

MATERIALS SCIENCE & ENGR (MSE)

MSE 101 Introduction to Metallurgy and Materials Science

2 credits

Earth resources, metallurgy, materials science, and manufacturing. (Fall only)

MSE 201 Elements of Materials Science

3 credits

Principles relating properties of metals, ceramics, polymers, and composites to their structures.

Prereq: CHEM 111, CHEM 111L

MSE 204 (s) Special Topics

Credit arranged

MSE 299 (s) Directed Study

Credit arranged

MSE 308 Thermodynamics of Materials

3 credits

First, second, and third laws of thermodynamics. Reaction equilibria. Phase diagrams. Thermodynamics of metallic and ceramic materials.

Prereq: MSE 201 and CHEM 112, CHEM 112L.

Coreq: MATH 310

MSE 313 Physical Metallurgy

3 credits

Theory, structure, and properties of materials. (Fall only)

Prereq: MSE 201

MSE 313L Physical Metallurgy Laboratory

1 credit

Metallographic principles and practices, hardness testing, structure-property correlations. One 2-hour lab per week.

Prereq or Coreq: MSE 313

MSE 340 Transport and Rate Processes I

4 credits

Cross-listed with CHE 340

Transport phenomena involving momentum, energy, and mass with applications to process equipment design. Coordinated lecture-lab periods.

Prereq: ENGR 335, MATH 310, and CHE 223 or MSE 201

MSE 393 Materials Engineering Projects

1-3 credits, max 9

Problems of a research exploratory nature.

Prereq: Permission

MSE 400 (s) Seminar

Credit arranged

MSE 404 (s) Special Topics

Credit arranged

MSE 412 Mechanical Behavior of Materials

3 credits

Theories of elasticity and plasticity, dislocation based plastic deformation, strengthening mechanisms, mechanical properties of solids and relevant testing methods, failure processes and theories, fracture mechanics. Coordinated lecture-lab periods.

Prereq: MSE 201 and Junior standing; or Permission

MSE 413 Phase Transformation and Kinetics

3 credits

Joint-listed with MSE 513

Free energy minimization algorithms. Construction of phase diagrams for liquid and solid systems. Reaction kinetics in liquid and solid systems. Determination of reaction kinetics parameters (reaction order, activation energy, reaction rate constants, etc.). Coordinated lecture-lab periods. Additional projects/assignments required for graduate credit.

Prereq: CHEM 112, CHEM 112L

MSE 415 Materials Selection and Design

3 credits

Selection of materials for use in structural applications; consideration of environment, stress conditions, cost, and performance as guide to properties; optimization of choice of materials and fabrication methods; open-ended problems of real applications in various industries. Recommended Preparation: MSE 313 and MSE 456. (Spring only)

Prereq: MSE 201 and ENGR 350

MSE 417 Instrumental Analysis

3 credits

Principles and laboratory experiments in x-ray diffraction, scanning electron microscopy, transmission electron microscopy, thermal analysis, etc. (Fall only)

Prereq: Junior/Senior standing in an engineering discipline

MSE 423 Corrosion

3 credits

Joint-listed with MSE 523.

Engineering aspects of corrosion and its control presented in ways of importance to a practicing engineer. Topics include corrosion economics, detecting and monitoring corrosion, regulations, specifications, safety. Emphasis on corrosion monitoring and corrosion fundamentals: chemical and electrochemical reactions; chemical and electrochemical equilibria-including Pourbaix diagrams; electrochemical kinetics. Selection and use of materials, from stainless steels to plastics. Failure analysis. Additional projects/assignments required for graduate credit. (Fall only)

Prereq: CHEM 112, CHEM 112L and MSE 201 or CHE 223; or Permission

MSE 427 Ceramics Materials

3 credits

Joint-listed with MSE 527.

Crystallography, ceramic crystal structures, phase diagrams, phase transformation; mechanical properties, thermal properties, electrical and magnetic properties. Additional projects/assignments required for graduate credit. Recommended Preparation: MSE 313.

MSE 432 Fundamentals of Thin Film Fabrication

3 credits

Physical deposition, chemical deposition, post deposition process, film characterization, and film properties. (Spring only)

Prereq: Senior standing or Permission

MSE 434 Fundamentals of Polymeric Materials

3 credits

Polymer structure/property relationships and engineering applications. Topics include: overview of polymer chemistry and physics as they inform structure and properties for real-world applications, including sustainability considerations. Coordinated lecture-lab periods.

Prereq: CHEM 111, CHEM 111L and CHEM 112, CHEM 112L

MSE 437 Radiation Effects on Materials

3 credits

Joint-listed with MSE 537, Cross-listed with NE 437, NE 537

Interactions between radiation and solids.

Prereq: MSE 201 or Permission

MSE 438 Fundamentals of Nuclear Materials**3 credits**

Joint-listed with MSE 538, Cross-listed with NE 438, NE 538

This course is designed for students who wish to learn about nuclear materials and fuels from a materials science viewpoint. Topics to be covered include crystal structure, diffusion, radiation damage processes etc. Term-projects and advanced problems required for graduate credit.

(Spring only)

Prereq: MSE 201 or NE 450; or Permission

MSE 453 Process Analysis & Design I**3 credits**

Cross-listed with CHE 453

Estimation of equipment and total plant costs, annual costs, profitability decisions, optimization; design of equipment, alternate process systems and economics, case studies of selected processes. CHE 453 and CHE 454/MSE 453 and MSE 454 are to be taken in sequence. (Fall only)

Prereq: CHE 330, CHE 341, and CHE 423; or MSE 201, MSE 308, MSE 313, MSE 340, and MSE 412

MSE 454 Process Analysis & Design II**3 credits**

Gen Ed: Senior Experience

Cross-listed with CHE 454

Estimation of equipment and total plant costs, annual costs, profitability decisions, optimization; design of equipment, alternate process systems and economics, case studies of selected processes. MSE 453 and 454 are to be taken in sequence. (Spring only)

Prereq: CHE 453 or MSE 453

MSE 456 Metallic Materials**3 credits**

Processes for extracting metals; various classes of metallic alloys; casting, powder metallurgy, mechanical working, and joining of metals. Emphasis on understanding relationship of processing, structure and properties. Some lab demonstration of metal fabrication processes included.

Prereq: MSE 313 or Permission

MSE 464 Materials Physics and Engineering**3 credits**

Joint-listed with MSE 564, Cross-listed with PHYS 464

Materials for circuits, Magnetism and magnetic materials, Ferroelectric and piezoelectric materials, Semiconductors, Optical properties of semiconductor for optoelectronics, thermal properties, electron band theory, superconductivity. Additional projects/assignments required for graduate credit. (Spring only)

Prereq: Senior standing in an Engineering or Physics major, or PHYS 305 and PHYS 321; or Permission.

MSE 498 (s) Internship

Credit arranged

MSE 499 (s) Directed Study

Credit arranged

MSE 500 Master's Research and Thesis

Credit arranged

MSE 501 (s) Seminar

Credit arranged

MSE 502 (s) Directed Study

Credit arranged

MSE 504 (s) Special Topics

Credit arranged

MSE 507 Microstructures and Defects**3 credits**

This course correlates microstructure and defects with mechanical, physical and chemical properties of engineering materials. The fundamental characteristics of point, line, surface and volume defects in crystals will be elucidated on an advanced level. The essential elements of microstructure and their role in engineering materials will be discussed.

Prereq: Graduate standing or Permission

MSE 512 Nuclear Components Inspection**3 credits**

Cross-listed with NE 512.

This course will cover various non-destructive testing techniques to evaluate the environmental degradation of the nuclear structural components. Remnant life estimation of structural components exposed to fatigue, creep and stress corrosion cracking service conditions will be discussed.

Prereq: Graduate standing or Permission

MSE 513 Phase Transformation and Kinetics**3 credits**

Joint-listed with MSE 413

Free energy minimization algorithms. Construction of phase diagrams for liquid and solid systems. Reaction kinetics in liquid and solid systems. Determination of reaction kinetics parameters (reaction order, activation energy, reaction rate constants, etc.). Coordinated lecture-lab periods. Additional projects/assignments required for graduate credit.

Prereq: CHEM 112, CHEM 112L

MSE 517 Reaction Kinetics**3 credits**

Application of absolute reaction rate theory; time and temperature dependence; kinetics of gas-solid reactions; kinetics of solid-solid reactions; corrosion, diffusion, and recrystallization.

Prereq: Materials Science Engineering graduate student or Permission

MSE 523 Corrosion**3 credits**

Joint-listed with MSE 423.

Engineering aspects of corrosion and its control presented in ways of importance to a practicing engineer. Topics include corrosion economics, detecting and monitoring corrosion, regulations, specifications, safety. Emphasis on corrosion monitoring and corrosion fundamentals: chemical and electrochemical reactions; chemical and electrochemical equilibria-including Pourbaix diagrams; electrochemical kinetics. Selection and use of materials, from stainless steels to plastics. Failure analysis. Additional projects/assignments required for graduate credit. (Fall only)

Prereq: CHEM 112, CHEM 112L and MSE 201 or CHE 223; or Permission

MSE 525 Electronic Materials**3 credits**

Study of major chemical and physical principles affecting properties of solid state engineering materials. Topics include bonding, carrier statistics, band-gap engineering, optical and transport properties, novel materials systems, characterization, magnetism, and comprehensive introduction to physics of solid state devices.

Prereq: Materials Science Engineering graduate student or Permission

MSE 527 Ceramic Materials**3 credits**

Joint-listed with MSE 427.

Crystallography, ceramic crystal structures, phase diagrams, phase transformation; mechanical properties, thermal properties, electrical and magnetic properties. Additional projects/assignments required for graduate credit. Recommended Preparation: MSE 313.

MSE 537 Radiation Effects on Materials**3 credits**

Joint-listed with MSE 437. Cross-listed with NE 437, NE 537.

Interactions between radiation and solids.

Prereq: MSE 201 or Permission

MSE 538 Fundamentals of Nuclear Materials**3 credits**

Joint-listed with MSE 438. Cross-listed with NE 438, NE 538.

This course is designed for students who wish to learn about nuclear materials and fuels from a materials science viewpoint. Topics to be covered include crystal structure, diffusion, radiation damage processes etc. Term-projects and advanced problems required for graduate credit. (Spring only)

Prereq: MSE 201 or NE 450; or Permission

MSE 564 Materials Physics and Engineering**3 credits**

Joint-listed with MSE 464, Cross-listed with PHYS 564

Materials for circuits, Magnetism and magnetic materials, Ferroelectric and piezoelectric materials, Semiconductors, Optical properties of semiconductor for optoelectronics, thermal properties, electron band theory, superconductivity. Additional projects/assignments required for graduate credit. (Spring only)

Prereq: Senior standing in an Engineering or Physics major, or PHYS 305 and PHYS 321; or Permission.

MSE 585 Nuclear Fuel Cycles**3 credits**

Cross-listed with NE 585

Processes to support the existing LWR fuel cycle. Alternative fuel cycles including U-233, Pu239 and mixed oxide fuels, and advanced reactor concepts. Recycling and recovery of nuclear materials, with emphasis on traditional fast reactor recycle.

Prereq: Permission

MSE 598 (s) Internship

Credit arranged

MSE 599 (s) Research

Credit arranged

MSE 600 Doctoral Research & Dissertation

Credit arranged