

Materials Science and Engineering (MSE)

Courses

MSE 60. Laboratory in Synthesis and Characterization of Materials. 4 Units.

Synthesis and characterization of ceramic, polymer, and semiconductor materials. Connect the process, structure, properties, and performance to materials science knowledge in a hands-on laboratory setting. Materials fee.

Prerequisite: ENGR 54 and CHEM 1C

Restriction: Materials Science and Engr Majors have first consideration for enrollment.

MSE 69. Electronic and Optical Properties in Materials. 4 Units.

Covers the electronic, optical, and dielectric properties of crystalline and amorphous materials to provide a foundation of the underlying physical principles governing the properties of existing and emerging electronic and photonic materials.

Prerequisite: PHYS 7D and PHYS 7E and (MATH 3A or ICS 6N) and MATH 3D and ENGR 54

Restriction: Materials Science and Engr Majors have first consideration for enrollment.

MSE 141. Nano-Scale Materials and Applications. 4 Units.

Overview of the chemistry, physics, and applications of nanometer-scale materials. Explore the effects of composition, bonding, and confinement on physical properties of nanomaterials, their chemical syntheses, and their device physics in electronic, optoelectronic, and energy technologies.

Prerequisite: (ENGR 1A or CHEM 1A or CHEM H2A) and ENGR 54 and MSE 69

Restriction: Biomedical Engineering Majors have first consideration for enrollment. Chemical Engineering Majors have first consideration for enrollment. Materials Science and Engr Majors have first consideration for enrollment.

Concurrent with MSE 241.

MSE 151. Polymeric Materials. 4 Units.

An introduction to physical aspects of polymers, including polymer molecular size and configuration, solution and bulk phase structural properties, mechanical properties including viscoelasticity and rheology, polymer synthesis methods, characterization techniques, processing methods, and examples from existing and emerging polymeric materials.

Prerequisite: ENGR 54 and (MSE 165A or CBE 40C or MAE 91)

Restriction: Materials Science and Engr Majors have first consideration for enrollment.

MSE 155. Mechanical Behavior and Design Principles. 4 Units.

Principles governing structure and mechanical behavior of materials, relationship relating microstructure and mechanical response with application to elasticity, plasticity, yielding, necking, creep, and fracture of materials. Introduction to experimental techniques to characterize the properties of materials. Design parameters.

Prerequisite: ENGR 54

Same as MAE 156.

Restriction: Mechanical Engineering Majors have first consideration for enrollment. Materials Science and Engr Majors have first consideration for enrollment. Aerospace Engineering majors have second consideration for enrollment.

MSE 155L. Mechanical Behavior Laboratory. 1 Unit.

Introduction to experimental techniques to characterize mechanical properties of materials. Emphasis on correlations between property and microstructure. Experiments include: plastic stability in tension, effect of grain size on flow stress, microstructural engineering. Materials fee.

Corequisite: MSE 155

Prerequisite: ENGR 54

Restriction: Materials Science and Engr Majors have first consideration for enrollment.

MSE 158. Ceramic Materials for Sustainable Energy. 4 Units.

A technical elective for students interested in materials. Topics covered include structure and properties of ceramic materials, and design for sustainable energy applications.

Prerequisite: ENGR 54

Restriction: Materials Science and Engr Majors have first consideration for enrollment. Chemical Engineering majors have second consideration for enrollment.

MSE 163. Computer Techniques in Experimental Research. 4 Units.

Principles and practical guidelines of automated materials testing. Computer fundamentals, programming languages, data acquisition and control hardware, interfacing techniques, programming strategies, data analysis, data storage, safeguard procedures.

Restriction: Materials Science and Engr Majors have first consideration for enrollment. Chemical Engineering majors have second consideration for enrollment.

MSE 164. X-ray Diffraction, Electron Microscopy, and Microanalysis. 4 Units.

Material characterization using X-ray diffraction and scanning electron microscopy (SEM). Topics include X-ray diffraction and analysis; SEM imaging and microanalysis. Materials fee.

Prerequisite: ENGR 54 and PHYS 7D

Restriction: Materials Science and Engr Majors have first consideration for enrollment.

MSE 164L. X-ray Diffraction, Electron Microscopy, and Microanalysis Lab. 1 Unit.

Material characterization using X-ray diffraction and scanning electron microscopy (SEM). Topics include X-ray diffraction and analysis; SEM imaging and microanalysis.

Prerequisite: ENGR 54 and PHYS 7D

Restriction: Materials Science and Engr Majors only.

MSE 165A. Thermodynamics of Materials. 4 Units.

Treatment of the laws of thermodynamics and their application in understanding properties and equilibrium states of engineering materials. Develops relationships pertaining to multiphase equilibrium and presents graphical constructions for interpretation of phase diagrams. Statistical thermodynamics in relation to materials phenomena.

Prerequisite: CHEM 1C and PHYS 7C

Restriction: Materials Science and Engr Majors have first consideration for enrollment.

MSE 165B. Diffusion and Heat Transport in Materials. 4 Units.

Examines how kinetics affect materials development, behavior, and processing. Highlights the ways in which kinetics and diffusion are key to designing materials processing and heat treating strategies, with examples in various applied topics.

Prerequisite: MSE 165A or CBE 40C or MAE 91. MSE 165A with a grade of C- or better

Restriction: Materials Science and Engr Majors have first consideration for enrollment.

MSE 165C. Materials Kinetics and Phase Transformations. 4 Units.

Treatment of the kinetics of solid-state reactions and reactions at interfaces. Thermodynamics and kinetics of phase transformations, including solidification processes, diffusional and diffusionless phase transformations.

Prerequisite: ENGR 54 and (MSE 165B or (CBE 120B and CBE 120C) or MAE 120). MSE 165B with a grade of C- or better

Restriction: Materials Science and Engr Majors have first consideration for enrollment.

MSE 165CL. Laboratory in Materials Kinetics and Phase Transformations. 1 Unit.

Covers topics of practical application of the kinetics of solid state reactions, reactions at interfaces, and the thermodynamics and kinetics of phase transformations to common materials systems.

Prerequisite: ENGR 54 and (MSE 165B or (CBE 120B and CBE 120C) or MAE 120). MSE 165B with a grade of C- or better

Restriction: Materials Science and Engr Majors only.

MSE 171. Green Engineering: Theory and Practice. 4 Units.

Methods and impacts of selecting alternative technologies, processes, materials, chemicals, to reduce pollution, waste, and use of toxic substances, thereby creating "green," environmentally responsible, sustainable solutions. Topics include environmental regulations, recycling, life-cycle assessment, economic analysis, design, green chemistry, and toxicology.

Restriction: Seniors only. Materials Science and Engr Majors have first consideration for enrollment.

MSE 173. Fundamentals of Materials Processing: How are Materials Processed to Make Things?. 4 Units.

An in-depth knowledge of manufacturing processes with focus on the fundamentals of materials processing (heat flow, mass flow, fluid flow, etc.). Processing fundamentals that apply to the three main classes of engineering materials: metals, ceramics, and polymers.

Prerequisite: ENGR 54

Restriction: Materials Science and Engr Majors have first consideration for enrollment.

MSE 174. Composite Materials Design. 3 Units.

Introduction to fiber-reinforced composites for mechanical applications. Properties of reinforcing fibers. Manufacture of fibers and composites. Micromechanics of fiber composites. Strength criteria and failure modes. Macromechanics in design of laminated composite structures.

Prerequisite: ENGR 54 and ENGR 150

MSE 175. Design Failure Investigation. 4 Units.

Survey of mechanisms by which devices fail, including overload, fatigue, corrosion, and wear. Use of fractography and other evidence to interpret failure modes and specify design/manufacturing changes. Students redesign failed parts or structures based on actual parts and/or case histories.

Prerequisite: ENGR 54

Restriction: Materials Science and Engr Majors have first consideration for enrollment. Chemical Engineering majors have second consideration for enrollment.

MSE 176. Surface and Adhesion Science. 4 Units.

Structure, thermodynamics of, kinetics, and reactions on surfaces. Surface electronic and mechanical properties and characterization of all classes of materials including metals, semiconductors, ceramics, polymers, and soft materials. Adhesion between different materials is also addressed.

Prerequisite: (CBE 110 or MSE 165C) and (MSE 141 or MSE 69)

Same as CBE 183.

Restriction: Chemical Engineering Majors have first consideration for enrollment. Materials Science and Engr Majors have first consideration for enrollment.

Concurrent with MSE 276 and CBE 283.

MSE 189A. Senior Design Project I. 3 Units.

Group supervised senior design projects that deal with materials selection in engineering design and that involve case studies in ethics, safety, design, failure modes, new products, and patents. Activities conclude with a presentation of the projects. Materials fee.

Prerequisite: ENGR 54 and MSE 155 and MSE 60 and MSE 165C

Grading Option: In Progress (Letter Grade with P/NP).

Restriction: Seniors only. Materials Science and Engr Majors only. MSE 189A, MSE 189B, and MSE 189C must be taken in the same academic year.

MSE 189B. Senior Design Project II. 3 Units.

Group supervised senior design projects that deal with materials selection in engineering design and that involve case studies in ethics, safety, design, failure modes, new products, and patents. Activities conclude with a presentation of the projects. Materials fee.

Prerequisite: MSE 189A

Grading Option: In Progress (Letter Grade with P/NP).

Restriction: Seniors only. Materials Science and Engr Majors only. MSE 189A, MSE 189B, and MSE 189C must be taken in the same academic year.

MSE 189C. Senior Design Project III. 3 Units.

Group supervised senior design projects that deal with materials selection in engineering design and that involve case studies in ethics, safety, design, failure modes, new products, and patents. Activities conclude with a presentation of the projects. Materials fee.

Prerequisite: MSE 189B

Restriction: Seniors only. Materials Science and Engr Majors only. MSE 189A, MSE 189B, and MSE 189C must be taken in the same academic year.

MSE 190. Materials Selection and Design. 4 Units.

Meaning and phases of design; design considerations; properties of engineering materials; materials property charts; materials selection; process selection; multi-constraint and multi-objective design. Selection of shape in mechanical components. Designing with hybrid materials: challenges and opportunities. Environmental considerations; case studies.

Prerequisite: ENGR 54 and ENGR 150

Restriction: Materials Science and Engr Majors have first consideration for enrollment.

MSE 191. Materials Outreach. 3 Units.

Demonstrates major concepts in Materials Science and Engineering. Concepts of materials engineering covered include deformation in crystalline solids, effects of heat treatment on mechanical properties, thermal barrier materials, composites design, mechanical behavior of polymers, superconductivity in ceramics.

Prerequisite: ENGR 54

Restriction: Materials Science and Engr Majors have first consideration for enrollment.

MSE 195. Special Topics in Materials Science and Engineering. 1-4 Units.

Studies in selected areas of Materials Science and Engineering. Topics addressed vary each quarter.

Prerequisite: Prerequisites vary.

Repeatability: Unlimited as topics vary.

MSE 198. Group Study. 1-4 Units.

Group study of selected topics in engineering.

Repeatability: May be repeated for credit unlimited times.

Restriction: Upper-division students only.

MSE 199. Individual Study. 1-4 Units.

Supervised independent reading, research, or design for undergraduate Engineering majors. Students taking individual study for design credit are to submit a written paper to the instructor and to the Undergraduate Student Affairs Office in the School of Engineering.

Repeatability: May be taken for credit for 8 units.

Restriction: Materials Science and Engr Majors only.

MSE 199P. Individual Study. 1-4 Units.

Supervised independent reading, research, or design for undergraduate Engineering majors. Students taking individual study for design credit are to submit a written paper to the instructor and to the Undergraduate Student Affairs Office in the School of Engineering.

Grading Option: Pass/no pass only.

Repeatability: May be repeated for credit unlimited times.

MSE 200. Crystalline Solids: Structure, Imperfections, and Properties. 4 Units.

Principles and concepts underlying the study of advanced materials including alloys, composites, ceramics, semiconductors, polymers, ferroelectrics, and magnetics. Crystal structure and defects, surface and interface properties, thermodynamics and kinetics of phase transformations, and material processing, related to fundamental material properties.

Restriction: Graduate students only.

MSE 201A. Critical Analysis and Technical Communication I. 2 Units.

Develop an understanding of the process to conduct research. Topics include performing analytical analysis of the scientific literature, formation of a hypothesis, defining investigations to validate hypothesis, communicating analysis in written form, writing a research proposal.

Restriction: Graduate students only.

MSE 201B. Critical Analysis and Technical Communication II. 2 Units.

Develop oral presentation skills and skills to understand significance of published research. Topics include performing critical and analytical analysis of the scientific literature, connecting core course content with experimental/theoretical methods in the scientific literature, and communicating analysis in oral form.

Prerequisite: MSE 201A

Restriction: Graduate students only.

MSE 205. Materials Physics. 4 Units.

Covers the electronic, optical, and dielectric properties of crystalline materials to provide a foundation of the underlying physical principles of governing the properties of existing and emerging electronic and photonic materials.

Prerequisite: MSE 200

Restriction: Graduate students only.

MSE 241. Nano-Scale Materials and Applications. 4 Units.

Overview of the chemistry, physics, and applications of nanometer-scale materials. Explore the effects of composition, bonding, and confinement on physical properties of nanomaterials, their chemical syntheses, and their device physics in electronic, optoelectronic, and energy technologies.

Prerequisite: MSE 200 and MSE 205

Restriction: Graduate students only.

Concurrent with MSE 141.

MSE 249. Special Topics in Materials Science and Engineering. 1-4 Units.

Studies in selected areas of Materials Science and Engineering. Topics addressed vary each quarter.

Prerequisite: Prerequisites vary.

Repeatability: Unlimited as topics vary.

Restriction: Graduate students only.

MSE 254. Polymer Science and Engineering. 4 Units.

An introduction to physical aspects of polymers, including configuration and conformation of polymer chains and characterization techniques; crystallinity viscoelasticity, rheology, and processing.

Restriction: Graduate students only.

MSE 255A. Design with Ceramic Materials. 4 Units.

Dependence of ceramic properties on bonding, crystal structure, defects, and microstructure. Ceramic manufacturing technology. Survey of physical properties. Strength, deformation, and fracture of ceramics. Mechanical design with brittle, environment-sensitive materials exhibiting time-dependent strengths.

Prerequisite: ENGR 54

Restriction: Graduate students only.

MSE 256A. Mechanical Behavior of Engineering Materials. 4 Units.

Principles governing structure and mechanical behavior of materials, relationship relating microstructure and mechanical response with application to elasticity, plasticity, creep, and fatigue, study of rate-controlling mechanisms and failure modes, fracture of materials.

Restriction: Graduate students only.

MSE 256B. Fracture of Engineering Materials. 4 Units.

Fracture mechanics and its application to engineering materials. Elastic properties of cracks, the stress intensity factor, the crack tip plastic zone, the J integral approach, fracture toughness testing, the crack tip opening displacement, fracture at high temperatures, fatigue crack growth.

Restriction: Graduate students only.

MSE 259. Transmission Electron Microscopy. 4 Units.

The theory and operation of the transmission electron microscope (TEM), including the basic construction, electron optics, electron diffraction and reciprocal space, formation of image and electron diffraction information, microanalysis, and specimen preparation.

Prerequisite: MSE 200

Restriction: Graduate students only.

MSE 262. Grain Boundaries and Interfaces in Nanocrystalline Materials. 4 Units.

Structure and character of grain boundaries and interfaces in solids including nanocrystalline materials. Role of grain boundaries in chemical segregation, fracture, deformation, creep, conductivity, diffusion, and grain growth. Experimental techniques and computational methods used to characterize and model grain boundaries.

Prerequisite: MSE 200

MSE 264. Scanning Electron Microscopy. 4 Units.

The theory and operation of the scanning electron microscope (SEM) and X-ray microanalysis. Topics covered include the basic design and electron optics, electron beam - specimen interactions, image formation and interpretation, X-ray spectrometry, and other related topics and techniques.

Prerequisite: MSE 200

Restriction: Graduate students only.

MSE 265. Phase Transformations. 4 Units.

Advanced thermodynamics and kinetics of phase transformations and phase transitions.

Prerequisite: MSE 200

Restriction: Graduate students only.

MSE 267. Seminar in Systems Microbiology Research. 1 Unit.

A research and journal club seminar that covers topics on bacteria and phage using approaches and principles from biology, engineering, and physics.

Grading Option: Satisfactory/unsatisfactory only.

Repeatability: May be repeated for credit unlimited times.

Same as MBB 268, PHYS 268.

Restriction: Upper-division students only. Graduate students only.

MSE 271. Green Engineering: Theory and Practice. 4 Units.

Methods and impacts of selecting alternative technologies, processes, materials, chemicals, to reduce pollution, waste, and use of toxic substances, thereby creating "green," environmentally responsible, sustainable solutions. Topics include environmental regulations, recycling, life-cycle assessment, economic analysis, design, green chemistry, and toxicology.

Restriction: Graduate students only.

MSE 273. Electroceramics & Solid State Electrochemical Systems. 4 Units.

Theory, underlying principles, experimental techniques, and applications of electroceramics and solid-state electrochemical systems. Links solid state physics, atomic structure, thermodynamics, defect chemistry, and transport processes to electrical properties of ceramics - spanning from insulators to fast-ion conductors and HT superconductors.

Prerequisite: MSE 200

MSE 276. Surface and Adhesion Science. 4 Units.

Structure, thermodynamics of, kinetics, and reactions on surfaces. Surface electronic and mechanical properties and characterization of all classes of materials including metals, semiconductors, ceramics, polymers, and soft materials. Adhesion between different materials is also addressed.

Same as CBE 283.

Restriction: Graduate students only.

Concurrent with MSE 176 and CBE 183.

MSE 295. Seminar in Engineering. 1-4 Units.

Seminars by individual faculty in major fields of interest.

Grading Option: Satisfactory/unsatisfactory only.

Repeatability: Unlimited as topics vary.

Restriction: Graduate students only.

MSE 296. Master of Science Thesis Research. 1-16 Units.

Individual research or investigation conducted in preparation for the thesis required for the M.S. degree in Engineering.

Repeatability: May be repeated for credit unlimited times.

Restriction: Graduate students only.

MSE 297. Doctor of Philosophy Dissertation Research. 1-16 Units.

Individual research or investigation conducted in preparation for the dissertation required for the Ph.D. degree in Engineering.

Repeatability: May be repeated for credit unlimited times.

Restriction: Graduate students only.

MSE 298. Seminars in Materials Science and Engineering. 2 Units.

Presentation of advanced topics and reports of current research efforts in Materials Science and Engineering.

Grading Option: Satisfactory/unsatisfactory only.

Repeatability: May be repeated for credit unlimited times.

Restriction: Graduate students only.

MSE 299. Individual Research. 1-16 Units.

Individual research or investigation under the direction of an individual faculty member.

Grading Option: Satisfactory/unsatisfactory only.

Repeatability: May be repeated for credit unlimited times.

Restriction: Graduate students only.