

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. Enroll Info: So st

Requisites: None

Course Designation: Workplace - Workplace Experience Course

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2019

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 260 – MATERIALS EXPERIENCE

2 credits.

Provides overview of the field of Materials Science and Engineering, with significant design and hands-on components. Highlights different types of materials, with a focus on describing the extensive impact that Materials Science and Engineering has had on society. Small teams provide hands-on experience in materials design, synthesis, and processing and the fabrication of materials with desired properties and function. Enroll Info: None

Requisites: (MATH 113, 114, or 171) and (CHEM 103, 109, or 115 or concurrent enrollment)

Repeatable for Credit: No

Last Taught: Fall 2018

M S & E 299 – INDEPENDENT STUDY

1-3 credits.

Enroll Info: None

Requisites: Consent of instructor

Repeatable for Credit: No

Last Taught: Spring 2019

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 2018

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: MSE 330

Requisites: None

Repeatable for Credit: No

Last Taught: Spring 2019

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: MSE 330

Requisites: None

Repeatable for Credit: No

Last Taught: Fall 2018

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: MSE 332 or cons inst

Requisites: None

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2019

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

Last Taught: Spring 2019

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 2018

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: MSE 350, or 351 or consent of instructor

Requisites: None**Repeatable for Credit:** No**Last Taught:** Spring 2019**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: MSE 350, 351, or CBE 440 or concurrent registration

Requisites: None**Repeatable for Credit:** No**Last Taught:** Fall 2018**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: MSE 351 or concurrent registration MSE 360 or equivalent

Requisites: None**Repeatable for Credit:** No**Last Taught:** Spring 2019**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: MSE 352 or concurrent registration MSE 361

Requisites: None**Repeatable for Credit:** No**Last Taught:** Fall 2018**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 (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 2019**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: MSE 350 or 351

Requisites: None**Repeatable for Credit:** No**Last Taught:** Fall 2018**M S & E/N E 433 – PRINCIPLES OF CORROSION**
3 credits.

Thermodynamics and kinetics of metallic corrosion. The common forms of corrosion and corrosion susceptibility tests. Electrochemical measurement of corrosion rates. Corrosion prevention, economic considerations. High temperature oxidation and sulphidation. Corrosion case histories. Enroll Info: MSE 330 or equiv

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: MSE 330 and 351, or equiv

Requisites: None**Repeatable for Credit:** No**Last Taught:** Fall 2018

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

Structural (metallic, ceramic, plastic, composite): welding, soldering, brazing, diffusion bonding, adhesive bonding. Electronic: wave and reflow soldering; wire, flip-chip and wafer bonding. Bio: hip and knee implants; dental restorations and implants; medical devices. Nano: nano tubes, wires, fibers and composites. Enroll Info: MSE 350 or 351 or cons inst
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, MSE 352 or concurrent registration
Requisites: None
Repeatable for Credit: No
Last Taught: Spring 2019

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 2018

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: MSE 330 352
Requisites: None
Repeatable for Credit: No
Last Taught: Fall 2018

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 2018

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 MSE 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: MSE 370 or ME 313 and MSE 350 or cons inst
Requisites: None
Repeatable for Credit: No
Last Taught: Spring 2018

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 2018

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 of public identification, experimental design, data acquisition and analysis, and presentation of results. Enroll Info: MSE 331, MSE 352 and MSE 362
Requisites: None
Repeatable for Credit: No
Last Taught: Fall 2018

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. Enroll Info: None

Requisites: Materials Science and Engineering 470 is required.

Repeatable for Credit: No

Last Taught: Spring 2019

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 2019

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: MSE 330 or equiv

Requisites: None

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

Repeatable for Credit: No

Last Taught: Fall 2018

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 MSE 441 or equivalent

Requisites: None

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

Repeatable for Credit: No

Last Taught: Fall 2018

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 MSE 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 2019

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 2019

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**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Spring 2019**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**Last Taught:** Spring 2019**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:** Fall 2018**M S & E 748 – STRUCTURAL ANALYSIS OF MATERIALS**

3 credits.

Introduction to transmission electron microscopy of materials, including imaging, diffraction, and microanalysis. Enroll Info: MSE 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 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: MSE 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 MSE 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: MSE 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: Fall 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

Last Taught: Spring 2019

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: Spring 2019

M S & E 890 – PRE-DISSERTATOR'S RESEARCH

1-9 credits.

Enroll Info: For post-master's, pre-dissertator 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

Last Taught: Spring 2019

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 2019

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

Last Taught: Spring 2019

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