Materials Science and Engineering (MSE)

mse.engr.uconn.edu

5001. Principles of Materials Engineering

Three credits.

Accelerated Introduction to Materials Science and Engineering Concepts, including: structures and defects; phase diagrams; mechanical properties; electronic properties; magnetic properties; optical properties; thermal properties; functional materials; metals and alloys; ceramics; polymers; and composites.

5095. Special Topics in Materials Science and EngineeringVariable (1-3) credits. Prerequisite: Only MSE graduate students can register for this course, all others require instructor consent.Course taught on a provisional basis for the purposes of course development. Students may take multiple instances of MSE 5095, which all can count towards the applicable MSE graduate course credit requirements for M.S. Plan A, M.S. Plan B, M.Eng. or Ph.D. degrees, provided each instance covers a different topic.

5097. Research Methods in Materials Science and Engineering

Variable (1-3) credit. Prerequisite: Open to M.S. Plan B or M.Eng. students; major advisor approval required.

Introduction to modern methodologies of experimental or computational materials research. A maximum of three credits can count toward the MSE graduate course credit requirements for M.S. Plan B or M.Eng. degrees. Cannot substitute for any GRAD course or be used to satisfy M.S. or Ph.D. degree credit requirements for thesis or dissertation research.

5098. Variable Topics in Materials Science and Engineering

Variable (1-3) credits. May be repeated with a change in topic.

Advanced or specialized topics in materials science, engineering and/or technology. A maximum of three credits can count towards the applicable MSE graduate course credit requirements for M.S. Plan A, M.S. Plan B, M.Eng. or Ph.D. degrees.

5099. Independent Study in Materials Science and Engineering

Variable (1-3) credits. Prerequisite: Major advisor consent; open only to Materials Science and Engineering graduate students.

Specialized non-classroom-based coursework under the regular supervision of a faculty instructor, or as offered by an accredited third party source. Does not constitute original research. A maximum of three credits can count towards the applicable MSE graduate course credit requirements for M.S. Plan A, M.S. Plan B, M.Eng. or Ph.D. degrees.5301. Thermodynamics of Materials

Three credits.

Classical thermodynamics with emphasis on solutions and phase equilibria. Applications to unary and multicomponent, reacting and nonreacting, homogeneous and heterogeneous systems, including development of phase diagrams.

5305. Phase Transformations in Solids

Three credits.

Thermodynamics, kinetics and crystallography of phase transformations. Nucleation and growth kinetics. Order-disorder, ferroelectric, and ferromagnetic transformations.

5307. Solidification of Metals and Alloys

Three credits. Prerequisite: MSE 5301.

Thermodynamic and kinetic principles of solidification. Control of structure and properties of pure and multicomponent materials through casting and solidification processes. Application of solidification principles to shaped casting, continuous casting, crystal growth and particulate processes.

5309. Transport Phenomena in Materials Science and Engineering

Three credits.

Mechanisms and quantitative treatment of mass, energy, and momentum transfer will be discussed in the context of materials science and engineering applications. Increasingly complex and open-ended applications will be used to illustrate principles of fluid flow; heat conduction, radiation, and diffusion.

5310. Materials Modeling from First Principles

Three credits. Prerequisite: Instructor consent.

An overview of the theory and practices underlying modern electronic structure materials computations, primarily density functional theory (DFT). Students involved primarily/partially in materials computations, as well as those focused on experimental materials research wishing to learn about DFT techniques will benefit from this course.

5311. Mechanical Properties of Materials

Three credits.

Mechanics of deformation and fracture; dislocation theory; strength of ductile and brittle materials; toughness; strengthening mechanisms; toughening mechanisms; creep mechanisms; fatigue crack initiation and propagation; reliability and lifetime prediction.

5317. Electronic and Magnetic Properties of Materials

Three credits.

Crystal structures and interatomic forces, lattice vibrations, thermal, acoustic, and optical properties. Semiconductors, dielectric properties, magnetism, and magnetic properties, superconductivity. Device applications.

5320. Investigation of Special Topics

Three credits. May be repeated for a maximum of nine credits.

Special courses or individual readings.

5322. Materials Characterization

Three credits.

A review of the principal experimental methods used to reveal the microstructure and chemistry of materials. Diffraction techniques: x-ray, electron, neutron and proton scattering. Photon probes: photon microscopies, x-ray topography and XPS. Electron probes: SEM, TEM, EDX, EELS, AES. Atom and ion probes: RBS, SIMS, FIM, PIXE. Scanned probe microscopies.

5323. Transmission Electron Microscopy

Three credits. Prerequisite: MSE 5322 or instructor consent.

Electron beam-specimen interactions. Basics of electron microscopes. Diffraction: theory, types of patterns and interpretation. Imaging: diffraction contrast, phase contrast and other techniques. Spectrometry: x-ray microanalysis and electron energy-loss spectrometry.

5330. Classical Atomic-level Simulations in Materials Science and Engineering

Three credits.

Introduction to several classical atomic-level simulation techniques (molecular dynamics, Monte Carlo methods) with an emphasis on learning the art of designing simulations and analyzing data generated. The capabilities of the methods to investigate properties and response of materials and the current limitations of materials at the atomic scales will be covered.

5333. Imperfections in Crystalline Materials

Three credits. Prerequisite: Open only to Materials Science and Engineering graduate students.

Defects in materials: point defects, line defects, and planar defects. The origins, structure and distribution of defects in crystalline solids will be described. The influence of defects on material properties will be discussed in the context of materials science and engineering applications.

5334. Structure of Materials

Three credits.

Translation symmetry and space lattices, crystallographic computations, point and space groups, reciprocal space treatment of diffraction, and use of the International Tables for Crystallography. Chemical bonding and descriptive crystal chemistry of metals, ceramics and molecular solids. Structure of amorphous and vitreous materials and introduction to point, line and planar defects. Crystal anisotropy and relations between structure, symmetry and physical properties.

5335. High Temperature Materials

Three credits.

Strength-determining factors in advanced alloys, ceramics and composites. Role of material chemistry and microstructure. High temperature creep and crack growth. Oxidation. Thermomechanical behavior.

5336. Material Selection in Mechanical Design

Three credits. Prerequisite: MSE 2101; instructor consent required.

Study of materials and how they are chosen for various mechanical designs. A wide range of materials will be discussed (metal, ceramic, polymer, etc.) and their key properties (modulus, strength, density, etc.) in design will be reviewed. Guidelines for material selection will be shown. Design trades will also be discussed.

5343. Corrosion

Three credits.

Mechanisms, characteristics and types of corrosion. Test methods and evaluation of corrosion resistance. Suitability of metals, ceramics, and organic materials in corrosive environments. Oxidation and other high temperature gas-metal reactions.

5364. Advanced Composites

Three credits.

Mechanical properties, analysis and modeling of composite materials. The properties treated include stiffness, strength, fracture toughness, fatigue strength and creep resistance as they relate to fiber, whisker, particulate, and laminated composites.

5366. Alloy Casting Processes

Three credits.

Principles and practices of alloy solidification and casting processes are discussed and applied in the context of sand, investment, permanent mold and die-casting; continuous and direct chill casting; electroslag and vacuum arc remelting; crystal growth; rapid solidification; and laser coating.

5370. Ceramics

Three credits. Prerequisite: A knowledge of Materials Science at the undergraduate level, or MSE 5001.

A graduate-level treatment of the science and engineering of Ceramic Materials. Concepts to be studied include the structure of both crystalline and non-crystalline material, and defects (including point defects, dislocations and interfaces) in these materials. A broad range of special (for ceramics) methods for the preparation, processing and characterization of these materials will run throughout the course. An important component of the course is consideration of how the crystal structure determines or influences mechanical, electronic, magnetic, and thermal properties. Special topics may include functional ceramics, 2D ceramics, and connections between ceramics, economics and global affairs.

5700. Biomaterials and Tissue Engineering

(Also offered as MEDS 5313 and BME 5700.) Three credits. Prerequisite: Instructor consent. Recommended preparation: BME 3700.

A broad introduction to the field of biomaterials and tissue engineering. Presents basic principles of biological, medical, and material science as applied to implantable medical devices, drug delivery systems and artificial organs.

6401. Graduate Seminars in Materials Science and Engineering

One credit. May be repeated for credit.

Presentations by invited guest speakers on topics of current interest in various areas of Materials Science and Engineering.