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 diffu-
Arhenius 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 Depart-
ment 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
Fall. 2(1-3) P:M: (MSE 360 or concurrently) and (MSE 370 or concurrently) R: Open only to juniors or seniors in the Mat-
erials 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-
man 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 (CME 141 or CME 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 Bio-
medical Engineering. Administered by Mate-
rials Science and Engineering. P:M: (PSL
250 or concurrently) and MSE 250 SA:
MSE 424, BME 424, BME 324, MSE 324
Materials science of human implants. Design re-
quirements imposed by the human body, and need for
boilery protection.

426 Introduction to Composite Materials
Spring. 3(3-0) Interdepartmental with Me-
chanical Engineering. Administered by Ma-
terials 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.
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 seniors in the
Colleges of Engineering or Natural Science. SA: MSM 451
General properties, generation, and detection of x-
rays. Interaction with solids. Crystallography, recip-
icrystal, diffraction analysis, and techniques.
Single crystal methods. Stereographic projection. X-
ray microanalysis.

466 Design and Failure Analysis (W)
Spring. 3(2-3) P:M: (MSE 250) and comple-
tion 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.

477 Manufacturing Processes
Fall. Spring. 3(3-0) Interdepartmental with Me-
chanical Engineering. Administered by Me-
chanical 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, 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.

MATERIALS & MSE
SCIENCE AND
ENGINEERING
Department of Chemical Engineering
and Materials Science
College of Engineering

101 Materials and Society
Fall. 2(2-0) RB: High school physics, chem-
istry, 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, thermochemical 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 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:M: and MSE 250 R: Open only to juniors or seniors in the Materials Science and Engi-
neering 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:M: (ME 222 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:M: (PHY 184 or concur-
rently) 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.

454 Ceramic and Refractory Materials
Fall. 3(3-0) P:M: PHY 184B or 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 re-
quirement R: Open to students in the Mate-
rials Science and Engineering major. SA:
MSE 465
Fundamental principles of strengthening: toughen-
ing, specific strength, and stiffness. Material devel-
oment based on environmental, temperature, wear,
damping, fatigue, and economic considerations.

476 Physical Metallurgy of Ferrous and Alu-
minum Alloys
Fall. 3(3-0) P:M: 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.

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.

MSE—Materials Science and Engineering
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 seniors in the Materials Science and Engineering or Applied Engineering Sciences major. Approval of department. 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 problems. Preparation of written report, oral presentation, and defense of the project.

302 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.

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

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

570 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.

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

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

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.

964 Advanced Physical and Mechanical Properties of Materials I
Fall of even years. 3(3-0) A student may earn a maximum of 9 credits in all enrollments for this course. SA: MSM 960, MSM 964
Topics vary each semester. Topics such as anisotropic crystalline properties and displaceable phase transformations.

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

964B Displaceable Phase Transformations
Fall of even years. 3(3-0) SA: MSM 964B

965 Advanced Analytical Techniques
Fall of odd years. 3(3-0) A student may earn a maximum of 9 credits in all enrollments for this course. SA: MSM 960, MSM 965
Topics vary each semester. Topics such as environmental effects on materials and advanced techniques in electron microscopy.

965A Environmental Effects on Materials
Fall of odd years. 3(3-0) SA: MSM 965A
Influence of external and internal environments on degradation and fracture of metallic/nonmetallic materials. Environment-induced transport phenomena due to benign and aggressive environmental conditions and related fracture behavior of materials.

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

964A Advanced Physical and Mechanical Properties of Materials II
Spring of even years. 3(3-0) A student may earn a maximum of 9 credits in all enrollments for this course. SA: MSM 960, MSM 974
Topics vary each semester. Topics such as microcracking in brittle materials, or high temperature deformation and processing.

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.

975 Advanced Processing Techniques
Spring of odd years. 3(3-0) A student may earn a maximum of 9 credits in all enrollments for this course. SA: MSM 960, MSM 975
Topics vary each semester. Topics such as laser and plasma processing and ceramic processing.
975A  Laser and Plasma Processing
Spring of odd years. 3(3-0) RB: MSE 851
SA: MSM 980C, MSM 975

975B  Ceramic Processing
Spring of odd years. 3(3-0) RB: MSE 851
and MSE 875 SA: MSM 980A, MSM 975B
Fundamental aspects of and recent developments in ceramic powder processing. The processing stream from making the powder to consolidation.

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.