(s): Savas Tay Terms Offered: Winter
Prerequisite(s): Completion of the first two quarters of a Biological Sciences Fundamentals Sequence
Equivalent Course(s): MENG 24600

MENG 34700. Biodiagnostics and Biosensors. 100 Units.
This course focuses on the biological and chemical interactions that are important for the diagnosis of diseases and the design of new assays. The principles and mechanisms of molecular diagnostics and biosensors, as well as their applications in disease diagnosis, will be discussed. Bioanalytical methods including electrochemical, optical, chemical separation, and spectroscopic will be described. Surface functionalization and biomolecular interactions will be presented for the development of protein and DNA based biosensor applications. The goals for the course are to introduce the fundamental mechanisms of bioanalytical methods/tools, examples of specific methods for diagnostic purposes, and analytical methods necessary for developing new precision medicine tools.
Instructor(s): Mustafa Guler Terms Offered: Spring
Prerequisite(s): Completion of the first two quarters of a Biological Sciences Fundamentals Sequence
Equivalent Course(s): BIOS 28700, MENG 24700
MENG 34800. Quantitative Immunobiology. 100 Units.
The science of immunology was born at the end of the 19th century as a discipline focused on the body's defenses against infection. The following 120+ years has led to the discovery of a myriad of cellular and molecular players in immunity, placing the immune system alongside the most complex systems such as Earth's global climate and the human brain. The functions and malfunctions of the immune system have been implicated in virtually all human diseases. It is thought that cracking the complexity of the immune system will help manipulate and engineer it against some of the most vexing diseases of our times such as AIDS and cancer. To tackle this complexity, immunology in the 21st century - similar to much of the biological sciences - is growing closer to mathematics and data sciences, physics, chemistry and engineering. A central challenge is to use the wealth of large datasets generated by modern day measurement tools in biology to create knowledge, and ultimately predictive models of how the immune system works and can be manipulated. The goal of this course is to introduce motivated students to the quantitative approaches and reasoning applied to fundamental questions in immunology. Instructor(s): Nicolas Chevrier Terms Offered: Winter
Prerequisite(s): Completion of the first two quarters of a Biological Sciences Fundamentals Sequence. Knowledge of R is recommended but not required. Courses in immunology and microbiology are an advantage but not required (e.g., BIOS 25256 Immunobiology; BIOS 25206 Fundamentals of Bacterial Physiology).
Equivalent Course(s): MENG 24800, BIOS 26403, IMMU 34800

MENG 35100. Electrochemical Principles and Methods. 100 Units.
This course will cover topics related to basic electrochemical principles, methodologies, and systems. In particular, students will be given an overview of fundamental concepts related to electrochemical potential, electric double layer, electrode kinetics, and mass transport processes. In addition, the application of key electrochemical experimental methods will be covered. A few examples include cyclic voltammetry, AC impedance spectroscopy, and the rotating disk electrode. Throughout the course, students will apply basics principles of thermodynamics, kinetics, and transport phenomena. Lastly, a brief overview of traditional electrochemical systems and emerging technologies related to energy storage and conversion (e.g., lithium-ion batteries, flow batteries, and fuel cells) and bioelectronics applications will be discussed.
Instructor(s): Shrayesh Patel Terms Offered: Spring
Prerequisite(s): MENG 26102 and MENG 26201
Equivalent Course(s): MENG 25100

MENG 36300. Transport Phenomena. 100 Units.
This course covers essential aspects of molecular transport processes, including fluid dynamics, mass transport and diffusion processes, and energy and heat transport processes. It also discusses the coupling that arises between momentum, mass and energy transport processes.
Instructor(s): Jay Schieber Terms Offered: Autumn

MENG 37100. Biological Materials. 100 Units.
In this course, students will gain an understanding of the science and application of biomaterials, a field that utilizes fundamental principles of materials science with cell biology for applications in therapeutics and diagnostics. The course will introduce the basic classes of biomaterials, considering metals used in medicine, ceramics and biological inorganic materials such as hydroxyapatite, and polymers used in medicine. The basis of protein adsorption modulating biological interactions with these materials will be elaborated. Examples to be covered in the course will include polymers used in drug delivery, polymers used in protein therapeutics, polymers used in degradable biomaterial implants, polymers used in biodiagnostics, and hybrid and polymeric nanomaterials used as bioactives and bioactive carriers. An emphasis in the course will be placed on bioactive materials development. Students will be assessed through in-class discussions, take-home assignments and exams, and an end-of-term project on a topic of the student's choice.
Instructor(s): Jeffrey Hubbell and Mustafa Guler Terms Offered: Autumn
Prerequisite(s): BIOS 20186 and BIOS 20187, or BIOS 20234 and BIOS 20235
Note(s): This course does not meet the requirements for the Biological Sciences major.
Equivalent Course(s): MENG 27100, BIOS 29328

MENG 37200. Electronic and Quantum Materials for Technology. 100 Units.
This is a one-quarter introductory course on the science and engineering of electronic and quantum materials. The intended audience is upper-level undergraduate students and first-year graduate students in Molecular Engineering and other related fields, including Chemistry and Physics. We will learn the basics of electrical and optical properties of electronic materials, including semiconductors, metals, and insulators starting from a simple band picture, and will discuss how these materials enable modern electronic and optoelectronic devices and circuitry. We will also explore the modern synthesis techniques for these materials and the effects of reduced dimensions and emergent quantum properties. No comprehensive exposure to quantum mechanics, thermodynamics, or advanced mathematical skills will be assumed, even though working knowledge of these topics will be helpful.
Instructor(s): Jiwon Park Terms Offered: Spring
Prerequisite(s): CHEM 26200 or PHYS 23500 or instructor consent
Equivalent Course(s): MENG 27200

MENG 40000. First-Year Graduate Research Colloquium. 000 Units.
Aimed both at nurturing the highly interdisciplinary environment of the IME and at supporting first-year students in their selection of research advisors, this weekly seminar surveys the research interests and projects of IME faculty and fellows. Required for all first-year Molecular Engineering graduate students.
Instructor(s): Staff Terms Offered: Autumn
Prerequisite(s): Required for all first-year Molecular Engineering graduate students.
MENG 49700. Research: Related Departments, Institutes, and Industries. 300.00 Units.
Individualized study focused on Ph.D. research in the molecular engineering
Instructor(s): STAFF Terms Offered: Autumn Spring Summer Winter

MENG 49900. Research: Molecular Engineering. 300.00 Units.
No description available.
Instructor(s): Staff Terms Offered: Summer,Autumn,Winter,Spring

MENG 70000. Advanced Study: Molecular Engineering. 300.00 Units.
Advanced Study: Molecular Engineering
Font Notice

This document should contain certain fonts with restrictive licenses. For this draft, substitutions were made using less legally restrictive fonts. Specifically:

- Times was used instead of Trajan.
- Times was used instead of Palatino.

The editor may contact Leepfrog for a draft with the correct fonts in place.