Materials Science and Engineering (ENGRMSE)

Courses

ENGRMSE 50L. Principles of Materials Science and Engineering. 2 Units.
Introduction to the experimental techniques to characterize the properties of engineering materials. Emphasis on understanding the influence of microstructure on elastic, plastic, and fracture behavior. Topics include microstructure characterization, heat treatment, grain size effect, precipitation hardening, and impact loading. Materials fee.
Corequisite: ENGR 54

ENGRMSE 65A. 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: (ENGR 1A or CHEM 1A or CHEM H2A) and PHYSICS 7C
Overlap with ENGRMAE 91, CBE 40C.
Restriction: Materials Science Engineering Majors have first consideration for enrollment.

ENGRMSE 65B. Diffusion in Materials. 4 Units.
Prerequisite: ENGRMSE 65A. ENGRMSE 65A with a grade of C- or better
Restriction: Materials Science Engineering Majors have first consideration for enrollment.

ENGRMSE 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 ENGRMSE 169
Restriction: Biomedical Engineering Majors have first consideration for enrollment. Chemical Engineering Majors have first consideration for enrollment. Materials Science Engineering Majors have first consideration for enrollment.
Concurrent with ENGRMSE 241.

ENGRMSE 154. 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, mechanical properties, polymer alloys, processing, and application.
Prerequisite: ENGR 54 and (CBE 110 or ENGRMSE 165)
Same as CBE 181.
Restriction: Chemical Engineering Majors have first consideration for enrollment. Materials Science Engineering Majors have first consideration for enrollment.
Concurrent with ENGRMSE 254 and CBE 281.

ENGRMSE 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 ENGRMAE 156.
Restriction: Mechanical Engineering Majors have first consideration for enrollment. Chemical Engineering Majors have first consideration for enrollment. Materials Science Engineering Majors have first consideration for enrollment.
ENGRMSE 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: ENGRMSE 155
Prerequisite: ENGR 54

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

ENGRMSE 158. Ceramic Materials for Sustainable Energy. 3 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: Chemical Engineering Majors have first consideration for enrollment. Materials Science Engineering Majors have first consideration for enrollment.

ENGRMSE 160. Advanced Lab in Synthesis of Materials. 4 Units.
Synthesis and characterization of organic and inorganic materials including polymers and oxides. Techniques include electron and scanning probe microscopy, gel permeation chromatography, X-ray diffraction, porosimetry, and thermal analysis. Materials fee.
Prerequisite: ENGR 54

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

ENGRMSE 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, interface techniques, programming strategies, data analysis, data storage, safeguard procedures.
Restriction: Chemical Engineering Majors have first consideration for enrollment. Materials Science Engineering Majors have first consideration for enrollment.

ENGRMSE 164. X-ray Diffraction, Electron Microscopy, and Microanalysis. 3 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.
Corequisite: ENGRMSE 164L
Prerequisite: ENGR 54

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

ENGRMSE 164L. X-ray Diffraction, Electron Microscopy, and Microanalysis Lab. 2 Units.
Material characterization using X-ray diffraction and scanning electron microscopy (SEM). Topics include X-ray diffraction and analysis; SEM imaging and microanalysis.
Corequisite: ENGRMSE 164
Prerequisite: ENGR 54

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

ENGRMSE 165. Materials Kinetics and Phase Transformations. 3 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 ENGRMSE 65B. ENGRMSE 65B with a grade of C- or better
Restriction: Materials Science Engineering Majors have first consideration for enrollment.

ENGRMSE 169. 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: PHYSICS 7D and PHYSICS 7E and (MATH 3A or I&C SCI 6N) and MATH 3D

Restriction: Materials Science Engineering Majors have first consideration for enrollment.
ENGRMSE 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 Engineering Majors have first consideration for enrollment.

ENGRMSE 174. Composite Materials Design. 3 Units.

Prerequisite: ENGR 54 and ENGR 150

ENGRMSE 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: Chemical Engineering Majors have first consideration for enrollment. Materials Science Engineering Majors have first consideration for enrollment.

ENGRMSE 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 ENGRMSE 165) and (ENGRMSE 141 or ENGRMSE 169)

Same as CBE 183.

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

Concurrent with ENGRMSE 276 and CBE 283.

ENGRMSE 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.

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

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

ENGRMSE 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: ENGRMSE 189A

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

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

ENGRMSE 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: ENGRMSE 189B

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

ENGRMSE 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.

Restriction: Materials Science Engineering Majors have first consideration for enrollment.
ENGRMSE 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

Repeatability: May be taken for credit 4 times.

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

ENGRMSE 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.

ENGRMSE 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.

ENGRMSE 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 Engineering Majors only.

ENGRMSE 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.

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.

ENGRMSE 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.

Restriction: Graduate students only.

ENGRMSE 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: ENGRMSE 200 and ENGRMSE 205

Restriction: Graduate students only.

Concurrent with ENGRMSE 141.
ENGRMSE 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.

ENGRMSE 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.

Same as CBE 281.
Restriction: Graduate students only.
Concurrent with CBE 181 and ENGRMSE 154.

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

Prerequisite: ENGR 54
Restriction: Graduate students only.

ENGRMSE 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.

ENGRMSE 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: ENGRMSE 200
Restriction: Graduate students only.

ENGRMSE 261. High Temperature Deformation of Engineering Materials. 4 Units.
Theoretical and practical aspects of creep and superplasticity in metallic and non-metallic systems are presented. Topics include: creep testing methods, diffusional creep, deformation mechanism maps, and superplasticity in non-metallics.

Restriction: Graduate students only.

ENGRMSE 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: ENGRMSE 200
Restriction: Graduate students only.

ENGRMSE 265. Phase Transformations. 4 Units.
Advanced thermodynamics and kinetics of phase transformations and phase transitions.

Prerequisite: CBEMS 240
Restriction: Graduate students only.
ENGRMSE 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 MOL BIO 268, PHYSICS 268.
Restriction: Upper-division students only. Graduate students only.

ENGRMSE 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.

ENGRMSE 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: ENGRMSE 200

ENGRMSE 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 ENGRMSE 176 and CBE 183.

ENGRMSE 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.

ENGRMSE 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.

ENGRMSE 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.

ENGRMSE 298. Seminars in Materials Science Engineering. 2 Units.
Presentation of advanced topics and reports of current research efforts in Materials Science Engineering.
Grading Option: Satisfactory/unsatisfactory only.
Repeatability: May be repeated for credit unlimited times.
Restriction: Graduate students only.
ENGRMSE 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.