# MATERIALS SCIENCE AND ENGINEERING (MSE)

**MSE 2001. Introduction to Structure, Properties, and Processing of Materials I. (3 Credits)**
Bonding in materials, the crystal structure of metals and ceramics, and defects in materials will be introduced. Basic principles of phase diagrams and phase transformations will be given with particular emphasis on microstructural evolution and the effect of microstructure on the mechanical properties of metals and alloys. Introductory level knowledge of mechanical properties, testing methods, strengthening mechanisms, and fracture mechanics will be provided.
CHEM 1127Q or 1147Q. Not open to students who have passed MSE 2101.
View Classes (https://catalog.uconn.edu/course-search/?details&code=MSE%202001)

**MSE 2002. Introduction to Structure, Properties, and Processing of Materials II. (3 Credits)**
Structures, properties, and processing of ceramics; structure, properties and processing of polymers and composites; electrical, thermal, magnetic and optical properties of solids; and corrosion.
MSE 2001 or 2101.
View Classes (https://catalog.uconn.edu/course-search/?details&code=MSE%202002)

**MSE 2053. Materials Characterization and Processing Laboratory. (2 Credits)**
First semester of a three-semester MSE laboratory sequence. Foundational aspects of materials processing, specimen preparation, materials characterization, and materials design/selection will be introduced through experiments involving qualitative and quantitative microscopy, mechanical testing, thermal and mechanical processing. Course modules focus on metals, ceramics, and polymers.
MSE 2001 and MSE 2002, the latter can be taken concurrently.
View Classes (https://catalog.uconn.edu/course-search/?details&code=MSE%202053)

**MSE 2101. Materials Science and Engineering I. (3 Credits)**
Relation of crystalline structure to chemical, physical, and mechanical properties of metals and alloys. Testing, heat treating, and engineering applications of ferrous and non-ferrous alloys.
CHEM 1127Q or 1147Q. Not open to students who have passed MSE 2001.
View Classes (https://catalog.uconn.edu/course-search/?details&code=MSE%202101)

**MSE 2102. Materials Science and Engineering II. (3 Credits)**
Structures, properties, and processing of ceramics; structure, properties and processing of polymers and composites; electrical, thermal, magnetic and optical properties of solids; and corrosion.
MSE 2001 or 2101. Not open to students who have passed MSE 2002.
View Classes (https://catalog.uconn.edu/course-search/?details&code=MSE%202102)

**MSE 3001. Applied Thermodynamics of Materials. (4 Credits)**
Thermodynamic principles will be applied to the behavior and processing of materials. Topics covered will include thermodynamic properties, solution thermodynamics, phase equilibria, phase diagram prediction, gas-solid reactions and electrochemistry.
MSE 2001 or 2101.
View Classes (https://catalog.uconn.edu/course-search/?details&code=MSE%203001)

**MSE 3002. Transport Phenomena in Materials Processing. (3 Credits)**
Mechanisms and quantitative treatment of mass, energy, and momentum transfer will be applied to design and analysis of materials processing. Increasingly complex and open-ended engineering design projects will be used to illustrate principles of diffusion; heat conduction, convection, and radiation, and fluid flow.
MSE 3003 and MATH 2110Q, both of which may be taken concurrently.
View Classes (https://catalog.uconn.edu/course-search/?details&code=MSE%203002)

**MSE 3003. Phase Transformation Kinetics and Applications. (3 Credits)**
Principles and applications of phase transformations to control microstructure and materials properties. In depth, quantitative coverage will include vacancies, solid solutions, phase diagrams, diffusion, solidification of metals, nucleation and growth kinetics, and thermal treatments to control microstructure.
MSE 2001 or 2101.
View Classes (https://catalog.uconn.edu/course-search/?details&code=MSE%203003)

**MSE 3004. Mechanical Behavior of Materials. (3 Credits)**
Elements of elastic plastic deformation of materials and the role of crystal structure. Strengthening and toughening mechanisms. Fracture; including fatigue, stress corrosion and creep rupture. Test methods.
MSE 2001 or 2101.
View Classes (https://catalog.uconn.edu/course-search/?details&code=MSE%203004)

**MSE 3020. Failure Analysis. (3 Credits)**
Methods for determining the nature and cause of materials failure in structures and other mechanical devices. Analysis of case histories.
MSE 2001 or 2101.
View Classes (https://catalog.uconn.edu/course-search/?details&code=MSE%203020)

**MSE 3029. Ceramic Materials. (3 Credits)**
Microstructure of crystalline ceramics and glasses and role of thermodynamics and kinetics on its establishment. Effect of process variables on microstructure and ultimately on mechanical, chemical and physical properties.
MSE 2002; PHYS 1502Q.
View Classes (https://catalog.uconn.edu/course-search/?details&code=MSE%203029)

**MSE 3030. Introduction to Composite Materials. (3 Credits)**
Principles and applications of manufacturing and mechanics of polymer-matrix, and ceramic-matrix composites. Processing and properties of fibers. Interface characteristics. Design of components using composite materials.
MSE 3004.
View Classes (https://catalog.uconn.edu/course-search/?details&code=MSE%203030)

**MSE 3032. Introduction to High Temperature Materials. (3 Credits)**
Plastic deformation of metals and other solid materials at elevated temperatures. Dislocation mechanisms; creep processes; oxidation. Strengthening mechanism, including ordering and precipitation hardening.
MSE 2001 or 2101.
View Classes (https://catalog.uconn.edu/course-search/?details&code=MSE%203032)

**MSE 3034. Ferrous Alloys. (3 Credits)**
Application of materials science and engineering principles to extraction, refining, processing, phase transformations, heat treatment, properties and applications of iron-based alloys. Alloys covered include: plain-carbon steels, alloy steels (micro-alloyed, high-speed, stainless) and cast irons.
MSE 3001 and 3003, both of which may be taken concurrently. Open to juniors and seniors.
View Classes (https://catalog.uconn.edu/course-search/?details&code=MSE%203034)

**MSE 3036. Non-Ferrous Alloys. (3 Credits)**
Application of materials science and engineering principles to extraction, refining, processing, phase transformations, heat treatment, properties and applications of non-ferrous alloys. Materials covered include alloys of: aluminum, copper, magnesium, nickel, titanium, zinc and refractory metals.
MSE 3001 and 3003, both of which may be taken concurrently. Open to juniors and seniors.
View Classes (https://catalog.uconn.edu/course-search/?details&code=MSE%203036)

**MSE 3055. Materials Processing and Microstructures Laboratory. (2 Credits)**
Second semester of a 3-semester MSE laboratory sequence. Application of advanced characterization techniques, including x-ray diffraction, electron microscopy, differential scanning calorimetry, thermogravimetric analysis and Fourier-transform infrared spectroscopy, to all major classes of materials. Analysis of complex data sets. Culminates in a junior design project.
MSE 2053. Departmental consent required.
View Classes (https://catalog.uconn.edu/course-search/?details&code=MSE%203055)

**MSE 3056. Mechanical Behavior Laboratory. (2 Credits)**
Third semester of a 3-semester MSE laboratory sequence. Introduces methods for the quantification of material deformation, fatigue, and fracture, including tensile, bending, torsion, rheological, cyclic, and/or high temperature testing. Applicable to materials processed by drawing, forging, extrusion, rolling, and hot pressing, and their use in structural applications and design. Incorporates laboratory and computational modelling of thermal and mechanical behavior of materials.
MSE 3004, which may be taken concurrently.
View Classes (https://catalog.uconn.edu/course-search/?details&code=MSE%203056)

**MSE 3156. Polymeric Materials. (3 Credits)**
(Also offered as CHEG 3156.) Structure, properties, and chemistry of high polymers; solution and phase behavior; physical states, viscoelasticity and flow; production and polymer processing; design of polymers for specific applications.
Open only to School of Engineering students. Recommended preparation: CHEM 2444. Not open to students who have passed CHEM 3661.
View Classes (https://catalog.uconn.edu/course-search/?details&code=MSE%203156)

**MSE 3193. International Study in Materials Science and Engineering. (1-6 Credits)**
Special engineering topics taken in an international study program. May count toward the Major, substituting a core course or as a Professional or Technical Elective, only with consent of the advisor and approved plan of study.
May be repeated for a total of 6 credits
View Classes (https://catalog.uconn.edu/course-search/?details&code=MSE%203193)

**MSE 3700. Biomaterials. (3 Credits)**
Introduction to a series of implant materials, including metals, ceramics, glass ceramics, polymers, and composites, including comparison with natural materials. Issues related to mechanical properties, biocompatibility, degradation of materials by biological systems, and biological response to artificial materials will be addressed. Particular attention will be given to the materials for the total hip prosthesis, dental restoration, and implantable medical devices.
MSE 2001 or MSE 2101. Not open to students who have passed BME 3700.
View Classes (https://catalog.uconn.edu/course-search/?details&code=MSE%203700)

**MSE 4001. Electrical and Magnetic Properties of Materials. (3 Credits)**
Principles underlying electrical and magnetic behavior will be applied to the selection and design of materials. Topics covered will include: thermoelectricity, photoelectricity, conductors, semiconductors, superconductors, dielectrics, ferroelectrics, piezoelectricity, pyroelectricity, and magnetism. Device applications.
MSE 2101 or both PHYS 1502Q and MSE 2001.
View Classes (https://catalog.uconn.edu/course-search/?details&code=MSE%204001)

**MSE 4003. Materials Characterization. (3 Credits)**
Principles and experimental methods of optical, electron, and x-ray examination of engineering materials. Emphasis on use of x-ray analysis, with introduction to electron microscopy, Auger spectroscopy, scanning electron microscopy, and microanalysis.
MSE 2001 or 2101.
View Classes (https://catalog.uconn.edu/course-search/?details&code=MSE%204003)

**MSE 4004. Thermal/Mechanical Processing of Materials. (3 Credits)**
Fundamental principles of materials processing and their quantitative application to process design will be illustrated for deformation processes: forging, rolling, drawing, extrusion, injection molding, powder compaction and sintering.
MSE 3004, which may be taken concurrently.
View Classes (https://catalog.uconn.edu/course-search/?details&code=MSE%204004)

**MSE 4005. Processing of Materials in the Liquid and Vapor State. (3 Credits)**
Fundamental principles of materials processing and their quantitative application to process design will be illustrated for materials processes involving liquids and gasses: crystal growth, zone refining, shape casting, continuous casting, refining, welding, and vapor deposition.
MSE 3001 and 3002, both may be taken concurrently.
View Classes (https://catalog.uconn.edu/course-search/?details&code=MSE%204005)

**MSE 4021. Materials Joining. (3 Credits)**
Basic materials principles applied to fusion and solid phase welding, brazing and other joining processes. Effects of joining process and process variable values on microstructure, soundness and mechanical properties of as-processed joints. Treatment and properties of joints and joined assemblies. Joining defects and quality control.
MSE 2001 or 2101.
View Classes (https://catalog.uconn.edu/course-search/?details&code=MSE%204021)

**MSE 4034. Corrosion and Materials Protection. (3 Credits)**
Corrosion and materials protection designed for engineering students. Principles of materials degradation, extensive case histories and practical applications. Selection of metals, alloys, ceramics and polymers for atmospheric, soil, marine and chemical environments. Evaluation methods, protective measures and the techniques of failure analysis.
MSE 2001 or 2101.
View Classes (https://catalog.uconn.edu/course-search/?details&code=MSE%204034)

**MSE 4038. Alloy Casting Processes. (3 Credits)**
Principles of alloy solidification are discussed and applied in the context of sand, investment, and die casting; continuous and direct chill casting; electroslag and vacuum arc remelting, crystal growth, rapid solidification, and laser coating.
MSE 3002 and 3003, both of which may be taken concurrently.
View Classes (https://catalog.uconn.edu/course-search/?details&code=MSE%204038)

**MSE 4040. Materials Selection in Mechanical Design. (3 Credits)**
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. As part of the course, design trades will also be discussed.
MSE 3004.
View Classes (https://catalog.uconn.edu/course-search/?details&code=MSE%204040)

**MSE 4095. Special Topics in Materials Science and Engineering. (1-3 Credits)**
May be repeated for credit
View Classes (https://catalog.uconn.edu/course-search/?details&code=MSE%204095)

**MSE 4097. Undergraduate Research in Materials Science and Engineering. (1-3 Credits)**
Methods of research and development. Laboratory or computational investigation. Correlation and interpretation of experimental or modelling results. Writing technical reports and presenting conclusions.
May be repeated for a total of 3 credits
View Classes (https://catalog.uconn.edu/course-search/?details&code=MSE%204097)

**MSE 4098. Variable Topics in Materials Science and Engineering. (1-3 Credits)**
Does not constitute original research.
May be repeated for credit
View Classes (https://catalog.uconn.edu/course-search/?details&code=MSE%204098)

**MSE 4099. Independent Study in Materials Science and Engineering. (1-3 Credits)**
Specialized non-classroom-based coursework under the regular supervision of a faculty instructor. Does not constitute original research.
View Classes (https://catalog.uconn.edu/course-search/?details&code=MSE%204099)

**MSE 4240. Nanomaterials Synthesis and Design. (3 Credits)**
Introduces synthesis and design of materials in the nanoscale. Typical synthesis strategies of low dimensional materials including nanoparticles, nanowires, nanotubes and hierarchical nanostructures are presented and discussed. The reasons behind growth mechanisms are interpreted and the nanoscale structure-properties relations are described. Design strategies of multifunctional nanomaterials will be addressed as well. Readings from modern scientific literature are assigned weekly for in-class discussions.
MSE 2002.
View Classes (https://catalog.uconn.edu/course-search/?details&code=MSE%204240)

**MSE 4241. Nanomaterials Characterization and Application. (3 Credits)**
Introduces materials characterization and applications at the nanoscale. Standard and advanced methods in Scanning Probe Microscopy, Electron Microscopy, and Focused Ion Beams are presented. Self-Assembled and Lithographically defined structures are treated. Nanoscale particles, tubes, films, and structures are discussed. Applications for enhanced mechanical, electronic, magnetic, optical, and biological properties are described. Societal implications including performance, costs, environmental impacts, and health issues are addressed. Readings from modern scientific literature are assigned weekly for in-class discussions.
MSE 2002.
View Classes (https://catalog.uconn.edu/course-search/?details&code=MSE%204241)

**MSE 4701. Biomedical Materials and Implants. (3 Credits)**
This advanced course will enable students to further expand their knowledge in various aspects of biomaterials science, engineering and applications. The course will focus on the strategies to improve cell-material and tissue-implant interaction. An emphasis is placed on the biomaterial innovations and technologies that integrate bioactivity, functionality to improve the performance of the implants. The course will also provide an overview of the FDA regulatory pathways for biomaterial and implant approvals.
MSE 3700 or BME 3700. Not open to students who have passed BME 4701.
View Classes (https://catalog.uconn.edu/course-search/?details&code=MSE%204701)

**MSE 4800. Materials for Advanced Fossil Energy Systems. (3 Credits)**
Will familiarize students with the state of the art in fossil fuel power generation technologies ranging from conventional combustion to emerging technologies such as oxyfuel combustion; integrated coal gasification (IGCC) and fuel cell (IGFC) systems; and CO2 separation and sequestration.
MSE 3001 and 3002 both of which can be taken concurrently.
View Classes (https://catalog.uconn.edu/course-search/?details&code=MSE%204800)

**MSE 4801. Materials for Alternative, Renewable Energy. (3 Credits)**
Overview of energy conversion and storage systems - centralized and distributed generation to stationary and motive batteries; efficiency calculation and thermodynamics; electrochemistry - primary and secondary batteries; fuels - chemistry, processing, impurities; combustion, gasification and electrochemical systems; materials requirements; bulk and surface properties; metals, ceramics and superalloys; gas -metal interactions; gas - liquid -metal interactions; development trend - alloying principles, coatings, claddings; alloy processing and coating techniques.
MSE 3001 and 3002 both of which can be taken concurrently.
View Classes (https://catalog.uconn.edu/course-search/?details&code=MSE%204801)

**MSE 4901W. Capstone Design Project I. (3 Credits)**
Seniors working in teams with faculty and industry mentors solve open ended projects in design of materials, materials processes, and material systems. Oral and written reports are required in each semester. For students with high academic standing the BSE and MS projects may overlap.
MSE 3002; 3004; 3055; ENGL 1007 or 1010 or 1011 or 2011.
**Skill Codes:** COMP. Writing Competency
View Classes (https://catalog.uconn.edu/course-search/?details&code=MSE%204901W)

**MSE 4902W. Capstone Design Project II. (3 Credits)**
Seniors working in teams with faculty and industry mentors solve open ended projects in design of materials, products, and processes. Oral and written reports are required in each semester. For students with high academic standing the BSE and MS projects may overlap.
MSE 4901; ENGL 1007 or 1010 or 1011 or 2011.
**Skill Codes:** COMP. Writing Competency
View Classes (https://catalog.uconn.edu/course-search/?details&code=MSE%204902W)

**MSE 4996. Thesis Research in Materials Science and Engineering. (1-3 Credits)**
Academic research conducted by a student under the supervision of the thesis advisor that involves completing and documenting a major original project.
Up to three credits of MSE 4097 or 4996 can satisfy the Professional Elective requirement.
View Classes (https://catalog.uconn.edu/course-search/?details&code=MSE%204996)