MATERIALS SCIENCE & ENGR (MSE)

MSE Class Schedule (https://courses.illinois.edu/schedule/DEFAULT/DEFAULT/MSE)

Courses

MSE 101 Materials in Today's World credit: 3 Hours.
Introduction to the field of materials science. Examination and demonstration of materials and their properties in the context of their use in everyday objects. Survey of the role materials have played and will continue to play in shaping society. Intended for non-engineering majors. Technical elective credit is not given to College of Engineering majors. This course satisfies the General Education Criteria for:
UIUC: Physical Sciences

MSE 182 Introduction to MatSE credit: 2 Hours.
Overview of MatSE as a basis for understanding how structure, property, and processing relationships are developed and used for different types of materials. Case studies of advances in new materials and processes illustrating the role of materials in modern society. Laboratory-discussion demonstrations and experiments. Design-team analysis or synthesis of objects that use materials creatively.

MSE 183 Freshman Materials Laboratory credit: 1 Hour.
Team-based laboratory developing concepts introduced in MSE 182. Practical descriptions of materials concepts, literature research, experimental design, concept validation, teamwork, and presentation of results. Prerequisite: MSE 182.

MSE 199 Undergraduate Open Seminar credit: 1 to 5 Hours.
May be repeated to a maximum of 5 hours. May be repeated in the same term.

MSE 201 Phases and Phase Relations credit: 3 Hours.
Understanding microstructure. Quantitative examination of phases (crystalline and non-crystalline structures) and the relationships between phases (phase diagrams). Commercial practices for producing desired microscopic phase configurations and macroscopic shapes (processing). Credit is not given for both MSE 201 and MSE 280. Prerequisite: MSE 182; credit or concurrent enrollment in CHEM 104, MATH 231 and PHYS 211.

MSE 206 Mechanics for MatSE credit: 4 Hours.
Statics, mechanics of materials, and fluid mechanics concepts pertinent to the fields of materials science and engineering: force resultants; stresses and strains produced in elastic bodies; microscopic effects of different loading states (tension, compression, torsion, and bending) on deformable bodies; beam stresses and deflections; three-dimensional stresses and strains; stress and strain-rate relationships for Newtonian and non-Newtonian fluids; conservation equations (control volume analysis) for fluid flow; Reynolds number; slow inertial and turbulent flows. Credit is not given for both MSE 206 and either TAM 251 or TAM 335. Prerequisite: MATH 225, MATH 241 and PHYS 211; credit or concurrent enrollment in CS 101 and MSE 201.

MSE 280 Engineering Materials credit: 3 Hours.
Materials science and engineering of ceramics, electronic materials, metals and polymers. Bonding; crystallography; imperfections; processing and properties of semiconductors, polymers, metals, ceramics and composites; phase diagrams. Case studies. Credit is not given for both MSE 280 and any of CEE 300, ME 330, MSE 201. Prerequisite: CHEM 102 and PHYS 211.

MSE 304 Electronic Properties of Matls credit: 3 Hours.
Electronic structure and bonding of materials, electrical conduction in metals and semiconductors, and dielectric and magnetic properties of solids. Credit is not given for both MSE 304 and PHYS 460. Prerequisite: PHYS 214.

MSE 307 Materials Laboratory I credit: 3 Hours.
Experiments using optical and scanning electron microscopy and various thermal and thermodynamic measuring techniques. Familiarization with laboratory test instruments. MSE 307 and MSE 308 are approved for General Education credit only as a sequence. Both courses must be completed to receive Advanced Composition credit. Prerequisite: Credit or concurrent registration in MSE 401 and either MSE 201 or MSE 280. This course satisfies the General Education Criteria for:
UIUC: Advanced Composition

MSE 308 Materials Laboratory II credit: 3 Hours.
Experiments characterizing mechanical, transport, and magnetic-electric properties of materials and the use optical and scanning electron microscopy and infrared spectroscopy. MSE 307 and MSE 308 are approved for General Education credit only as a sequence. Both courses must be completed to receive Advanced Composition credit. Prerequisite: MSE 307; credit or concurrent registration in MSE 304 and MSE 405. This course satisfies the General Education Criteria for:
UIUC: Advanced Composition

MSE 395 Materials Design credit: 3 Hours.
Design of various engineering devices, objects, or systems. Team-based and faculty-guided projects directed toward the development of materials-based solutions to problems originating from student, faculty, and industrial suggestions. Solutions are based on the knowledge, skills, and design experience acquired in earlier course work and incorporate engineering, sustainability, manufacturability, ethical, health and safety, social, and political concerns. Prerequisite: This course is available to engineering majors with senior standing only.

MSE 396 Introduction to Research credit: 1 to 3 Hours.
Fundamental tenets of research including an introduction to laboratory safety, constructing a hypothesis, and the design of experiments to test the hypothesis. Basics of mathematical modeling and statistical analysis of data, including the analysis of research data. Emphasis on exposure to the basic procedures comprising engineering communication and the importance of verbal and written communication. Approved for Letter and S/U grading. May be repeated in separate terms.

MSE 397 Independent Study credit: 1 to 4 Hours.
Individual study of any topic in materials science and engineering selected by the student and conducted under the supervision of a member of the faculty. May be repeated to a maximum of 4 hours. Prerequisite: Consent of instructor.

MSE 398 Special Topics credit: 1 to 4 Hours.
Subject offerings of new and developing areas of knowledge in materials science and engineering intended to augment the existing curriculum. See Class Schedule or departmental course information for topics and prerequisites. May be repeated in the same or separate terms if topics vary.

Information listed in this catalog is current as of 03/2017
MSE 401 Thermodynamics of Materials credit: 3 Hours.  
Basic thermodynamic principles including energy, entropy, and free energy; macroscopic properties of hard and soft materials systems, such as equilibrium states, phases, and phase transitions. Application of phase diagrams. Statistical interpretation of thermodynamics on the atomistic level. 3 undergraduate hours. 3 graduate hours. Credit is not given for both MSE 401 and CHEM 444 or PHYS 427. Prerequisite: MSE 201 or MSE 280; credit or concurrent registration in MATH 285.

MSE 402 Kinetic Processes in Materials credit: 3 Hours.  
Kinetics of chemical reactions; rate equations, reaction mechanisms; transport processes; diffusion equations, atomic and molecular diffusion; phase transformations; nucleation, crystallization, displacive, spinodal decomposition; surface and interface phenomena; sintering, grain growth, recovery, and recrystallization. 3 undergraduate hours. 3 graduate hours. Prerequisite: MSE 201 and MSE 401.

MSE 403 Synthesis of Materials credit: 3 Hours.  
Fundamentals of the synthesis of materials. Principles of synthesis; processes, approaches, synthetic methodology and probes; methodologies in materials synthesis; polymerization, sol-gel processes, liquid and vapor phase synthesis, materials coupling reactions, and precursor-derived, radiation-induced and asymmetric synthesis. 3 undergraduate hours. 3 graduate hours. Prerequisite: MSE 201; credit or concurrent registration in MSE 401.

MSE 404 Laboratory Studies in Materials Science and Engineering credit: 1.5 Hours.  
Experiments include direct hands-on investigations or are performed through computational approaches. Laboratory experiences include both fundamental studies as well as investigations on more applied topics. 1.5 undergraduate hours. 1.5 graduate hours. May be repeated if topics vary. Prerequisite: MSE 307 and MSE 308 or permission of instructor. Senior standing.

MSE 405 Microstructure Determination credit: 3 Hours.  
Fundamentals and applications of various forms of microscopy and diffraction for characterization of physical microstructure of materials and of various forms of spectroscopy for characterization of chemical microstructure. 3 undergraduate hours. 3 graduate hours. Prerequisite: PHYS 214, CHEM 104, MSE 201, and MSE 307.

MSE 406 Thermal-Mech Behavior of Metals credit: 3 Hours.  
Fundamentals of elastic, viscoelastic and plastic deformation of materials, elementary theory of statics and dynamics of dislocations; strengthening mechanisms; behavior of composites; fracture and fatigue behavior; fundamentals of thermal behavior: heat capacity, thermal expansion and conductivity; effects of thermal stress. 3 undergraduate hours. 3 graduate hours. Credit is not given for both MSE 406 and either ME 430 or TAM 424. Prerequisite: MSE 206; credit or concurrent registration in MSE 401.

MSE 420 Ceramic Materials & Properties credit: 3 Hours.  
Ceramic material fundamentals, emphasizing structure-property relations. Development, use, and control of the properties of a wide variety of ceramic materials from a physico-chemical point of view. 3 undergraduate hours. 3 graduate hours.

MSE 421 Ceramic Processing credit: 3 or 4 Hours.  
Microstructure development and processing of ceramic materials, with an emphasis on structure-property-processing relationships. Processing methodologies and their effects on microstructural development. Illustration and examination of several ceramic components within this context. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: MSE 420.

MSE 422 Electrical Ceramics credit: 3 Hours.  
Electrical ceramics, from insulators to conductors, and magnetic and optical materials; the role of the processing cycle and microstructure development on the design and performance of electrical components; capacitors, resistors, and inductors; structure-property relations for pyro-, piezo-, and ferroelectric materials; perovskite and spinel based structures; varistors, thermists, transducers, actuators, memory elements, multilayered components, and their applications. Design project. 3 undergraduate hours. 3 graduate hours. Prerequisite: MSE 420.

MSE 423 Ceramic Processing Laboratory credit: 3 Hours.  
Experiments and demonstrations involving a wide range of modern ceramic processing methods will be conducted to develop fundamental understanding of the relationships between raw materials, processing methods, microstructural development, and physical properties. Lab emphasis on the underlying physics and chemistry of processing and design of processing routes to achieve desired material properties. Technical reports. 3 undergraduate hours. 3 graduate hours. Prerequisite: MSE 421.

MSE 440 Mechanical Behavior of Metals credit: 3 Hours.  
Mechanical behavior of solids: crystal plasticity, dislocations, point defects and grain boundaries, creep and fatigue behavior, and fracture. 3 undergraduate hours. 3 graduate hours. Prerequisite: MSE 406.

MSE 441 Metals Processing credit: 3 Hours.  
Melt, mechanical, thermal, powder, and surface processing of metals. Extraction of metals, joining of metals, metal composites, and metal recycling. Relationships between the processing of metals, the microstructures that are produced, and the behavior of metal components. 3 undergraduate hours. 3 graduate hours. Prerequisite: MSE 406.

MSE 442 Metals Laboratory credit: 3 Hours.  
Advanced metallurgy laboratory. Effects of heat treatment; mechanical testing; oxidation and corrosion; metallography of selected alloys. 3 undergraduate hours. 3 graduate hours. Prerequisite: MSE 308, MSE 440, and MSE 441.

MSE 443 Design of Engineering Alloys credit: 3 Hours.  
Application of science and engineering principles to the design, selection, and performance of engineering alloys. Alloy classes, design, effect of alloying elements, relation to processing variables, and structure-property relationships; design project. 3 undergraduate hours. 3 graduate hours. Prerequisite: MSE 401 and MSE 402.

MSE 444 Corrosion of Metals credit: 3 or 4 Hours.  
Electrochemistry, thermodynamics, and kinetics of corrosion; behavior of ferrous and nonferrous metals; corrosion rates; corrosion control; cathodic and anodic protection; high-temperature corrosion; corrosion testing; electrolytic machining methods. 3 undergraduate hours. 3 or 4 graduate hours.

MSE 450 Polymer Science & Engineering credit: 3 or 4 Hours.  
Polymer solution properties, conformation, and molecular weight characterization. Rheological and viscoelastic behavior: relaxations and transitions, rubber elasticity. Crystalinity, morphology, and deformation of crystalline polymers. Blends and composites. Methods of fabrication. 3 undergraduate hours. 3 or 4 graduate hours.

MSE 452 Polymer Laboratory credit: 3 Hours.  
Experimental investigations of polymer synthesis, characterization (molecular, thermal, structural and electronic), processing and device fabrication. 3 undergraduate hours. 3 graduate hours. Prerequisite: MSE 450.
MSE 453  Plastics Engineering  credit: 3 Hours.
Engineering characteristics of plastics; viscoelasticity, viscosity, yield, and fracture; reinforced polymers; processing; environmental considerations; applicability of technical data sheets; design (project); current advances. 3 undergraduate hours. 3 graduate hours. Prerequisite: MSE 450.

MSE 454  Mechanics of Polymers  credit: 3 Hours.
Same as AE 427 and TAM 427. See TAM 427.

MSE 455  Macromolecular Solids  credit: 3 Hours.
Mechanical behavior of amorphous and semi-crystalline polymers; overview of polymer structure and characterization; polymer morphology; orientation effects, rubber elasticity, polymer linear viscoelasticity using Boltzmann superposition and mechanical models; measurement of viscoelastic properties; relaxation and transitions; polymeric yield phenomena and plastic flow; deformation mechanisms; fracture and craze formation; impact and fatigue. 3 undergraduate hours. 3 graduate hours. Prerequisite: MSE 450.

MSE 456  Mechanics of Composites  credit: 3 Hours.
Behavior of composite materials and their use in engineering structures: behavior and properties of the constituent fibers and matrices, micromechanical predictions of composite properties, anisotropic elasticity, behavior of composite laminae, and classical lamination theory; fracture mechanisms, failure theories; behavior of composite plates and beams. Same as AE 428 and TAM 428. 3 undergraduate hours. 3 graduate hours. Prerequisite: AE 321, CEE 300, ME 330, or MSE 406.

MSE 457  Polymer Chemistry  credit: 3 or 4 Hours.
Methods used to synthesize macromolecules. Descriptive and mechanistic organic chemistry as they relate to polymer synthesis. Same as CHEM 480. 3 undergraduate hours. 3 or 4 graduate hours.

MSE 458  Polymer Physics  credit: 3 or 4 Hours.
Physics of polymer systems. Equilibrium conformation, structure, properties and phase transitions of polymer solutions, dense melts, liquid crystals, mixtures, block copolymers, surfaces and interfaces, gels and rubbers, biopolymers, and electronic polymers. Same as CHEM 482. 3 or 4 graduate hours. Prerequisite: MSE 401.

MSE 460  Electronic Materials I  credit: 3 Hours.
Materials science, engineering, and processing of semiconductors. Semiconductor structure and chemistry relationships to electronic and optical properties. Control of processing to achieve desired properties; design and production of novel materials. 3 undergraduate hours. 3 graduate hours. Prerequisite: ECE 340; MSE 304 or PHYS 460.

MSE 461  Electronic Materials II  credit: 3 Hours.
Materials science, engineering, and processing of microlithographic materials, conductors, and dielectrics for electronic applications. Performance related to materials properties and processing. Processing commonly used in microelectronic circuit manufacture for metallization, dielectric formation, and lithography. 3 undergraduate hours. 3 graduate hours. Prerequisite: ECE 340.

MSE 462  Electronic Materials Lab  credit: 3 Hours.
Fabrication, analysis, and properties of thin film materials. Principles and practice of (i) deposition of thin film materials by vacuum evaporation, sputtering and plasma assisted processes; (ii) modification of properties by thermal reaction, surface treatment, etc.; (iii) characterization of key properties including electrical conductivity, optical properties, and stress. Methods to optimize the film microstructure and engineering properties via growth techniques. 3 undergraduate hours. 3 graduate hours. Prerequisite: ECE 340.

MSE 466  Materials in Electrochem Syst  credit: 3 Hours.
Materials issues in electrochemical systems including fundamental thermodynamics, kinetics and electrode processes in electrochemical systems and materials specific issues in the materials design, materials in energy storage and conversion systems, and electrochemical corrosion. Emphasis placed on issues of materials selection, microstructure, systems design, materials limitations, and data analysis. 3 undergraduate hours. 3 graduate hours. Credit is not given for both MSE 466 and CHEM 524.

MSE 470  Design and Use of Biomaterials  credit: 3 Hours.
Characterization and use of biomaterials in medical applications. Concepts of biocompatibility in terms of structure and properties of materials and interactions between materials and proteins, cells, and tissue. Issues related to the design of biomaterials. Design of biomaterials to meet specific medical needs. 3 undergraduate hours. 3 graduate hours. Prerequisite: Credit or concurrent registration in both MCB 252 and either CHEM 232 or MSE 403.

MSE 472  Biomaterials Laboratory  credit: 3 Hours.
Experiments involving the chemistry and physics of biomaterials, biocompatibility of materials, tissue regeneration, rheology of biomaterials and tissues, structural studies of biomaterials, and controlled release of small molecules and drugs. Laboratory techniques for protein purification, cytotoxicity testing, tissue culture, mechanical testing, microscopy, and X-ray diffraction. Same as BIOE 473. 3 undergraduate hours. 3 graduate hours. Prerequisite: MSE 470.

MSE 473  Biomolecular Materials Science  credit: 3 Hours.
Fundamental and unifying principles in biomolecular materials science. Nucleic acids, proteins, lipids, and sugars. Specific and non-specific interactions which govern biomolecular behavior in a wide range of contexts (e.g., self-assembly, cell adhesion). Present knowledge and empirical evidence integrated with discussions of experimental characterization and manipulation techniques in biotechnology. Application of course content and expository research into current literature via a case study term project. 3 undergraduate hours. 3 graduate hours.

MSE 474  Biomedical Materials and Nanomedicine  credit: 3 Hours.
Design and synthesis of polymeric biomaterials and nanobiomaterials for their applications in drug and gene delivery. Part (1) fundamental biopolymer synthesis: functional group protection and de-protection; bioconjugation; protein pegylation and design and synthesis of natural and synthetic non-degradable and degradable polymers, hydrogels, bio-inspired materials, and stimuli responsive biomaterials. Part (2) preparation of nanomedicines for drug and gene delivery: nanofabrication of micelles, nanoparticles, protein conjugates, drug conjugates, nanoencapsulates, and polymeric vesicles; in-vitro and in-vivo small-molecule, gene, and protein delivery. Impact of the chemical structures of biopolymers on the stability, biocompatibility, toxicity, and in-vitro and in-vivo efficacy; clinical translation of the resulting nanomedicines in drug delivery. 3 undergraduate hours. 3 graduate hours. Prerequisite: CHEM 236 or MSE 457, MCB 450.

MSE 480  Surfaces and Colloids  credit: 3 or 4 Hours.
Chemistry and physics of surfaces and interfaces, with emphasis on behavior in liquid media. Surface composition; surface and interfacial forces; colloidal stability and flocculation; amphiphilic molecules. Same as CHEM 488. 3 or 4 undergraduate hours. Prerequisite: MSE 401.
MSE 481  Electron Microscopy  credit: 3 or 4 Hours.
Theory and application of transmission electron microscopy and
diffraction with emphasis on thin crystals; electron optics, interference
phenomena, interpretation of images and diffraction patterns, specimen
preparation. 3 undergraduate hours. 4 graduate hours. Prerequisite:
MSE 405.

MSE 484  Composite Materials  credit: 3 or 4 Hours.
Metal, ceramic, and polymer matrix composites. Interrelationships
between processing, microstructure, and properties. Selecting composite
materials for different engineering applications. 3 undergraduate hours. 3
or 4 graduate hours. Prerequisite: MSE 201 and MSE 206.

MSE 485  Atomic Scale Simulations  credit: 3 or 4 Hours.
Application of Monte Carlo and Molecular Dynamics techniques in
primarily classical simulations to understand and predict properties
of microscopic systems in materials science, physics, biology, and
chemistry. Numerical algorithms, connections between simulation
results and real properties of materials (structural or thermodynamic),
and statistical and systematic error estimation using real simulation
programs. Simulation project comprised of scientific research, algorithm
development, and presentation. Same as CSE 485 and PHYS 466. 3
undergraduate hours. 4 graduate hours. Prerequisite: MSE 401; one of C,
C++, or Fortran programming experience.

MSE 487  Materials for Nanotechnology  credit: 3 or 4 Hours.
Survey of the synthesis, processing, structure properties and
technological applications of materials with nanometer dimensions.
Semiconductor nanocrystals and size-dependent optical properties;
metal nanostructures and plasmonics; nanowires and nanotubes;
electronics and optoelectronics; nanoscale heterostructures; assembly
and fabrication. 3 undergraduate hours. 3 or 4 graduate hours.
Prerequisite: MSE 401 and PHYS 214.

MSE 488  Optical Materials  credit: 3 or 4 Hours.
Optical properties of materials of current and potential technological
importance and application to devices. Applicable optics fundamentals
based on Maxwell's equations. Liquid crystals for displays;
photopolymers for holographic data storage; electro-optic materials
for high speed light modulators; electroluminescent materials for light
emitting diodes. Application of optics, materials and chemistry in design
of practical devices. 3 undergraduate hours. 3 or 4 graduate hours.
Prerequisite: MATH 285 and PHYS 214.

MSE 489  Matl Select for Sustainability  credit: 3 or 4 Hours.
Quantitative methods to optimize the selection of materials including
traditional (minimize mass or volume, maximize performance) and
sustainability (minimize energy consumption and CO2 emission during
synthesis, maximize recyclability) goals. Tradeoff methods to optimize
both via engineering design and materials selection for product lifetime,
economic outlay and return, time dynamics and materials consumption,
recycling, and disposal. Application of commercial software to optimize
selections. For engineering and science majors only. 3 undergraduate
hours. 4 graduate hours.

MSE 492  Lab Safety Fundamentals  credit: 1 Hour.
Key aspects of laboratory setups, operating procedures, and emergency
preparedness measures necessary for the experimentalist. Same as
CHEM 494. 1 undergraduate hour. 1 graduate hour. Approved for S/U
grading only.

MSE 497  Independent Study  credit: 1 to 4 Hours.
Individual study of any topic in materials science and engineering under
the supervision of a member of the faculty. 1 to 4 undergraduate hours.
1 to 4 graduate hours. May be repeated to a maximum of 4 hours.
Prerequisite: Consent of instructor.

MSE 498  Special Topics  credit: 1 to 4 Hours.
Subject offerings of new and developing areas of knowledge in materials
science and engineering intended to augment the existing curriculum.
See Class Schedule or departmental course information for topics and
prerequisites. 1 to 4 undergraduate hours. 1 to 4 graduate hours. May be
repeated in the same or separate terms if topics vary.

MSE 499  Senior Thesis  credit: 1 to 5 Hours.
Individual research in an area of materials science and engineering under
the supervision of members of the staff. 1 to 5 undergraduate hours. No
graduate credit. May be repeated to a maximum of 6 hours. Prerequisite:
Grade point average of 3.0 and consent of instructor.

MSE 500  Statistical Thermodyn of Matls  credit: 4 Hours.
Atomistic concepts of statistical thermodynamics and their relationship
to classical phenomenological thermodynamics. Application of the
methods of statistical thermodynamics and statistical mechanics to
describe the structure, phase behavior, and properties of both hard and
soft materials. Prerequisite: MSE 401.

MSE 501  Kinetic Processes in Materials  credit: 4 Hours.
Fundamentals of rate processes in materials, both from a
phenomenological and an atomistic point of view, with special emphasis
on the kinetics of transformations and the transport of matter in solids.
Prerequisite: MSE 500 or PHYS 560.

MSE 529  Hard Materials Seminar  credit: 0 to 1 Hours.
Seminar on current research in science and engineering of hard
materials; presentations by visiting lecturers, staff, and students.
Approved for S/U grading only. May be repeated.

MSE 559  Soft Materials Seminar  credit: 0 to 1 Hours.
Seminar on current research in the science and engineering of soft
materials; presentations by visiting lecturers, staff, and students.
Approved for S/U grading only. May be repeated.

MSE 565  Thin Film Materials  credit: 3 Hours.
Thin solid films bonded to relatively thick substrates such as
microelectronic devices, thermal barrier coatings in gas turbine engines,
mems devices, flexible electronics, and biomedical instruments.
Quantitative understanding of the consequences of mechanical stress
in film-substrate structures, arising from fabrication methods or
service conditions: substrate curvature, film delamination, film fracture,
dislocation formation, plastic flow and stress-driven evolution of surface
morphology.

MSE 580  Diffraction Physics of Matls  credit: 4 Hours.
Quantitative treatment of the physical basis of X-ray, electron,
and neutron diffraction instrumentation and use for structural
characterization. Applications in materials science and condensed
matter physics including structure of condensed matter, defects, phase
transitions, disorder, surfaces, and interfaces. Prerequisite: MSE 405 or
PHYS 436.

MSE 581  Advanced Electron Microscopy  credit: 4 Hours.
Theory of electron microscopy and use for materials structure
characterization and microanalysis. Physics of electron microscopes;
kinematic and dynamic electron diffraction theory; defect image contrast;
high resolution electron microscopy; electron probe formation; STEM;
inelastic scattering and microanalysis. Practical experience via laboratory
demonstrations and project assignments. Prerequisite: MSE 405 and
MSE 481.
MSE 582  *Surface Physics*  credit: 4 Hours.
Theory and experiment describing atomic behavior on crystal surfaces; thermodynamics of surfaces; surface energy; diffraction and structure; gas-solid collisions; Brownian motion, diffusion, and evaporation; electron and ion emission, tunneling; Van der Waals forces; theory of chemical interactions; kinetics and statistics of adsorption. Prerequisite: MSE 501 or PHYS 560.

MSE 583  *Dynamics of Complex Fluids*  credit: 3 or 4 Hours.
Microscopic statistical treatment of the structure and dynamics of polymers, colloids, gels, and other soft materials. Fundamental connections between molecular architecture, intermolecular forces, collective fluid structure, and time-dependent phenomena; Brownian motion, Langevin equation theory, and viscoelasticity; diffusion in colloidal suspensions, gels, and glasses; dynamics of polymer solutions and melts. Prerequisite: MSE 401.

MSE 584  *Point and Line Defects*  credit: 4 Hours.
Formation and interactions of point and line defects in solids including metals, semiconductors, dielectrics, and ionic conductors. Theoretical treatment of thermal equilibrium and non-equilibrium conditions. Application to impurity diffusion, ion irradiation, dislocation generation and motion, ionic conductivity, and deep level electronic defects. Prerequisite: MSE 401 or MSE 501; PHYS 460 or PHYS 560.

MSE 585  *Materials Engrg Practicum*  credit: 0 to 2 Hours.
Internships or co-ops in industrial or governmental settings pre-approved by the department to foster engineering educational aspects and utilized prior MatSE course work. A paper describing the general area of the practicum, with appropriate references and, to the extent permitted by employer confidentiality, the student’s contribution required. In addition to the paper, a report documenting work completed, verified by the work supervisor, to the extent permitted by confidentiality, and a questionnaire answered by the work supervisor form the basis for the grade. Approved for S/U grading only. May be repeated in separate terms to a maximum of 4 hours.

MSE 590  *Research Seminars*  credit: 0 to 1 Hours.
Discussions and lectures on current research under the direction of individual staff members. Approved for S/U grading only. May be repeated. Prerequisite: Consent of instructor.

MSE 595  *Materials Colloquium*  credit: 0 to 1 Hours.
Presentation of (i) cutting-edge materials research by visiting lectures from academia as well as national and industrial research laboratories and (ii) some of the current research conducted in the Department. Approved for S/U grading only. May be repeated.

MSE 597  *Independent Study*  credit: 1 to 4 Hours.
Individual study of any topic in materials science and engineering under the supervision of a member of the faculty. May be repeated to a maximum of 4 hours. Prerequisite: Consent of instructor.

MSE 598  *Special Topics*  credit: 1 to 4 Hours.
Subject offerings of new and developing areas of knowledge in materials science and engineering intended to augment the existing curriculum. See Class Schedule or departmental course information for topics and prerequisites. May be repeated in the same or separate terms if topics vary.

MSE 599  *Thesis Research*  credit: 0 to 16 Hours.
Approved for S/U grading only. May be repeated.