Department of Materials Science and Engineering

The Department of Materials Science and Engineering offers three graduate degree programs: the Master of Engineering (MEng), the Master of Science (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.

For students wishing to concentrate in the areas of Materials for Energy Systems, Structural Materials, and Opto-Electronic Materials, the faculty have identified specific courses that would be particularly relevant. However, these "Concentrations" are suggestions only. Students are encouraged to select electives that best satisfy their specific educational objectives.

Prospective students will be engineers, typically with industrial experience, who aspire to substantially advance in their careers and ultimately to lead large, complex organizations, including governments.

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.

Master of Science (MS)

The MS degree is designed for students with a BS in engineering, or physical, biological, or earth science. The emphasis in this program is on technical, sociological, economic and environmental problems involved in the design, construction, and operation of engineering structures, processes and equipment.

Doctor of Philosophy (PhD)

Students pursuing the PhD may also declare a Designated Emphasis (DE) in one of the following: 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

Uniform minimum requirements for admission

The following minimum requirements apply to all programs and will be verified by the Graduate Division:

1. A bachelor's degree or recognized equivalent from an accredited institution;
2. A minimum grade-point average of B or better (3.0);
3. If the applicant comes from a country or political entity (e.g. Quebec) where English is not the official language, adequate proficiency in English to do graduate work, as evidenced by a TOEFL score of at least 570 on the paper-and-pencil test, 230 on the computer-based test, 90 on the iBT test, or an IELTS Band score of at least 7 (note that individual programs may set higher levels for any of these); and
4. Enough undergraduate training to do graduate work in the given field.

Applicants who already hold a graduate degree

The Graduate Council views academic degrees as evidence of broad research training, not as vocational training certificates; therefore, applicants who already have academic graduate degrees should be able to take up new subject matter on a serious level without undertaking a graduate program, unless the fields are completely dissimilar.

Programs may consider students for an additional academic master's or professional master's degree if the additional degree is in a distinctly different field.

Applicants admitted to a doctoral program that requires a master's degree to be earned at Berkeley as a prerequisite (even though the applicant already has a master's degree from another institution in the same or a closely allied field of study) will be permitted to undertake the second master's degree, despite the overlap in field.

The Graduate Division will admit students for a second doctoral degree only if they meet the following guidelines:

1. Applicants with doctoral degrees may be admitted for an additional doctoral degree only if that degree program is in a general area of knowledge distinctly different from the field in which they earned their original degree. For example, a physics PhD could be admitted to a doctoral degree program in music or history; however, a student with a doctoral degree in mathematics would not be permitted to add a PhD in statistics.
2. Applicants who hold the PhD degree may be admitted to a professional doctorate or professional master's degree program if there is no duplication of training involved.

Applicants may only apply to one single degree program or one concurrent degree program per admission cycle.

Any applicant who was previously registered at Berkeley as a graduate student, no matter how briefly, must apply for readmission, not admission, even if the new application is to a different program.

Required documents for admissions applications

1. **Transcripts:** Upload unofficial transcripts with the application for the departmental initial review. Official transcripts of all college-level work will be required **if admitted**. Official transcripts must be in sealed envelopes as issued by the school(s) you have attended. Request a current transcript from every post-secondary school that you have attended, including community colleges, summer sessions, and extension programs.
   If you have attended Berkeley, upload unofficial transcript with the application for the departmental initial review. Official transcript with evidence of degree conferral ***will not*** be required if admitted.

2. **Letters of recommendation:** Applicants can request online letters of recommendation through the online application system. Hard copies of recommendation letters must be sent directly to the program, not the Graduate Division.

3. **Evidence of English language proficiency:** All applicants from countries in which the official language is not English are required to submit official evidence of English language proficiency. This requirement applies to applicants from Bangladesh, Burma, Nepal, India, Pakistan, Latin America, the Middle East, the People's Republic of China, Taiwan, Japan, Korea, Southeast Asia, and most European countries. However, applicants who, at the time of application, have already completed at least one year of full-time academic course work with grades of B or better at a U.S. university may submit an official transcript from the U.S. university to fulfill this requirement. The following courses will not fulfill this requirement: 1) courses in English as a Second Language, 2) courses conducted in a language other than English, 3) courses that will be completed after the application is submitted, and 4) courses of a non-academic nature. If applicants have previously been denied admission to Berkeley on the basis of their English language proficiency, they must submit new test scores that meet the current minimum from one of the standardized tests.

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
Select one of the following in Structure & Bonding:		3
MAT SCI 201B	Course Not Available	
MAT SCI 202	Crystal Structure and Bonding	
MAT SCI 215	Computational Materials Science	
Materials Characterization:		
MAT SCI 204	Theory of Electron Microscopy and X-Ray Diffraction	2-3
or MAT SCI 241	Electron Microscopy Laboratory	
Select one of the following in Material Properties:		3-4
MAT SCI 205	Defects in Solids	
MAT SCI C212	Deformation and Fracture of Engineering Materials	
MAT SCI 213	Environmental Effects on Materials Properties and Behavior	
MAT SCI 223	Semiconductor Materials	
MAT SCI 224	Magnetism and Magnetic Materials	
MAT SCI C225	Thin-Film Science and Technology	
MAT SCI 251	Polymer Surfaces and Interfaces	
MAT SCI 260	Surface Properties of Materials	
Select one of the following in Materials Processing:		3-4
MAT SCI 121	Metals Processing	
MAT SCI C216	Macromolecular Science in Biotechnology and Medicine	
MAT SCI 221	Course Not Available	
MAT SCI 223	Semiconductor Materials	
MAT SCI 224	Magnetism and Magnetic Materials	
MAT SCI C225	Thin-Film Science and Technology	
MAT SCI 251	Polymer Surfaces and Interfaces	
Teaching Pedagogy:		
MAT SCI 375A	Science and Engineering Pedagogy	1-2
or MAT SCI 375B	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 6 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;
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 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 on 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 Group Studies, Seminars, or Group Research-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 Individual Study or Research 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 Advisor.

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 Individual Study or Research. The remaining 12 units may be graded upper division or graduate courses approved by the major field advisor.

Curriculum

Courses Required

Thermodynamics:		
MAT SCI 201A	Thermodynamics and Phase Transformations in Solids	4
Structure & Bonding:		
MAT SCI 202	Crystal Structure and Bonding	3
or MAT SCI 215	Computational Materials Science	
Materials Characterization:		
MAT SCI 204	Theory of Electron Microscopy and X-Ray Diffraction	2-3
or MAT SCI 241	Electron Microscopy Laboratory	
Select one of the following in Materials Properties:		3-4
MAT SCI 205	Defects in Solids	
MAT SCI C212	Deformation and Fracture of Engineering Materials	
MAT SCI 213	Environmental Effects on Materials Properties and Behavior	
MAT SCI 223	Semiconductor Materials	
MAT SCI 224	Magnetism and Magnetic Materials	
MAT SCI C225	Thin-Film Science and Technology	
MAT SCI 251	Polymer Surfaces and Interfaces	
MAT SCI 260	Surface Properties of Materials	
Select one of the following in Materials Processing:		3-4
MAT SCI 121	Metals Processing	
MAT SCI C216	Macromolecular Science in Biotechnology and Medicine	
MAT SCI 221	Course Not Available	
MAT SCI 223	Semiconductor Materials	
MAT SCI 224	Magnetism and Magnetic Materials	
MAT SCI C225	Thin-Film Science and Technology	
MAT SCI 251	Polymer Surfaces and Interfaces	
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 on 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 advisor 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/Comprehensive Exam (Plan II)

Students are required to pass a comprehensive examination. This requirement is waived for students who have passed the preliminary examination. For those students who chose not to take the preliminary examination, the major field advisor will appoint a committee of two departmental faculty members to administer the comprehensive examination.

At least a month before the student intends to graduate, a project report based on MAT SCI 299 Individual Study or Research 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; and 5 semester units in the capstone project units.

Curriculum

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

General Program Concentration

Technical Electives I		
Select one of the following:		3
MAT SCI 201A	Thermodynamics and Phase Transformations in Solids	
MAT SCI 204	Theory of Electron Microscopy and X-Ray Diffraction	
MAT SCI 215	Computational Materials Science	
MAT SCI 223	Semiconductor Materials	
MAT SCI 224	Magnetism and Magnetic Materials	
MAT SCI C226	Photovoltaic Materials; Modern Technologies in the Context of a Growing Renewable Energy Market	
MAT SCI 251	Polymer Surfaces and Interfaces	
Technical Electives II & III		
Select two of the following:		6-7
MAT SCI 202	Crystal Structure and Bonding	
MAT SCI 205	Defects in Solids	
MAT SCI C212	Deformation and Fracture of Engineering Materials	
MAT SCI 213	Environmental Effects on Materials Properties and Behavior	
MAT SCI C216	Macromolecular Science in Biotechnology and Medicine	
MAT SCI 221	Course Not Available	
MAT SCI C225	Thin-Film Science and Technology	

Materials for Advanced Energy Systems Concentration

Technical Electives I		
Select one of the following:		3
MAT SCI 201A	Thermodynamics and Phase Transformations in Solids	
MAT SCI 204	Theory of Electron Microscopy and X-Ray Diffraction	
MAT SCI 226C	Course Not Available	
Technical Electives II & III		
Select two of the following:		6-7
MAT SCI 202	Crystal Structure and Bonding	
MAT SCI 221	Course Not Available	
MAT SCI C225	Thin-Film Science and Technology	

Materials for Advanced Structural Materials Concentration

Technical Electives I		
Select one of the following:		3
MAT SCI 201A	Thermodynamics and Phase Transformations in Solids	
MAT SCI 204	Theory of Electron Microscopy and X-Ray Diffraction	
MAT SCI 215	Computational Materials Science	
Technical Electives II & III		
Select 6-7 units of the following:		6-7
MAT SCI 202	Crystal Structure and Bonding	
MAT SCI 205	Defects in Solids	
MAT SCI C212	Deformation and Fracture of Engineering Materials	

Advances in Opto-Electronic Materials Concentration

Technical Electives I		
Select one of the following:		3
MAT SCI 201A	Thermodynamics and Phase Transformations in Solids	
MAT SCI 223	Semiconductor Materials	
MAT SCI 224	Magnetism and Magnetic Materials	
Technical Electives II & III		
Select 6-7 units of the following:		6-7
MAT SCI 202	Crystal Structure and Bonding	
MAT SCI C225	Thin-Film Science and Technology	

Capstone/Master's Project (Plan II)

Your team capstone project analyzes and addresses an industry challenge to integrate the core curriculum with your technical coursework.

Materials Science and Engineering

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

MAT SCI 201A Thermodynamics and Phase Transformations in Solids 4 Units
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.
Rules & Requirements

Prerequisites: 102, 103, Engineering 115, or consent of instructor. 201A is 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.

MAT SCI 202 Crystal Structure and Bonding 3 Units
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.
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: Chrzan

MAT SCI 204 Theory of Electron Microscopy and X-Ray Diffraction 3 Units
Basic principles of techniques used in the characterization of engineering materials by electron microscopy, diffraction, and spectroscopy; emphasis on detailed analysis of defects responsible for materials properties. Modern electrical, optical and particle beam techniques for characterization of bulk single crystals and their crystalline and amorphous layers. Examples Hall effect, Deep Level Transient Spectroscopy, IR-Spectroscopy.
Rules & Requirements

Prerequisites: 102, 103 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.

Instructors: Gronsky, Minor

MAT SCI 205 Defects in Solids 3 Units
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.
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

MAT SCI C208 Biological Performance of Materials 4 Units
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.
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: Engineering 45; Chemistry C130/Molecular and Cell Biology C100A or Engineering 115 or equivalent; Bioengineering 102 and 104 recommended

Hours & Format

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

MAT SCI C211 Mechanics of Solids 3 Units
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.
Rules & Requirements

Prerequisites: Graduate standing or consent of instructor

Credit Restrictions: Students will receive no credit for 231 after taking 231A or 231B prior to Fall 1992.

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

MAT SCI C212 Deformation and Fracture of Engineering Materials 4 Units
This course covers deformation and fracture behavior of engineering materials for both monotonic and cyclic loading conditions.
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

Also listed as: MEC ENG C225

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

MAT SCI C214 Micromechanics 3 Units
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.
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

MAT SCI 215 Computational Materials Science 3 Units
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.
Rules & Requirements

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

Hours & Format

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

Additional Details

Subject/Course Level: Materials Science and Engineering/Graduate

Grading: Letter grade.

Instructor: Chrzan

MAT SCI C216 Macromolecular Science in Biotechnology and Medicine 4 Units
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.
Rules & Requirements

Prerequisites: Bioengineering 115 or equivalent; 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

MAT SCI 223 Semiconductor Materials 3 Units
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.
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

MAT SCI 224 Magnetism and Magnetic Materials 3 Units
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.
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.

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

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

MAT SCI 241 Electron Microscopy Laboratory 2 Units
Basic techniques and operations of transmission, and scanning, electron microscopy; x-ray microanalysis, energy loss spectroscopy; specimen preparation, interpretation of data; individual projects in materials science.
Rules & Requirements

Prerequisites: 204 (can be taken concurrently)

Hours & Format

Fall and/or spring: 15 weeks - 6 hours of laboratory per week

Additional Details

Subject/Course Level: Materials Science and Engineering/Graduate

Grading: Letter grade.

Instructors: Gronsky, Minor

MAT SCI C250 Nanomaterials in Medicine 3 Units
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.
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

MAT SCI 251 Polymer Surfaces and Interfaces 3 Units
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.
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

MAT SCI 260 Surface Properties of Materials 3 Units
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.
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

MAT SCI C261 Introduction to Nano-Science and Engineering 3 Units
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.
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 when topic changes.

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

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

MAT SCI C287 Computational Design of Multifunctional/Multiphysical Composite Materials 3 Units
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.
Rules & Requirements

Prerequisites: An undergraduate degree in the applied sciences or 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.

Instructor: Zohdi

Also listed as: MEC ENG C202

MAT SCI 290A Special Topics in Materials Science 3 Units
Lectures and appropriate assignments on fundatmental or applied topics of current interest in materials science and engineering.
Rules & Requirements

Prerequisites: Graduate standing

Repeat rules: Course may be repeated for credit when topic changes.

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

MAT SCI 290M Special Problems in Materials Science 3 Units
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.
Rules & Requirements

Prerequisites: 201A-201B or consent of instructor

Repeat rules: Course may be repeated for credit when topic changes.

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

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

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

MAT SCI 298 Group Studies, Seminars, or Group Research 1 - 8 Units
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.
Rules & Requirements

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

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.

MAT SCI 299 Individual Study or Research 1 - 12 Units
Individual investigation of advanced materials science problems.
Rules & Requirements

Prerequisites: Graduate standing in engineering

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

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.

MAT SCI 375A Science and Engineering Pedagogy 2 Units
Discussion and research of pedagogical issues. Supervised practice teaching in materials science and engineering.
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

MAT SCI 375B Supervised Teaching of Materials Science and Engineering 1 Unit
Disucssion and research of pedagogical issues. Supervised practice teaching in Materials and Science and Engineering.
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

MAT SCI 601 Individual Study for Master's Students 1 - 8 Units
Individual study for the comprehensive or language requirements in consultation with the field adviser.
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. Course may be repeated for credit when topic changes.

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.

MAT SCI 602 Individual Study for Doctoral Students 1 - 8 Units
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).
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. Course may be repeated for credit when topic changes.

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.