MATERIALS—MSE—Materials Science and Engineering

Department of Chemical Engineering and Materials Science
College of Engineering

200 Materials and Society
Fall, 2(2-0) RB: High school physics and chemistry.
Material capabilities, limitations, and their utilization
in the service and advancement of society. Role of
materials in our day-to-day lives. Resource and
environmental concerns including current material-
related issues.

250 Materials Science and Engineering
Fall, Spring, Summer. 3(2-2) P: 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: (MSE 250 or concurrently) and
(MTH 234 or MTH 254H or LBS 220) R:
Open only to juniors or seniors in the Col-
lege of Engineering. SA: MSE 351
Enthalpy. Entropy. Free energy. Phase changes in
metal, ceramic, and polymer materials systems.
Application to alloying, phase diagram determina-
tion, and electrochemistry.

320 Mechanical Properties of Materials
Fall. 3(3-0) P: (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 poly-
mers. Three-dimensional stress-states. Stress,
strain, and compliance tensors. Test methods. Elas-
tic, viscoelastic, and plastic deformation. Fracture,
fatigue, and creep.

331 Materials Characterization Methods I
Fall. 1(0-3) P: (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 microstruc-
ture-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: (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, semicon-
ductors 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: MSE 310 and (MSE 350 or
concurrently) R: Open only to juniors or se-
niors in the College of Engineering. SA: MSE 352
Fick’s laws of diffusion. Models of solid state dif-
fusion. Arrhenius plots. Use of non-equilibrium ener-
gy 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: 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 micro-
structure, properties, and form of components.

381 Materials Characterization Methods II
Spring. 2(1-3) P: (MSE 360 or concurrently) and
(MSE 370 or concurrently) R: Open only
for 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 microstruc-
tures, properties, and fracture surfaces in metal,
ceramic, and polymer systems.

401 Quantitative Human Biology
Spring. 3(4-0) Interdepartmental with Hu-
an Anatomy and Biomedical Engineering
and Radiology. Administered by Biomedical
Engineering. P: (MTH 235 and PHY 184)
and (PSL 250 or concurrently) or (PSL 431 or
concurrently) or (ANTR 350 or concur-
rently) 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 Biometrics and Biocompatibility
Spring. 3(3-0) Interdepartmental with Bio-
medical Engineering. Administered by Mate-
rials Science and Engineering. P: (PSL 250
or concurrently) and MSE 250 SA: MSM
424, BME 424, BME 324, MSE 324
Materials science of human implants. Design re-
quirements imposed by the human body, and need for
bodily protection.

426 Introduction to Composite Materials
Spring. 3(3-0) Interdepartmental with Me-
chaneical Engineering. Administered by Ma-
terials Science and Engineering. P: ME 222
R: Open only to juniors or seniors in the Col-
lege of Engineering. SA: MSM 444
Constituents and interfacial bonding. Manufacturing
techniques. Microstructure and micromechanics.
Material characterization. Failure and damage.
Composite structure design.

451 Microscopic and Diffraction Analysis
of Materials
Fall. 3(2-3) P: 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, reci-
procal lattice, diffraction analysis, and techniques.
Single crystal methods. Stereographic projection. X-
ray microanalysis.

454 Ceramic and Refractory Materials
Fall. 3(3-0) P: PHY 184 RB: MSE 350 and
MSE 381 R: Open only to seniors in the Col-
lege 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: (MSE 331 and MSE 381) and
completion of Tier I writing requirement R: Open to seniors in the Materials
Science and Engineering major. SA: MSM 465
Fundamental principles of strengthening: toughen-
ing, specific strength, and stiffness. Material devel-
opment based on environmental, temperature, wear,
damping, fatigue, and economic considerations.

466 Design and Failure Analysis (W)
Spring. 3(2-3) P: (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 compo-
nents and role of design. Non-destructive evalu-
ation. Legal and economic aspects of materials fail-
ure. Student projects.

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

477 Manufacturing Processes
Fall, Spring. 3(3-0) Interdepartmental with Me-
chanical Engineering. Administered by Me-
chanical Engineering. P: (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, form-
ing, 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 stu-
dent may earn a maximum of 6 credits in all
enrollments for this course. R: Open only to
juniors or seniors in the College of Engi-
neering. Approval of department. SA: MSM 490
Individualized reading and research.
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.

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: 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 mechanical related problem. Preparation of written report, oral presentation, and defense of the project.

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.

Thermodynamics of Solids  
Fall. 3(3-0) SA: MSM 851


Advanced Rate Theory and Diffusion  
Spring. 3(3-0) RB: MSE 851 SA: MSM 855


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.

Advanced Theory of Solids  
Spring. 3(3-0) SA: MSM 865


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


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.

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.

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.

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.

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 topics of current importance in materials science or engineering.

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.

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.

Anisotropic Crystalline Properties  
Fall of even years. 3(3-0) RB: MSE 851 SA: MSM 960B, MSM 964A


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.