

Master of Business Administration—MBA

- 826 International, Comparative, and Cross-Cultural Business**
Spring, Summer. 2(2-0) R: Open only to MBA students.

International businesses' approaches to global markets, economic trade issues, methods of entry, and organizational alternatives. Cross-cultural differences and their impacts on business practices. Trade agreements, strategic alliances, negotiations, and cultural consequences. Offered half of semester.

- 841 Studies in the Global Marketplace**
Summer. 3(1-4) Summer: International trip. R: Open only to MBA students.

Commercial, economic, cultural, and political aspects of global environments. Exposure to leading executives and government representatives in world markets. Comparative framework for competitive strategy in a multi-country context. International field trip required.

- 850 Strategic Management**
Fall. 2(2-0) R: Open only to MBA students.
Concepts and methods that integrate previous training in functional areas of management. Total firm perspective and ways top managers create and sustain competitive advantage in today's challenging global marketplace.

- 891 Special Topics in Business Management**
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 MBA students.

Current and emerging issues in management. New and changing developments affecting managers.

- 893 MBA Internship Experience**
Fall, Spring, Summer. 1 credit. A student may earn a maximum of 2 credits in all enrollments for this course. RB: Completion of at least one semester in the MBA program. R: Open to MBA students except students in the Advanced Management Program or Program in Integrative Management.

Internship in business organizations; application of business knowledge and management techniques in a work environment.

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: (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 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: (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.

- 324 Biomaterials and Biocompatibility**
Spring. 3(3-0) Interdepartmental with Biomedical Engineering. P: (PSL 250 or concurrently) and (MSE 250) R: Open only to students in the College of Engineering. SA: MSM 424

Materials science of human implants. Design requirements imposed by the human body. Need for bodily protection.

- 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 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: (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: (MSE 310 and MSE 350 or concurrently) R: Open only to juniors or seniors in the College of Engineering. SA: MSE352

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: (MSE 310 and MSE 350 or concurrently) R: Open only to juniors or seniors in the Materials Science and Engineering major. 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: (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 Biomedical Engineering; Radiology; Human Anatomy. Administered by College of Engineering. P: (MTH 235 and PHY 184) and (PSL 250 or concurrently or PSL 431 or concurrently) and (CEM 141 or CEM 151) and (ANTR 350 or concurrently) 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.

- 426 Introduction to Composite Materials**
Spring. 3(3-0) Interdepartmental with Mechanical Engineering. P: (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**
Spring. 3(2-3) P: (PHY 184 or PHY 184B) RB: (MSE 350 and MSE 381) R: Open only to 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: (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 (W)**
Spring. 3(3-0) P: (MSE 331 and MSE 381) and completion of Tier I writing requirement. 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 Fracture and Failure Analysis**
Fall. 3(2-3) P: (MSE 250) RB: (MSE 331 and MSE 320) R: Open only to seniors in the College of Engineering. SA: MSM 466

Modes and causes of failure in mechanical components. Non-destructive evaluation. Legal and economic aspects of materials failure. Analysis illustrated in student projects requiring integration of prior course work.

- 476 Physical Metallurgy of Ferrous and Aluminum Alloys**
Fall of even years. 3(3-0) P: (MSE 250) RB: (MSE 310) and (MSE 360) and (MSE 370) 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, case hardening. Joining of materials, welding.
- 477 Manufacturing Processes**
Fall. 3(3-0) Interdepartmental with Mechanical Engineering. Administered by Department of Mechanical Engineering. P: (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.
- 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: 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.

Mechanical Science and Engineering—MSE

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.

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.

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: (MTH 1825) or designated score on Mathematics placement test. Not open to students with credit in MTH 112.
Functions and graphs. Equations and inequalities. Systems of equations. Matrices. Linear programming. Simplex algorithm. Probability and statistics.

112 Finite Mathematics: Applications of College Algebra
Fall, Spring, Summer. 3(3-0) P: (MTH 103) or designated score on Mathematics placement test. SA: MTH 106 Not open to students with credit in MTH 110.
Combinatorics, probability and statistics, mathematics of finance, geometry, transition matrices, and linear programming. The course emphasizes applications and includes work using spreadsheets.

114 Trigonometry
Fall, Spring, Summer. 3(3-0) P: (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: (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: (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: (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: (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: (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: (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: (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.

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: (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.