

# MATERIALS SCIENCE & ENGR (MSE)

## **MSE 1010 Introduction to Metallurgy and Materials Science (2 credits)**

Earth resources, metallurgy, materials science, and manufacturing.

Typically Offered: Fall.

## **MSE 2040 (s) Special Topics (1-16 credits, max 99)**

Credit arranged

## **MSE 2990 (s) Directed Study (1-16 credits, max 99)**

Credit arranged

## **MSE 3080 Thermodynamics of Materials (3 credits)**

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

**Prereqs:** ENGR 2150 and CHEM 1120, CHEM 1120L.

**Coreqs:** MATH 3100

## **MSE 3130 Physical Metallurgy (3 credits)**

Theory, structure, and properties of materials. Typically Offered: Fall.

**Prereqs:** ENGR 2150

## **MSE 3130L Physical Metallurgy Laboratory (1 credit)**

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

**Coreqs:** MSE 3130

## **MSE 3400 Transport and Rate Processes I (4 credits)**

Cross-listed with CHE 3400

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

**Prereqs:** ENGR 3350, MATH 3100, and CHE 2230 or ENGR 2150

## **MSE 3930 Materials Engineering Projects (1-3 credits, max 9)**

Problems of a research exploratory nature.

**Prereqs:** Permission

## **MSE 4000 (s) Seminar (1-16 credits, max 99)**

Credit arranged

## **MSE 4040 (s) Special Topics (1-16 credits, max 99)**

Credit arranged

## **MSE 4120 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.

**Prereqs:** ENGR 2150 and Junior standing; or Permission

## **MSE 4130 Phase Transformation and Kinetics (3 credits)**

Joint-listed with MSE 5130

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.

**Prereqs:** CHEM 1120, CHEM 1120L

## **MSE 4170 Instrumental Analysis (3 credits)**

Principles and laboratory experiments in x-ray diffraction, scanning electron microscopy, transmission electron microscopy, thermal analysis, etc. Typically Offered: Fall.

**Prereqs:** Junior/Senior standing in an engineering discipline

## **MSE 4230 Corrosion (3 credits)**

Joint-listed with MSE 5230

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, and 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.

Typically Offered: Fall.

**Prereqs:** CHEM 1120, CHEM 1120L and ENGR 2150 or CHE 2230; or Permission

## **MSE 4270 Ceramics Materials (3 credits)**

Joint-listed with MSE 5270

Crystallography, ceramic crystal structures, phase diagrams, and phase transformation; mechanical properties, thermal properties, and electrical and magnetic properties. Additional projects/assignments required for graduate credit. Recommended Preparation: MSE 3130.

## **MSE 4320 Fundamentals of Thin Film Fabrication (3 credits)**

Physical deposition, chemical deposition, post deposition process, film characterization, and film properties. Typically Offered: Spring.

**Prereqs:** Senior standing or Permission

## **MSE 4340 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.

**Prereqs:** CHEM 1111, CHEM 1111L and CHEM 1120, CHEM 1120L

## **MSE 4370 Radiation Effects on Materials (3 credits)**

Cross-listed with NE 4370

Joint-listed with MSE 5370, NE 5370

Interactions between radiation and solids.

**Prereqs:** ENGR 2150 or Permission

## **MSE 4380 Fundamentals of Nuclear Materials (3 credits)**

Cross-listed with NE 4380

Joint-listed with MSE 5380, NE 5380

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. Typically Offered: Spring.

**Prereqs:** ENGR 2150 or NE 4500; or Permission

## **MSE 4530 Process Analysis & Design I (3 credits)**

Cross-listed with CHE 4530

Estimation of equipment and total plant costs, annual costs, profitability decisions, and optimization; design of equipment, alternate process systems and economics, and case studies of selected processes. CHE/ MSE 4530 and CHE/MSE 4540 are to be taken in sequence. Typically Offered: Fall.

**Prereqs:** CHE 3300, CHE 3410, and CHE 4230; or ENGR 2150, MSE 3080, MSE 3130, MSE 3400, and MSE 4120

**MSE 4540 Process Analysis and Design II (3 credits)**

General Education: Capstone Experience

Cross-listed with CHE 4540

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 4530 and CHE 4540 are to be taken in sequence. Typically Offered: Spring.

**Prereqs:** CHE 4530 or MSE 4530

**MSE 4560 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.

**Prereqs:** MSE 3130 or Permission

**MSE 4980 (s) Internship (1-16 credits, max 99)**

Credit arranged

**MSE 4990 (s) Directed Study (1-16 credits, max 99)**

Credit arranged

**MSE 5000 Master's Research and Thesis (1-16 credits, max 99)**

Credit arranged

**MSE 5010 (s) Seminar (1-16 credits, max 99)**

Credit arranged

**MSE 5020 (s) Directed Study (1-16 credits, max 99)**

Credit arranged

**MSE 5040 (s) Special Topics (1-16 credits, max 99)**

Credit arranged

**MSE 5070 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.

**Prereqs:** Graduate standing or Permission

**MSE 5120 Nuclear Components Inspection (3 credits)**

Cross-listed with NE 5120

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.

**Prereqs:** Graduate standing or Permission

**MSE 5130 Phase Transformation and Kinetics (3 credits)**

Joint-listed with MSE 4130

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.

**MSE 5170 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.

**Prereqs:** Materials Science Engineering graduate student or Permission

**MSE 5230 Corrosion (3 credits)**

Joint-listed with MSE 4230

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, and 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. Typically Offered: Fall.

**MSE 5250 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.

**Prereqs:** Materials Science Engineering graduate student or Permission

**MSE 5270 Ceramics Materials (3 credits)**

Joint-listed with MSE 4270

Crystallography, ceramic crystal structures, phase diagrams, and phase transformation; mechanical properties, thermal properties, and electrical and magnetic properties. Additional projects/assignments required for graduate credit. Recommended Preparation: MSE 3130.

**MSE 5370 Radiation Effects on Materials (3 credits)**

Cross-listed with NE 5370

Joint-listed with MSE 4370, NE 4370

Interactions between radiation and solids.

**MSE 5380 Fundamentals of Nuclear Materials (3 credits)**

Cross-listed with NE 5380

Joint-listed with MSE 4380, NE 4380

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. Typically Offered: Spring.

**MSE 5850 Nuclear Fuel Cycles (3 credits)**

Cross-listed with NE 5850

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. Typically Offered: Fall.

**Prereqs:** Permission

**MSE 5980 (s) Internship (1-16 credits, max 99)**

Credit arranged

**MSE 5990 (s) Research (1-16 credits, max 99)**

Credit arranged

**MSE 6000 Doctoral Research & Dissertation (1-45 credits, max 99)**

Credit arranged