MATERIALS SCIENCE & ENGINEERING (MAT_SCI)

MAT_SCI 101-0 Modern Materials and Society (1 Unit)  Introduction to materials-how they function, how they are made, the devices they enable, and their impact on society. Role of materials developments in technological innovation and global competitiveness. Fulfills Weinberg College distribution requirements; not intended for engineering students. Prerequisites: high school mathematics and science background. Natural Sciences Distro Area

MAT_SCI 190-0 MS & E Freshman Seminar (1 Unit)  Laboratory-oriented, with research projects emphasizing use of the scanning electron microscope and other modern apparatus; correlation of structure with other properties of materials. Lectures, laboratory.

MAT_SCI 201-0 Introduction to Materials (1 Unit)  Introduction to atomic and molecular organization in solids, with emphasis on structure-property relations in ceramics, electronic materials, metals, and polymers. Not to be taken for credit with or after MAT_SCI 301-0. Prerequisite: CHEM 131-0, CHEM 151-0, or CHEM 171-0.

MAT_SCI 301-0 Materials Science Principles (1 Unit)  Bonding, crystal structure, and defects in solids. Phase diagrams in condensed matter systems. Equilibrium and non-equilibrium development of microstructures. Processing/structure/ property/performance relationships underlying behavior of metals, ceramics, plastics, and composites. Mechanical, electrical, and chemical properties of engineering materials. Prerequisites: CHEM 131-0, CHEM 151-0, or CHEM 171-0; major in materials science and engineering or chemical and biological engineering.

MAT_SCI 314-0 Thermodynamics of Materials (1 Unit)  Classical and statistical thermodynamics; entropy and energy functions in liquid and solid solutions, and their applications to phase equilibria. Lectures, problem solving. Materials science and engineering degree candidates may not receive credit for 314 with or after CHEM 342-1. Prerequisite: CHEM 132-0, CHEM 152-0, or CHEM 172-0; MATH 228-1; or PHYSICS 135-1 or equivalent.


MAT_SCI 316-1 Microstructural Dynamics (1 Unit)  Principles underlying development of microstructures. Defects, diffusion, phase transformations, nucleation and growth, thermal and mechanical treatment of materials. Lectures, laboratory. Prerequisite: MAT_SCI 315-0 or equivalent.

MAT_SCI 316-2 Microstructural Dynamics (1 Unit)  Principles underlying development of microstructures. Defects, diffusion, phase transformations, nucleation and growth, thermal and mechanical treatment of materials. Lectures, laboratory. Prerequisite: MAT_SCI 315-0 or equivalent.

MAT_SCI 318-0 Materials Selection (1 Unit)  Methods of specifying materials and the processes for making them in the context of a given application. Service performance of materials based on their physical and chemical properties. Case studies and use of high-level databases. Prerequisite: MAT_SCI 201-0 or equivalent.

MAT_SCI 331-0 Soft Materials (1 Unit)  Different kinds of polymeric materials. Relationships between structure and physical properties; rubber elasticity, the glassy state, crystallinity in polymers. Lectures, laboratory. Prerequisites: MAT_SCI 301-0 or equivalent; MAT_SCI 314-0 or CHEM 342-1; MAT_SCI 316-1 and MAT_SCI 316-2 highly recommended.

MAT_SCI 332-0 Mechanical Behavior of Solids (1 Unit)  Plastic deformation and fracture of metals, ceramics, and polymeric materials; structure/property relations. Role of imperfections, state of stress, temperatures, strain rate. Lectures, laboratory. Prerequisites: MAT_SCI 316-1; MAT_SCI 316-2 (may be taken concurrently); CIV_ENV 216-0 or consent of instructor.

MAT_SCI 333-0 Composite Materials (1 Unit)  Introduction to ceramic- metal- polymer-matrix composites for structural applications. Emphasis on structure (reinforcements, architecture), properties (elasticity, strength, toughness, creep), processing, role of interface. Prerequisites: MAT_SCI 316-1, MAT_SCI 316-2, MAT_SCI 332-0.

MAT_SCI 336-0 Chemical Synthesis of Materials (1 Unit)  The design of materials targeting important properties through processes that break and form primary chemical bonds. Fundamental principles and main methodologies, including polymerization, biosynthesis, self-assembly, sol-gel reactions, synthesis of nanomaterials, vapor-phase synthesis, and composite synthesis. Prerequisite: junior standing in materials science and engineering or consent of instructor.

MAT_SCI 337-0 Conducting Polymers (1 Unit)  Fundamentals and applications of conducting polymers. Hands-on experience in synthesizing conducting polymer nanostructures. Prerequisite: MAT_SCI 331-0 or consent of instructor.

MAT_SCI 340-0 Ceramic Processing (1 Unit)  Steps in production of fired ceramic articles. Powder preparation and characterization, compact formation, slip casting, extrusion and injection molding; firing, liquid-phase and solid-state sintering. Lectures, laboratory. Prerequisite: MAT_SCI 316-1 or equivalent.

MAT_SCI 341-0 Introduction to Modern Ceramics (1 Unit)  Applications of ceramic materials, with emphasis on structure (bond, crystal, glass, defect, micro-); properties (thermal, electrical, optical, magnetic, mechanical); and processing (powders, forming, densification). Prerequisites: MAT_SCI 316-1, MAT_SCI 316-2 or consent of instructor.

MAT_SCI 351-1 Introductory Physics of Materials (1 Unit)  Quantum mechanics; applications to materials and engineering. Band structures and cohesive energy; thermal behavior; electrical conduction; semiconductors; amorphous semiconductors; magnetic behavior of materials; liquid crystals. Lectures, laboratory, problem solving. Prerequisites: MAT_SCI 301-0 or equivalent or consent of instructor; GEN_ENG 205-4 or equivalent; PHYSICS 135-2, PHYSICS 135-3; MAT_SCI 351-1 is prerequisite for MAT_SCI 351-2.

MAT_SCI 351-2 Introductory Physics of Materials (1 Unit)  Quantum mechanics; applications to materials and engineering. Band structures and cohesive energy; thermal behavior; electrical conduction; semiconductors; amorphous semiconductors; magnetic behavior of materials; liquid crystals. Lectures, laboratory, problem solving. Prerequisites: MAT_SCI 301-0 or equivalent or consent of instructor; GEN_ENG 205-4 or equivalent; PHYSICS 135-2, PHYSICS 135-3; MAT_SCI 351-1 is prerequisite for MAT_SCI 351-2.

MAT_SCI 353-0 Bioelectronics (1 Unit)
Development and design of sensors, stimulators, and their medical devices for biointegrated electronics. Materials design and fabrication of passive and active components for sensitive, multimodal, and robust wearable and implantable devices.

**MAT_SCI 354-0 Bioelectronics Lab (0.34 Unit)**
Laboratories focused on the practical implementation, instrumentation, and fabrication of wearables and skinsensing. Applications range from vital sign monitoring to rehabsensation.

**MAT_SCI 355-0 Electronic Materials (1 Unit)**
Prerequisite: MAT_SCI 316-1 or consent of instructor.

**MAT_SCI 357-0 Nanomaterials for Information Storage (1 Unit)**
Overview of materials used for magnetic data storage and of the recording and read processes. Information storage systems, such as optical, solid-state, and probe. Theoretical background for understanding the four energy terms that control the properties of magnetic materials when they are patterned at the nanoscale.

**MAT_SCI 360-0 Introduction to Electron Microscopy (1 Unit)**
Theories and practice involved in application of scanning electron microscopy and transmission electron microscopy. Lectures, laboratory. Primarily for undergraduates and for graduate students in other departments.
Prerequisites: MAT_SCI 301-0; PHYSICS 135-2; PHYSICS 135-3 or equivalent.

**MAT_SCI 361-0 Crystallography & Diffraction (1 Unit)**
Elementary crystallography. Basic diffraction theory; reciprocal space. Applications to structure analysis, preferred orientation. Film and counter techniques. Lectures, laboratory.
Prerequisites: GEN_ENG 205-4; PHYSICS 135-2; PHYSICS 135-3.

**MAT_SCI 362-0 Point, Line & Planar Imperfections (1 Unit)**
Introduction to point defects, dislocactions, and internal interfaces in crystalline solids. Interactions among point, line, and planar imperfections. Metals, ionic solids, semiconductors.
Prerequisite: MAT_SCI 315-0.

**MAT_SCI 370-0 Biomaterials (1 Unit)**
Introduction to biomaterials from a materials science perspective, focusing on synthesis, structure, and properties. Materials used for human repair (permanent implants, devices, materials for drug delivery, tissue-engineering scaffolds); naturally occurring and engineered materials synthesized through biotechnology; biomimetic materials that copy microstructures from nature. Taught with BMD_ENG 343-0; may not receive credit for both courses.

**MAT_SCI 371-0 Biomaterials: Hierarchical Architecture & Function (1 Unit)**
How biologically based processing of mineralorganic composites used by living organisms inspires new approaches to materials synthesis in many critical applications—locomotion (bones), defense (shells), and sensing (light, acceleration, magnetic fields).
Prerequisite: MAT_SCI 316-2 or equivalent, or consent of instructor.

**MAT_SCI 376-0 Nanomaterials (1 Unit)**
Introduction to structure-property relationships of materials processed at the nanometer scale. Highly interdisciplinary course appropriate for undergraduate and graduate students in other departments.
Prerequisite: MAT_SCI 351-1 or consent of instructor.

**MAT_SCI 380-0 Intro Surface Science & Spectroscopy (1 Unit)**
Surface spectroscopy, including Auger spectroscopy, photoemission, and LEED. Surface dynamics and thermodynamics. Electronic properties of surfaces and interfaces. Gas-surface interactions.
Prerequisite: MAT_SCI 351-1 or equivalent.

**MAT_SCI 381-0 Materials for Energy-Efficient Technology (1 Unit)**
A materials science approach to the challenges of energy efficient technology: energy content of materials; advanced materials for energy harvesting, transmission, storage, and conversion; materials for energy efficient transportation and housing. Term paper and oral presentation.
Prerequisite: MAT_SCI 201-0, MAT_SCI 301-0, or consent of instructor.

**MAT_SCI 382-0 Electrochemical Energy Materials and Devices (1 Unit)**
Prerequisite: senior standing or consent of instructor.

**MAT_SCI 385-0 Electronic and Thermal Properties of Materials (1 Unit)**

**MAT_SCI 390-0 Materials Design (1 Unit)**
Prerequisites: MAT_SCI 315-0, MAT_SCI 316-1, MAT_SCI 316-2, or consent of instructor.

**MAT_SCI 391-0 Process Design (1 Unit)**
Processing of materials. Design and analysis of experiments to identify and optimize key parameters to control properties and performance. Resolving conflicting requirements. Statistical process control.
Prerequisite: MAT_SCI 316-1 or equivalent.

**MAT_SCI 394-0 Honors Project in Materials Science (1 Unit)**
Independent study and/or research linked to MAT_SCI 396-1 and MAT_SCI 396-2. Comprehensive report on a specific area of modern materials science and engineering. Prerequisite: registration in department honors program.

**MAT_SCI 395-0 Special Topics in Materials Science and Engineering (1 Unit)**
Topics suggested by students or faculty and approved by the department.

**MAT_SCI 396-1 Senior Project in Materials Science and Engineering (1 Unit)**
To be taken in two consecutive quarters. Independent basic or applied research project, conceived and performed under the direction of a department faculty member. Prerequisite: senior standing in materials science program.

**MAT_SCI 396-2 Senior Project in Materials Science and Engineering (1 Unit)**
To be taken in two consecutive quarters. Independent basic or applied research project, conceived and performed under the direction of a department faculty member. Prerequisite: senior standing in materials science program.

**MAT_SCI 397-0 Special Topics in Materials Science and Engineering (0.34 Unit)**
Special Topics in Materials Science and Engineering. Laboratory emphasis.
MAT_SCI 399-0 Projects (1 Unit) Individual problems, including library and design work; comprehensive report on a specific phase of modern materials science. Credit to be arranged.