MSE - MATERIALS SCIENCE & ENGINEERING

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

Courses

MSE 101 Materials in Today's World credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/MSE/101/)
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:
Nat Sci Tech - Phys Sciences

MSE 182 Introduction to MatSE credit: 2 Hours. (https://courses.illinois.edu/schedule/terms/MSE/182/)
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 Introductory Materials Science and Engineering Laboratory credit: 1 Hour. (https://courses.illinois.edu/schedule/terms/MSE/183/)
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. (https://courses.illinois.edu/schedule/terms/MSE/199/)
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. (https://courses.illinois.edu/schedule/terms/MSE/201/)
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. (https://courses.illinois.edu/schedule/terms/MSE/206/)
Statics and mechanics of materials 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. Credit is not given for both MSE 206 and TAM 251. Prerequisite: MATH 241 and PHYS 211. Credit or concurrent enrollment in CS 101 or CS 124 or CS 125; and MATH 225 or 257 or MATH 415; and MSE 201.

MSE 280 Engineering Materials credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/MSE/280/)
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. (https://courses.illinois.edu/schedule/terms/MSE/304/)
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. (https://courses.illinois.edu/schedule/terms/MSE/307/)
Experiments using optical microscopy and various thermal and thermodynamic measuring techniques including differential scanning calorimetry. Experience with laboratory test instruments and technical communication, including reports and oral presentations. 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 201 and MSE 401.
This course satisfies the General Education Criteria for:
Advanced Composition

MSE 308 Materials Laboratory II credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/MSE/308/)
Experiments characterizing mechanical, transport, and electronic properties of materials and the use of optical microscopy, quartz crystal microbalance, and various mechanical testing equipment. Technical communication is refined through the use of lab reports and oral presentations. 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 307 and MSE 406.
This course satisfies the General Education Criteria for:
Advanced Composition

MSE 396 Introduction to Research credit: 1 to 3 Hours. (https://courses.illinois.edu/schedule/terms/MSE/396/)
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. (https://courses.illinois.edu/schedule/terms/MSE/397/)
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. Prerequisite: Consent of instructor.

MSE 398 Special Topics credit: 1 to 4 Hours. (https://courses.illinois.edu/schedule/terms/MSE/398/)
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 401 Thermodynamics of Materials credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/MSE/401/)
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. (https://courses.illinois.edu/schedule/terms/MSE/402/)
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 recystallization. 3 undergraduate hours. 3 graduate hours. Prerequisite: MSE 201 and MSE 401.

MSE 403 Synthesis of Materials credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/MSE/403/)
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. (https://courses.illinois.edu/schedule/terms/MSE/404/)
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. (https://courses.illinois.edu/schedule/terms/MSE/405/)
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: MSE 201, MATH 285 and PHYS 214.

MSE 406 Thermal-Mech Behavior of Matls credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/MSE/406/)
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 201 and 401.

MSE 420 Ceramic Materials & Properties credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/MSE/420/)
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. Prerequisite: MSE 401. Credit or concurrent registration in MSE 405.

MSE 421 Ceramic Processing credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/MSE/421/)
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. (https://courses.illinois.edu/schedule/terms/MSE/422/)
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, thermistors, transducers, actuators, memory elements, multilayered components, and their applications. Design project. 3 undergraduate hours. 3 graduate hours. Prerequisite: MSE 420.

MSE 440 Mechanical Behavior of Metals credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/MSE/440/)
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. (https://courses.illinois.edu/schedule/terms/MSE/441/)
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 443 Design of Engineering Alloys credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/MSE/443/)
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 450 Polymer Science & Engineering credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/MSE/450/)
Polymer solution properties, conformation, and molecular weight characterization. Rheological and viscoelastic behavior: relaxations and transitions, rubber elasticity. Crystallinity, morphology, and deformation of crystalline polymers. Blends and composites. Methods of fabrication. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: MSE 401.

MSE 453 Plastics Engineering credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/MSE/453/)
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 455 Macromolecular Solids credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/MSE/455/)
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 206 or TAM 251.

MSE 456 Mechanics of Composites credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/MSE/456/)
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 206.

MSE 457 Polymer Chemistry credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/MSE/457/)
Methods used to make polymers including reaction mechanisms, kinetics, and analytical techniques. Emphasis on understanding how macromolecule structure, composition, and properties are controlled through a variety of synthetic approaches. Same as CHEM 480. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CHEM 232.

MSE 458 Polymer Physics credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/MSE/458/)
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 undergraduate hours. 3 or 4 graduate hours. Prerequisite: MSE 401.

MSE 460 Electronic Materials I credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/MSE/460/)
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. (https://courses.illinois.edu/schedule/terms/MSE/461/)
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 464 Magnetic Materials and their Applications credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/MSE/464/)
Fundamental properties of magnetic materials with an emphasis on magnetic structure (including domains) and dynamics and how they manifest themselves in different inhomogeneous materials systems, such as nanoparticles and thin film heterostructures. Includes discussion of different interactions with magnetic systems through light, heat, and electronic degrees of freedom. These physical phenomena are put into context for modern applications in medicine, energy, and information technologies. 3 undergraduate hours. 4 graduate hours. Prerequisite: ECE 340, MSE 304 or PHYS 460.

MSE 466 Electrochemical Energy Conversion credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/MSE/466/)
Fundamental mechanism, materials, and device design of electrochemical energy conversion systems such as batteries, fuel cells, electrolyzers, and supercapacitors. Emphasis is placed on the thermodynamics and kinetics of electrode processes, as well as materials specific issues for renewable energy. 3 undergraduate hours. 3 graduate hours. Prerequisite: MSE 304 or equivalent course in electronic structure of materials.

MSE 470 Design and Use of Biomaterials credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/MSE/470/)
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 473 Biomolecular Materials Science credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/MSE/473/)
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. Prerequisite: MCB 150; MSE 403 or CHEM 440 or CHEM 472.

MSE 474 Biomaterials and Nanomedicine credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/MSE/474/)
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: nanofabritation 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. (https://courses.illinois.edu/schedule/terms/MSE/480/)
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 undergraduate hours. 3 or 4 graduate hours. Prerequisite: MSE 401.

MSE 481 Electron Microscopy credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/MSE/481/)
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 485 Atomic Scale Simulations credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/MSE/485/)
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. (https://courses.illinois.edu/schedule/terms/MSE/487/)
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. (https://courses.illinois.edu/schedule/terms/MSE/488/)
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. (https://courses.illinois.edu/schedule/terms/MSE/489/)
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. Prerequisite: MSE 201.

MSE 492 Lab Safety Fundamentals credit: 1 Hour. (https://courses.illinois.edu/schedule/terms/MSE/492/)
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 494 Materials Design Thinking credit: 1 Hour. (https://courses.illinois.edu/schedule/terms/MSE/494/)
Introduction to design methodologies in the context of Materials Science and Engineering. Topics include Human Centered Design (HCD), Statistical Modeling, Design Tradeoffs, Material Selection, Materials Design, and Team Management. Development of design projects for implementation in a subsequent course (MSE 495). Understanding of objectives and constraints such as economic, manufacturability, environmental, ethical, health and safety, sustainability, social, and political concerns as they relate to project design. 1 undergraduate hour. No graduate credit. Prerequisite: MSE 308.

MSE 495 Materials Design credit: 2 Hours. (https://courses.illinois.edu/schedule/terms/MSE/495/)
Continuation of MSE 494. Design teams evaluate alternatives, finalize concepts, model and analyze solutions, build and test a final product (physical or digital), and present the results professionally. Solutions are based on the knowledge, skills, and design experience acquired in earlier course work and incorporate realistic constraints. 2 undergraduate hours. No graduate credit. Prerequisite: Credit in MSE 494.

MSE 497 Independent Study credit: 1 to 4 Hours. (https://courses.illinois.edu/schedule/terms/MSE/497/)
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. Prerequisite: Consent of instructor.

MSE 498 Special Topics credit: 1 to 4 Hours. (https://courses.illinois.edu/schedule/terms/MSE/498/)
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. (https://courses.illinois.edu/schedule/terms/MSE/499/)
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. (https://courses.illinois.edu/schedule/terms/MSE/500/)
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. (https://courses.illinois.edu/schedule/terms/MSE/501/)
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 522 Solid State Ionics credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/MSE/522/)
Solid state ionic materials applied in energy conversion, energy storage, catalysis, sensing, responsive coatings, neuromorphic computing, and memory. Underlying point defect behavior, i.e., transport and reactions, through equilibrium thermodynamics, chemical kinetics, and irreversible thermodynamics. Practical solid state electrochemistry techniques and case studies. Prerequisite: MSE 401; MSE 403; MSE 420; MSE 422 or equivalents.

MSE 529 Hard Materials Seminar credit: 0 to 1 Hours. (https://courses.illinois.edu/schedule/terms/MSE/529/)
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 552 Mass and Ion Transport in Polymers credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/MSE/552/)
Molecular and ion transport in polymers: This course will cover a range of topics associated with small molecule (gas, liquid, dye) and ion transport in polymers starting from a fundamental perspective. Applications including gas separations, drug diffusion, liquid extractions, water purification, and electrolytes for batteries will also be discussed. Prerequisite: MSE 450, CHBE 456, or equivalent.

MSE 559 Soft Materials Seminar credit: 0 to 1 Hours. (https://courses.illinois.edu/schedule/terms/MSE/559/)
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 580 Diffraction Physics of Matls credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/MSE/580/)
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. (https://courses.illinois.edu/schedule/terms/MSE/581/)
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. (https://courses.illinois.edu/schedule/terms/MSE/582/)
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. (https://courses.illinois.edu/schedule/terms/MSE/583/)
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. (https://courses.illinois.edu/schedule/terms/MSE/584/)
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. (https://courses.illinois.edu/schedule/terms/MSE/585/)
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. (https://courses.illinois.edu/schedule/terms/MSE/590/)
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. (https://courses.illinois.edu/schedule/terms/MSE/595/)
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 596 Graduate Introduction to Research credit: 1 Hour. (https://courses.illinois.edu/schedule/terms/MSE/596/)
Key research principles, including lab safety, research ethics, hypothesis development, and experimental design. Students explore topic selection, the purpose of research, and engineering communication essentials. Emphasis is on clear, concise verbal and written skills. By semester's end, students present an elevator pitch and a detailed research talk, supported by several preparatory written assignments for a final research report. Approved for S/U grading only. Prerequisite: Restricted to MS or PHD: Materials Sci & Engr. Special enrollment may be permitted by the Associate Head for Graduate Program in MatSE Department, with instructor approval.

MSE 597 Independent Study credit: 1 to 4 Hours. (https://courses.illinois.edu/schedule/terms/MSE/597/)
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. (https://courses.illinois.edu/schedule/terms/MSE/598/)
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. Approved for Letter and S/U grading. May be repeated in the same or separate terms if topics vary.

MSE 599 Thesis Research credit: 0 to 16 Hours. (https://courses.illinois.edu/schedule/terms/MSE/599/)
Approved for S/U grading only. May be repeated in the same term or in separate terms.