

# MATERIALS SCIENCE & ENGR (MSE)

## **MSE 101 Introduction to Metallurgy and Materials Science (2 credits)**

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

## **MSE 204 (s) Special Topics (1-16 credits)**

Credit arranged

## **MSE 299 (s) Directed Study (1-16 credits)**

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.

**Prereqs:** ENGR 215 and CHEM 112, CHEM 112L.

**Coreqs:** MATH 310

## **MSE 313 Physical Metallurgy (3 credits)**

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

**Prereqs:** ENGR 215

## **MSE 313L Physical Metallurgy Laboratory (1 credit)**

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

**Prereqs or Coreqs:** 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 lec-lab periods.

**Prereqs:** ENGR 335, MATH 310, and CHE 223 or ENGR 215

## **MSE 393 Materials Engineering Projects (1-3 credits, max 9)**

Problems of a research exploratory nature.

**Prereqs:** Permission

## **MSE 400 (s) Seminar (1-16 credits)**

Credit arranged

## **MSE 404 (s) Special Topics (1-16 credits)**

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.

**Prereqs:** ENGR 215 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.

**Prereqs:** CHEM 112, CHEM 112L

## **MSE 415 Materials Selection and Design (3 credits)**

Cross-listed with ME 415

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 Typically Offered: Spring.

**Prereqs:** ENGR 215 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)

**Prereqs:** 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)

**Prereqs:** CHEM 112, CHEM 112L and ENGR 215 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)

**Prereqs:** 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.

**Prereqs:** CHEM 111, CHEM 111L and CHEM 112, CHEM 112L

## **MSE 437 Radiation Effects on Materials (3 credits)**

Joint-listed with MSE 537

Interactions between radiation and solids.

**Prereqs:** ENGR 215 or Permission.

## **MSE 438 Fundamentals of Nuclear Materials (3 credits)**

Cross-listed with NE 438

Joint-listed with MSE 538, 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. Typically Offered: Spring.

**Prereqs:** ENGR 215 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.

**MSE 454 Process Analysis and Design II (3 credits)**

General Education: 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. CHE 453 and CHE 454 are to be taken in sequence. (Spring only)

**Prereqs:** 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.

**Prereqs:** MSE 313 or Permission

**MSE 498 (s) Internship (1-16 credits)**

Credit arranged

**MSE 499 (s) Directed Study (1-16 credits)**

Credit arranged

**MSE 500 Master's Research and Thesis (1-16 credits)**

Credit arranged

**MSE 501 (s) Seminar (1-16 credits)**

Credit arranged

**MSE 502 (s) Directed Study (1-16 credits)**

Credit arranged

**MSE 504 (s) Special Topics (1-16 credits)**

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.

**Prereqs:** 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.

**Prereqs:** Graduate standing or Permission

**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.

**Prereqs:** 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)

**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.

**Prereqs:** 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

Interactions between radiation and solids.

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

Joint-listed with MSE 438, 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. Typically Offered: Spring.

**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. Typically Offered: Fall.

**Prereqs:** Permission

**MSE 598 (s) Internship (1-16 credits)**

Credit arranged

**MSE 599 (s) Research (1-16 credits)**

Credit arranged

**MSE 600 Doctoral Research & Dissertation (1-45 credits)**

Credit arranged