

**999 Doctoral Dissertation Research**  
 Fall, Spring, Summer. 1 to 24 credits. A student may earn a maximum of 99 credits in all enrollments for this course. R: Open only to Ph.D. students in the Department of Marketing and Supply Chain Management. Approval of department. SA: ML 999, MTA 999

Doctoral dissertation research.

## MASTER OF BUSINESS ADMINISTRATION MBA

### The Eli Broad College of Business and The Eli Broad Graduate School of Management

**800 The Global Organization and the Firm's Strategic Position**  
 Fall, Spring. 2(2-0) R: Open only to MBA students.

Organizational goals, design, and control of the global business enterprise. Maximization of shareholder value, competitive forces, configuring the value-added chain. Strategies for implementing new organizational forms. Designing and managing strategic change.

**802 Financial Accounting**  
 Fall. 2(2-0) R: Open only to MBA students.  
 Financial accounting model underlying financial statements of firms. Information in financial statements and role of these statements in capital markets. Information intermediaries, regulators, and role of independent auditor. Standard setting and the impact of changing standards. Globalization of standards. Offered first half of semester.

**804 Applied Data Analysis for Managers**  
 Fall. 2(2-0) RB: (STT 315) R: Open only to MBA students. Not open to students with credit in MSC 833.  
 Analysis of business and economic data to support managerial decision-making. Building, interpreting, and applying regression models. Time series and forecasting. Offered second half of semester.

**806 Business Ethics and the Legal Environment**  
 Spring. 2(2-0) R: Open only to MBA students.  
 Framework for identifying, analyzing, and resolving ethical dilemmas in business. Key legal topics in business using critical thinking analysis.

**808 Leadership and Teamwork**  
 Fall. 1(1-0) R: Open only to MBA students.  
 Understanding team management and leadership through experiential and skill-based learning. Effective communication, including the use of electronic communication technologies for team development and maintenance. Active practice of teamwork, communication, and leadership skills. Offered first half of semester.

**812 Managerial Accounting**  
 Spring. 2(2-0) R: Open only to MBA students.  
 Performance measurement and incentive system design. Organization structure, budgeting, and transfer pricing. Target costing. Relevant costs and management decision models. Activity-based costing. Aligning management accounting and firm strategy. Accounting for quality. International perspective on management accounting issues. Offered second half of semester.

**814 Applied Economics**  
 Spring. 2(2-0) R: Open only to MBA students.  
 Economic view of the firm. Modeling market mechanics in supply and demand, marginal concepts, elasticity, market characteristics, pricing with market power, and strategic behavior. Applications to business problems and situations. Principal-agent relationships and wealth maximization. Offered first half of semester.

**816 Business Presentations**  
 Fall. 1(1-1) R: Open only to MBA students.  
 Development of effective interpersonal communication skills. Oral communications in business settings.

**820 Marketing Management**  
 Fall. 3(3-0) R: Open only to MBA students.  
 Leadership principles. Decision-making. Fundamental marketing concepts such as segmentation, target marketing, positioning, growth strategies, revenue management, product management, and communication strategies. Problem-solving and marketing planning.

**821 Supply Chain Management**  
 Fall. 3(3-0) R: Open only to MBA students.  
 Integrative approach to product design, development, and delivery. Flow of products from concept development through delivery to the final user, including product and process development, managing information and product flows, total quality management, and resource and capacity management.

**822 Financial Management**  
 Fall. 3(3-0) R: Open only to MBA students.  
 Investment decisions by firms. Value creation, risk and return, pricing models, and financial markets. Financing alternatives, market efficiency, capital budgeting, and leverage and risk relationships. Optimizing firm value. Agency problems and effects on investment and financing decisions.

**823 Information Technology Management**  
 Spring. 2(2-0) R: Open only to MBA students.  
 Role of information technology in operations, decision making, and learning in organizations. Competitive and economic benefits from managing information technology resources. Competitive advantage, efficient operations, and improved decision quality. Offered second half of semester.

**824 Managing the Workforce**  
 Spring. 2(2-0) R: Open only to MBA students.  
 Role of workforce management in fulfilling the goals and mission of the organization. Theories and applications of management principles to acquiring, motivating, and rewarding employees and structuring their work. Domestic and international issues in the workplace. Offered first half of semester.

**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: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.

## Materials and Science and Engineering—MSE

- 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: 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:M: (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: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 Biomedical Engineering; Radiology; Human Anatomy. Administered by College of Engineering. P:M: (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.
- 425 Biomaterials and Biocompatibility**  
Spring. 3(3-0) Interdepartmental with Biomedical 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. 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 (W)**  
Spring. 3(3-0) P:M: (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 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) and (MSE 381) 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) and (MSE 360) 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 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 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.
- 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.