

# Materials Science and Engineering

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The Department of Materials Science and Engineering offers three graduate degree programs: the Master of Engineering (MEng), 5th Year Bachelor of Science and Master of Science (BS/MS), and the Doctor of Philosophy (PhD).

## Master of Engineering (MEng)

In collaboration with other departments in the College of Engineering, Materials Science and Engineering is offering a professional master's degree. The accelerated program is designed to develop professional engineering leaders in materials science and engineering who are seeking knowledge and leadership experience in MSE.

Prospective students will be engineers, typically with industrial experience, who aspire to substantially advance in their careers and ultimately to lead large, complex organizations, both in the public and private sectors.

You may choose to apply to either the full-time one-year program or part-time program for working professionals. You will be asked to choose which option you will be considered for during the application process. Both options employ the same standards and criteria for admissions.

## 5th Year Bachelor of Science and Master of Science (BS/MS)

The Department of Materials Science and Engineering offers a five-year combined BS/MS program to our undergraduate student cohort. In this program, the existing four-year undergraduate program (BS) will be augmented with a fifth year of graduate study that provides a professionally-oriented component, preparing students for careers in engineering or engineering management within the business, government, and industrial sectors. This five-year program emphasizes interdisciplinary study through an independent project coupled to coursework.

## Doctor of Philosophy (PhD)

Students pursuing the PhD may also declare a designated emphasis (DE) in one of the following programs: Communication, Computation, and Statistics; Computational and Genomic Biology; Computational Science and Engineering; Energy Science and Technology; or Nanoscale Science and Engineering.

## Admission to the University

### Applying for Graduate Admission

Thank you for considering UC Berkeley for graduate study! UC Berkeley offers more than 120 graduate programs representing the breadth and depth of interdisciplinary scholarship. A complete list of graduate academic departments, degrees offered, and application deadlines can be found on the Graduate Division website (<http://grad.berkeley.edu/programs/list/>).

Prospective students must submit an online application to be considered for admission, in addition to any supplemental materials specific to the

program for which they are applying. The online application can be found on the Graduate Division website (<http://grad.berkeley.edu/admissions/>).

## Admission Requirements

The minimum graduate admission requirements are:

1. A bachelor's degree or recognized equivalent from an accredited institution;
2. A satisfactory scholastic average, usually a minimum grade-point average (GPA) of 3.0 (B) on a 4.0 scale; and
3. Enough undergraduate training to do graduate work in your chosen field.

For a list of requirements to complete your graduate application, please see the Graduate Division's Admissions Requirements page (<https://grad.berkeley.edu/admissions/steps-to-apply/requirements/>). It is also important to check with the program or department of interest, as they may have additional requirements specific to their program of study and degree. Department contact information can be found here (<http://guide.berkeley.edu/graduate/degree-programs/>).

## Where to apply?

Visit the Berkeley Graduate Division application page (<http://grad.berkeley.edu/admissions/apply/>).

## Admission to the Program

Admission decisions are based on a combination of factors, including academic degrees and records, the statement of purpose, letters of recommendation, test scores, and relevant work experience. The MSE department also considers the appropriateness of your goals to the degree program in which you are interested and to the research interests of the program's faculty.

To be considered for graduate admissions in MSE you need:

- A bachelor's degree or recognized equivalent (must be conferred prior to enrollment into our program) from an accredited institution in engineering, physics or chemistry is required. We do not accept students without these types of degrees.
- Sufficient undergraduate training to do graduate work in your chosen field.
- A minimum grade-point average (GPA) of 3.0 (B). International students should be in the top 5% of their class.
- We require three letters of recommendation submitted online.
- A general Graduate Record Exam (GRE) General Test score (85th percentile or higher is desirable) in the Verbal/Analytical/Quantitative sections.

## Normative Time Requirements

### Normative Time to Advancement

**Step I:** Pass the preliminary exam—scheduled prior to the start of the second semester. In this oral exam, students must demonstrate (i) mastery of the essential components of a Materials Science and Engineering education at a level commensurate with the completion of an undergraduate MSE degree at Berkeley, and (ii) their ability to use this knowledge in ongoing research.

**Step II:** Complete the minimum number of semester units of formal course work (major and minors) is 28, of which 16 must be in graduate units in the major field.

**Step III:** Pass the qualifying exam.

## Normative Time in Candidacy

**Step IV:** Submission of the doctoral dissertation.

## Total Normative Time

Total normative time is five years.

## Time to Advancement

### Curriculum

#### Courses Required

Approved study list per student's research interest but must include course requirements below:

Thermodynamics

MAT SCI 201A	Thermodynamics and Phase Transformations in Solids	4
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Select one Structure & Bonding course from the following: 3

MAT SCI 201B	Thermodynamics, Phase Behavior and Transport Phenomena in Materials [4]	
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MAT SCI 202	Crystal Structure and Bonding [4]	
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MAT SCI 215	Computational Materials Science [3]	
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Select one Materials Characterization course from the following:

MAT SCI 204	Materials Characterization [3] (204& 204D must be taken together.)	
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MAT SCI 204D	Materials Characterization (204& 204D must be taken together.)	1
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MAT SCI 241	Electron Microscopy Laboratory [4]	
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MAT SCI 242	Advanced Spectroscopy	3
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Select one Material Properties course from the following: 3-4

MAT SCI 205	Defects in Solids [3]	
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MAT SCI C212	Deformation and Fracture of Engineering Materials [4]	
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MAT SCI 213	Environmental Effects on Materials Properties and Behavior [3]	
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MAT SCI 217	Properties of Dielectric and Magnetic Materials [3]	
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MAT SCI 223	Semiconductor Materials [3]	
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MAT SCI 224	Magnetism and Magnetic Materials [3]	
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MAT SCI C225	Thin-Film Science and Technology [3]	
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MAT SCI 251	Polymer Surfaces and Interfaces [3]	
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MAT SCI 260	Surface Properties of Materials [3]	
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Select one Material Processing course from the following: 3-4

MAT SCI 121	Metals Processing [3]	
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MAT SCI C216	Macromolecular Science in Biotechnology and Medicine [4]	
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MAT SCI 223	Semiconductor Materials [3]	
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MAT SCI 224	Magnetism and Magnetic Materials [3]	
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MAT SCI C225	Thin-Film Science and Technology [3]	
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MAT SCI 251	Polymer Surfaces and Interfaces [3]	
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Teaching Pedagogy:

MAT SCI 375A	Science and Engineering Pedagogy	1-2
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or MAT SCI 37!Supervised Teaching of Materials Science and Engineering

## Preliminary Exams

In this oral exam students must demonstrate:

1. Mastery of the essential components of a Materials Science and Engineering education at a level commensurate with the completion of an undergraduate MSE degree at Berkeley, and
2. Their ability to use this knowledge in ongoing research.

The examination is divided into six topics germane to ceramic, metallic, semiconducting, and soft materials, including their appropriate composites. Six faculty examiners are appointed each semester by the department chair, one examiner per topic, who conduct the exam in individual oral interviews lasting approximately 20 minutes. The examination topics are:

1. Thermodynamics;
2. Phase Transformations;
3. Bonding, Crystallography, and Crystal Defects;
4. Materials Characterization;
5. Mechanical Properties; and
6. Electronic Properties.

## Qualifying Examination

The PhD qualifying exam tests the student's ability to identify a significant problem, to assemble the background information needed to grasp it in the context of the field, and to construct a technical approach that provides a plausible path to its solution. At the same time, the qualifying exam will test the student's knowledge of the subject matter within the broad research field and his or her major field.

The examination consists of two parts, namely, a written proposal, and the oral examination:

1. **Written Proposal.** The proposal describes the intended PhD research. At least two weeks before the examination date the student must submit a written research proposal to his/her committee. The proposal must include a one-page abstract and be roughly five to ten pages long. It must contain a concise statement of the research problem and its significance, a discussion of the technical background, the technical approach (experimental and/or theoretical), the anticipated results, and a bibliography. This written proposal is to be prepared by the student without direct collaboration or assistance from the faculty.
2. **The Examination.** The student should prepare a 30-minute oral presentation of the research proposal(s). The committee will question the student on the material presented orally, the material contained in the written proposal, and the general technical background to the research area. The student should be familiar with the relevant literature. The student must also defend the significance of the research problem and the viability of the technical approach. The second part of the examination consists of questions in the major and minor fields.

## Time in Candidacy

### Dissertation

### Required Professional Development

### Teaching

The faculty of the Department of Materials Science and Engineering considers teaching experience to be an important part of a doctoral student's program of study and requires that all graduate students pursuing a PhD serve at least one semester as a graduate student instructor (GSI) in an MSE course (usually after the first year).

### Seminar

All graduate students are required to enroll (MAT SCI 298-Sect 1) and attend the weekly department colloquium series.

## Unit Requirements

There are two plans for the master of science degree.

Plan I requires a minimum of 20 semester units are required, of which at least 8 must be strictly graduate units in the major subject (University requirement), and of these 8, there shall be no more than 2 units of credit for MAT SCI 299 while the remaining units must be graded course units. The remaining 12 units may be upper division or graduate courses proposed by the student and research supervisor and approved by the major field adviser.

Plan II requires a minimum 24 semester units is required, of which at least 12 must be strictly graduate units in the major subject, and of these 12 units, there shall be no more than a total of 2 units of credit MAT SCI 299. The remaining 12 units may be graded upper division or graduate courses approved by the major field adviser.

## Curriculum

### Courses Required

Thermodynamics:		
MAT SCI 201A	Thermodynamics and Phase Transformations in Solids	4
Structure & Bonding:		
MAT SCI 201B	Thermodynamics, Phase Behavior and Transport Phenomena in Materials	4
MAT SCI 202	Crystal Structure and Bonding	3-4
	or MAT SCI 21:Computational Materials Science	
Materials Characterization:		
MAT SCI 204	Materials Characterization	3-4
	or MAT SCI 24:Electron Microscopy Laboratory	
Select one of the following in Materials Properties:		3-4
MAT SCI 205	Defects in Solids [3]	
MAT SCI C212	Deformation and Fracture of Engineering Materials [4]	
MAT SCI 213	Environmental Effects on Materials Properties and Behavior [3]	
MAT SCI 217	Properties of Dielectric and Magnetic Materials [3]	
MAT SCI 223	Semiconductor Materials [3]	
MAT SCI 224	Magnetism and Magnetic Materials [3]	
MAT SCI C225	Thin-Film Science and Technology [3]	
MAT SCI 251	Polymer Surfaces and Interfaces [3]	
MAT SCI 260	Surface Properties of Materials [3]	

Select one of the following in Materials Processing:		3-4
MAT SCI 121	Metals Processing [3]	
MAT SCI C216	Macromolecular Science in Biotechnology and Medicine [4]	
MAT SCI 223	Semiconductor Materials [3]	
MAT SCI 224	Magnetism and Magnetic Materials [3]	
MAT SCI C225	Thin-Film Science and Technology [3]	
MAT SCI 251	Polymer Surfaces and Interfaces [3]	
Electives - for remaining units required (20, Plan I; 24, Plan II)		5-9

## Capstone/Thesis (Plan I)

A thesis is required. The research topic and research supervisor must be specified in the program of study form.

The thesis committee is formally appointed by the dean of the Graduate Division upon recommendation of the student's major field adviser and the AAC. It consists of three members: the research supervisor plus one other member from the department, and one member either be from outside the College of Engineering or from a field of engineering not closely related to that of the candidate. The student is encouraged to consult all committee members while the research is in progress.

## Capstone Report (Plan II)

At least a month before the student intends to graduate, a project report based on MAT SCI 299 work or on a phase of his/her work as a research assistant and approved by the project supervisor, must be submitted to the committee. It is the student's responsibility to see that the final corrected report is submitted and the examination taken by the last day of the semester.

## Unit Requirements

- Minimum units to complete the degree is 25 semester units (must be in 200 series).
- 12 units must be materials science and engineering units; 8 semester units must be in core leadership curriculum units (must be in 200 series)
  - 2 Semester units - Capstone Integration (taken S/U)
  - 3 Semester units - Engineering Leadership I (taken for a letter grade)
  - 3 Semester units - Engineering Leadership II (taken for a letter grade)
- Maximum number of Capstone Project Units (297M A-B): 5(2 Fall, 3 Spring)
- Minimum GPA: All students required to have a minimum of 3.0
- Minimum units required: 12 units (Full Time)
- Comprehensive Exam

## Curriculum

These concentrations are suggestions only. Students are encouraged to select electives that best satisfy their specific educational objectives.

## General Program Concentration

Materials Science and Engineering is a diverse field of study drawing from all areas of physical science such as chemistry, physics, biology, and engineering. In addition to drawing from the physical sciences, materials science and engineering often crosses these disciplinary boundaries. The general program recognizes the inherent interdisciplinary nature of materials science and engineering and allows

students to tailor their program of study to address their personal interests

### Technical Electives

Select from the following:	3
MAT SCI 200A Survey of Materials Science	4
MAT SCI 201A Thermodynamics and Phase Transformations in Solids	4
MAT SCI 201B Thermodynamics, Phase Behavior and Transport Phenomena in Materials	4
MAT SCI 204 Materials Characterization	3
MAT SCI 204D Materials Characterization	1
MAT SCI 223 Semiconductor Materials	3
MAT SCI C226 Photovoltaic Materials; Modern Technologies in the Context of a Growing Renewable Energy Market	3
MAT SCI 202 Crystal Structure and Bonding	3
MAT SCI 205 Defects in Solids	3
MAT SCI C212 Deformation and Fracture of Engineering Materials	4
MAT SCI 213 Environmental Effects on Materials Properties and Behavior	3
MAT SCI 215 Computational Materials Science	3
MAT SCI C216 Macromolecular Science in Biotechnology and Medicine	4
MAT SCI 217 Properties of Dielectric and Magnetic Materials	3
MAT SCI 218 Optical Materials and Devices	3
MAT SCI C225 Thin-Film Science and Technology	3

### Biomaterials

Traditionally, biomaterials encompass synthetic alternatives to the native materials found in our body. A central limitation in the performance of traditional materials used in medical device, biotechnological, and pharmaceutical industries is that they lack the ability to integrate with biological systems through either a molecular or cellular pathway, which has relegated biomaterials to a passive role dictated by the constituents of a particular environment, leading to unfavorable outcomes and device failure. The design and synthesis of materials that circumvent their passive behavior in complex mammalian cells is the focus of the work conducted within the MSE Department at Berkeley.

**Biomimetic Surface Engineering:**

Surface modification of medical implants to control wound healing and tissue regeneration.

**Biologically-defined Microdevices:**

Design and fabrication of surfaces, using advanced pattern techniques, to facilitate cell and molecular-based microarrays.

### Technical Electives

Select from the following:	3
MAT SCI 200A Survey of Materials Science	4
MAT SCI 201A Thermodynamics and Phase Transformations in Solids	4
MAT SCI 201B Thermodynamics, Phase Behavior and Transport Phenomena in Materials	4
MAT SCI 204 Materials Characterization	3
MAT SCI 204D Materials Characterization	1
MAT SCI C208 Biological Performance of Materials	4

MAT SCI C216 Macromolecular Science in Biotechnology and Medicine	4
MAT SCI 251 Polymer Surfaces and Interfaces	3
MAT SCI 260 Surface Properties of Materials	3

### Advanced Structural Materials

This area focuses on the relationships between the chemical and physical structure of materials and their properties and performance. Regardless of the material class metallic, ceramic, polymeric or composite, an understanding of the structure-property relationships provides a scientific basis for developing engineering materials for advanced applications. Fundamental and applied research in this field responds to an ever-increasing demand for improved or better-characterized materials.

### Technical Electives

Select from the following:	3
MAT SCI 200A Survey of Materials Science	4
MAT SCI 201A Thermodynamics and Phase Transformations in Solids	4
MAT SCI 204 Materials Characterization	3
MAT SCI 204D Materials Characterization	1
MAT SCI 205 Defects in Solids	3
MAT SCI C211 Mechanics of Solids	3
MAT SCI C212 Deformation and Fracture of Engineering Materials	4
MAT SCI 213 Environmental Effects on Materials Properties and Behavior	3
MAT SCI C214 Micromechanics	3
MAT SCI 215 Computational Materials Science	3

### Electronic, Magnetic and Optical Materials

This group of materials is defined by its functionality. Semiconductors, metals, and ceramics are used today to form highly complex systems, such as integrated electronic circuits, optoelectronic devices, and magnetic and optical mass storage media. In intimate contact, the various materials, with precisely controlled properties, perform numerous functions, including the acquisition, processing, transmission, storage, and display of information. Electronic, Magnetic and Optical materials research combines the fundamental principles of solid-state physics and chemistry, of electronic and chemical engineering, and of materials science. Nanoscale science and engineering is of increasing importance in this field.

### Technical Electives I

Select from the following:	3
MAT SCI 200A Survey of Materials Science	4
MAT SCI 201A Thermodynamics and Phase Transformations in Solids	4
MAT SCI 201B Thermodynamics, Phase Behavior and Transport Phenomena in Materials	4
MAT SCI 202 Crystal Structure and Bonding	4
MAT SCI 205 Defects in Solids	3
MAT SCI 215 Computational Materials Science	3
MAT SCI C216 Macromolecular Science in Biotechnology and Medicine	4
MAT SCI 217 Properties of Dielectric and Magnetic Materials	3
MAT SCI 218 Optical Materials and Devices	3

MAT SCI 223	Semiconductor Materials	3
MAT SCI 224	Magnetism and Magnetic Materials	3
MAT SCI C225	Thin-Film Science and Technology	3
MAT SCI C226	Photovoltaic Materials; Modern Technologies in the Context of a Growing Renewable Energy Market	3

## Computational Materials

Computational methods are increasingly important in all areas of science and engineering, Computational Materials Science capitalizes on advancements in these fields, which include high throughput approaches and machine learning. Materials Science and Engineering applications range from the theoretical prediction of the electronic and structural properties of materials to chemical kinetics and equilibria or modeling the chemical kinetics and equilibria in a materials processing operation, to now predicting the existence of new materials and their properties. These advances in computational techniques have yielded remarkable insight into materials behaviors, particularly at the nanoscale. Under favorable circumstances, it is now possible to predict in exquisite detail many properties of materials at the nanoscale (one nanometer = 1 billionth of a meter) by merely solving Schrodinger's famous equation. These advancements have positioned researchers within the department to be very active in developing data for the Materials Project <https://materialsproject.org> (<https://materialsproject.org/>), an effort to construct a database of all computable properties for all known materials.

### Technical Electives:

Select from the following:

MAT SCI 200A	Survey of Materials Science	4
MAT SCI 201A	Thermodynamics and Phase Transformations in Solids	4
MAT SCI 201B	Thermodynamics, Phase Behavior and Transport Phenomena in Materials	4
MAT SCI 202	Crystal Structure and Bonding	3
MAT SCI 205	Defects in Solids	3
MAT SCI C211	Mechanics of Solids	3
MAT SCI C212	Deformation and Fracture of Engineering Materials	4
MAT SCI C214	Micromechanics	3
MAT SCI 215	Computational Materials Science	3
MAT SCI C286	Modeling and Simulation of Advanced Manufacturing Processes	3

## Chemical and Electrochemical

Chemical and Electrochemical materials include both the chemical and electrochemical processing of materials, and the chemical and electrochemical behavior of materials. The former includes the scientific and engineering principles utilized in mineral processing, smelting, leaching, and refining materials, and many of the advanced techniques of processing microelectronic devices such as etching and deposition techniques. The latter includes the chemical synthesis of novel materials, environmental degradation of materials, the compatibility of materials with specific environments, along with materials used in advanced energy storage devices, and catalytic materials for energy and the environment.

### Technical Electives:

Select from the following:

MAT SCI 200A	Survey of Materials Science	4
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MAT SCI 201A	Thermodynamics and Phase Transformations in Solids	4
MAT SCI 201B	Thermodynamics, Phase Behavior and Transport Phenomena in Materials	4
MAT SCI 204	Materials Characterization	3
MAT SCI 204D	Materials Characterization	1
MAT SCI 205	Defects in Solids	3
MAT SCI 213	Environmental Effects on Materials Properties and Behavior	3
MAT SCI 223	Semiconductor Materials	3
MAT SCI C225	Thin-Film Science and Technology	3
MAT SCI C226	Photovoltaic Materials; Modern Technologies in the Context of a Growing Renewable Energy Market	3
MAT SCI 260	Surface Properties of Materials	3

## Materials Science and Engineering

Expand all course descriptions [+] Collapse all course descriptions [-]

### MAT SCI 200A Survey of Materials Science 4 Units

Terms offered: Fall 2024, Fall 2023, Fall 2022

A survey of Materials Science at the beginning graduate level, intended for those who did not major in the field as undergraduates. Focus on the nature of microstructure and its manipulation and control to determine engineering properties. Reviews bonding, structure and microstructure, the chemical, electromagnetic and mechanical properties of materials, and introduces the student to microstructural engineering.

Survey of Materials Science: Read More [+]

#### Rules & Requirements

**Prerequisites:** Graduate standing or consent of instructor

#### Hours & Format

**Fall and/or spring:** 15 weeks - 4 hours of lecture per week

#### Additional Details

**Subject/Course Level:** Materials Science and Engineering/Graduate

**Grading:** Letter grade.

Survey of Materials Science: Read Less [-]

## MAT SCI 201A Thermodynamics and Phase Transformations in Solids 4 Units

Terms offered: Fall 2024, Fall 2023, Fall 2022

The laws of thermodynamics, fundamental equations for multicomponent elastic solids and electromagnetic media, equilibrium criteria. Application to solution thermodynamics, point defects in solids, phase diagrams. Phase transitions, Landau rule, symmetry rules. Interfaces, nucleation theory, elastic effects. Kinetics: diffusion of heat, mass and charge; coupled flows.

Thermodynamics and Phase Transformations in Solids: Read More [+]

### Rules & Requirements

**Prerequisites:** MAT SCI 102, MAT SCI 103, ENGIN 40, or consent of instructor

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture and 1 hour of discussion per week

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Ceder

Thermodynamics and Phase Transformations in Solids: Read Less [-]

## MAT SCI 201B Thermodynamics, Phase Behavior and Transport Phenomena in Materials 4 Units

Terms offered: Spring 2024, Spring 2023, Fall 2021

This course will cover the laws of classical thermodynamics, principles of statistical mechanics, and laws governing the transport of mass and momentum in materials. Applications will include the construction of equilibrium and nonequilibrium phase diagrams and the kinetics of phase transformations in both soft and hard materials.

Thermodynamics, Phase Behavior and Transport Phenomena in Materials: Read More [+]

### Rules & Requirements

**Prerequisites:** 102, 103, Engineering 115 or consent of instructor. 201A is a prerequisite to 201B

### Hours & Format

**Fall and/or spring:** 15 weeks - 4 hours of lecture per week

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Omar

Thermodynamics, Phase Behavior and Transport Phenomena in Materials: Read Less [-]

## MAT SCI 202 Crystal Structure and Bonding 4 Units

Terms offered: Spring 2024, Spring 2022, Spring 2020

Regular, irregular arrays of points, spheres; lattices, direct, reciprocal; crystallographic point and space groups; atomic structure; bonding in molecules; bonding in solids; ionic (Pauling rules), covalent, metallic bonding; structure of elements, compounds, minerals, polymers.

Crystal Structure and Bonding: Read More [+]

### Hours & Format

**Fall and/or spring:** 15 weeks - 4 hours of lecture per week

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Chrzan

Crystal Structure and Bonding: Read Less [-]

## MAT SCI 204 Materials Characterization 3 Units

Terms offered: Spring 2024, Spring 2023, Spring 2022

This 3-unit course will cover basic principles and techniques used for the characterization of engineering materials. The course is designed to introduce graduate students to the basic principles of structural, chemical and property characterization techniques. The course is grounded in modern x-ray diffraction and electron microscopy techniques for characterization of the chemical and structural properties of a material. The course introduces the fundamental theoretical framework for diffraction, spectrometry and imaging methods.

Materials Characterization: Read More [+]

### Objectives & Outcomes

**Course Objectives:** Materials characterization lies at the heart of understanding the property-structure-processing relationships of materials. The goal of the course is to prepare graduate students from materials science to understand the basic principles behind material characterization tools and techniques. More specifically, this class will provide students (1) a thorough introduction to the principles and practice of diffraction, (2) introductory exposure to a range of common characterization methods for the determination of structure and composition of solids.

**Student Learning Outcomes:** A successful student will learn (1) the theory of x-ray and electron diffraction, (2) basic elements of electron microscopy, (3) basic aspects of spectroscopy.

### Rules & Requirements

**Prerequisites:** MAT SCI 102- a basic knowledge of structure, bonding and crystallography will be assumed

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/Graduate

**Grading:** Letter grade.

**Instructors:** Scott, Minor

Materials Characterization: Read Less [-]

## MAT SCI 204D Materials Characterization 1 Unit

Terms offered: Spring 2024, Spring 2023, Spring 2022

This 1-unit course will introduce specialized techniques used for the characterization of engineering materials beyond routine x-ray diffraction and electron microscopy. The course is designed to complement a basic course in x-ray diffraction and electron microscopy by introducing graduate students to characterization methods such as ion beam analysis, magnetic measurements, synchrotron techniques, scanning probe techniques, neutron scattering, optical spectroscopy and dynamic characterization.

Materials Characterization: Read More [+]

### Objectives & Outcomes

**Course Objectives:** Materials characterization lies at the heart of understanding the property-structure-processing relationships of materials. The goal of the course is to prepare graduate students from materials science and related disciplines to understand the basic principles behind ion beam analysis, magnetic measurements, synchrotron techniques, scanning probe techniques, neutron scattering, optical spectroscopy and dynamic characterization.

### Rules & Requirements

**Prerequisites:** Graduate standing in engineering, physics or chemistry; MAT SCI 102; and concurrent enrollment in MAT SCI 204

### Hours & Format

**Fall and/or spring:** 15 weeks - 1 hour of discussion per week

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/Graduate

**Grading:** Letter grade.

**Instructors:** Scott, Minor

Materials Characterization: Read Less [-]

## MAT SCI 205 Defects in Solids 3 Units

Terms offered: Spring 2022, Spring 2020, Spring 2014

Many properties of solid state materials are determined by lattice defects. This course treats in detail the structure of crystal defects, defect formation and annihilation processes, and the influence of lattice defects on the physical and optical properties of crystalline materials.

Defects in Solids: Read More [+]

### Rules & Requirements

**Prerequisites:** PHYSICS 7C or consent of instructor

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Ramesh

Defects in Solids: Read Less [-]

## MAT SCI C208 Biological Performance of Materials 4 Units

Terms offered: Fall 2024, Fall 2023, Fall 2022

This course is intended to give students the opportunity to expand their knowledge of topics related to biomedical materials selection and design. Structure-property relationships of biomedical materials and their interaction with biological systems will be addressed. Applications of the concepts developed include blood-materials compatibility, biomimetic materials, hard and soft tissue-materials interactions, drug delivery, tissue engineering, and biotechnology.

Biological Performance of Materials: Read More [+]

### Objectives & Outcomes

**Course Objectives:** The course is separated into four parts spanning the principles of synthetic materials and surfaces, principles of biological materials, biological performance of materials and devices, and state-of-the-art materials design. Students are required to attend class and master the material therein. In addition, readings from the clinical, life and materials science literature are assigned. Students are encouraged to seek out additional reference material to complement the readings assigned. A mid-term examination is given on basic principles (parts 1 and 2 of the outline). A comprehensive final examination is given as well. The purpose of this course is to introduce students to problems associated with the selection and function of biomaterials. Through class lectures and readings in both the physical and life science literature, students will gain broad knowledge of the criteria used to select biomaterials, especially in devices where the material-tissue or material-solution interface dominates performance. Materials used in devices for medicine, dentistry, tissue engineering, drug delivery, and the biotechnology industry will be addressed.

This course also has a significant design component (~35%). Students will form small teams (five or less) and undertake a semester-long design project related to the subject matter of the course. The project includes the preparation of a paper and a 20 minute oral presentation critically analyzing a current material-tissue or material-solution problem. Students will be expected to design improvements to materials and devices to overcome the problems identified in class with existing materials.

**Student Learning Outcomes:** Work independently and function on a team, and develop solid communication skills (oral, graphic & written) through the class design project.

- Develop an understanding of the social, safety and medical consequences of biomaterial use and regulatory issues associated with the selection of biomaterials in the context of the silicone breast implant controversy and subsequent biomaterials crisis.
- Design experiments and analyze data from the literature in the context of the class design project.
- Understanding of the origin of surface forces and interfacial free energy, and how they contribute to the development of the biomaterial interface and ultimately biomaterial performance.
- Apply math, science & engineering principles to the understanding of soft materials, surface chemistry, DLVO theory, protein adsorption kinetics, viscoelasticity, mass diffusion, and molecular (i.e., drug) delivery kinetics.
- Apply core concepts in materials science to solve engineering problems related to the selection biomaterials, especially in devices where the material-tissue or material-solution interface dominates performance.

### Rules & Requirements

**Prerequisites:** MAT SCI 45; and CHEM C130 / MCEU BI C100A or

## MAT SCI C211 Mechanics of Solids 3 Units

Terms offered: Fall 2024, Fall 2023, Fall 2022

Mechanical response of materials: Simple tension in elastic, plastic and viscoelastic members. Continuum mechanics: The stress and strain tensors, equilibrium, compatibility. Three-dimensional elastic, plastic and viscoelastic problems. Thermal, transformation, and dealloying stresses. Applications: Plane problems, stress concentrations at defects, metal forming problems.

Mechanics of Solids: Read More [+]

### Rules & Requirements

**Prerequisites:** Graduate standing or consent of instructor

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Govindjee

**Also listed as:** CIV ENG C231

Mechanics of Solids: Read Less [-]

## MAT SCI C212 Deformation and Fracture of Engineering Materials 4 Units

Terms offered: Spring 2024, Spring 2022, Spring 2021

This course covers deformation and fracture behavior of engineering materials for both monotonic and cyclic loading conditions.

Deformation and Fracture of Engineering Materials: Read More [+]

### Rules & Requirements

**Prerequisites:** Civil Engineering 130, Engineering 45

### Hours & Format

**Fall and/or spring:** 15 weeks - 4 hours of lecture per week

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/Graduate

**Grading:** Letter grade.

**Instructors:** Ritchie, Pruitt, Komvopoulos

**Formerly known as:** Materials Science and Engineering C212, Mechanical Engineering C225

**Also listed as:** MEC ENG C225

Deformation and Fracture of Engineering Materials: Read Less [-]



## MAT SCI 213 Environmental Effects on Materials Properties and Behavior 3 Units

Terms offered: Fall 2014, Fall 2013, Fall 2012

Review of electrochemical aspects of corrosion; pitting and crevice corrosion; active/passive transition; fracture mechanics approach to corrosion; stress corrosion cracking; hydrogen embrittlement; liquid metal embrittlement; corrosion fatigue; testing methods.

Environmental Effects on Materials Properties and Behavior: Read More [+]

### Rules & Requirements

**Prerequisites:** MSE 112 or equivalent

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Devine

Environmental Effects on Materials Properties and Behavior: Read Less [-]

## MAT SCI C214 Micromechanics 3 Units

Terms offered: Fall 2023, Spring 2022, Spring 2018

Basic theories, analytical techniques, and mathematical foundations of micromechanics. It includes 1. physical micromechanics, such as mathematical theory of dislocation, and cohesive fracture models; 2. micro-elasticity that includes Eshelby's eigenstrain theory, comparison variational principles, and micro-crack/micro-cavity based damage theory; 3. theoretical composite material that includes the main methodologies in evaluating overall material properties; 4. meso-plasticity that includes meso-damage theory, and the crystal plasticity; 5. homogenization theory for materials with periodic structures.

Micromechanics: Read More [+]

### Rules & Requirements

**Prerequisites:** Consent of instructor

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/Graduate

**Grading:** Letter grade.

**Instructors:** Govindjee, Li

**Also listed as:** CIV ENG C236

Micromechanics: Read Less [-]

## MAT SCI 215 Computational Materials Science 3 Units

Terms offered: Fall 2021, Fall 2019, Spring 2019

Introduction to computational materials science. Development of atomic scale simulations for materials science applications. Application of kinetic Monte Carlo, molecular dynamics, and total energy techniques to the modeling of surface diffusion processes, elastic constants, ideal shear strengths, and defect properties. Introduction to simple numerical methods for solving coupled differential equations and for studying correlations.

Computational Materials Science: Read More [+]

### Rules & Requirements

**Prerequisites:** Graduate standing in engineering or sciences, or consent of instructor

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/Graduate

**Grading:** Letter grade.

**Instructors:** Chrzan, Asta, Ceder, Sherburne

Computational Materials Science: Read Less [-]

## MAT SCI C216 Macromolecular Science in Biotechnology and Medicine 4 Units

Terms offered: Spring 2024, Spring 2023, Spring 2022

Overview of the problems associated with the selection and function of polymers used in biotechnology and medicine. Principles of polymer science, polymer synthesis, and structure-property-performance relationships of polymers. Particular emphasis is placed on the performance of polymers in biological environments. Interactions between macromolecular and biological systems for therapy and diagnosis. Specific applications will include drug delivery, gene therapy, tissue engineering, and surface engineering.

Macromolecular Science in Biotechnology and Medicine: Read More [+]

### Rules & Requirements

**Prerequisites:** BIO ENG 115. Open to seniors with consent of instructor

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture and 1 hour of discussion per week

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Healy

**Also listed as:** BIO ENG C216

Macromolecular Science in Biotechnology and Medicine: Read Less [-]

## **MAT SCI 217 Properties of Dielectric and Magnetic Materials 3 Units**

Terms offered: Spring 2021, Fall 2020, Spring 2017

Introduction to the physical principles underlying the dielectric and magnetic properties of solids. Processing-microstructure-property relationships of dielectric materials, including piezoelectric, pyroelectric, and ferroelectric oxides, and of magnetic materials, including hard- and soft ferromagnets, ferrites and magneto-optic and -resistive materials.

The course also covers the properties of grain boundary devices (including varistors) as well as ion-conducting and mixed conducting materials for applications in various devices such as sensors, fuel cells, and electric batteries.

Properties of Dielectric and Magnetic Materials: [Read More \[+\]](#)

### **Rules & Requirements**

**Prerequisites:** PHYSICS 7A, PHYSICS 7B, and PHYSICS 7C; or PHYSICS 7A, PHYSICS 7B, and consent of instructor; MAT SCI 111 is recommended

### **Hours & Format**

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### **Additional Details**

**Subject/Course Level:** Materials Science and Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Martin

Properties of Dielectric and Magnetic Materials: [Read Less \[-\]](#)

## **MAT SCI 218 Optical Materials and Devices 3 Units**

Terms offered: Spring 2024, Fall 2021, Fall 2020

This course provides an overview of the fundamental physics, processing and device applications of optical materials, including conventional and van der Waals semiconductors, plasmonic materials, metamaterials, etc. This course gives graduate students an introduction of the recent developments in the research fields of optical materials and nanophotonics. Topics covered include:

Basic concepts on light-matter interactions. Excitons, biexcitons and trions. Polaritons: plasmons, phonons and magnons. Plasmonic materials and their applications. Near field optics and its application in plasmonics. Raman spectroscopy and surface/tip enhanced Raman (SERS/TERS). Metamaterials: negative refraction, super-resolution imaging and optical invisibility.

Optical Materials and Devices: [Read More \[+\]](#)

### **Objectives & Outcomes**

**Course Objectives:** This course is designed to give graduate students an introduction of the recent developments in the research fields of optical materials and nanophotonics.

### **Rules & Requirements**

**Prerequisites:** Graduate standing in engineering, physics or chemistry

### **Hours & Format**

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### **Additional Details**

**Subject/Course Level:** Materials Science and Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Yao

Optical Materials and Devices: [Read Less \[-\]](#)

## MAT SCI 223 Semiconductor Materials 3 Units

Terms offered: Fall 2024, Fall 2022, Fall 2021

Semiconductor purification and crystal growth techniques. Doping, radiation damage, and annealing. Metal-semiconductor interfaces and reactions. Interaction between defects and impurities during processing of devices. Major electronic and optical methods for the analysis of semiconductors.

Semiconductor Materials: Read More [+]

### Rules & Requirements

**Prerequisites:** PHYSICS 7C or consent of instructor

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/Graduate

**Grading:** Letter grade.

**Instructors:** Dubon, Wu

Semiconductor Materials: Read Less [-]

## MAT SCI 224 Magnetism and Magnetic Materials 3 Units

Terms offered: Fall 2018, Fall 2016, Fall 2014

This course covers the fundamentals of magnetism and magnetic materials in the first two-thirds of the class. Topics include magnetic moments in classical versus quantum mechanical pictures, diamagnetism, paramagnetism, crystal field environments, dipolar and exchange interactions, ferromagnetism, antiferromagnetism, magnetic domains, magnetic anisotropy, and magnetostriction. Magnetic materials covered include transition metals, their alloys and oxides, rare earths and their oxides, organic and molecular magnets. Throughout the course, experimental techniques in magnetic characterization will be discussed. The second part of the course will focus on particular magnetic materials and devices that are of technological interest (e.g., magnetoresistive and magneto-optical materials and devices). Additional topics include biomagnetism and spin glasses.

Magnetism and Magnetic Materials: Read More [+]

### Rules & Requirements

**Prerequisites:** 111 or equivalent or consent of instructor; 117 recommended

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/Graduate

**Grading:** Letter grade.

Magnetism and Magnetic Materials: Read Less [-]

## MAT SCI C225 Thin-Film Science and Technology 3 Units

Terms offered: Fall 2024, Fall 2023, Fall 2022

Thin-film nucleation and growth, microstructural evolution and reactions. Comparison of thin-film deposition techniques. Characterization techniques. Processing of thin films by ion implantation and rapid annealing. Processing-microstructure-property-performance relationships in the context of applications in information storage, ICs, micro-electromechanical systems and optoelectronics.

Thin-Film Science and Technology: Read More [+]

### Rules & Requirements

**Prerequisites:** Graduate standing in engineering, physics, chemistry, or chemical engineering

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/Graduate

**Grading:** Letter grade.

**Instructors:** Wu, Dubon

**Also listed as:** AST C225

Thin-Film Science and Technology: Read Less [-]

## MAT SCI C226 Photovoltaic Materials; Modern Technologies in the Context of a Growing Renewable Energy Market 3 Units

Terms offered: Fall 2015, Spring 2013, Spring 2011

This technical course focuses on the fundamentals of photovoltaic energy conversion with respect to the physical principals of operation and design of efficient semiconductor solar cell devices. This course aims to equip students with the concepts and analytical skills necessary to assess the utility and viability of various modern photovoltaic technologies in the context of a growing global renewable energy market.

Photovoltaic Materials; Modern Technologies in the Context of a Growing Renewable Energy Market: Read More [+]

### Rules & Requirements

**Prerequisites:** Material Science and Mineral Engineering 111 or 123 or equivalent. Should have a firm foundation in electronic and optical props of semiconductors and basic semiconductor device physics

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/Graduate

**Grading:** Letter grade.

**Also listed as:** ENE,RES C226

Photovoltaic Materials; Modern Technologies in the Context of a Growing Renewable Energy Market: Read Less [-]

## MAT SCI 228 Additive Fabrication Processes and Systems for Advanced Materials 3 Units

Terms offered: Fall 2023

This course covers engineering principles, system designs, process dynamics and construction of advanced additive manufacturing (AM) techniques. Students will explore the process-structure-property relationships for 3D printing of polymer, metal, ceramic, composites and beyond. The course will introduce 3D topology, cellular and metamaterials enabled by AM. Through course projects, students will create new materials or engineering products using AM processes. Additive Fabrication Processes and Systems for Advanced Materials: Read More [+]

### Rules & Requirements

**Prerequisites:** Physics 7A, Engineering 27, Engineering 29, Materials Science and Engineering 45, Mechanical Engineering C85, or instructor's permission

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Zheng

Additive Fabrication Processes and Systems for Advanced Materials: Read Less [-]

## MAT SCI 241 Electron Microscopy Laboratory 4 Units

Terms offered: Spring 2024, Spring 2023, Spring 2022

This course covers the basic principles of techniques used in the characterization of engineering materials by electron microscopy, diffraction, and spectroscopy. In addition to lectures on the theory of electron diffraction and microscopy, there is a hands-on laboratory that offers detailed practical training in the operation of the transmission electron microscope (TEM) in all of its major functional diffraction and imaging modes. Electron Microscopy Laboratory: Read More [+]

### Rules & Requirements

**Prerequisites:** MAT SCI 104

### Hours & Format

**Fall and/or spring:** 15 weeks - 4 hours of laboratory and 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/Graduate

**Grading:** Letter grade.

**Instructors:** Gronsky, Minor

Electron Microscopy Laboratory: Read Less [-]

## MAT SCI 242 Advanced Spectroscopy 3 Units

Terms offered: Spring 2023, Spring 2021, Spring 2020

Advanced structural and functional characterization of materials using spectroscopic methods. Techniques to be discussed include state of the art optical, x-ray and ion-beam spectroscopies used for characterization of advanced materials and devices.

Advanced Spectroscopy: Read More [+]

### Rules & Requirements

**Prerequisites:** MAT SCI 204 or MAT SCI 205; or consent of instructor

### Hours & Format

**Fall and/or spring:** 15 weeks - 2 hours of lecture and 3 hours of laboratory per week

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/Graduate

**Grading:** Letter grade.

Advanced Spectroscopy: Read Less [-]

## MAT SCI 243 Electronic Materials Characterization 3 Units

Terms offered: Spring 2024

This course provides a detailed overview of important characterization techniques used to study the electrical, optical, magnetic, and piezoelectric properties of thin films, with an emphasis on semiconductors, for device applications. Key properties that can be extracted from each technique will be described and compared. Important models to extract key materials characteristics from raw data collected through ex situ and in situ techniques will also be introduced. This course emphasizes characterization techniques commonly available in modern laboratory settings and in industry.

Electronic Materials Characterization: Read More [+]

### Objectives & Outcomes

**Course Objectives:** To bring students to an appreciation of the power of combining characterization techniques.

To familiarize students with some of the important methods of materials and device characterization useful in electronic, magnetic, optical and piezoelectric materials research.

To help students acquire the knowledge and hone the thought processes necessary to choose and use materials characterization techniques wisely.

To help students to become aware of the development of new characterization technologies, how to find them, and how to judge them.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Al Balushi

Electronic Materials Characterization: Read Less [-]

## MAT SCI C250 Nanomaterials in Medicine 3 Units

Terms offered: Fall 2022, Fall 2021, Fall 2020

The course is designed for graduate students interested in the emerging field of nanomedicine. The course will involve lectures, literature reviews and proposal writing. Students will be required to formulate a nanomedicine research project and write an NIH-style proposal during the course. The culmination of this project will involve a mock review panel in which students will serve as peer reviewers to read and evaluate the proposals.

Nanomaterials in Medicine: Read More [+]

### Objectives & Outcomes

**Course Objectives:** To review the current literature regarding the use of nanomaterials in medical applications; (2) To describe approaches to nanomaterial synthesis and surface modification; (3) To understand the interaction of nanomaterials with proteins, cells and biological systems; (4) To familiarize students with proposal writing and scientific peer review.

**Student Learning Outcomes:** Students should be able to (1) identify the important properties of metal, polymer and ceramic nanomaterials used in healthcare; (2) understand the role of size, shape and surface chemistry of nanomaterials in influencing biological fate and performance; (3) understand common methods employed for surface modification of nanomaterials; (4) comprehend the range of cell-nanomaterial interactions and methods for assaying these interactions; (5) read and critically review the scientific literature relating to nanomedicine; (6) formulate and design an experimental nanomedicine research project; (7) understand the principles of the peer review system.

### Rules & Requirements

**Prerequisites:** Graduate Standing

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Messersmith

**Also listed as:** BIO ENG C250

Nanomaterials in Medicine: Read Less [-]

## MAT SCI 251 Polymer Surfaces and Interfaces 3 Units

Terms offered: Spring 2024, Spring 2022, Fall 2020

The course is designed for graduate students to gain a fundamental understanding of the surface and interfacial science of polymeric materials. Beginning with a brief introduction of the principles governing polymer phase behavior in bulk, it develops the thermodynamics of polymers in thin films and at interfaces, the characterization techniques to assess polymer behavior in thin films and at interfaces, and the morphologies of polymer thin films and other dimensionally-restricted structures relevant to nanotechnology and biotechnology. Field trips to national user facilities, laboratory demonstrations and hands-on experiments, and guest lectures will augment the courses lectures. Polymer Surfaces and Interfaces: Read More [+]

### Rules & Requirements

**Prerequisites:** Chemistry 1A or Engineering 5; Material Science and Engineering 151 recommended

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Xu

Polymer Surfaces and Interfaces: Read Less [-]

## MAT SCI 260 Surface Properties of Materials 3 Units

Terms offered: Fall 2024, Spring 2023, Fall 2020

Thermodynamics of surfaces and phase boundaries, surface tension of solids and liquids, surface activity, adsorption, phase equilibria, and contact angles, electrochemical double layers at interfaces, theory, and applications.

Surface Properties of Materials: Read More [+]

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Salmeron

**Formerly known as:** Mineral Engineering 260

Surface Properties of Materials: Read Less [-]

## MAT SCI C261 Introduction to Nano-Science and Engineering 3 Units

Terms offered: Spring 2015, Spring 2013, Spring 2012

A three-module introduction to the fundamental topics of Nano-Science and Engineering (NSE) theory and research within chemistry, physics, biology, and engineering. This course includes quantum and solid-state physics; chemical synthesis, growth fabrication, and characterization techniques; structures and properties of semiconductors, polymer, and biomedical materials on nanoscales; and devices based on nanostructures. Students must take this course to satisfy the NSE Designated Emphasis core requirement.

Introduction to Nano-Science and Engineering: Read More [+]

### Rules & Requirements

**Prerequisites:** Major in physical science such as chemistry, physics, etc., or engineering; consent of advisor or instructor

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/Graduate

**Grading:** Letter grade.

**Instructors:** Gronsky, S.W. Lee, Wu

**Also listed as:** BIO ENG C280/NSE C201/PHYSICS C201

Introduction to Nano-Science and Engineering: Read Less [-]

## **MAT SCI C286 Modeling and Simulation of Advanced Manufacturing Processes 3 Units**

Terms offered: Fall 2024, Spring 2024, Spring 2023

This course provides the student with a modern introduction to the basic industrial practices, modeling techniques, theoretical background, and computational methods to treat classical and cutting edge manufacturing processes in a coherent and self-consistent manner.

Modeling and Simulation of Advanced Manufacturing Processes: Read More [+]

### **Objectives & Outcomes**

**Course Objectives:** An introduction to modeling and simulation of modern manufacturing processes.

### **Rules & Requirements**

**Prerequisites:** An undergraduate course in strength of materials or 122

### **Hours & Format**

**Fall and/or spring:** 15 weeks - 3 hours of lecture and 1 hour of discussion per week

### **Additional Details**

**Subject/Course Level:** Materials Science and Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Zohdi

**Also listed as:** MEC ENG C201/NUC ENG C226

Modeling and Simulation of Advanced Manufacturing Processes: Read Less [-]

## **MAT SCI C287 Computational Design of Multifunctional/Multiphysical Composite Materials 3 Units**

Terms offered: Spring 2012

The course is self-contained and is designed in an interdisciplinary manner for graduate students in engineering, materials science, physics, and applied mathematics who are interested in methods to accelerate the laboratory analysis and design of new materials. Examples draw primarily from various mechanical, thermal, diffusive, and electromagnetic applications.

Computational Design of Multifunctional/Multiphysical Composite Materials: Read More [+]

### **Rules & Requirements**

**Prerequisites:** An undergraduate degree in the applied sciences or engineering

### **Hours & Format**

**Fall and/or spring:** 15 weeks - 3-3 hours of lecture and 0-1 hours of discussion per week

### **Additional Details**

**Subject/Course Level:** Materials Science and Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Zohdi

**Also listed as:** MEC ENG C202

Computational Design of Multifunctional/Multiphysical Composite Materials: Read Less [-]

## **MAT SCI 290A Special Topics in Materials Science 3 Units**

Terms offered: Fall 2016, Fall 2015, Fall 2014

Lectures and appropriate assignments on fundatmental or applied topics of current interest in materials science and engineering.

Special Topics in Materials Science: Read More [+]

### **Rules & Requirements**

**Prerequisites:** Graduate standing

**Repeat rules:** Course may be repeated for credit without restriction.

### **Hours & Format**

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### **Additional Details**

**Subject/Course Level:** Materials Science and Engineering/Graduate

**Grading:** Letter grade.

**Formerly known as:** 290M

Special Topics in Materials Science: Read Less [-]

## MAT SCI 290M Special Problems in Materials Science 3 Units

Terms offered: Spring 2009, Spring 2008, Spring 2006  
Selected topics in the thermodynamic, kinetic or phase transformation behavior of solid materials. Topics will generally be selected based on student interest in Mat Sci 201A-201B. The course provides an opportunity to explore subjects of particular interest in greater depth. Special Problems in Materials Science: Read More [+]

### Rules & Requirements

**Prerequisites:** MAT SCI 201A and MAT SCI 201B; or consent of instructor

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Morris

Special Problems in Materials Science: Read Less [-]

## MAT SCI 296A Independent Research for Five-Year BS/MS Program 1 - 2 Units

Terms offered: Fall 2024, Fall 2023, Fall 2022  
This is the first semester of a two-course sequence for those majors in the five year BS/MS program. Students are expected to formulate, develop and initiate an independent research project under the supervision of a research advisor. This course will meet once at the beginning of the semester to outline the expectations of the course. Periodic meetings covering topics such as maintaining a lab notebook, effective oral communication, and writing a journal publication will be scheduled. Students will be expected to keep a laboratory notebook outlining their progress during the semester. A progress report will be due at the end of Materials Science and Engineering 296A. Students will also be expected to give an oral presentation, describing their research project and progress toward their goals in front of their peers at the end of the semester.

Independent Research for Five-Year BS/MS Program: Read More [+]

### Rules & Requirements

**Prerequisites:** Acceptance into the five year BS/MS program

### Hours & Format

**Fall and/or spring:** 15 weeks - 1-2 hours of independent study per week

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/Graduate

**Grading:** Offered for satisfactory/unsatisfactory grade only.

Independent Research for Five-Year BS/MS Program: Read Less [-]

## MAT SCI 296B Independent Research for Five-Year BS/MS Program 1 - 2 Units

Terms offered: Spring 2024, Spring 2023, Spring 2022  
This is the second semester of a two-course sequence for those majors in the five year BS/MS program. Students are expected to complete an independent research project under the supervision of a research advisor initiated in Materials Science and Engineering 296A. This course will meet once at the beginning of the semester to outline the expectations of the course. Periodic meetings covering topics such as data analysis and design of experiment will be scheduled. Students will be expected to keep a laboratory notebook outlining their progress during the semester. A final report in journal publication form will be due at the end of the semester. Each student will also give a final presentation on his/her research project at the end of the semester.

Independent Research for Five-Year BS/MS Program: Read More [+]

### Rules & Requirements

**Prerequisites:** 296A

### Hours & Format

**Fall and/or spring:** 15 weeks - 1-2 hours of independent study per week

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/Graduate

**Grading:** Offered for satisfactory/unsatisfactory grade only.

Independent Research for Five-Year BS/MS Program: Read Less [-]

## MAT SCI 298 Group Studies, Seminars, or Group Research 1 - 8 Units

Terms offered: Fall 2024, Spring 2024, Fall 2023  
Advanced study in various subjects through special seminars on topics to be selected each year, informal group studies of special problems, group participation in comprehensive design problems or group research on complete problems for analysis and experimentation.

Group Studies, Seminars, or Group Research: Read More [+]

### Rules & Requirements

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1-8 hours of seminar per week

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/Graduate

**Grading:** Offered for satisfactory/unsatisfactory grade only.

Group Studies, Seminars, or Group Research: Read Less [-]



## MAT SCI 299 Individual Study or Research 1 - 12 Units

Terms offered: Fall 2024, Summer 2024, Summer 2024 10 Week Session  
Individual investigation of advanced materials science problems.

Individual Study or Research: Read More [+]

### Rules & Requirements

**Prerequisites:** Graduate standing in engineering

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1-12 hours of independent study per week

### Summer:

6 weeks - 1-12 hours of independent study per week

8 weeks - 1-12 hours of independent study per week

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/Graduate

**Grading:** Offered for satisfactory/unsatisfactory grade only.

Individual Study or Research: Read Less [-]

## MAT SCI 375A Science and Engineering Pedagogy 2 Units

Terms offered: Fall 2016, Fall 2015, Fall 2014

Discussion and research of pedagogical issues. Supervised practice teaching in materials science and engineering.

Science and Engineering Pedagogy: Read More [+]

### Rules & Requirements

**Prerequisites:** Graduate standing and appointment, or interest in appointment, as a graduate student instructor

### Hours & Format

**Fall and/or spring:** 15 weeks - 1-2 hours of seminar per week

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/Professional course for teachers or prospective teachers

**Grading:** Offered for satisfactory/unsatisfactory grade only.

**Instructor:** Gronsky

**Formerly known as:** Material Science and Engineering 300

Science and Engineering Pedagogy: Read Less [-]

## MAT SCI 375B Supervised Teaching of Materials Science and Engineering 1 Unit

Terms offered: Prior to 2007

Discussion and research of pedagogical issues. Supervised practice teaching in Materials and Science and Engineering.

Supervised Teaching of Materials Science and Engineering: Read More [+]

### Rules & Requirements

**Prerequisites:** Graduate standing and appointment, or interest in appointment, as a graduate student instructor

### Hours & Format

**Fall and/or spring:** 15 weeks - 1-2 hours of seminar per week

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/Professional course for teachers or prospective teachers

**Grading:** Offered for satisfactory/unsatisfactory grade only.

**Formerly known as:** Material Science and Engineering 300

Supervised Teaching of Materials Science and Engineering: Read Less [-]

## MAT SCI 601 Individual Study for Master's Students 1 - 8 Units

Terms offered: Spring 2024, Spring 2023, Spring 2022

Individual study for the comprehensive or language requirements in consultation with the field adviser.

Individual Study for Master's Students: Read More [+]

### Rules & Requirements

**Prerequisites:** Graduate standing in engineering

**Credit Restrictions:** Course does not satisfy unit or residence requirements for master's degree.

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1-8 hours of independent study per week

### Additional Details

**Subject/Course Level:** Materials Science and Engineering/Graduate examination preparation

**Grading:** Offered for satisfactory/unsatisfactory grade only.

Individual Study for Master's Students: Read Less [-]

## **MAT SCI 602 Individual Study for Doctoral Students 1 - 8 Units**

Terms offered: Spring 2024, Spring 2023, Spring 2022

Individual study in consultation with the major field adviser, intended to provide an opportunity for qualified students to prepare themselves for the various examinations required of candidates for the Ph.D. (and other doctoral degrees).

Individual Study for Doctoral Students: [Read More](#) [+]

### **Rules & Requirements**

**Prerequisites:** Graduate standing in engineering

**Credit Restrictions:** Course does not satisfy unit or residence requirements for doctoral degree.

**Repeat rules:** Course may be repeated for credit without restriction.

### **Hours & Format**

**Fall and/or spring:** 15 weeks - 0 hours of independent study per week

### **Additional Details**

**Subject/Course Level:** Materials Science and Engineering/Graduate examination preparation

**Grading:** Offered for satisfactory/unsatisfactory grade only.

Individual Study for Doctoral Students: [Read Less](#) [-]