
MSE Materials Science and Engineering

- MSE 101 MATERIALS ENGINEERING. (1)**
An introduction to the materials engineering profession. Professional growth, conduct, ethics and organizations. Introduction to the techniques of materials engineering.
- MSE 201 MATERIALS SCIENCE. (3)**
Microscopic and macroscopic structure as related to the properties of materials with engineering applications. Prereq or concur: MA 114 and freshman chemistry.
- MSE 202 MATERIALS SCIENCE LABORATORY. (1)**
To teach students the basic materials characterization laboratory techniques and demonstrate the difference in properties between different types of materials. Prereq: Concurrent enrollment in MSE 201.
- MSE 301 MATERIALS SCIENCE II. (3)**
Introduction to processing of ceramic, polymer and composite materials; relating the structure and bonding in these materials to their properties; considerations in choosing appropriate materials for engineering applications. Prereq: MSE 201, or consent of instructor.
- MSE 351 MATERIALS THERMODYNAMICS. (3)**
Solution thermodynamics; partial molal quantities; ideal and non-ideal solutions; application of thermodynamics to phase equilibria; heterogeneous equilibria; free energy-composition relationships; temperature-pressure relationships. Prereq: MSE 201, MA 213 or concurrent.
- MSE 395 INDEPENDENT WORK IN MATERIALS ENGINEERING. (1-3)**
Research for undergraduate departmental students. May be repeated to a maximum of 12 credits. Prereq: Department major and approval of chairperson.
- MSE 401G METAL AND ALLOYS. (3)**
Crystal structures, phase diagrams, diffusion, nucleation and growth, deformation, recovery, recrystallization and grain growth are discussed to understand the structure-property relations in metals and alloys. Prereq: MSE 201, 301 and Engineering Standing.
- MSE 402G ELECTRONIC MATERIALS AND PROCESSING. (3)**
This course will examine electron behavior in a variety of materials and the processing methods used for integrated device production. Additional topics will include thin film growth, diffusion, oxidation, electronic device principals, defect control, and a survey of current challenges to the semiconductor industry. Prereq: MSE 201, MSE 301 or related engineering/science senior/graduate level courses with instructor permission.
- MSE 403G CERAMIC ENGINEERING AND PROCESSING. (3)**
Microstructure of crystalline ceramics and glasses, and role of thermodynamics and kinetics in its formation. Effect of microstructure on mechanical and physical properties. Prereq: MSE 201, MSE 301 or consent of instructor, Engineering standing.
- MSE 404G POLYMERIC MATERIALS. (3)**
Synthesis, structure, and processing of polymers, useful geometric forms, mechanical and thermal properties, crystallinity, polymer blends, evaluation of polymers for specific applications (aerospace, automotive, biomedical), laboratory activities for each of the above. Prereq: Engineering standing. CHE 230 or CHE 236. MSE 301 or consent of instructor. (Same as CME 404G.)
- MSE 407 MATERIALS LABORATORY I. (3)**
Various laboratory experiments that demonstrate behavior of polymers, metals, ceramics, and electronic materials. Includes instruction and practice in use of numerous instruments and equipment, typical of the materials engineering discipline. Data reduction, analysis, and interpretation is covered, as well as correct writing of reports. Prereq: MSE 202, MSE 301, MSE 351, Engineering standing. This course is a Graduation Composition and Communication Requirement (GCCR) course in certain programs, and hence is not likely to be eligible for automatic transfer credit to UK.
- MSE 408 MATERIALS LABORATORY II. (3)**
Various laboratory experiments that illustrate crystal structure, behavior of multi-component systems, and failure modes. Provides hands-on experience with some more advanced characterization methods of polymers, metals, and ceramics. Includes data reduction, analysis, and interpretation, as well as correct writing of reports. Prereq: MSE 407.

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MSE 436 MATERIAL FAILURE ANALYSIS. (3)

A review of common engineering materials, their potential failure mechanisms and corresponding technology developed to avoid these failures. This course illustrates applications of current technology to practical industrial problems and is designed for engineers of all disciplines. Prereq: MSE 201 and EM 302 and Engineering standing.

#MSE 470 APPLICATION OF MATERIALS ENGINEERING TO DESIGN PROBLEMS. (1)

An introduction to aspects of design in materials science and engineering. This course enables students to begin planning and performing preliminary work toward their projects that will form the basis of the capstone materials engineering design experience in the subsequent Spring semester. Students planning to take MSE 480 in the following Spring semester are encouraged to enroll. Prereq: MSE 401G; senior standing in the Materials Engineering (MSE) program.

MSE 480 MATERIALS DESIGN. (3)

A capstone engineering design experience involving analysis, with some treatments of engineering economics of real processes, design of materials, fabrication problems and techniques, and prediction of model material systems. Prereq: MSE 408.

MSE 506 MECHANICS OF COMPOSITE MATERIALS. (3)

A study of structural advantages of composite materials over conventional materials, considering high strength-to-weight and stiffness-to-weight ratios. Fiber reinforced, laminated and particulate materials are analyzed. Response of composite structures to static and dynamic loads, thermal and environmental effects, and failure criteria are studied. Prereq: EM 302, engineering standing or consent of instructor. (Same as EM/ME 506.)

MSE 531 POWDER METALLURGY. (3)

Study of the principles of powder metallurgy relating to alloys of unusual compositions, metal and nonmetal combinations, porous and laminated products, composite metals, and high-melting alloys. Prereq: Consent of instructor.

MSE 535 MECHANICAL PROPERTIES OF MATERIALS. (3)

Introductory elasticity and plasticity theory; crystallographic nature of slip and twinning; fracture. Prereq: MSE 201, EM 302 and engineering standing or consent of instructor.

MSE 538 METALS PROCESSING. (3)

Solidification of molten alloys; fundamentals of metal working; application of metal working theories to forging, rolling, extrusion, drawing and sheet forming. Prereq: Engineering standing.

#MSE 552 AUTOMOTIVE PLASTICS. (3)

Overview of materials and processes for the application of plastics in the automotive industry. Engineering properties of plastics, rheology and governing relations for melt process flows. Plastic injection molding including design, control, and simulation of molding operations. Plastic part design and material selection; material testing and quality control. Prereq: Engineering Standing, MSE 201 or enrollment in the Production Engineering Certificate. (Same as CME 552.)

MSE 554 CHEMICAL AND PHYSICAL PROCESSING OF POLYMER SYSTEMS. (3)

Theory and practice as related to the chemical and physical processing of polymer systems. Polymer rheology, heat transfer in polymer flows, polymer engineering properties. Polymer processing operations and materials selection; flow instabilities. Prereq: CME 330, CME 425 or ME 325; or consent of instructor. This course is open only to graduate students or undergraduates with engineering standing. (Same as CME/ME/MFS 554.)

MSE 555 INTRODUCTION TO MICRO-/NANO-ELECTROMECHANICAL SYSTEMS. (3)

This course provides an overview of micromachined structures with an emphasis on operational theory and fabrication technology. Prereq: Engineering standing or consent of instructor. (Same as EE/ME 555.)

MSE 556 INTRODUCTION TO COMPOSITE MATERIALS. (3)

Modern composite materials and their applications. Basic concepts and definitions. Fundamental properties of fibers and polymer resins. Manufacturing methods. Analysis and design of laminated and chopped fiber reinforced composites. Micro- and macro-mechanical analysis of elastic constants. Failure theory of composite materials. Computational design of composites. Prereq: Engineering Standing, and EM 302 or with instructor permission. (Same as CME/ME/MFS 556.)

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MSE 569 ELECTRONIC PACKAGING SYSTEMS AND MANUFACTURING PROCESSES. (3)

Study of packaging systems which interconnect, support, power, cool, protect, and maintain electronic components. The course will address systems at the chip, board, and product levels. Topics include design, properties, materials, manufacture, and performance of various packaging systems. Laboratory will provide familiarity with design software and production equipment and processes. Prereq: EE 211 or EE 305, EE 360 or MSE 402G, or consent of instructor. (Same as EE 569.)

MSE 570 FUNDAMENTALS OF NANOELECTRONIC DEVICES AND MATERIALS. (3)

Energy bands in crystals; heterostructures; quantum wells and low dimensional systems; the two-dimensional electron gas and MODFET; transmission in nanostructures; current topics in nanoscale devices. Prereq: EE 360 and engineering standing, or consent of instructor. (Same as EE/ME 570.)

MSE 585 MATERIALS CHARACTERIZATION TECHNIQUES. (3)

This course will present the fundamentals of x-ray and electron beam interactions with solid-state materials. Both elastic and inelastic interactions will be treated, with emphasis on elastic diffraction effects. Prereq: MSE 301 and Engineering standing, or graduate status or consent of instructor.

MSE 599 TOPICS IN MATERIALS SCIENCE AND ENGINEERING (Subtitle required). (1-4)

A detailed investigation of a topic of current significance in engineering and materials science such as: biomedical synthetics, electronic properties of materials, advances in metal working, history of materials technology, quantitative metallography. Theory of disclinations, scanning electron microscopy. May be repeated to a maximum of eight credits, but only four credits can be earned under the same title. A particular topic may be offered at most twice under the MSE 599 number. Prereq: Variable; given when topic identified.

PREREQUISITE FOR GRADUATE WORK: Students desiring to take any of the following courses should have a thorough working knowledge of chemistry, physics and mathematics.

MSE 601 INTRODUCTION TO MATERIALS SCIENCE AND ENGINEERING. (3)

The purpose of this course is to provide a general background in the field of materials science and engineering for graduate level students. Fundamental topics include chemical bonding in materials, crystal structure and defects, diffusion and phase diagrams. The mechanical, electrical and optical properties of materials will be discussed in the context of processing history and application. Important concepts such as anisotropic properties of materials and their tensor representation will be introduced. The course covers major materials systems (metals, ceramics, polymers, composites, and electronic materials) and offers examples of materials applications in a range of technical areas. Prereq: Graduate standing in chemical engineering or materials science and engineering, or consent of instructor.

MSE 607 ANALYSIS OF METAL CUTTING PROCESSES. (3)

Advanced study of metal cutting involving the mechanics of metal cutting including cutting forces, tool-wear/tool-life and temperature analysis, surface finish and integrity, chip control, machinability assessments and advances in cutting tool technology. Prereq: ME 505. (Same as ME/MFS 607).

MSE 620 COMPUTATIONAL MATERIALS SCIENCE ENGINEERING. (3)

The effective use of existing computer software in the area of materials science engineering. Use of computers to model processes and examine and predict materials properties at the macroscopic and atomistic level. Prereq: Graduate standing in physical sciences and engineering, strong background in material properties and structure similar to the material covered in MSE 401G, MSE 403G, and MSE 404G, and some programming experience in C or FORTRAN; or consent of instructor.

MSE 632 ADVANCED MATERIALS SCIENCE. (3)

Classification of solids, atomic structure and bonding, relation of structure to properties, deformation behavior and failure. Prereq: Consent of instructor.

MSE 635 ADVANCED MECHANICAL METALLURGY. (3)

Theory of dislocations in crystals and their role in strength, plasticity, work hardening and fracture of crystalline solids. Prereq: Consent of instructor.

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- MSE 636 DISLOCATION THEORY. (3)**
Fundamentals of elastic theory of dislocations and the kinematics of dislocation motion: straight dislocations, curved dislocation, self-energies, interactions with other crystal defects, dislocation multiplication. Prereq: MSE 535 or EM 531 or equivalent.
- MSE 650 ADVANCED MATERIALS THERMODYNAMICS. (3)**
Study of reactions of materials with chemical environments. Introduction to irreversible thermodynamics. Emphasis on current literature. Prereq: Consent of instructor.
- MSE 663 OPTOELECTRONIC DEVICES. (3)**
Theory and applications of photodetectors, solar cells, semiconductor lasers, light emitting diodes and display devices, nanocrystalline structures and organic semiconductors applications in optoelectronic devices. Prereq: EE 360 or MSE 402G, consent of instructor and/or graduate standing. (Same as EE 663.)
- MSE 664 MULTIDISCIPLINARY SENSORS LABORATORY. (3)**
A multidisciplinary laboratory course with laboratory experiences in areas related to sensors and sensing architectures, typically including chemistry, chemical and materials engineering, and electrical engineering. Lecture, 1 hour; laboratory, 2 hours. Prereq: One year of college chemistry, calculus and physics. GS 660 or by consent of instructor. (Same as CHE/CME/EE 664.)
- MSE 699 ADVANCED TOPICS IN MATERIALS SCIENCE AND ENGINEERING (Subtitle required.) (3)**
A detailed investigation of an advanced topic of current significance in materials science and engineering such as (1) nanometer materials, (2) structures of superconductors and (3) materials characterization under high rates of deformation. May be repeated under different subtitles to a maximum of nine credits, but only three credits can be earned under the same title. A particular topic may be offered at most twice under the MSE 699 number. Prereq: Variable, given when topic is identified.
- MSE 748 MASTER'S THESIS RESEARCH. (0)**
Half-time to full-time work on thesis. May be repeated to a maximum of six semesters. Prereq: All course work toward the degree must be completed.
- MSE 749 DISSERTATION RESEARCH. (0)**
Half-time to full-time work on dissertation. May be repeated to a maximum of six semesters. Prereq: Registration for two full-time semesters of 769 residence credit following the successful completion of the qualifying exams.
- MSE 767 DISSERTATION RESIDENCY CREDIT. (2)**
Residency credit for dissertation research after the qualifying examination. Students may register for this course in the semester of the qualifying examination. A minimum of two semesters are required as well as continuous enrollment (Fall and Spring) until the dissertation is completed and defended.
- MSE 768 RESIDENCE CREDIT FOR THE MASTER'S DEGREE. (1-6)**
May be repeated to a maximum of 12 hours.
- MSE 769 RESIDENCE CREDIT FOR THE DOCTOR'S DEGREE. (0-12)**
May be repeated indefinitely.
- MSE 771 SEMINAR. (0)**
Review of current literature in the field of metallurgical engineering and presentation of papers thereon. Presentation of talks on departmental research. Group and panel discussions. Required of all graduate students every semester. Lecture, one hour per week.
- MSE 781 SPECIAL PROBLEMS, LITERATURE AND LABORATORY. (1-3)**
Literature research and planning of research programs; shop problems and technical writing, including a term paper, are required. Consultation and lecture by appointment. May be repeated to a maximum of nine credits.
- MSE 782 SPECIAL PROBLEMS, LITERATURE AND LABORATORY. (3)**
A continuation of MSE 781. Laboratory, six hours; consultation and lecture by appointment. May be repeated to a maximum of nine credits.
- MSE 790 RESEARCH IN MATERIALS SCIENCE. (3-9)**
Active research (experiments, library work, theory) toward Ph.D. degree. May be repeated indefinitely.