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. Enroll Info: So st
Requisites: None
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. Enroll Info: HS chem or physics.
Open to Freshmen
Requisites: None
Repeatable for Credit: No
Last Taught: Fall 1998

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. Enroll Info: Open to Fr or stdts who have not declared a major
Requisites: None
Repeatable for Credit: No
Last Taught: Fall 2015

M S & E 299 — INDEPENDENT STUDY
1-3 credits.
Enroll Info: None
Requisites: Consent of instructor
Repeatable for Credit: No
Last Taught: Spring 2018

M S & E 330 — THERMODYNAMICS OF MATERIALS
4 credits.
Introduction to thermodynamics of materials, equilibrium constants, solutions, heterogeneous equilibria and electrochemistry. Enroll Info: CHEM 104 & MATH 222
Requisites: None
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. Enroll Info: MS&E 330
Requisites: None
Repeatable for Credit: No
Last Taught: Spring 2018

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. Enroll Info: MS&E 330
Requisites: None
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. Enroll Info: MS&E 332 or cons inst
Requisites: None
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2018

M S & E 350 — INTRODUCTION TO MATERIALS SCIENCE
3 credits.
Basic structure and resulting properties, phase equilibria, metastability, rate and growth processes in solids. Enroll Info: CHEM 103 or equivalent or consent of instructor
Requisites: None
Repeatable for Credit: No

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. Enroll Info: CHEM 104 or equivalent
Requisites: None
Repeatable for Credit: No
Last Taught: Fall 2017
M S & E 352 — MATERIALS SCIENCE-TRANSFORMATION OF SOLIDS
3 credits.

The basic factors that determine phase equilibria, structural and transformation characteristics of solids. Principles governing the thermodynamics and kinetics of phase transformations and microstructure evolution. Nucleation and growth processes in precipitation, recrystallization, solidification, oxidation, martensitic, ordering and spinodal reactions. Transformation behavior in polymers, biomaterials and nanomaterials. Enroll Info: MS&E 350, or 351 or consent of instructor
Requisites: None
Repeatable for Credit: No
Last Taught: Spring 2018

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. Enroll Info: MS&E 350, 351, or CBE 440 or concurrent registration
Requisites: None
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. Enroll Info: MS&E 350 or concurrent registration & MS&E 360 or equivalent
Requisites: None
Repeatable for Credit: No
Last Taught: Spring 2018

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. Enroll Info: MS&E 352 or concurrent registration & MS&E 362 or equivalent
Requisites: None
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). Enroll Info: None
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. Enroll Info: So st
Requisites: None
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. Enroll Info: CHEM 341 or equiv
Requisites: None
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
Last Taught: Spring 2018

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. Enroll Info: MS&E 350 or 351
Requisites: None
Repeatable for Credit: No
Last Taught: Fall 2016

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

Requisites: None
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. Enroll Info: MS&E 330 and 351, or equiv
Requisites: None
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: None
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. Enroll Info: EMA 214 or concurrent registration or consent of instructor, & MS&E 352 or concurrent registration
Requisites: None
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. Enroll Info: Sr st
Requisites: None
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. Enroll Info: None
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. Enroll Info: MS&E 330 & 352
Requisites: None
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. Enroll Info: None
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. Enroll Info: ME 311 or MS&E 370
Requisites: None
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. Enroll Info: MS&E 370 or ME 313 and MS&E 350 or cons inst
Requisites: None
Repeatable for Credit: No
Last Taught: Fall 2017

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. Enroll Info: Consent of instructor or senior standing
Requisites: None
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. Enroll Info: Senior standing
Requisites: None
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 MS&E students. Emphasis on creativity and application of fundamental principles of public identification, experimental design, data acquisition and analysis, and presentation of results. Enroll Info: MS&E 331, MS&E 352 and MS&E 362
Requisites: None
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 MS&E students. Emphasis on creativity and application of fundamental principles in problem identification, experimental design, data acquisition and analysis, and presentation of results. Enroll Info: None
Requisites: Materials Science and Engineering 470 is required.
Repeatable for Credit: No
Last Taught: Spring 2018

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. Enroll Info: EMA 201 or 214, 304, or cons inst
Requisites: None
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
Last Taught: Spring 2018

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. Enroll Info: MS&E 474 or cons inst
Requisites: None
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
Last Taught: Spring 2007

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. Enroll Info: None
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. Enroll Info: MS&E 330 or equiv
Requisites: None
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.
Principles of the mechanics of solid multiphase systems. Role of heterogeneity and anisotropy in determining physical properties including elastic, dielectric and piezoelectric properties. Applications in lightweight structures, ultrastrong materials, materials for protection of the body, and materials for the replacement of human tissues. Materials with fibrous, lamellar, particular, and cellular structures. Heterogeneous materials of biological origin. Biomimetic and bio-inspired materials. Enroll Info: EMA 303 or ME 306 or MS&E 441 or equivalent
Requisites: None
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. Enroll Info: CBE 440 or MS&E 351 or ECE 335; or cons inst
Requisites: None
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. Enroll Info: None

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

Last Taught: Spring 2018

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. Enroll Info: Senior or graduate student status in a physical sciences program

Requisites: None

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

Repeatable for Credit: No

Last Taught: Spring 2018

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. Enroll Info: Sr st or cons inst

Requisites: None

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. Enroll Info: None

Requisites: None

Repeatable for Credit: No

Last Taught: Spring 2018

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

Courses in Metallurgical Engineering. Enroll Info: None

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. Enroll Info: None

Requisites: Graduate/professional standing

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

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Summer 2016

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. Enroll Info: MS&E 474, 475, or equiv, or cons inst

Requisites: Graduate/professional standing

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

Repeatable for Credit: No

Last Taught: Spring 2004

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

Introduction to transmission electron microscopy of materials, including imaging, diffraction, and microanalysis. Enroll Info: MS&E 448

Requisites: Graduate/professional standing

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

Repeatable for Credit: No

Last Taught: Spring 2018

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. Enroll Info: None

Requisites: Graduate/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. Enroll Info: MS&E 352 or equiv
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No

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. Enroll Info: MS&E 352 and 530 or equivalent
Requisites: Graduate/professional standing
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- & low-k dielectrics; and up-and-coming and next-generation materials. Enroll Info: PHYSICS 551 or MS&E 456 or equivalent
Requisites: Graduate/professional standing
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. Enroll Info: MS&E 748 or con reg & cons inst
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2018

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. Enroll Info: None
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2018

M S & E 790 — MASTER'S RESEARCH OR THESIS
1-9 credits.
Enroll Info: None
Requisites: Declared in a Materials Science and Engineering, Materials Science, or Materials Engineering graduate program
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.
Enroll Info: None
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Summer 2018

M S & E 890 — PRE-DISSERTATOR'S RESEARCH
1-9 credits.
Enroll Info: For post-master's, pre-dissertation students
Requisites: Declared in a Materials Science and Engineering, Materials Science, or Materials Engineering graduate program
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. Enroll Info: Intended for, but not limited to, 1st yr grad stdts
Requisites: Graduate/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 990 — RESEARCH AND THESIS
1-9 credits.

Enroll Info: None
Requisites: Declared in a Materials Science and Engineering, Materials Science, or Materials Engineering PhD program
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.

Enroll Info: None
Requisites: Consent of instructor
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2000