**MATERIALS SCIENCE AND ENGINEERING (M S & E)**

**M S & E 1 — COOPERATIVE EDUCATION PROGRAM**
1 credit.

Work experience which combines classroom theory with practical knowledge of operations to provide students with a background upon which to base a professional career.

**Requisites:** So st

**Course Designation:** Workplace - Workplace Experience Course

**Repeatable for Credit:** Yes, unlimited number of completions

**M S & E 150 — MATERIALS SCIENCE FOR NON-ENGINEERS**
3 credits.

A non-mathematical treatment of the structure and resulting properties of metals, plastics, ceramics, glasses and composite materials. The interaction between materials and the environment, heat, mechanical forces, light, electric and magnetic fields. Open to Freshmen

**Requisites:** HS chem or physics.

**Repeatable for Credit:** No

**M S & E 250 — INTRODUCTION TO MODERN MATERIALS**
1 credit.

This course is designed to provide incoming students with an overview of the structure of materials and the relation to properties. Special emphasis is placed on modern materials and recent advancements in their application.

**Requisites:** Open to Fr or stdts who have not declared a major

**Repeatable for Credit:** No

**M S & E 299 — INDEPENDENT STUDY**
1-3 credits.

**Requisites:** Consent of instructor

**Repeatable for Credit:** No

**M S & E 330 — THERMODYNAMICS OF MATERIALS**
4 credits.

Introduction to thermodynamics of materials, equilibrium constants, solutions, heterogeneous equilibria and electrochemistry.

**Requisites:** CHEM 104 MATH 222

**Repeatable for Credit:** No

**Last Taught:** Fall 2017

**M S & E 331 — TRANSPORT PHENOMENA IN MATERIALS**
3 credits.

Basic principles of fluid flow, heat transfer and diffusion are introduced. Examples relevant to design and processing of materials including metals, semiconductors, glasses, polymers, and ceramics are given.

**Requisites:** MSE 330

**Repeatable for Credit:** No

**M S & E 332 — MACROPROCESSING OF MATERIALS**
3 credits.

Topics include: ironmaking and steelmaking; production of Cu, Zn, Al and Mg by electrolysis; solidification processing of alloys by ingot casting, continuous casting and directional solidification; growth of bulk single crystals of semiconductors and ceramics from melts.

**Requisites:** MSE 330

**Repeatable for Credit:** No

**Last Taught:** Fall 2017

**M S & E 333 — MICROPROCESSING OF MATERIALS**
3 credits.

Integration of materials science theory and materials engineering practice as applied to the processing of materials at the microscopic level.

**Requisites:** MSE 332 or cons inst

**Repeatable for Credit:** Yes, unlimited number of completions

**M S & E 350 — INTRODUCTION TO MATERIALS SCIENCE**
3 credits.

Basic structure and resulting properties, phase equilibria, metastability, rate and growth processes in solids.

**Requisites:** CHEM 103 or equivalent or consent of instructor

**Repeatable for Credit:** No

**Last Taught:** Fall 2017

**M S & E 351 — MATERIALS SCIENCE-STRUCTURE AND PROPERTY RELATIONS IN SOLIDS**
3 credits.

Introduction to: atomic, electronic, and defect structures in materials; diffusional, mechanical and electrical properties of materials; and the role of structure and defects in diffusional, mechanical, and electrical properties.

**Requisites:** CHEM 104 or equivalent

**Repeatable for Credit:** No

**Last Taught:** Fall 2017

**M S & E 352 — MATERIALS SCIENCE-TRANSFORMATION OF SOLIDS**
3 credits.


**Requisites:** MSE 350, or 351 or consent of instructor

**Repeatable for Credit:** No

**M S & E 360 — MATERIALS LABORATORY I**
1 credit.

Laboratory instruction in sample preparation for and applications of quantitative microscopy, x-ray diffraction, and properties measurement in the context of structure-property relationships in materials.

**Requisites:** MSE 350, 351, or CBE 440 or concurrent registration

**Repeatable for Credit:** No

**Last Taught:** Fall 2017
M S & E 361 — MATERIALS LABORATORY II
2 credits.

Experimental principles of materials science. Thermal, kinetic, structural, and materials synthesis experiments and associated concepts, data analysis, and presentation.
Requisites: MSE 351 or concurrent registration MSE 360 or equivalent
Repeatable for Credit: No

M S & E 362 — MATERIALS LABORATORY III
2 credits.

Experiments in the mechanical and electronic properties of matter in bulk and thin films; computer instrument control; and data analysis.
Requisites: MSE 352 or concurrent registration MSE 361
Repeatable for Credit: No
Last Taught: Fall 2017

M S & E 363 — BASIC MATERIALS CHARACTERIZATION TECHNIQUES
2 credits.

The purpose of this course is to familiarize students with a variety of modern characterization techniques. Three general subject areas are covered: Physical Properties: Thermogravimetric analysis (TGA); differential scanning calorimetry (DSC); dynamic mechanical analysis (DMA); gel permeation chromatography (GPC). Spectroscopy, optical and x-ray: Ultraviolet/visible (UV/VIS), molecular-infrared/Raman, Rheology; x-ray crystal and powder diffraction. Microscopy: scanning electron microscopy (SEM), SEM and energy dispersive analysis (EDS).
Requisites: M S & E 350 and M S & E 351
Repeatable for Credit: No

M S & E 401 — SPECIAL TOPICS IN MATERIALS SCIENCE AND ENGINEERING
1-3 credits.

Special topics of interest to students in materials science and engineering.
Requisites: So st
Course Designation: Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2018

M S & E/CHEM 421 — POLYMERIC MATERIALS
3 credits.

Polymer chemistry and physics terminologies, structure-property relationship, polymer characterization, polymer synthesis, material requirements for optoelectronics including conjugated polymers, thin film transistors, light emitting diodes, non-linear optical materials, holographic data storage and liquid crystal polymers.
Requisites: CHEM 341 or equiv
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No

M S & E/N E 423 — NUCLEAR ENGINEERING MATERIALS
3 credits.

Fundamentals of fuel and cladding behavior in terms of thermal properties, chemical behavior and radiation damage.
Requisites: MSE 350 or 351
Repeatable for Credit: No
Last Taught: Fall 2016

M S & E/N E 433 — PRINCIPLES OF CORROSION
3 credits.

Requisites: MSE 330 or equiv
Repeatable for Credit: No
Last Taught: Spring 2016

M S & E 434 — INTRODUCTION TO THIN-FILM DEPOSITION PROCESSES
3 credits.

Introduction to major thin-film deposition techniques and properties of thin films. Evaporation, plasma assisted processes with emphasis on sputter deposition, chemical vapor deposition ion beams. Film properties and characterization methods, applications.
Requisites: MSE 330 and 351, or equiv
Repeatable for Credit: No
Last Taught: Fall 2017

M S & E/M E 435 — JOINING OF MATERIALS: STRUCTURAL, ELECTRONIC, BIO AND NANO MATERIALS
3 credits.

Requisites: MSE 350 or 351 or cons inst
Repeatable for Credit: No
Last Taught: Spring 2011

M S & E 441 — DEFORMATION OF SOLIDS
3 credits.

Elastic and plastic deformation of real solids. Dislocation theory with applications to metals and alloys. Fracture, fatigue, brittle failure and methods for measuring the mechanical properties of materials.
Requisites: EMA 214 or concurrent registration or consent of instructor, MSE 352 or concurrent registration
Repeatable for Credit: No
Last Taught: Fall 2017

M S & E 445 — MULTICOMPONENT PHASE EQUILIBRIA
3 credits.

Applications of the phase rule to metallurgical and mineralogical reactions.
Requisites: Sr st
Repeatable for Credit: No
Last Taught: Spring 2005
M S & E 448 — CRYSTALLOGRAPHY AND X-RAY DIFFRACTION
3 credits.
Crystal symmetry, projection methods, X-ray studies of structural problems in the solid state.
Requisites: None
Repeatable for Credit: No
Last Taught: Fall 2017

M S & E 451 — INTRODUCTION TO CERAMIC MATERIALS
3 credits.
Primary objectives are to: 1) analyze how atoms and ions combine to form 3D crystals and glasses; 2) examine phase equilibria to understand the driving forces for the formation of particular ceramic phases; 3) introduce and discuss the nature of defects in ceramics; 4) discuss the migration of matter and of charge in ceramics; and 5) discuss properties and processing technologies of ceramics.
Requisites: MSE 330 352
Repeatable for Credit: No
Last Taught: Fall 2017

M S & E 456 — ELECTRONIC, OPTICAL, AND MAGNETIC PROPERTIES OF MATERIALS
3 credits.
Quantitative description of electronic, optical, and magnetic structure-property relationships of materials. Strategies for the development of new materials and introduction to applications of these materials.
Requisites: M S & E 333, M S & E 352, and (PHYSICS 202, 208 or 248)
Repeatable for Credit: No
Last Taught: Fall 2017

M S & E 461 — ADVANCED METAL CASTING
3 credits.
Metallurgical and engineering principles applied in the foundry and related industries, primarily for those interested in foundry engineering.
Requisites: ME 311 or MSE 370
Repeatable for Credit: No
Last Taught: Fall 2017

M S & E/M E 462 — WELDING METALLURGY
3 credits.
Metallurgical principles applied to welding; mechanisms of strengthening, phase equilibria, and microstructure of the weld zone. Modern processes including laser and electron beam welding.
Requisites: MSE 370 or ME 313 and MSE 350 or cons inst
Repeatable for Credit: No

M S & E 463 — MATERIALS FOR ELEVATED TEMPERATURE SERVICE
3 credits.
The design, properties, processing and selection of high temperature materials for structural applications. The fundamentals of diffusion, phase transformations, dislocation motion and oxidation governing the high temperature mechanical properties and structural performance of metallic and ceramic materials.
Requisites: Consent of instructor or senior standing
Repeatable for Credit: No
Last Taught: Fall 2015

M S & E 465 — FUNDAMENTALS OF HEAT TREATMENT
3 credits.
Principles of phase transformations, heat transfer and mechanical properties as applied to heat treatment practice. The design, modeling and analysis of heat treatment processes.
Requisites: Senior standing
Repeatable for Credit: No
Last Taught: Fall 2006

M S & E 470 — CAPSTONE PROJECT I
1 credit.
Capstone experiences in materials design, selection, and application for MSE students. Emphasis on creativity and application of fundamental principles in problem identification, experimental design, data acquisition and analysis, and presentation of results.
Requisites: MSE 331, MSE 352 and MSE 362
Repeatable for Credit: No
Last Taught: Fall 2017

M S & E 471 — CAPSTONE PROJECT II
3 credits.
Capstone experiences in materials design, selection and application for MSE students. Emphasis on creativity and application of fundamental principles in problem identification, experimental design, data acquisition and analysis, and presentation of results.
Requisites: Materials Science and Engineering 470 is required.
Repeatable for Credit: No

M S & E/G L/E/GEOSCI 474 — ROCK MECHANICS
3 credits.
Classification of rock masses, stress and strain in rock, elastic and time-dependent behavior of rock, state of stress in rock masses, failure mechanisms, lab testing, geological and engineering applications.
Requisites: EMA 201 or 214, 304, or cons inst
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No

M S & E/G L/E/GEOSCI 475 — ROCK MECHANICS APPLICATIONS TO ENVIRONMENTAL PROBLEMS
3 credits.
Classification of rock for specific engineering purposes, in situ testing, applications to surface mining and slope stability, applications to underground mining and excavations, applications to waste disposal and underground storage, applications to novel methods of in situ mining, applications to earthquakes.
Requisites: MSE 474 or cons inst
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
M S & E 521 — ADVANCED POLYMERIC MATERIALS
3 credits.

This course is directed at graduate and advanced undergraduates with focused interest in polymeric materials. Basic principles of compatibility between macromolecules and small molecules, physical chemistry of blends and concepts in phase separation, and selected topics on materials design using self-assembly concepts.

Requisites: M S E/CHEM/M S & E 421

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2017

M S & E 530 — THERMODYNAMICS OF SOLIDS
3 credits.

Thermodynamics of condensed matters as applied to materials science and engineering.

Requisites: MSE 330 or equiv

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2017

M S & E/E M A 541 — HETEROGENEOUS AND MULTIPHASE MATERIALS
3 credits.


Requisites: EMA 303 or ME 306 or MSE 441 or equivalent

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2016

M S & E/CBE/E C E 544 — PROCESSING OF ELECTRONIC MATERIALS
3 credits.

Physics and chemistry principles underlying microelectronic materials processing. Effects of processing on materials and structures important in microelectronic and opto-electronic devices.

Requisites: CBE 440 or MSE 351 or ECE 335; or cons inst

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2009

M S & E 551 — STRUCTURE OF MATERIALS
3 credits.

Atomic, nanoscale and microscale structure of materials. Course is designed for first year graduate students with interests in materials research.

Requisites: Graduate standing or M S & E 351 and M S & E 451

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

M S & E 553 — NANOMATERIALS & NANOTECHNOLOGY
3 credits.

The principal objectives of the course are to: i) introduce advanced processing methods for synthesizing nanomaterials, ranging from single nanoparticles to three-dimensional nanostructures, ii) discuss important thermodynamic and kinetic theories related to such processing, iii) describe methods for characterizing the structure and properties of nanomaterials, iv) discuss current and emerging applications for nanomaterials, and v) illustrate the interdisciplinary nature of nanotechnology and address critical challenges.

Requisites: Senior or graduate student status in a physical sciences program

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

M S & E 560 — FUNDAMENTALS OF ATOMISTIC MODELING
3 credits.

Introduction to basic concepts of atomistic modeling in materials, including classical and quantum mechanical energy methods, energy optimization, molecular statistics, molecular dynamics, and Monte Carlo. Relevant aspects of thermodynamics, statistical mechanics, quantum mechanics, and computer programming will also be presented.

Requisites: Sr st or cons inst

Repeatable for Credit: No

Last Taught: Spring 2017

M S & E 570 — PROPERTIES OF SOLID SURFACES
3 credits.

Introduction to structure and electronic properties; surface energy; thermodynamics of surfaces; diffusion. Surface barriers, work function, vibrational and electronic states. Chemical interactions: chemisorption, oxidation, corrosion, absorption kinetics, catalysis. Experimental methods and applications in metals, semiconductors.

Requisites: None

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

M S & E 699 — INDEPENDENT STUDY
1-4 credits.

Courses in Metallurgical Engineering.

Requisites: Consent of instructor

Course Designation: Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions
M S & E 702 — GRADUATE COOPERATIVE EDUCATION PROGRAM
1-2 credits.

Work experience that combines classroom theory with practical knowledge of operations to provide students with a background on which to develop and enhance a professional career. The work experience is tailored for MS students from within the U.S. as well as eligible international students.

**Requisites:** Graduate or professional standing

**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement

**Repeatable for Credit:** Yes, unlimited number of completions

M S & E/G L E 705 — ADVANCED ROCK MECHANICS
3 credits.

Elastic, viscoelastic and plastic behavior of rock, crack phenomena and mechanisms of rock fracture, finite element solutions, dynamic rock mechanics, engineering and geological applications.

**Requisites:** MSE 474, 475, or equiv, or cons inst

**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement

**Repeatable for Credit:** No

M S & E 748 — STRUCTURAL ANALYSIS OF MATERIALS
3 credits.

Introduction to transmission electron microscopy of materials, including imaging, diffraction, and microanalysis.

**Requisites:** MSE 448

**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement

**Repeatable for Credit:** No

M S & E 750 — IMPERFECTIONS AND MECHANICAL PROPERTIES
3 credits.

Mathematical theory of dislocations and other crystal imperfections; mechanical properties of crystals in relation to imperfections.

**Requisites:** Graduate or professional standing

**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement

**Repeatable for Credit:** No

Last Taught: Spring 2016

M S & E 751 — ADVANCED MATERIALS SCIENCE: DIFFUSION AND REACTIONS
3 credits.

Selected topics in materials science and engineering such as phase stability, diffusion and kinetic processes in metals, semi-conductors and ceramics.

**Requisites:** MSE 352 or equiv

**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement

**Repeatable for Credit:** No

Last Taught: Spring 1991

M S & E 752 — ADVANCED MATERIALS SCIENCE: PHASE TRANSFORMATIONS
3 credits.

Phase transformations, nucleation theory and the role of structural imperfections, alloy phase equilibria, interface reactions and growth kinetics, continuous transformations.

**Requisites:** MSE 352 and 530 or equivalent

**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement

**Repeatable for Credit:** No

Last Taught: Fall 2017

M S & E 756 — STRUCTURE AND PROPERTIES OF ADVANCED ELECTRONIC MATERIALS
3 credits.

Prepares graduate students for research in electronic materials and related areas by examining (1) how does the physical structure of a material affect its electronic structure and properties: and (2) state-of-the-art advance electronic materials. Topics include: molecular and organic semiconductors; carbon nanomaterials (nanotubes, nanoribbons and graphene); advances in conventional bulk zinc-blende and wurtzite semiconductors; polycrystalline, amorphous, and disordered materials; state-of-the-art high- k dielectrics; and up-and-coming and next-generation materials.

**Requisites:** PHYSICS 551 or MSE 456 or equivalent

**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement

**Repeatable for Credit:** No

Last Taught: Fall 2017

M S & E 758 — TRANSMISSION ELECTRON MICROSCOPY LABORATORY
1 credit.

An introduction to the practice of transmission electron microscopy (TEM) and TEM sample preparation through hands-on laboratory training.

**Requisites:** MSE 748 or con reg cons inst

**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement

**Repeatable for Credit:** No

M S & E 760 — MOLECULAR DYNAMICS AND MONTE CARLO SIMULATIONS IN MATERIALS SCIENCE
3 credits.

Students will learn algorithms and develop codes for molecular dynamics (MD) and Monte Carlo (MC) simulations of materials. Techniques for parallel programming (MPI) will be introduced and practiced. Advanced techniques based on MD and MC will be presented.

**Requisites:** Graduate or professional standing

**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement

**Repeatable for Credit:** No

M S & E 790 — MASTER’S RESEARCH OR THESIS
1-9 credits.

**Requisites:** Graduate standing

**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement

**Repeatable for Credit:** Yes, unlimited number of completions
M S & E 803 — SPECIAL TOPICS IN MATERIALS SCIENCE
1-3 credits.

Requisites: Graduate or professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2018

M S & E 890 — PRE-DISSERTATOR'S RESEARCH
1-9 credits.

Enroll Info: For post-master's, pre-dissertator students
Requisites: Graduate or professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions

M S & E 900 — MATERIALS RESEARCH SEMINAR
1 credit.

Introduces graduate students to the breadth, wealth and practices of materials research at the University of Wisconsin and in the professional materials research community.
Requisites: Intended for, but not limited to, 1st yr grad stdts
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions

M S & E 990 — RESEARCH AND THESIS
1-9 credits.

Requisites: None
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions

M S & E 999 — INDEPENDENT WORK
1-3 credits.

Requisites: Consent of instructor
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions