MATERIALS SCIENCE AND ENGINEERING (MSE)

MSE 099 Undergraduate Research and/or Independent Study
An opportunity for the student to become closely associated with a professor (1) in a research effort to develop research skills and technique and/or (2) to develop a program of independent in-depth study in a subject area in which the professor and student have a common interest. The challenge of the task undertaken must be consistent with the student's academic level. To register for this course, the student and professor jointly submit a detailed proposal to the undergraduate curriculum chairman no later than the end of the first week of the term. Note: a maximum of 2 c.u. of MSE 099 may be applied toward the B.A.S. or B.S.E. degree requirements.
One-term course offered either term
Activity: Independent Study
1 Course Unit
Notes: Open to all students

MSE 215 Introduction to Functional Materials: From Macro to Nanoscale
The purpose of this course is: 1) to introduce key concepts underlying the design, properties and processing of functional materials and their applications, and 2) to apply these concepts in the rapidly growing field of nanomaterials and nanotechnology. Fundamental chemical and physical principles underlying electronic, dielectric, optical and magnetic properties will be developed in the context of metals, semiconductors, insulators, crystals, glasses, polymers and ceramics. Miniaturization and the nanotechnology revolution confronts materials science with challenges and opportunities. Examples in which nanoscale materials exhibit qualitatively different properties compared to bulk will be emphasized.
Course usually offered in spring term
Prerequisite: MSE 221
Activity: Lecture
1 Course Unit

MSE 220 Introduction to Materials Science and Engineering
The course is an introduction to the most important concepts in materials science and engineering with a goal of building the foundations for all other courses related to materials and how to think about materials in other areas of engineering and the physical sciences. It covers atomic bonding, crystal structure and symmetry, glasses, defects, diffusion, elasticity, plasticity, fracture, phase diagrams, phase transformations, and an introduction into thermal, electrical, magnetic and optical properties and materials processing. Material classes will include metals, ceramics, polymers, semiconductors, and composites.
Course usually offered in fall term
Also Offered As: MEAM 220
Prerequisite: PHYS 140 or MEAM 110
Corequisites: PHYS 141 and MATH 240
Activity: Lecture
1 Course Unit

MSE 221 Quantum Physics of Materials
This course develops the background in basic physics required to understand the behavior of electrons in atoms, molecules and solids. Beginning with experiments and ideas that led to the foundation and postulates of Quantum Mechanics, the behavior of an electron in simple potential wells is treated. The electron in a harmonic oscillator well and the Coulomb potential of a hydrogen atom are treated next. Pauli's exclusion principle and generalization to multi-particle systems are introduced. The Fermi energy, density of states and free electron band structure will be introduced. Many state-of-the-art materials analysis techniques will also be demonstrated throughout the course.
One-term course offered either term
Prerequisites: PHYS 140, 141 concurrent and MATH 240
Activity: Lecture
1 Course Unit
Notes: Meets Natural Science Requirement

MSE 250 Nano-scale Materials Lab
In this class you will learn laboratory methods used to synthesize materials, to examine the structure of materials, to measure electrical, mechanical and thermal properties, and to investigate the relationships between processing, structure and properties. Emphasis is placed on laboratory skills, technical understanding, and technical communications (figures, writing). The laboratory exercises involve: 1) learning how to use state of the art equipment for studying the properties and internal structure of materials, 2) qualitative and quantitative interpretation of data and observations, and 3) the development of analytical skills necessary to form general and fundamental conclusions from observations and data. This course focuses on how materials' structure and chemistry can be controlled to tailor properties and how properties of nanoscale materials can differ significantly from their bulk counterparts.
Course usually offered in spring term
Prerequisite: MSE 220
Activity: Lecture
1 Course Unit

MSE 260 Energetics of Macro and Nano-scale Materials
Basic principles of chemical thermodynamics as applied to macro and nano-sized materials. This course will cover the fundamentals of classical thermodynamics as applied to the calculation and prediction of phase stability, chemical reactivity and synthesis of materials systems. The size-dependent properties of nano-sized systems will be explored through the incorporation of the thermodynamic properties of surfaces. The prediction of the phase stability of two and three component systems will be illustrated through the calculation and interpretation of phase diagrams for metallic, semiconductor, inorganic systems.
Course usually offered in spring term
Prerequisite: CHEM 102
Activity: Lecture
1 Course Unit

MSE 296 Introduction To Negotiation
Activity: Lecture
1 Course Unit

MSE 330 Self-Assembly of Soft Materials
Soft matter is found in diverse applications including sports (helmets & cloths); food (chocolate, egg); consumer products (e.g., lotions and shampoo); and devices (displays, electronics). Whereas solids and liquids are typically hard and crystalline or soft and fluid, respectively, soft matter can exhibit both solid and liquid like behavior. In this class, we investigate the thermodynamic and dynamic principles common to soft matter as well as soft (weak) forces, self-assembly and phase behavior. Classes of matter include colloidal particles, polymers, liquid crystalline molecules, amphiphilic molecules, biomacromolecules/membranes, and food. Active learning activities will be included.
Course usually offered in fall term
Also Offered As: BE 330
Prerequisites: CHEM 102 or equivalent; MSE 220 or BE 220 or introductory physical chemistry course.
Activity: Lecture
1 Course Unit

MSE 360 Structure at the Nanoscale
To understand the atomic arrangements of crystalline matter, this class focuses on crystallography, symmetry, and diffraction techniques. The first half focuses on learning how to describe the structure of crystalline matter through the basics of crystallography and symmetry by introducing two-dimensional symmetry operations, point, and plane groups; this knowledge is then extended into three-dimensions to arrive at an understanding of space lattices and space groups. The second half is concerned with applying this information to understand structures through various diffraction and microscopy techniques.
Course usually offered in fall term
Activity: Lecture
1 Course Unit

MSE 393 Materials Selection
Throughout mankind's history, materials have played a critical role in civilization and technology. The selection of materials has been based on availability and functionality. The rapid advances of materials technologies in the last 150 years, however, have made nearly all classes and forms of materials available, at a cost. These costs include the dollars and cents costs that typically accompany the use of stronger, lighter materials, but environmental costs are also important and significant. Therefore, in theory at least, materials selection can now proceed on a rational basis as an optimization process involving performance and costs - both financial and environmental. In this course, we will focus on structural applications where mechanical design is central. By the end of the course, the students can expect to acquire a level of engineering familiarity with a broad range of materials, and be prepared to undertake responsible material design projects in the future.
Course usually offered in spring term
Prerequisites: MSE 220, Junior standing or approval of the insturctor
Activity: Lecture
1 Course Unit

MSE 405 Mechanical Behavior of Macro/Nanoscale Materials
The application of continuum and microstructural concepts to elasticity and plasticity and the mechanisms of plastic flow and fracture in metals, polymers and ceramics. Topics covered include elasticity, viscoelasticity, plasticity, crystal defects, strengthening, crystallographic effects, twinning, creep and fatigue. Emphasis will be on mathematical and physical understanding rather than problem solving.
Course usually offered in spring term
Also Offered As: MEAM 405, MEAM 505, MSE 505
Prerequisites: MSE 220 and/or MEAM 210 or the equivalent background, MATH 240 or equivalent
Activity: Lecture
1 Course Unit

MSE 430 Polymers and Biomaterials
Polymer is one of the most widely used materials in our daily life, from the rubber tires to clothes, from photoresists in chip manufacturing to flexible electronics and smart sensors, from Scotch tapes to artificial tissues. This course teaches entry-level knowledge in polymer synthesis, characterization, thermodynamics, and structure-property relationship. Emphasis will be on understanding both chemical and physical aspects of polymers, polymer chain size and molecular interactions that drive the microscopic and macroscopic structures and the resulting physical properties. We will discuss how to apply polymer designs to advance nanotechnology, electronics, energy and biotechnology. Case studies include thermodynamics of block copolymer thin films and their applications in nanolithography, shape memory polymers, hydrogels, and elastomeric deformation and applications.
Course usually offered in fall term
Also Offered As: CBE 430, CBE 510, MSE 580
Prerequisites: MSE 260 or equivalent course in Thermodynamics or Physical Chemistry (such as CBE 231, CHEM 221, MEAM 203)
Activity: Lecture
1 Course Unit

MSE 440 Phase Transformations
The state of matter is dependent upon temperature, thermal history, and other variables. In this course the science of structural transitions is treated, with the purpose in mind of utilizing them for producing materials with superior properties. The subjects covered include the methods of structural analysis, solidification, solid state transformation, and order-disorder transition.
Course usually offered in spring term
Prerequisites: MSE 220, MSE 260, or equivalent or permission of the instructor
Activity: Lecture
1 Course Unit

MSE 455 Electrochemical Engineering of Materials
After introducing electrochemical concepts (redox reactions, electrolytic versus galvanic cells, standard oxidation potentials), this course will cover the broad impact of electrochemical phenomena on materials. Topics that will be discussed include: (1) Materials extraction from their ores to finished products by electrowinning, (2) Chemical refining (Mond process) and electrorefining of materials, (3) Materials degradation by destructive electrochemical corrosion, (4) Three-dimensional nanostructured materials by selective electrochemical corrosion, (5) Enhancing the electrochemical performance of materials via nanostructuring - e.g. lithium-ion battery electrodes; (6) Enhancing the electrochemical performance of materials via surface chemistry - e.g. oxygen evolution electrocatalysts; (7) Light-enhanced electrochemical performance of materials - e.g. solar water splitting photoelectrocatalysts. Students will be engaged in interactive classroom activities.
Course usually offered in fall term
Also Offered As: MSE 555
Activity: Lecture
1 Course Unit

MSE 460 Computational Materials Science
This course provides an introduction to modeling and simulation in materials science, covering continuum methods (e.g. finite element methods) and atomistic and molecular simulation (e.g. molecular dynamics). These tools play an increasingly important role in modern engineering. You will get hands-on training in both the fundamentals and applications of these methods to key engineering problems. The lectures will provide an exposure to areas of application, based on the scientific exploitation of the power of computation. We will use software packages (Comsol and LAMMPS) and thus extensive programming skills are not required. Matlab background needed for the course will be covered in a self-contained module.
One-term course offered either term
Prerequisites: Junior or Senior Standing. Ability to write simple computer codes would be an advantage.
Activity: Lecture
1 Course Unit

MSE 465 Fabrication and Characterization of Micro and Nanostructured Devices
This course surveys various processes that are used to produce materials structured at the micron and nanometer scales for electronic, optical and biological applications. Basic principles of materials chemistry, physics, thermodynamics and surface/interfacial science are applied to solid state, liquid, and colloidal approaches to making materials. A wide range of nano- and microfabrication techniques, including photolithography, soft lithography, nanoimprint lithography, 3D printing and self-assembly, are covered. The course is heavily lab based, with 30% of class time and 50% of the homework devoted to hands on experiences and lab report writing. Lab assignments are a series of structured individual/group projects. Evaluation is based on 3 lab reports, 4 problem sets with journal paper reading assignment, and a final project design.
Course usually offered in spring term
Also Offered As: MSE 565
Activity: Lecture
1 Course Unit

MSE 495 Senior Design
The senior design course is a two-semester capstone program that gives students the opportunity to design and execute an original experimental or theoretical project in materials science, engineering, or product/device development that is solving a real world problem. Students will work closely with a scientific advisor in their lab and meet once a week in the classroom to learn from an innovative curriculum that will build real-world skills in the context of their research and design project. These skills include project management, networking, teamwork, impactful written and verbal communications, upward management, self-reflection and feedback. Students will also learn how to design research in the context of having an impact on the world. This will be through weekly vignettes of innovative materials science solutions that solve problems in industries ranging from construction to healthcare to consumer products.
Course usually offered in fall term
Activity: Lecture
1 Course Unit

MSE 496 Senior Design
The senior design course is a two-semester capstone program that gives students the opportunity to design and execute an original experimental or theoretical project in materials science, engineering, or product/device development that is solving a real world problem. Students will work closely with a scientific advisor in their lab and meet once a week in the classroom to learn from an innovative curriculum that will build real-world skills in the context of their research and design project. These skills include project management, networking, teamwork, impactful written and verbal communications, upward management, self-reflection and feedback. Students will also learn how to design research in the context of having an impact on the world. This will be through weekly vignettes of innovative materials science solutions that solve problems in industries ranging from construction to healthcare to consumer products.
Course usually offered in spring term
Activity: Lecture
1 Course Unit

MSE 500 Experimental Methods in Materials Science
This laboratory course introduces students to a variety of experimental methods used in materials science and engineering. Hands-on training will be provided for atomic force microscopy, X-ray diffraction and scattering, mechanical testing with image capture, and dynamic light scattering. Students will use numerous software packages for data collection and analysis, as well as being introduced to LabVIEW as a method for customizing experiments. In addition, students will see demonstrations of scanning electron microscopy, transmission electron microscopy, and electron diffraction and analyze data from these methods. The format for the course will include a weekly lecture (1.5 hours), a weekly lab session (4 hours) and six assignments.
Course usually offered in fall term
Prerequisites: Permission of the Undergraduate Curriculum Chair and Instructor
Activity: Lecture
1 Course Unit

MSE 505 Mechanical Properties of Macro/Nanoscale Materials
The application of continuum and microstructural concepts to elasticity and plasticity and the mechanisms of plastic flow and fracture in metals, polymers and ceramics. Topics covered include elasticity, viscoelasticity, plasticity, crystal defects, strengthening, crystallographic effects, twinning, creep and fatigue. Emphasis will be on mathematical and physical understanding rather than problem solving.
Course usually offered in spring term
Also Offered As: MEAM 405, MSE 405
Activity: Lecture
1 Course Unit

MSE 507 Fundamentals of Materials
This course will provide a graduate level introduction to the science and engineering of materials. It is designed specifically to meet the needs of students who will be doing research that involves materials but who do not have an extensive background in the field. The focus is on fundamental aspects of materials science and will emphasize phenomena and how to describe them.
One-term course offered either term
Also Offered As: MEAM 507
Activity: Lecture
1 Course Unit

MSE 515 Mathematics for Materials Science
Covers mathematics encountered in various problems encountered in materials science: Complex analysis, analytic functions and use in evaluation of definite integrals. Fourier and Laplace transforms (used in diffraction and when solving differential equations). Linear transformations and tensors (continuum analyses of elastic, electric, etc. properties of crystals). Sturm-Liouville theory of linear differential operators (mathematics of quantum mechanics). Partial differential equations (wave, Laplace and diffusion equation).
Course usually offered in fall term
Activity: Lecture
1 Course Unit

MSE 520 Structure of Materials
Crystal structure and bonding. Symmetry: line, plane, point, and space groups. Symmetry considerations in structure-property relations. Physical optics, diffraction as Fourier transforms. Effects of size, shape, temperature and distortion on diffraction intensity. Diffraction of gas, liquid, fibers, and DNA. Diffuse scattering, order/disorder. Pair distribution function, inverse problem, small angle scattering. Radiation-matter interaction, scattering physics, atomic and electronic spectroscopy.
Course usually offered in spring term
Prerequisites: Permission of the Undergraduate Curriculum Chair and Instructor
Activity: Lecture
1 Course Unit

MSE 525 Nanoscale Science and Engineering
Overview of existing device and manufacturing technologies in microelectronics, optoelectronics, magnetic storage, Microsystems, and biotechnology. Overview of near- and long-term challenges facing those fields. Near- and long-term prospects of nanoscience and related technologies for the evolutionary sustension of current approaches, and for the development of revolutionary designs and applications.
Course usually offered in fall term
Also Offered As: ESE 525
Prerequisites: ESE 218 or PHYS 240 or MSE 220 or equivalent, or by permission
Activity: Lecture
1 Course Unit

MSE 530 Thermodynamics and Phase Equilibria
Fundamental elements of engineering thermodynamics, statistical thermodynamics, chemical thermodynamics and defect thermodynamics. Thermodynamic functions, stability, phase transitions, mixtures (gases, condensed matter, polymer solution), defects and interfaces. Phase diagrams and predominance diagrams. Applications to energy problems (engines, efficiency, power, electrochemical cells) and properties (Curie's law, rubber elasticity, specific heat, phonon/photon spectra, constitutive equations, equation of states).
Course usually offered in fall term
Prerequisites: Permission of the Undergraduate Curriculum Chair and Instructor
Activity: Lecture
1 Course Unit

MSE 536 Electronic Properties of Materials
This course will introduce the physical principles underlying broad spectrum of electronic properties in the solid state. Starting with the band structure of solids, the course will give an overview of electronic, dielectric, magnetic, thermal and optical properties of materials. The treatment will use quantum mechanical and statistical mechanical concepts familiar to students at the undergraduate level. Commonly used theories and models will be introduced and their predictions will be compared with observations. Students who have taken MSE 221/MSE 260 and/or MSE 570/MSE 575 will benefit from this advanced introduction to material properties.
Course usually offered in spring term
Activity: Lecture
1 Course Unit

MSE 537 Nanotribology
Engineering is progressing to ever smaller scales, enabling new technologies, materials, devices, and applications. This course will provide an introduction to nano-scale tribology and the critical role it plays in the developing areas of nanoscience and nanotechnology. We will discuss how contact, adhesion, friction, lubrication, and wear at interfaces originate, using an integrated approach that combines concepts of mechanics, materials science, chemistry, and physics. We will cover a range of concepts and applications, drawing connections to both established and new approaches. We will discuss the limits of continuum mechanics and present newly developed theories and experiments tailored to describe micro- and nano-scale phenomena. We will emphasize specific applications throughout the course. Reading of scientific literature, critical peer discussion, individual and team problem assignments, and a peer-reviewed literature research project will be assigned as part of the course.
Taught by: Faculty
One-term course offered either term
Also Offered As: MEAM 537
Prerequisites: Freshman physics; MEAM 354 or equivalent, or consent of instructor.
Activity: Lecture
1 Course Unit

MSE 540 Phase Transformations
The phase of a material determines macroscopic properties such as strength, diffusion, and permeability. Whereas thermodynamics provides an idealistic understanding of phase behavior, the real phase (composition) and morphology of a solid material depends on the rate of transformation from one state to another. Namely, kinetics is the study of the rates at which systems approach the ideal state predicted by thermodynamics. Thus, transport/diffusion underlies our understanding of phase transformations. Technology applications will include, polymer nanocomposites as kinetically arrested materials, rapid solidification to create new materials, purification methods for integrated circuits, and drug delivery.
Course usually offered in spring term
Prerequisites: Permission of the Undergraduate Curriculum Chair and Instructor
Activity: Lecture
1 Course Unit

MSE 545 Materials for Energy and Environmental Sustainability
This course will cover the fundamental materials science issues central to the design of sustainable energy technology. The goal of this course is to expose students to the emerging advances in materials science and materials chemistry that underpin technologies for energy conversion (fuel cells, thermoelectrics, photovoltaics, wind energy etc..), storage (biofuels, artificial photosynthesis, batteries etc) and distribution (smart grids and hydrogen and methane economy concepts etc..) and to place these in a real world context. This class will emphasize concepts in "green materials and green engineering practices" that are emerging with a global focus on "Sustainable Technology." "Sustainability is defined as meeting the needs of the present without compromising the ability of future generations to meet their needs." Engineering materials and processes at all scales; molecular/nanometer, micro, and the macro-scale are critical to developing the tools society required to meet the growing needs for energy and sustainable materials for the built environment. This course is appropriate for graduate students and advanced undergraduates in Penn's Material Science Programs. Core MSE curriculum components in thermodynamics, structure, electronic & ionic transport, mechanics, polymers and optical materials will be expected, and exposure to the preparation in basic Chemistry and Physics will be advantageous in this highly interdisciplinary course.
Course usually offered in fall term
Activity: Lecture
1 Course Unit

MSE 550 Elasticity and Micromechanics of Materials
This course is targeted to engineering students working in the areas on micro/nanomechanics of materials. The course will start with a quick review of the equations of linear elasticity and proceed to solutions of specific problems such as the Hertz contact problem, Eshelby's problem, etc. Failure mechanisms such as fracture and the fundamentals of dislocations/plasticity will also be discussed.
Taught by: Vitek
Course usually offered in fall term
Also Offered As: MEAM 519
Prerequisites: Permission of the Undergraduate Curriculum Chair and Instructor
Activity: Lecture
1 Course Unit

MSE 555 Electrochemical Engineering of Materials
After introducing electrochemical concepts (redox reactions, electrolytic versus galvanic cells, standard oxidation potentials), this course will cover the broad impact of electrochemical phenomena on materials. Topics that will be discussed include: (1) Materials extraction from their ores to finished products by electrowinning, (2) Chemical refining (Mond process) and electrorefining of materials, (3) Materials degradation by destructive electrochemical corrosion, (4) Three-dimensional nanostructured materials by selective electrochemical corrosion, (5) Enhancing the electrochemical performance of materials via nanostructuring - e.g. lithium-ion battery electrodes; (6) Enhancing the electrochemical performance of materials via surface chemistry - e.g. oxygen evolution electrocatalysts; (7) Light-enhanced electrochemical performance of materials - e.g. solar water splitting photoelectrocatalysts. Students will be engaged in interactive classroom activities.
Course usually offered in fall term
Also Offered As: MSE 455
Activity: Lecture
1 Course Unit

MSE 561 Atomic Modeling in Materials Science
This course covers two major aspects of atomic level computer modeling in materials. 1. Methods: Molecular statics, Molecular dynamics, Monte Carlo, Kinetic Monte Carlo as well as methods of analysis of the results such as radial distribution function, thermodynamics deduced from the molecular dynamics, fluctuations, correlations and autocorrelations. 2. Semi-empirical descriptions of atomic interactions: pair potentials, embedded atom method, covalent bonding, ionic bonding. Basics of the density functional theory. Mechanics, condensed matter physics, thermodynamics and statistical mechanics needed in interpretations are briefly explained.
Course usually offered in spring term
Also Offered As: MEAM 553
Prerequisites: Ability to write a basic code in a computer language such as fortran, C, C++
Activity: Lecture
1 Course Unit

MSE 565 Fabrication and Characterization of Nanostructured Devices
This course surveys various processes that are used to produce materials structured at the micron and nanometer scales for electronic, optical and biological applications. Basic principles of materials chemistry, physics, thermodynamics and surface/interfacial science are applied to solid state, liquid, and colloidal approaches to making materials. A wide range of nano- and microfabrication techniques, including photolithography, soft lithography, nanoimprint lithography, 3D printing and self-assembly, are covered. The course is heavily lab based, with 30% of class time and 50% of the homework devoted to hands on experiences and lab report writing. Lab assignments are a series of structured individual/group projects. Evaluation is based on 3 lab reports, 4 problem sets with journal paper reading assignment, and a final project design.
Course usually offered in spring term
Also Offered As: MSE 465
Prerequisite: MSE 360 or permission of the instructor
Activity: Lecture
1 Course Unit

MSE 570 Physics of Materials I
Failures of classical physics and the historical basis for quantum theory. Postulates of wave mechanics; uncertainty principle, wave packets and wave-particle duality. Schrodinger equation and operators; eigenvalue problems in 1 and 3 dimensions (barriers, wells, hydrogen, atom). Perturbation theory; scattering of particles and light. Use of computer-aided self-study will be made.
Course usually offered in fall term
Prerequisites: Undergraduate physics and math through modern physics and differential equations
Activity: Lecture
1 Course Unit

MSE 575 Statistical Mechanics
Statistical Mechanics is a unique branch of physics that permeates our understanding of matter at all length scales, from nanometers to stellar dimensions, and ranging in temperatures from pico-Kelvin (or lower) to billions of degrees Kelvin. This course will provide an overview of select topics in equilibrium and non-equilibrium statistical mechanics. The course will introduce the basic postulates of classical and quantum equilibrium statistical mechanics, explain the methodology of calculating observable properties, and discuss several applications in diverse fields. The second part of the course will introduce the methodology of non-equilibrium processes and discussing important theorems and results in the linear response regime. Finally, a brief discussion of systems far from equilibrium will be presented. Select applications from condensed matter physics, chemistry, materials science, biology, astrophysics, economics and meteorology will be used to illustrate the fundamental principles.
Course usually offered in spring term
Activity: Lecture
1 Course Unit

MSE 580 Polymers and Biomaterials
Polymer is one of the most widely used materials in our daily life, from the rubber tires to clothes, from photoresists in chip manufacturing to flexible electronics and smart sensors, from Scotch tapes to artificial tissues. This course teaches entry-level knowledge in polymer synthesis, characterization, thermodynamics, and structure-property relationship. Emphasis will be on understanding both chemical and physical aspects of polymers, polymer chain size and molecular interactions that drive the microscopic and macroscopic structures and the resulting physical properties. We will discuss how to apply polymer designs to advance nanotechnology, electronics, energy and biotechnology. Case studies include thermodynamics of block copolymer thin films and their applications in nanolithography, shape memory polymers, hydrogels, and elastomeric deformation and applications.
Course usually offered in fall term
Also Offered As: MSE 430
Prerequisites: MSE 260 or equivalent course in thermodynamics or physical chemistry (such as CBE 231, MEAM 203)
Activity: Lecture
1 Course Unit

MSE 597 Master's Thesis Research
One-term course offered either term
Activity: Masters Thesis
1 Course Unit

MSE 599 Master's Indep Study
One-term course offered either term
Activity: Independent Study
1 Course Unit

MSE 610 Transmission Electron Microscopy and Crystalline Imperfections
Theory and application of transmission electron microscopy methods to problems in materials science and engineering, condensed matter physics, soft matter, polymeric materials , inorganic chemistry and chemical engineering. The principles of microscope operation, electron scattering, image formation and spectroscopy will be described, with an emphasis on both theory and experiment. With laboratory.
Course not offered every year
Activity: Lecture
1 Course Unit

MSE 640 Optical Materials
This course discusses the optical properties of modern materials engineered for specific functionality and cover exciting new developments being made in this rapidly evolving field. Emphasis is placed on how modern nanotechnology reshapes the light-matter interaction and delivers novel optical properties that are not available in nature.
Course usually offered in spring term
Activity: Lecture
1 Course Unit

MSE 650 Mechanics of Soft and Biomaterials
This course is aimed to expose the students to a variety of topics in mechanic materials via discussion of "classic" problems that have had the widest impact long period of time and have been applied to analyze the mechanical behavior a variety of biological and engineering materials.
Course not offered every year
Also Offered As: MEAM 650
Activity: Lecture
1 Course Unit

MSE 790 Selected Topics in Materials Science and Engineering
Students should check department office for special topics.
One-term course offered either term
Activity: Lecture
1 Course Unit
Notes: Both terms

MSE 895 Teaching Practicum.
One-term course offered either term
Activity: Lecture
1 Course Unit