MATERIALS SCIENCE AND ENGINEERING MSE

**Department of Chemical Engineering
and Materials Science
College of Engineering**

250   Materials Science and Engineering
Fall, Spring. 3(3-2) 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.

351   Thermochemistry of Materials
Fall. 3(3-0) P:M: (CEM 151 or CEM 141 or LBS 171) and (MTH 234 or MTH 254H or LBS 220) Not open to students with credit in BE 351 or CHE 321 or ME 201.
State variables, laws of thermodynamics, phase and chemical equilibria. Gas and condensed phase relationships, solutions, interfaces, point defects, electrochemistry.

352   Diffusion in Solids
Spring. 3(3-0) P:M: (MSE 250) and (MSE 351 or ME 201) R: Open only to students in the Materials Science and Engineering major. SA: MSM 352
Diffusion and mass transport. Kinetics of diffusion-controlled processes. Point defects, nucleation and growth, interface motion.

355   Mechanical Behavior of Materials
Fall. 3(3-0) P:M: (ME 222 and MSE 250) R: Open only to students in the Department of Chemical Engineering and Materials Science or Department of Mechanical Engineering. SA: MSM 355
Stress and strain, crystal elasticity, anelasticity and viscoelasticity. Mechanical properties in tension and torsion. Crystallographic aspects of plasticity.

356   Deformation Mechanisms
Spring. 3(3-0) P:M: (MSE 355) R: Open only to students in the Materials Science and Engineering major. SA: MSM 356
Elementary dislocation theory, slip and twinning. Deformation of single and polycrystals. Temperature and strain rate effects. Work hardening, solution and particle strengthening. Creep, fatigue and fracture in metals, ceramics and polymers.

365   Physical Metallurgy I
Fall. 3(3-0) P:M: (MSE 250) and (MSE 351 or concurrently or ME 201 or concurrently) R: Open only to students in the Engineering Mechanics or Materials Science and Engineering major. SA: MSM 365
Complex binary and ternary phase diagrams. Solidification. Recovery, recrystallization and grain growth. Phase transformations.

375   Materials Science Laboratory I
Fall. 1(0-3) P:M: (MSE 355 or concurrently) R: Open only to students in the Engineering Mechanics or Materials Science and Engineering major. SA: MSM 375
Phase transformations. Recrystallization. Precipitation and aging. Microscopy. Structure-property relations.

376   Materials Science Laboratory II
Spring. 1(0-3) P:M: (MSE 355) R: Open only to students in the Materials Science and Engineering or Engineering Mechanics major. SA: MSM 376
Strengthening. Yielding, creep, and fracture. Plasticity. Thermal activation. Damping. Marsensite and shape memory.

380   Polymeric Materials
Spring. 3(3-0) P:M: (CEM 151 or CEM 141 or LBS 171) and (ME 201 or concurrently or MSE 351 or concurrently) R: Open only to students in the Department of Chemical Engineering and Materials Science. SA: MSM 380
Polymers and engineering plastics. Chemical, physical and mechanical properties. Environmental effects on polymers. Manufacturing processes. Coatings.

424   Biomaterials and Biocompatibility
Spring. 3(3-0) Interdepartmental with Biomedical Engineering. P:M: (PSL 250 and MSE 250) SA: MSM 424
Materials science of human implants. Design requirements imposed by the body's milieu and the need to protect the body.

426   Introduction to Composite Materials
Spring. 3(3-0) Interdepartmental with Mechanical Engineering. P:M: (ME 222) R: Open only to students in the Department of Chemical Engineering and Materials Science. 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   X-Ray Crystallography
Fall. 3(2-3) P:M: (MSE 250) and (PHY 184 or concurrently or PHY 184B or concurrently) R: Open only to seniors or graduate students in the Materials Science and Engineering major. 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: (MSE 365) R: Open only to students in the Engineering Mechanics or Materials Science and Engineering major. SA: MSM 454
Ceramic and glassy materials. High temperature processes. Mechanical and physical properties of technical ceramics.

455   Theory of Solids
Fall. 3(3-0) P:M: (MSE 250) and (PHY 184 or PHY 184B or concurrently) R: Open only to students in the Engineering Mechanics or Materials Science and Engineering major. SA: MSM 455
Atomic theory of materials. Free electron theory of metals. Electrons in a periodic field. Insulators, semiconductors. Thermal properties. Dielectric and magnetic behavior. Superconductivity.

465   Design and Application of Engineering Materials
Spring. 3(3-0) P:M: (MSE 355 and MSE 365) R: Open only to students in the Engineering Mechanics or 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   Failure Analysis
Spring. 3(2-2) P:M: (MSE 355) R: Open only to students in the Department of Chemical Engineering and Materials Science. SA: MSM 466
Modes and causes of failure in mechanical components. Non-destructive evaluation. Legal and economic aspects of materials failure. Analysis illustrated through student projects requiring integration of knowledge from several courses.

476   Physical Processing of Materials
Fall of even years. 3(3-0) P:M: (MSE 365) R: Open only to students in the Materials Science and Engineering major. SA: MSM 476
Heat treatment and properties of ferrous alloys. Casting and solidification. Effects of alloying elements, high strength low alloy steels, hardenability, case hardening. Joining of materials, welding.

477   Manufacturing Processes
Fall. 3(3-0) Interdepartmental with Mechanical Engineering. Administered by Department of Mechanical Engineering. P:M: (ME 222 and MSE 250) and completion of Tier I writing requirement. R: Open only to students in the Engineering Arts, Engineering Mechanics, Manufacturing Engineering and Materials Science and 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.

480   Chemical Processing of Materials
Fall of even years. 3(3-0) P:M: (MSE 352 or CHE 312) R: Open only to students in the Department of Chemical Engineering and Materials Science. SA: MSM 480
Processing of metals, ceramics, and polymers. Material and energy balances. Reduction and oxidation. Extractive technology of iron, steel, and principal non-ferrous metals. Colloidal preparation of ceramics.

483   Environmental Effects on Materials
Fall of odd years. 3(3-0) P:M: (MSE 352) R: Open only to students in the Materials Science and Engineering major. SA: MSM 483
Electrochemical processes and kinetics. Metallic corrosion and protection. Degradation of ceramics, polymers and composites.

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 Engineering Arts 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.

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. 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.

885   Seminar
Fall, Spring. 1(1-0) SA: MSM 885
Oral presentations of students' research or literature survey.

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.

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 displacive phase transformations.

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.

964B   Displacive Phase Transformations
Fall of even years. 3(3-0) SA: MSM 964B
Crystallography and thermodynamics of displacive phase transformations. Twinning. Thermoelastic and non-thermoelastic martensites. WLR theory. Multiple-well potentials. Self-accommodation and interface mobility. Shape memory, superelasticity, transformation toughening and transformation-induced plasticity.

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 970, 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 970A, MSM 965B
Experimental methods in transmission electron microscopy. Microanalytical, chemical, microbeam, diffraction and lattice imaging techniques.

974   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 980, 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
Application of laser and plasma technology in materials processing. Optical and surface properties. Thin films. Heat and mass flow. Heat-treating. Cutting, drilling, and joining.

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.

MATHEMATICS   MTH

Department of Mathematics
College of Natural Science

1005 Fundamentals of Algebra
Summer. 1(1-0)
Factoring. Rational and exponential expressions. Linear and quadratic relations. Fractions and distributive laws. Functions

100E Intermediate Algebra Workshop for the Mathematics Enrichment Program
Fall, Spring. 1(0-4) R: Approval of department. C: MTH 1825 concurrently.
Enrichment topics in intermediate algebra for students in the Mathematics Enrichment Program.

103 College Algebra
Fall, Spring, Summer. 3(3-0) P:M: (MTH 1825)or designated score on Mathematics placement test. Not open to students with credit in LBS 117 or MTH 116.
Number systems; functions and relations; exponents and logarithms; elementary theory of equations; inequalities; and systems of equations.

103E College Algebra Workshop for the Mathematics Enrichment Program
Fall, Spring. 1(0-4) R: Approval of department. C: MTH 103 concurrently.
Enrichment topics in college algebra for students in the Mathematics Enrichment Program.

106 The Significance of Mathematics
Fall, Spring, Summer. 3(3-0) P:M: (MTH 103) or designated score on Mathematics placement test.
Numbers and numeracy, geometry, growth patterns, and statistics. Selected applications to the arts, sciences, and social sciences.

106E The Significance of Mathematics Workshop for the Mathematics Enrichment Program
Spring. 1(0-4) R: Approval of department C: MTH 106 concurrently.
Enrichment topics in The Significance of Mathematics for the Math Enrichment Program.

110 Finite Mathematics and Elements of College Algebra
Fall, Spring, Summer. 5(5-0) P:M: (MTH 1825) or designated score on Mathematics placement test.
Functions and graphs. Equations and inequalities. Systems of equations. Matrices. Linear programming. Simplex algorithm. Probability and statistics.

114 Trigonometry
Fall, Spring, Summer. 3(3-0) P:M: (MTH 103) SA: MTH 104 Not open to students with credit in MTH 116.
Radian and degree measure of angles. Definitions and graphs of trigonometric functions and their inverses. Solving trigonometric equations. Applications including identities, indirect measurement and trigonometric modeling.

116 College Algebra and Trigonometry
Fall, Spring, Summer. 5(5-0) P:M: (MTH 1825)or designated score on Mathematics placement test. Not open to students with credit in LBS 117 or MTH 103.
Functions and graphs. Equations and inequalities. Exponential and logarithmic functions. Trigonometric functions. Systems of equations. Binomial theorem.

116E Precalculus Workshop for the Emerging Scholars Program
Fall. 1(0-4) R: Approval of department. C: MTH 116 concurrently.
Enrichment topics in precalculus for students in the Emerging Scholars Program.

124 Survey of Calculus I
Fall, Spring, Summer. 3(3-0) P:M: (MTH 103 or MTH 116 or LBS 117)or designated score on Mathematics placement test. Not open to students with credit in LBS 118 or MTH 132 or MTH 152H.
Study of limits, continuous functions, derivatives, integrals and their applications.

124E Survey of Calculus with Applications I Mathematics Enrichment Workshop
Fall. 1(0-4) R: Approval of mathematics department C: MTH 124 concurrently.
Enrichment topics in Survey of Calculus with Applications I for students in the Mathematics Enrichment Program.

126 Survey of Calculus II
Fall, Spring, Summer. 3(3-0) P:M: (MTH 124) Not open to students with credit in MTH 133 or MTH 153H.
Application of partial derivatives, integrals, optimization of functions of several variables and differential equations.

132 Calculus I
Fall, Spring, Summer. 3(3-0) P:M: (MTH 103 and MTH 114) or (MTH 116 or LBS 117)or designated score on Mathematics placement test. Not open to students with credit in LBS 118 or MTH 152H.
Limits, continuous functions, derivatives and their applications. Integrals and the fundamental theorem of calculus.

132E Calculus I Workshop for the Emerging Scholars Program
Fall, Spring. 2(0-6) R: Approval of department. C: MTH 132 concurrently.
Enrichment topics in Calculus I for students in the Emerging Scholars Program.

133 Calculus II
Fall, Spring, Summer. 4(4-0) P:M: (MTH 132 or MTH 152H) Not open to students with credit in LBS 118 or LBS 119 or MTH 153H.
Applications of the integral and methods of integration. Improper integrals. Polar coordinates and parametric curves. Sequences and series. Power series.

133E Calculus II Workshop for the Emerging Scholars Program
Fall, Spring. 1(0-4) R: Approval of department. C: MTH 133 concurrently.
Enrichment topics in Calculus II for students in the Emerging Scholars Program.

152H Honors Calculus I
Fall. 3(3-0) R: Honors College student or approval of department. Not open to students with credit in LBS 118 or MTH 132.
Limits, continuous functions, derivatives, integrals, fundamental theorem of calculus. Special emphasis on concepts and theory.

153H Honors Calculus II
Fall, Spring. 3(3-0) P:M: (MTH 152H) Not open to students with credit in LBS 119 or MTH 133.
The integral. Improper integrals. Polar coordinates and parametric curves. Sequences and series. Power and Taylor series. Special emphasis on concepts and theory.

1825 Intermediate Algebra
Fall, Spring, Summer. 3(3-0)
Properties of real numbers. Factoring. Roots and radicals. First and second degree equations. Linear inequalities. Polynomials. Systems of equations.

201 Mathematical Investigations I
Fall, Spring, Summer. 3(3-0) P:M: (MTH 103 or MTH 110 or MTH 116 or LBS 117 or MTH 124 or MTH 132 or MTH 152H or LBS 118) or designated score on Mathematics placement test. R: Open only to students in the Education major or Special Education major whose area of emphasis is emotional impairment or deaf education or learning disabilities or visual impairment or General Science-Interdepartmental major or Child Development major or Teacher Certification Internship-Year Studies program.
Mathematics for prospective elementary teachers. Numbers, problem solving, geometry, functions, statistics and probability.

202 Mathematical Investigations II
Fall, Spring, Summer. 3(3-0) P:M: (MTH 201) R: Open only to students in the Education major or Special Education major whose area of emphasis is emotional impairment or deaf education or learning disabilities or visual impairment or General Science-Interdepartmental major or Child Development major or Teacher Certification Internship-Year Studies program.
A continuation of MTH 201.

234 Multivariable Calculus
Fall, Spring, Summer. 4(4-0) P:M: (MTH 133 or MTH 153H or LBS 119) Not open to students with credit in MTH 254H.
Vectors in space. Functions of several variables and partial differentiation. Multiple integrals. Line and surface integrals. Green's and Stokes's theorems.

235 Differential Equations
Fall, Spring, Summer. 3(3-0) P:M: (MTH 234 or MTH 254H) Not open to students with credit in MTH 255H.
Separable and exact equations, linear equations and variation of parameters, series solutions, higher order linear equations, systems of first order linear equations, introduction to partial differential equations and Fourier Series.