# Pritzker School of Molecular Engineering

Website: https://pme.uchicago.edu/

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- Alexander High
- Jun Huang
- Chong Liu
- Peter Maurer

- Shrayesh Patel
- Sihong Wang

Assistant Professors

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- Huanhuan Joyce Chen
- Po-Chun Hsu
- Juan Mendoza
- Mark Mimee
- Samantha Riesenfeld
- Milos Simic
- Allison Squires
- Ruben Verresen
- Joshua Weinstein
- Jie Xu
- Shuolong Yang
- Tian Zhong

Consortium for Advanced Science and Engineering (CASE) Affiliates of PME at Argonne National Laboratory

- Daniel Abraham
- Khalil Amine
- Christopher Arges
- Ilke Arslan
- Edward F. Barry
- Anand Bhattacharya
- James Burrow
- Yue Cao
- Wei Chen
- Justin G. Connell
- Claus Daniel
- Seth B. Darling
- Massimiliano Delferro
- Jeffrey W. Elam
- Farah Fahim
- Ahmed A. Farghaly
- Chris Fry
- Xu Han
- F. Joseph Heremans
- Stephan O. Hruszkewycz
- Chukwunwike (Nwike) Iloeje
- Christopher Johnson
- Uisung Lee
- Jilian Li
- Chen Liao
- Di-Jia Liu
- Tongchao Liu
- Pietro Papa Lopes
- Alex B. Martinson
- Suresh Narayanan
- Benjamin Pingault
- Orlando Quaranta
- May Wu

- Guiliang Xu
- Zhengcheng Zhang

The Pritzker School of Molecular Engineering (PME) advances the mission of translating advances in basic physics, chemistry, biology, and computation into new tools to address important societal problems and to create a research and teaching environment that enhances and transmits these capabilities to future generations.

The 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.

Many PME researchers conduct much of their work at the William Eckhardt Research Center, which includes cutting-edge clean rooms, molecular imaging facilities, biomolecular research labs, and a wet-lab for nanofabrication and other materials work, and/or at Argonne National Laboratory, which is home to 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/).

## Admission to Graduate Programs

The PME 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 Doctor of Philosophy in Molecular Engineering, the Doctor of Philosophy in Quantum Science and Engineering, and the Master of Engineering in Molecular Engineering programs should have a bachelor’s degree in a STEM field and fulfill the English-language requirements of the University of Chicago (required for non-native English speakers only). Please visit the PME's Ph.D. programs (https://pme.uchicago.edu/academics/phd-programs/) and Master's program (https://pme.uchicago.edu/academics/masters-of-engineering/) websites for the application requirements and more information on how to apply.

## Doctor of Philosophy Degree Requirements (Molecular Engineering)

The PME Doctor of Philosophy (Ph.D.) in Molecular Engineering (ME) degree requirements are articulated fully on the PME website (https://pme.uchicago.edu/current-students/pme-phd-graduate-handbook/) and the key aspects summarized below. In addition, the PME adopts the residency requirement of the University of Chicago as a part of the degree requirements.

### Course Requirements

Graduate students entering the ME PME Ph.D. program are expected to fulfill a set of course requirements including three thematic core courses, four in-depth courses in the research field of choice, and two broad elective courses for a total of nine courses. Courses used to meet program requirements must be completed with grades of B or higher.

1. **Thematic Core Courses (3)** in the student's area of expertise: Immunoengineering, Materials for Sustainability and Health, or Quantum Engineering.
2. **In-depth Courses (4)** in the research field of their choice in graduate-level PME or fellow STEM courses. Students select courses in consultation with their primary research and/or academic advisor(s) that will best satisfy their personal needs and program requirements.
3. **Broad Electives (2)** may be satisfied by any course at the University of Chicago and can serve to develop skills in leadership, communication, technology development, and entrepreneurship through courses in, for example, public policy, business, or the humanities. They can also be used to acquire or renew basic understanding in STEM subject areas.

First-year students are required to register for and attend MENG 40300 – PME Research Professionalization Seminar. This course provides an overview of the types of competencies and non-academic knowledge associated with successful graduate research careers.

### Advisor Match Process

All ME PME Ph.D. students participate in the research group matching process in which they are expected to secure a primary academic research advisor who will guide them through the course of their doctoral research and financially support their study. As a highly interdisciplinary environment, there are many opportunities to work with multiple faculty members within the PME (https://pme.uchicago.edu/people/faculty-directory/) and/or with faculty in other partner divisions (https://pme.uchicago.edu/about/partners/) at the University of Chicago and members of the Consortium for Advanced Science and Engineering (CASE) and are affiliated with PME (https://pme.uchicago.edu/people/case-directory/) (e.g., scientists and engineers with this status at Argonne National Laboratory).

## Candidacy

Graduate students pursue candidacy for the Ph.D during the second term of their second year. To establish candidacy, ME PME Ph.D. students are required to develop a research proposal and give an oral presentation of their written proposal to a faculty review committee for approval. Students must also complete all core courses and all in-depth courses to be admitted to candidacy.

## Dissertation Thesis

All students in the ME PME Ph.D. program are required to prepare, submit, and defend an original dissertation thesis project; organize the logistics of the thesis defense; and submit a final copy of the dissertation to the Dissertation Office site (https://www.lib.uchicago.edu/research/scholar/phd/).

## Teaching Requirements

Pedagogical training is an important component of the doctoral training provided within the PME, and the ME PME Ph.D. program requires that all PhD students engage in meaningful teaching experiences. Students typically complete this requirement by completing two quarters as a Teaching Assistant for a PME course. Teaching assignments are determined based on department need, although some consideration may be given to student preferences.

## Academic Policies

The PME provides full financial support to all ME Ph.D. students throughout their graduate study at the PME as long as they remain in good standing. Individuals not continuing in their Ph.D. program of study may be awarded an incidental or terminal Master's degree if they have registered full time in the division for a minimum of three quarters and have completed with grades of C or better the three cores courses, four in-depth courses, and at least 200 units of MENG 49900 – Research: Molecular Engineering, for a total of 900 units.

# Doctor of Philosophy Degree Requirements (Quantum Science and Engineering)

The PME Doctor of Philosophy (Ph.D.) degree in Quantum Science and Engineering (QSE) requirements are articulated fully on the PME website (https://pme.uchicago.edu/current-students/pme-phd-graduate-handbook/) and the key aspects summarized below. In addition, the PME adopts the residency requirement of the University of Chicago as a part of the degree requirements.

## Course Requirements

QSE PhD students entering the program are expected to fulfill a set of course requirements including three core courses, four in-depth courses, and two broad elective courses for a total of nine courses. Courses used to meet program requirements must be completed with grades of B or higher.

- **QSE Core Courses (3)** aim to provide a foundation for advanced coursework in both fundamental and applied areas of quantum science.
- **In-depth Courses (4)** in graduate-level PME or fellow STEM courses. Students typically select courses in consultation with their primary research and/or academic advisor(s) that will best satisfy their personal needs and program requirements.
- **Broad Electives (2)** may be satisfied by any course at the University of Chicago and can serve to develop skills in leadership, communication, technology development, and entrepreneurship through courses in, for example, public policy, business, or the humanities. They can also be used to acquire or renew basic understanding in STEM subject areas.

First-year students are required to register for and attend MENG 40300 – PME Research Professionalization Seminar. This course provides an overview of the types of competencies and non-academic knowledge associated with successful graduate research careers.

## Advisor Match Process

All QSE PME Ph.D. students participate in the research group matching process in which they are expected to secure a primary academic research advisor who will guide them through the course of their doctoral research and financially support their study. As a highly interdisciplinary environment, there are many opportunities to work with multiple faculty members within the PME (https://pme.uchicago.edu/people/faculty-directory/) and/or with faculty in other partner divisions (https://pme.uchicago.edu/about/partners/) at the University of Chicago and members of the Consortium for Advanced Science and Engineering (CASE) who are affiliated with

PME (https://pme.uchicago.edu/people/case-directory/) (e.g., scientists and engineers with this status at Argonne National Laboratory).

## Candidacy

Graduate students pursue candidacy for the Ph.D during the second term of their second year. To establish candidacy, ME PME Ph.D. students are required to develop a research proposal and give an oral presentation of their written proposal to a faculty review committee for approval. Students must also complete all core courses and all in-depth courses to be admitted to candidacy.

## Dissertation Thesis

All students in the QSE PME Ph.D. program are required to prepare, submit, and defend an original dissertation thesis project; organize the logistics of the thesis defense; and submit a final copy of the dissertation to the Dissertation Office site (https://www.lib.uchicago.edu/research/scholar/phd/).

## Teaching Requirements

Pedagogical training is an important component of the doctoral training provided within the PME, and the QSE PME Ph.D. program requires that all PhD students engage in meaningful teaching experiences. Students typically complete this requirement by completing two quarters as a Teaching Assistant for a PME course. Teaching assignments are determined based on department need, although some consideration may be given to student preferences.

## Academic Policies

The PME provides full financial support to all QSE PhD students throughout their graduate study at the PME as long as they remain in good standing. Individuals not continuing in their PhD program of study may be awarded an incidental or terminal Master's degree if they have registered full time in the division for a minimum of three quarters and have completed with grades of C or better the three cores courses, four in-depth courses, and at least 200 units of MENG 49900 – Research: Molecular Engineering, for a total of 900 units.

# Master of Engineering Degree Requirements

The Master of Engineering (MEng) program at Pritzker Molecular Engineering provides a technical and professional education that prepares students to assume leadership positions in engineering innovation. The degree consists of a one-week workshop and the completion of twelve (12) or nine (9) 100-unit courses, depending on the student's course plan. Specific details for the various tracks can be found on the Masters of Engineering website (https://pme.uchicago.edu/academics/masters-of-engineering/).

Each course used to meet program requirements must be completed with a “C-” grade (or better), and a minimum cumulative GPA of 2.7 must be maintained to earn the degree.

## 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): Terry Johnson Terms Offered: Autumn
Prerequisite(s): Completion of the general education requirements in mathematics and physical or biological sciences
Note(s): May not be counted toward PME doctoral in-depth course requirements.
Equivalent Course(s): MENG 20000

**MENG 30210. The Material Science of Art-Suzanne Deal Booth Conservation Seminar. 100 Units.**
This course will introduce students to the methods, theories, and strategies of scientific approaches to the study of art objects and will consider the meaning of different materials and surfaces across artistic media. It will showcase new scholarship in the fields of heritage science and object-driven art history, drawing strength from collaborative work among scientists, conservators, art historians, and curators. Heritage science draws on the applied sciences and engineering to understand how to preserve the world's cultural heritage and forge connections between making and meaning. The course will explore scientific methods for investigating the production and use of art objects. Focusing on the material studies of paintings and sculptures, pigments, and their binding media, students will learn about the material makeup of art objects. Readings will be drawn from a variety of disciplines, including material science and chemistry, art history, visual and material culture, anthropology, and philosophy.
Instructor(s): M. Kokkori Terms Offered: Spring
Prerequisite(s): This course fulfills the following requirements in the ARTH major and minor: Theory and Methodology.
Equivalent Course(s): ARTH 37800, ARTH 27800, MENG 20210

**MENG 30400. Commercializing Products with Molecular Engineering. 100 Units.**
Many technologies and products that have been successfully commercialized benefit from engineering at the molecular scale. This course will present case studies of such technologies and products, including those drawn from the fields of pharmaceuticals (e.g., biologics, nanoparticle-based drugs, and excipients for enhanced drug solubility), food products (e.g., Cavamax by Wacker Chemie that applies beta-cyclodextrin for molecular encapsulation to improve flavor solubility), and industrial products (e.g., Febreze Air freshener, sunscreens with UV protection, photographic films, and slurries for polishing surfaces). Each case study will examine: the unmet market need addressed by the product, the science behind the molecular engineering of the technology, the background/history of the technology, and key attributes/decisions made by inventors along the pathway to commercialization. Upon completion of the course, students will be able to understand the overall process for developing a new technology/product, outline the steps to design the key critical-to-quality (CTQ) attributes, describe how to monetize a technology/product, and recognize the avenues available to protect the technology/product or create barriers to entry to the market.
Instructor(s): Atul Khare, Kathleen Akers Terms Offered: Spring
Prerequisite(s): MENG 20000 or MENG 21100
Note(s): May not be counted toward PME doctoral in-depth course requirements.
Equivalent Course(s): MENG 20400

**MENG 30500. Responsible and Effective Technology Management. 100 Units.**
A variety of cases exploring engineering decision making, considering both practical and ethical concerns, in the context of existing and emerging technologies will be discussed. Students will learn how to deal with complex and ambiguous situations, systems, and personalities; and to navigate them responsibly and constructively.
Instructor(s): Ray Cocco, Abe Janis Terms Offered: Winter
Note(s): May not be counted toward PME doctoral in-depth course requirements.

**MENG 31100. Math 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, statistical mechanics, transport) of molecular engineering. The content of this course mainly includes differential equations, statistics, complex analysis and integral transforms, 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 study in other thematic core courses for the Materials Systems area, as well as in future research activities.
Instructor(s): Sihong Wang Terms Offered: Autumn
Prerequisite(s): Required Math Courses in the Core, Algebra, Calculus, Physics

**MENG 31200. 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): Allison Squires Terms Offered: Autumn
Prerequisite(s): MENG 21400 or CHEM 26100-26200 or PHYS 27900 or equivalent, or the consent of the instructor

**MENG 31300. 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): Melody Swartz Terms Offered: Winter

**MENG 31400. Advanced 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): Tian Zhong Terms Offered: Autumn
Prerequisite(s): Equivalent to MENG 21300-26100, PHYS 23410-23510, or CHEM 26100.

**MENG 31500. Advanced Quantum Engineering II. 100 Units.**
Quantum mechanics underlies many areas of modern engineering, including materials science, photonics, electronics, metrology, and information processing. This course will give students a grounding in foundational aspects of quantum theory that play a crucial role in understanding and developing quantum technologies. Topics to be discussed may include perturbation theory (time-dependent and time-independent), the addition of angular momentum, many-particle systems and exchange statistics, quantum entanglement, Bell's theorem, the quantum adiabatic theorem, scattering theory, and path-integral methods. This course assumes that students have taken a prior graduate-level quantum mechanics course.
Instructor(s): Aashish Clerk Terms Offered: Winter

Prerequisite(s): MENG 31400 and PHYS 34100

**MENG 31800-31900. Graduate Engineering Design.**
This 200-unit project-based design sequence connects graduate student teams to academic, industrial, and/or clinical mentors with a problem to solve. Available projects, and project areas, will change from year to year. This experiential learning course emphasizes the design process and the application of scientific knowledge to wisely search for and select solutions. It also serves as an opportunity to practice professional conduct and consider responsible engineering in the context of design.

**MENG 31800. Graduate Engineering Design I. 100 Units.**
First quarter of Graduate Engineering Design.
Instructor(s): Terry Johnson Terms Offered: Autumn
Note(s): Restricted to students in the PME's Master of Engineering program.

**MENG 31900. Graduate Engineering Design II. 100 Units.**
Second quarter of Graduate Engineering Design.
Instructor(s): Terry Johnson Terms Offered: Winter
Note(s): Restricted to students in the PME's Master of Engineering program.

**MENG 32200. 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): Jun Huang Terms Offered: Autumn
Prerequisite(s): Completion of the first two quarters of a Biological Sciences Fundamentals Sequence including cell and molecular biology and genetics.
Equivalent Course(s): MOMN 34310, BIOS 21508, MENG 22200

**MENG 32300. 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 three quarters of a Biological Sciences Fundamentals Sequence
Equivalent Course(s): MENG 22300, BIOS 28411

**MENG 33000. Experimental Bioengineering Laboratory. 100 Units.**
This course provides a broad knowledge and hands-on experience in bioengineering and biomaterials. The topics to be covered include the design and characterization of materials for biomaterials, cellular engineering, nanomedicine, synthetic vaccines, immunotherapies, drug delivery, tissue engineering, bioimaging, biodiagnostics and biosensors. This course also includes experimental modules for hands-on experience relevant to the topics discussed in the lectures. Students will develop skills and experience relevant to methodologies in bioengineering research. Chromatography, spectroscopy, mechanical testing, particle size analysis, and protein activity assays will be utilized in the laboratory. Students will learn to apply knowledge of bioengineering research tools to design and conduct bioengineering experiments for which they will analyze, interpret, and present the experimental results.
Instructor(s): Mustafa Guler Terms Offered: Spring
Prerequisite(s): MENG 23100 or MENG 23150
Equivalent Course(s): MENG 23000

**MENG 33100. 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.
Terms Offered: Autumn. Will not be offered in 2025/26 academic year.
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 23100

**MENG 33110. Stem Cell Biology, Regeneration, and Disease Modeling. 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): Huanhuan Chen Terms Offered: Autumn
Prerequisite(s): BIOS 20186 or BIOS 20234
Equivalent Course(s): MENG 23110, MPMM 34300, BIOS 21507

**MENG 33120. The Structural Basis of Biomolecular Engineering. 100 Units.**
In this highly practical course, students will learn different approaches to interrogate the structure-function relationship of proteins. Essential skills in identifying related protein sequences, performing multiple sequence alignments, and visualizing and interpreting conservation in the context of available structures will be acquired. The most basic method of biomolecular engineering is based on rationale design which uses such knowledge of sequence and structure to predict or explore changes in function in a low throughput manner. Advanced methods that employ evolutionary platforms, such as phage-, ribosome-, and yeast display, will also be introduced for screening large libraries of biomolecules to find variants with a specific function of interest. Additional biomolecular engineering topics to be covered may include computational tools to model and design proteins, protein fusions, enzymatic or chemical modifications to change function, and pharmacokinetics. Students will be assessed through in-class discussion, take-home assignments, exams, and an end-of-term project chosen by the student with approval from the instructor(s).
Instructor(s): Juan Mendoza Terms Offered: Spring
Prerequisite(s): BIOS 20200
Equivalent Course(s): MENG 23120

**MENG 33130. Omics Technologies and Applications in Biological Systems. 100 Units.**
Modern genomic and proteomic technologies are transforming the analysis and engineering of biological systems. One part of the course will introduce the molecular biology of genomics, including how and why next-generation sequencing is used to measure DNA, RNA, and epigenetic patterns. In addition to experimental tools, it will cover key computational concepts for transforming raw genomic data into biologically meaningful data, as well as the application of those results to analyze biological systems. Specific topics will vary but will include single-cell RNA-sequencing and its analysis in different settings. The other part of the course will focus on technologies that enable the identification of proteins and their dysregulation in disease. Examples include mass spectrometry techniques to determine the exact number of proteins in cells, as well as techniques that identify the types and locations of post-translational protein modifications, such as histone methylation, that are frequently associated with diseases such as cancer. Additionally, the course will review methods to discover protein-protein interactions using computational and experimental screening methods. Student assessments will be made through in-class discussion, take-home assignments, exams, and an end-of-term project chosen by the student with approval from the instructor(s).
Instructor(s): Samantha Riesenfeld Terms Offered: Autumn
Prerequisite(s): BIOS 20200 or equivalent, and experience with data analysis and computation in R or Python (e.g., MENG 26030, BIOS 20151/20152, STAT/CMSC 11800, or STAT 22000).
Equivalent Course(s): MENG 23130

**MENG 33150. 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.
Equivalent Course(s): BIOS 28410, MENG 23150

**MENG 33200. Principles of Immunology. 100 Units.**
In this course students will gain a comprehensive understanding of the essential principles of immunology. The course will introduce the concept of innate immunity and pattern recognition and how antigen is processed for presentation to the immune system. We will examine how antigen presentation links innate and adaptive

immunity. We will then discuss the two arms of adaptive immunity (humoral and cellular) in detail from their development to effector stages. In the last section of the course we will discuss some key aspects of immune system function including immunological memory and vaccination, immunological tolerance and its failure (autoimmunity/allergy), and mucosal immunology and the microbiome. Students will present primary articles related to the topics discussed in class in a weekly discussion section. The course will be graded on class participation, quizzes, a midterm, and a final essay-based exam.
Instructor(s): Cathryn Nagler Terms Offered: Autumn
Prerequisite(s): BIOS 20186 or BIOS 20234 (or equivalent undergraduate coursework with the permission of the instructor)
Equivalent Course(s): MENG 23200

**MENG 33210. Fundamentals and Applications of the Human Microbiota. 100 Units.**
Thousands of microbes colonize the human body to collectively establish the human microbiota. Research findings over the past two decades have led to a growing appreciation of the importance of the microbiota in various facets of human health. This course will explore the human microbiota through a critical review of the primary scientific literature. The first portion of the course will cover distinct ways by which the human microbiota impacts mammalian health. The second part of the course will focus on established and developing microbiota-targeting biotechnologies. Students will leave the course with a general understanding of the current state of human microbiota research and its therapeutic and diagnostic applications.
Instructor(s): S. Light, M. Mimee Terms Offered: Winter
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals Sequence. Third or fourth year standing or consent of instructor.
Note(s): GP.
Equivalent Course(s): MICR 38000, BIOS 25207, MENG 23210

**MENG 33300. 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).
Note(s): CB. GP.
Equivalent Course(s): MENG 23300, IMMU 34800, BIOS 26403

**MENG 33310. Immunoengineering Laboratory. 100 Units.**
The goal of this laboratory course is to provide students with an original and hands-on research experience in the fields of immunoengineering and synthetic immunology, whereby new molecules will be designed and tested by students in the lab to probe or control immune processes. Specifically, students will study how newly discovered cancer vaccines work. The course will cover wet lab techniques to manipulate and analyze DNA, proteins, and cells, including next-generation sequencing, genome editing, cellular imaging, and nanobodies. In addition, computational tools will be used for processing and analyzing the data generated by students during class. The outcome of students' research during this class will help decipher the inner workings of successful anti-tumor vaccines, which is important to inform future cancer immunotherapies
Instructor(s): Nicolas Chevrier Terms Offered: Winter
Prerequisite(s): Completion of the first two quarters of a Biological Sciences Fundamentals Sequence. Prior molecular and cellular biology wet lab work experience is an advantage but not required.
Equivalent Course(s): MENG 23310

**MENG 33320. Immunogenomics I. 100 Units.**
Our understanding of immune cell function has benefited greatly from advances in next generation sequencing and the genetic characterization of immune cells has become a powerful tool to understand adaptive and innate immunity. This course will train students to tackle immunological questions using quantitative and systems-levels approaches. The topics covered will include: - Introduction of innate and adaptive immunity - Evolution of the different arms of the immune system - Population variation in immune responses - Genomic technologies and applications - Study design in genomic studies - Paper-based discussion of key immunological concepts and how we can study them using systems immunology approaches
Instructor(s): Luis Barreiro Bana Jabri Terms Offered: Autumn
Note(s): REQUIRED for Students in the CSI Track

Equivalent Course(s): IMMU 48000

**MENG 33330. Immunogenomics II: Data Science in Systems Immunology. 100 Units.**
This course presents essential concepts in genomic data science and trains students to apply the concepts in immunological contexts. The course encourages students to think independently about genomic analyses. Students will gain an understanding of how to use basic statistics, linear algebra, and computation to explore, analyze, and interpret published RNA-sequencing data (bulk and single-cell) and immune-cell receptor sequencing data. Student performance will be assessed through in-class discussions, take-home assignments and exams, and an end-of-term final project of the student's choice.
Instructor(s): Samantha Riesenfeld, Joshua Weinstein Terms Offered: Winter
Prerequisite(s): Basic programming skills in R or Python, including control structures, data loading and saving, creating basic plots, and working with data frames. Basic molecular biology, including the central dogma.
Note(s): This course is required for, but not limited to, the Computational and Systems Immunology PhD track in Immunology.
Equivalent Course(s): MENG 23330, IMMU 48900

**MENG 33340. Engineering Immunotherapeutics. 100 Units.**
Engineering Immunotherapeutics
Instructor(s): Cathryn Nagler Terms Offered: Spring
Prerequisite(s): Two quarters of a Biological Sciences fundamental sequence, undergraduate third- or fourth-year standing, or permission of the instructor. Knowledge of fundamental concepts of innate and adaptive immunity from prior course work is required. The detailed molecular understanding of immunology covered in MENG 23200/33200 is not required.
Equivalent Course(s): MENG 23340

**MENG 33500. 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 21500, BIOS 20236, and BIOS 20200 are recommended but not required.
Equivalent Course(s): MENG 23500

**MENG 33510. 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. Will not be offered in 2025/26 academic year.
Prerequisite(s): MATH 13300 (or higher), or MATH 13200 (or higher) plus BIOS 20151 or BIOS 20152 or BIOS 20236
Equivalent Course(s): MENG 23510

**MENG 35100. 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 Terms Offered: Autumn
Prerequisite(s): MENG 21400 or CHEM 26200 or PHYS 27900

Equivalent Course(s): MENG 25100

**MENG 35110. 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 25110, CHEM 39100

**MENG 35120. 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 25100
Equivalent Course(s): MENG 25120

**MENG 35130. Soft Matter Characterization Laboratory. 100 Units.**
The goal of this course is to train students in the fundamental experimental approaches to polymer and soft materials characterization. The course will cover both the theory and practice of techniques focused on three themes: molar mass determination (size exclusion chromatography, laser light scattering, NMR spectroscopy); morphology and structure (x-ray scattering, electron microscopy, atomic force microscopy); and thermo-mechanical properties (calorimetry, thermogravimetry, dynamic mechanical analysis, rheometry, tensile testing). Contextual application of these characterization techniques to modern research problems will be introduced. Through this course, students will develop foundational experimental skills necessary for addressing research challenges in modern polymer and soft materials science and engineering.
Instructor(s): Philip Griffin Terms Offered: Winter
Prerequisite(s): MENG 25100
Equivalent Course(s): MENG 25130

**MENG 35140. Functional Polymers for Electronics, Photonics, and Energy Technology. 100 Units.**
In this course, students will learn the fundamental principles of the functional properties of polymers that enable their use in electronics, photonics and energy technology. The topics mainly include electron and ion transport properties, relationships between chemical structures and energy band structures, photo-excitation properties, luminescent properties, thermoelectric property, ferroelectric and ferromagnetic properties, as well as the associated device categories of organic field-effect transistors, organic light-emitting diodes, lasers, electrochromic devices, photovoltaic cells, and photodetectors.
Instructor(s): Sihong Wang Terms Offered: Winter
Prerequisite(s): MENG 25100 (or MENG 35100), AND CHEM 22000 and CHEM 22100
Equivalent Course(s): MENG 25140

**MENG 35200. Solids, Materials, Surfaces. 100 Units.**
This course is an introduction to modern materials chemistry. It covers basic chemistry and physics of condensed systems, such as solids, polymers, and nanomaterials. The electronic structure of metals, semiconductors and magnetically ordered phases will be discussed. We will review optical and electronic properties of different classes of materials using examples of hard and soft condensed matter systems and drawing structure-property relationships for conventional solids, polymers, and nanomaterials. Finally, the course will cover the fundamentals of surface science and material synthesis, applying modern understanding of nucleation and growth phenomena.
Instructor(s): D. Talapin Terms Offered: Autumn
Prerequisite(s): CHEM 26100, CHEM 26200, and CHEM 26300, or equivalent
Equivalent Course(s): CHEM 39000

**MENG 35210. Complex Fluids and Non-Newtonian Flows. 100 Units.**
Definition of a complex liquid and microrheology. Division of complex fluids into suspensions, solutions, and melts. Suspensions as colloidal and noncolloidal. Extra stress and relation to the stresslet. Suspension rheology including Brownian and non-Brownian fibers. Microhydrodynamics and the Fokker-Planck equation. Linear viscoelasticity and the weak flow limit. Polymer solutions including single mode (dumbbell) and multimode models. Nonlinear viscoelasticity. Intermolecular effects in nondilute solutions and melts and the concept of reptation.
Instructor(s): Eric Shaqfeh Terms Offered: Autumn
Prerequisite(s): Low Reynolds number hydrodynamics or consent of instructor.

**MENG 35300. 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): Chong Liu Terms Offered: Autumn
Prerequisite(s): MENG 21400 or CHEM 26200 or PHYS 27900 (or concurrent)
Equivalent Course(s): MENG 25300

**MENG 35310. Energy Storage and Conversion Devices. 100 Units.**
Addressing the challenges of a sustainable energy future requires a foundational knowledge of current and emerging energy conversion and storage technologies. Energy conversion devices such as solar cells and fuel cells to energy storage systems such as lithium-ion batteries and redox-flow batteries will be covered. Devices related to carbon capture and conversion in addition to 'green fuels' will be introduced as well. Applying basic principles of chemistry, thermodynamics, and transport phenomena, this course will provide a deep understanding of the operational mechanisms, resources, and material properties of each device and the synergies between them.
Instructor(s): Chibueze Amanchukwu Terms Offered: Winter
Prerequisite(s): MENG 21400 (or CHEM 26200 or PHYS 27900) AND MENG 21500
Equivalent Course(s): MENG 25310

**MENG 35320. 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 21400 (or CHEM 26200 or PHYS 27900) and MENG 21500
Equivalent Course(s): MENG 25320

**MENG 35330. Materials and Characterization Tools to Address Challenges in Energy and Water. 100 Units.**
The development of new materials, as well as understanding the materials' structure and dynamics, are at the heart of addressing the challenges in energy and water technologies. This course will introduce students to the design and development of advanced functional materials that enable energy and water related technologies. The importance of all classes of materials spanning metals, alloys, ceramics, polymers, glasses, and their combinations as composite materials will be covered. To understand material properties and function, students will learn about essential characterization tools including microscopy, spectroscopy and mechanical testing techniques. In addition, the course will convey the importance of advanced characterization tools available at X-ray and neutron facilities that are essential in revealing unique physical properties.
Instructor(s): Junhong Chen Terms Offered: Winter. Offered in alternating academic years. Will not be offered in 2026/27 academic year.
Prerequisite(s): MENG 21400 (or CHEM 26200 or PHYS 27900)
Equivalent Course(s): MENG 25330

**MENG 35340. Photonic Materials for Energy and Sustainability. 100 Units.**
This course will provide students with photonic science's perspective on global energy and sustainability. Global warming is the outcome of solar heat gain and radiative heat loss, a balance which has been tilted by excessive CO2 concentrations. Photonic materials science will allow us to re-think the possibilities to harvest, convert, and divert solar energy input while reducing and reusing waste heat. This course will lay the foundations in optic principles, physical origins of materials' optical properties, and various types of light-matter interactions. This theoretical background will be used to introduce applications such as solar cells, thermophotovoltaic cells, radiative cooling, light-emitting diodes, solar geoengineering, and smart building envelopes.
Instructor(s): Po-Chun Hsu Terms Offered: Spring
Prerequisite(s): MENG 21400 or CHEM 26200 or PHYS 27900

**MENG 35350. Experimental Electrochemistry Laboratory. 100 Units.**
This laboratory course introduces students to the fundamental experimental concepts that underlie modern electrochemical systems and is designed to accompany the lecture course Electrochemical Principles and Methods (MENG 25320/35320). Students will conduct simple electrochemical experiments that reinforce the key principles of thermodynamics, kinetics, and mass transport covered in the lecture course. Students begin by learning to construct and operate a simple potentiostat, a powerful analytical tool for characterizing electrochemical systems. Using industry-standard potentiostats, students will perform common three-electrode measurements, including potential-step methods, Tafel analysis, cyclic voltammetry, and impedance spectroscopy. Building on this foundation, students apply their knowledge in application-oriented modules involving electrodeposition, capacitive deionization, and battery cycling. Lab work emphasizes hands-on exploration, clear data interpretation, and practical troubleshooting as students investigate how real systems behave. Students will also sharpen their paper-reading and presentation skills through guided literature review sessions and group presentations. The class meets once per week for a 4-hour laboratory and group-

discussion session, with optional open-lab access as needed. The course builds both a strong understanding of electrochemical fundamentals and the practical skills necessary to work with emerging energy and sustainability technologies.
Instructor(s): Adarsh Suresh Terms Offered: Spring
Prerequisite(s): MENG 21400 (or CHEM 26200 or PHYS 27900) and MENG 21500

**MENG 35500. Classical Molecular and Materials Modeling. 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 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. Students will also establish expertise in scientific programming in Python 3.
Instructor(s): Andrew Ferguson Terms Offered: Winter
Prerequisite(s): MENG 21400 (or CHEM 26200 or PHYS 27900) and MATH 18500. MENG 21200, or prior course work or research experience with elementary programming, is strongly recommended.
Equivalent Course(s): MENG 25500

**MENG 35510. Quantum Molecular and Materials Modeling. 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): Laura Gagliardi, Giulia Galli Terms Offered: Spring
Prerequisite(s): MENG 26100, PHYS 23510, CHEM 26100, or instructor consent
Equivalent Course(s): CHEM 26800, CHEM 36800, MENG 25510

**MENG 35640. AI, Automation, and Autonomous Experimentation for Materials Discovery. 100 Units.**
This course introduces students to the principles and practice of AI-guided, automated, and autonomous experimentation for materials discovery. As materials research faces urgent challenges in sustainability, energy, and health, traditional trial-and-error approaches are often too slow and inefficient. Advances in laboratory automation, data-driven decision-making, and closed-loop experimentation provide new ways to explore experimental spaces more systematically, efficiently, and reproducibly. The course teaches the core foundations and practical toolbox for AI-driven experimentation, including laboratory automation, integration, design of experiments, representation of experiments and data, and AI/ML methods for experimental decision-making. Representative case studies drawn from molecular engineering, spanning polymers, chemistry, energy materials, and characterization workflows, are used to guide students through real AI-enabled experimental scenarios. Rather than focusing on building robotic systems or developing new machine learning architectures, the course emphasizes experimental judgment, decision logic, and effective human-in-the-loop control in AI-driven automated workflows for materials discovery.
Instructor(s): Jie Xu Terms Offered: Spring
Prerequisite(s): Familiarity with basic machine learning concepts is helpful but not required. All necessary concepts will be introduced at a practical, application-oriented level. No prior programming experience is required. Hands-on components use guided notebooks with pre-written code, with emphasis on experimental reasoning and decision-making.
Equivalent Course(s): MENG 25640

**MENG 36200. QuantumLab. 100 Units.**
The QuantumLab course is an advanced laboratory course where students gain experience in a broad range of quantum technologies and instrumentation. The experiments reflect current research directions of quantum science and the University of Chicago's quantum program. Students will perform these experiments in small groups and study quantum effects in different quantum systems, including photons, cold atoms, quantum circuits and materials, and defect-centers. Furthermore, participants will acquire experience in instrumentation, electronics, optics, data taking and analysis.
Instructor(s): Alex High Terms Offered: Autumn Spring Winter
Prerequisite(s): MENG 21300 or PHYS 23410 or CHEM 26100
Equivalent Course(s): MENG 26200

**MENG 36400. 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 linear algebra is expected, including matrix multiplication, matrix inversion, and eigenvector-eigenvalue problems. 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): MATH 18500 or MATH 19620 or equivalent

Equivalent Course(s): MENG 26400

**MENG 36500. 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): MENG 21300 and MENG 26100, or PHYS 23410-23510, strongly recommended but not required
Equivalent Course(s): MENG 26500

**MENG 36600. Electronic and Quantum Materials for Technology. 100 Units.**
This is an 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.
Instructor(s): Shuolong Yang Terms Offered: Winter
Prerequisite(s): MENG 26100, PHYS 23510, CHEM 26100, or instructor consent
Equivalent Course(s): CHEM 39300, MENG 26600

**MENG 36620. Physics of Solid State Semiconductor Devices. 100 Units.**
This course covers the fundamental concepts needed to understand nanoelectronic solid state semiconductor devices. After an overview of the basic properties of semiconductors and electronic transport in semiconductors, we will explore the device physics behind some of the major semiconductor devices that have changed our lives. These include the p-n junction diode, the metal-oxide-semiconductor transistor (MOSFET), the photovoltaics cell (solar cell), the semiconductor light emitting diode (LED) and injection laser, dynamic random access memory (DRAM), and Flash memory. These devices collectively form the backbone behind all computing, communications, and sensing systems used today.
Instructor(s): Supratik Guha Terms Offered: Winter. Offered in alternating academic years. Will be offered in 2026/27 academic year.
Prerequisite(s): MENG 21300 (or PHYS 23500 or CHEM 26100) or PHYS 22700 or PHYS 23600
Equivalent Course(s): MENG 26620

**MENG 36630. 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): Andrew Cleland Terms Offered: Spring
Prerequisite(s): PHYS 13300 and CHEM 10200, or equivalent
Equivalent Course(s): MENG 26630

**MENG 37100. Implementation of Quantum Information Processors. 100 Units.**
This course emphasizes the experimental aspects of quantum information focusing on implementations rather than algorithms. Several candidates for quantum information systems will be discussed including ion traps, neutral atoms, superconducting circuits, semiconducting quantum dots, and linear optics. Students will develop an appreciation for the basic physics of these systems, and their relative merits in a variety of quantum information applications.
Instructor(s): Andrew Cleland Terms Offered: Spring
Prerequisite(s): MENG 31400 or PHYS 34100 or instructor consent

**MENG 37200. Quantum Dissipation and Quantum Measurement. 100 Units.**
This course introduces 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 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): MENG 31400 or PHYS 34100 or instructor consent

**MENG 37400. Advanced Quantum Information and Computation. 100 Units.**
This course covers the foundations of quantum theory, quantum communication, quantum metrology, quantum computation, quantum error correction, and topological quantum computation.
Instructor(s): Liang Jiang Terms Offered: Winter
Prerequisite(s): MENG 31400 or PHYS 34100 or instructor consent

**MENG 37500. Quantum Measurements and Metrology. 100 Units.**
This course provides an introduction into the concepts and applications of quantum measurements and quantum metrology. We will derive the formal basis of quantum measurements, quantify the information that can be extracted through a measurement and discuss the impact of entanglement. This course will also give a comprehensive overview of different quantum sensing modalities and their technical applications in timekeeping, sensing, imaging and testing of fundamental physics.
Instructor(s): Peter Maurer Terms Offered: Autumn
Prerequisite(s): MENG 31400 or PHYS 34100 or instructor consent

**MENG 39700. Practicum Experience. 50 Units.**
MENG 39700 provides students in the Master of Engineering (MEng) program the opportunity to engage in a mentored practicum experience in industry, a non-profit, or a national lab. Students enrolled in this course will work in a designated organization and are expected to engage meaningfully in its activities and contribute to its project goals.
Instructor(s): Terry Johnson (Director, MEng Program) Terms Offered: Autumn Spring Summer Winter. Does not count toward the three for-credit courses required each quarter for full-time status.
Prerequisite(s): Registration by instructor consent only.

**MENG 39900. Research Experience: Molecular Engineering Lab. 50 Units.**
MENG 39900 provides students in the Master of Engineering (MEng) program the opportunity to gain structured research experience in a PME-affiliated laboratory. Students enrolled in this course will work with a designated faculty mentor and are expected to engage meaningfully in laboratory activities, attend all research group meetings, and contribute to project goals.
Instructor(s): Terry Johnson (Director, MEng Program) Terms Offered: Autumn Spring Summer Winter
Prerequisite(s): Registration by instructor consent only.
Note(s): Does not count toward the three for-credit courses required each quarter for full-time status or the overall graduation requirement.

**MENG 40100. Grand Challenges in Molecular Engineering I. 000 Units.**
A survey of the research themes in Molecular Engineering for first-year graduate students.
Instructor(s): Staff Terms Offered: Autumn
Prerequisite(s): Required for all first-year Molecular Engineering graduate students.

**MENG 40200. Grand Challenges in Molecular Engineering II. 000 Units.**
A survey of the research themes in Molecular Engineering for first-year graduate students.
Instructor(s): Staff Terms Offered: Winter
Prerequisite(s): Required for all first-year Molecular Engineering graduate students.

**MENG 40300. PME Research Professionalization Seminar. 000 Units.**
Professionalization involves the development of skills, identities, norms, and values associated with becoming part of an academic or professional community. With the overall goal of positioning first-year doctoral students to function as professionals in the community of engineering researchers, this seminar aims both to build professional competencies and to foster understanding of the roles/responsibilities of researchers. In addition to introducing doctoral students to core principles and practices beyond research and coursework, the seminar will also foster social cohesion and scientific identity. Topics covered will include research ethics, leadership in the lab, freedom of expression, and equity/diversity/inclusion. As a graduate seminar, active participation and discussion will be expected.
Instructor(s): Staff Terms Offered: Spring
Prerequisite(s): Required for all first-year Molecular Engineering graduate students.

**MENG 49700. Research: Related Departments, Institutes, and Industries. 300.00 Units.**
For students requiring course registration for internships or similar professional training opportunities. Students must speak to their PI and receive approval from the Dean of Students before they may be enrolled.
Instructor(s): STAFF Terms Offered: Autumn Spring Summer Winter

**MENG 49900. Research: Molecular Engineering. 100-300 Units.**
Molecular engineering research
Instructor(s): Faculty Terms Offered: Autumn Spring Summer Winter
Note(s): Please select desired number of units when registering

**MENG 70000. Advanced Study: Molecular Engineering. 300.00 Units.**
Advanced Study: Molecular Engineering

**MENG 75000. Advanced Research. 300.00 Units.**
TBD
Terms Offered: Autumn