MATERIALS SCIENCE AND ENGINEERING MSE

Department of Chemical Engineering and Materials Science
College of Engineering

101 Materials and Society
Fall. 2(2-0) RB: High school physics, chemistry, mathematics.
Material capabilities, limitations, and their utilization in the service and advancement of society.

250 Materials Science and Engineering
Fall, Spring, Summer. 3(2-2) P:M: CEM 141 or CEM 151 or LBS 171 SA: MSM 250
Structure of metals, ceramics and polymers. Phase diagrams, thermomechanical treatments, physical and mechanical properties, diffusion, microstructure studies, environmental effects.

310 Phase Equilibria in Materials
Fall. 3(3-0) P:M: (MSE 250 or concurrently) and (MTH 234 or MTH 254H or LBS 220) R: Open only to juniors or seniors in the College of Engineering. SA: MSE 351
Enthalpy. Entropy. Free energy. Phase changes in metal, ceramic, and polymer materials systems. Application to alloying, phase diagram determination, and electrochemistry.

320 Mechanical Properties of Materials
Fall. 3(3-0) P:M: (ME 222 or concurrently) and MSE 250 R: Open only to juniors or seniors in the Materials Science and Engineering major. SA: MSE 355
Mechanical behavior of metals, ceramics, and polymers. Three-dimensional stress-states. Stress, strain, and compliance tensors. Test methods. Elastic, viscoelastic, and plastic deformation. Fracture, fatigue, and creep.

331 Materials Characterization Methods I
Fall. 1(0-3) P:M: (MSE 310 or concurrently) and (MSE 320 or concurrently) R: Open only to juniors or seniors in the Materials Science and Engineering major. SA: MSE 375
Thermal analysis. Optical and Scanning Electron Microscopy Laboratory for characterizing microstructure-property relationships. Effects of processing on microstructures, properties, and fracture surfaces in metal, ceramic and polymer systems.

350 Electronic Structure and Properties of Materials
Spring. 3(3-0) P:M: (PHY 184 or concurrently) and (CEM 141 or CEM 151 or LBS 171) Not open to students with credit in MSE 455.
Fundamentals of electrical, thermal, magnetic and optical properties of metals, dielectrics, semiconductors and polymers. Crystal structure, reciprocal space, quantum mechanics, electron band structure, and phonons. Materials applications in electronics and optoelectronics.

360 Fundamentals of Microstructural Design
Spring. 3(3-0) P:M: MSE 310 and (MSE 350 or concurrently) R: Open only to juniors or seniors in the College of Engineering. SA: MSE 352
Fick's laws of diffusion. Models of solid state diffusion. Arrhenius plots. Use of non-equilibrium energy storage from solidification, phase changes, and deformation to predict and control microstructural changes and stability during processing in metal, ceramic, and polymer systems.

370 Physical Processing of Materials
Spring. 3(3-0) P:M: MSE 310 or CHE 321 RB: MSE 250 and (MSE 350 or concurrently) R: Open to students in the Department of Chemical Engineering and Materials Science. SA: MSE 365, MSE 380
Physical processing of powders. Mixing and casting. Surface modification of ceramic, polymeric, and metallic materials in order to engineer the microstructure, properties, and form of components.

381 Materials Characterization Methods II
Spring. 2(1-3) P:M: (MSE 360 or concurrently) and (MSE 370 or concurrently) R: Open only to juniors or seniors in the Materials Science and Engineering major. SA: MSE 376
X-ray and infrared spectroscopic analysis laboratory for the characterization of microstructure-property relationships. Effects of processing on microstructures, properties, and fracture surfaces in metal, ceramic, and polymer systems.

401 Quantitative Human Biology
Spring. 3(4-0) Interdepartmental with Human Anatomy and Biomedical Engineering and Radiology. Administered by Biomedical Engineering. P:M: (MTH 235 and PHY 184) and ((PSL 250 or concurrently) or (PSL 431 or concurrently) or (ANTR 350 or concurrently)) and (CEM 141 or CEM 151) RB: (CSE 131 or concurrently) or (CSE 231 or concurrently) or PSL 410
Qualitative description and quantitative engineering analysis of selected, tractable human-biological systems. Multi-disciplinary problem-solving among medical and engineering professionals.

425 Biomaterials and Biocompatibility
Spring. 3(3-0) Interdepartmental with Biomedical Engineering. Administered by Materials Science and Engineering. P:M: (PSL 250 or concurrently) and MSE 250 SA: MSM 424, BME 424, BME 324, MSE 324
Materials science of human implants. Design requirements imposed by the human body, and need for bodily protection.

426 Introduction to Composite Materials
Spring. 3(3-0) Interdepartmental with Mechanical Engineering. Administered by Materials Science and Engineering. P:M: ME 222 R: Open only to juniors or seniors in the College of Engineering. SA: MSM 444
Constituents and interfacial bonding. Manufacturing techniques. Microstructure and micromechanics. Theory of anisotropy. Classical laminate theory. Material characterization. Failure and damage. Composite structure design.

451 Microscopic and Diffraction Analysis of Materials
Fall. 3(2-3) P:M: PHY 184 or PHY 184B or PHY 234B RB: MSE 350 and MSE 381 R: Open only to juniors or seniors or graduate students in the Colleges of Engineering or Natural Science. SA: MSM 451
General properties, generation, and detection of x-rays. Interaction with solids. Crystallography, reciprocal lattice, diffraction analysis, and techniques. Single crystal methods. Stereographic projection. X-ray microanalysis.

454 Ceramic and Refractory Materials
Fall. 3(3-0) P:M: PHY 184 RB: MSE 350 and MSE 381 R: Open only to seniors in the College of Engineering. SA: MSM 454
Ceramic and glassy materials. High temperature processes. Mechanical and physical properties of technical ceramics.

465 Design and Application of Engineering Materials
Spring. 3(3-0) P:M: (MSE 331 and MSE 381) and completion of Tier I writing requirement R: Open to students in the Materials Science and Engineering major. SA: MSM 465
Fundamental principles of strengthening: toughening, specific strength, and stiffness. Material development based on environmental, temperature, wear, damping, fatigue, and economic considerations.

466 Design and Failure Analysis (W)
Spring. 3(2-3) P:M: (MSE 250) and completion of Tier I writing requirement RB: MSE 320 and MSE 331 R: Open only to seniors in the College of Engineering. SA: MSM 466
Modes and causes of failure in mechanical components and role of design. Non-destructive evaluation. Legal and economic aspects of materials failure. Student projects.

476 Physical Metallurgy of Ferrous and Aluminum Alloys
Fall. 3(3-0) P:M: MSE 250 RB: MSE 310 R: Open only to seniors in the College of Engineering. SA: MSM 476
Heat treatment and properties of ferrous and aluminum alloys. Casting and solidification. Effects of alloying elements, high strength low alloy steels, hardenability, and case hardening. Joining of materials, such as welding.

477 Manufacturing Processes
Fall, Spring. 3(3-0) Interdepartmental with Mechanical Engineering. Administered by Mechanical Engineering. P:M: (ME 222 and MSE 250) and completion of Tier I writing requirement R: Open only to students in the Applied Engineering Sciences, Materials Science and Engineering, and Mechanical Engineering majors. SA: MSM 481
Fundamentals of manufacturing processes such as casting, heat treating, particulate processing, forming, machining, joining, and surface processing. Selection of manufacturing processes based on design and materials.

490 Independent Study
Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Open only to juniors or seniors in the College of Engineering. Approval of department. SA: MSM 490
Individualized reading and research.

491 Selected Topics
Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Open only to students in the Department of Chemical Engineering and Materials Science. SA: MSM 491
Topics of current interest in materials science or engineering.

499 Senior Research and Design Project (W)
Fall, Spring, Summer. 2 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course. P:M: Completion of Tier I writing requirement. R: Open only to seniors in the Materials Science and Engineering or Applied Engineering Sciences major. Approval of department. SA: MSM 499
Design and analysis to solve materials and/or mechanics related problem. Preparation of written report, oral presentation, and defense of the project.

802 Research Methods
Fall. 3(3-0) Interdepartmental with Chemical Engineering. Administered by Chemical Engineering.
Skills required for graduate research. Critically reviewing the literature, defining a fundamental research problem, effective oral and written technical presentations, ethics, and statistics.

851 Thermodynamics of Solids
Fall. 3(3-0) SA: MSM 851
Use of Jacobians. Thermodynamic functions. Thermodynamics of solid-solid phase transformation. Thermoelastic solids, rubber elasticity, and stressed solids. Surfaces and interfaces, point defects in solids. Thermodynamics of solids under high pressure.

855 Advanced Rate Theory and Diffusion
Spring. 3(3-0) RB: MSE 851 SA: MSM 855
Review of Fick's Laws. Atomistic aspects of diffusion. Defects in solids. Probabilistic basis of random walk. Green's function solutions.

862 Dislocation Theory
Fall. 3(3-0) SA: MSM 862
Advanced theory of dislocations and other crystal defects in metals, ceramics, aggregates and ordered compounds. Elasticity theory of straight dislocations, dislocation strain energy, mobility, obstacle interactions, reactions, and core effects.

865 Advanced Theory of Solids
Spring. 3(3-0) SA: MSM 865
Quantum mechanics. Free electron theory. Energy bands, semiconductors. Dielectrics and ferroelectrics. Dia-, para-, ferro-, and antiferro-magnetism. Superconductivity. Thermal properties.

870 Electron Microscopy in Materials Science
Spring. 3(2-3) R: Open only to graduate students in the Materials Science and Engineering major or approval of department. SA: MSM 870
Theory of electron diffraction. Electromagnetic lenses. Image formation in transmission electron microscopy. Defect analysis and diffraction contrast.

871 Material Surfaces and Interfaces
Fall of odd years. 3(3-0) Interdepartmental with Chemical Engineering. Administered by Materials Science and Engineering. RB: CEM 392 or CEM 434 or MSE 351 R: Open only to graduate students in the Department of Chemical Engineering and Materials Science or Department of Chemistry or School of Packaging. SA: MSM 871
Physical and chemical nature of solid surfaces and their interaction with gases, liquids, and other solids. Characterization of surfaces and solid-solid interfaces. Relation of surface and interfacial structure to engineering phenomena.

875 Engineering Ceramics
Fall of odd years. 3(3-0) RB: MSE 851 SA: MSM 875
Physical properties of engineering ceramics. Transport properties of ceramics, especially in ferrites and garnets. Optical ceramic materials.

876 Advanced Polymeric Materials
Fall of even years. 3(3-0) SA: MSM 876
Advanced topics in polymer structure and properties. Thermoplastics, thermosets, polyblends and elastomers. Processing techniques. Deformation and mechanical properties. Thermal, optical and chemical properties. Composites.

890 Independent Study
Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Approval of department. SA: MSM 890
Individualized reading and research of student's interest.

891 Selected Topics
Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Approval of department. SA: MSM 891
Special topics of current importance in materials science or engineering.

892 Seminar
Fall, Spring. 1(0-2) A student may earn a maximum of 4 credits in all enrollments for this course. Interdepartmental with Chemical Engineering. Administered by Chemical Engineering. R: Open only to Chemical Engineering majors.
Presentations of detailed studies of one or more specialized aspects of chemical engineering and materials science.

899 Master's Thesis Research
Fall, Spring, Summer. 1 to 8 credits. A student may earn a maximum of 24 credits in all enrollments for this course. SA: MSM 899
Master's thesis research.

964A Anisotropic Crystalline Properties
Fall of even years. 3(3-0) RB: MSE 851 SA: MSM 960B, MSM 964A
Crystallography. Tensor representation. Magnetic susceptibility. Electric polarization. Stress and strain. Thermal expansion. Piezoelectricity. Elasticity. Transport properties.

965B Advanced Techniques in Electron Microscopy
Fall of odd years. 3(3-0) RB: MSE 870 SA: MSM 970A, MSM 965B
Experimental methods in transmission electron microscopy. Microanalytical, chemical, microbeam, diffraction and lattice imaging techniques.

974A Microcracking in Brittle Materials
Spring of even years. 3(3-0) RB: MSE 875 SA: MSM 960A, MSM 974A
Microcracking mechanisms and the effect of microcracks on mechanical, thermal and electrical properties. Microcracking theories. Experimental investigations of microcracks.

974B High Temperature Deformation and Processing
Spring of even years. 3(3-0) RB: MSE 851 and MSE 862 SA: MSM 980B, MSM 974B
Theoretical and design principles applied to the control of creep, superplasticity, cavitation, recrystallization, and texture changes. Metallic, alloy, intermetallic, ceramic, and composite systems.

990 Independent Study
Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course. SA: MSM 990
Individualized reading and research.

991 Selected Topics
Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Approval of department. SA: MSM 991
Special advanced topics in materials science and engineering, and mechanics.

999 Doctoral Dissertation Research
Fall, Spring, Summer. 1 to 24 credits. A student may earn a maximum of 72 credits in all enrollments for this course. SA: MSM 999
Doctoral dissertation research.