930. Theory of Transportation-Distribution Systems
Fall of odd-numbered years. 3(3-0)
P: ML 805. R: Open only to Ph.D. students in the College of Business.
Transportation-distribution research on systems integration. Elements of networks, systems, and economic theory in the design, evaluation, and control of logistics systems. Topics include strategic logistics, forecasting, and system integration models.
QP: MTA 809 QA: MTA 930

931. Transportation and Distribution Research Methods
Fall of even-numbered years. 3(3-0)
P: ML 900. R: Open only to Ph.D. students in Business. Techniques and methodology of system design, customer services and policy formulation.
QP: MTA 930 QA: MTA 931

932. Transportation and Distribution Development Policy
Fall of even-numbered years. 3(3-0)
P: ML 805. R: Open only to Ph.D. students in College of Business. The interaction of government, carrier, and user logistics and distribution strategies, particularly at the macrocorporate and national policy levels.
QP: MTA 931 QA: MTA 932

940. International Business Theory
Fall of even-numbered years. 3(3-0)
P: ML 820. ML 822.
Theories explaining international business phenomena. Varying perspectives on international business activities, concepts, and frameworks.
QP: MTA 860 or MTA 892

941. International Business Research Issues
Spring of even-numbered years. 3(3-0)
P: ML 940.
Scientific methods of research on international business. Topics include cultural bias and organizing multi-country studies.
QP: MTA 922 QA: MTA 863

995. Directed Research Paper
Fall, Spring, Summer. 1-10
P: ML 921.
Open only to Ph.D. students in Marketing and Transportation Administration. Preparation of a research paper under the direction of a seminar faculty member.
QP: MTA 921

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: Approval of department.
QP: MTA 999

MATERIALS SCIENCE AND MECHANICS

MSM

Department of Materials Science and Mechanics
College of Engineering

160. Engineering Communications
Fall, Spring. 3(3-0)
P: MTH 116 or concurrently.
Computer-aided design and drafting. Preclinical sketching. Two and three dimensional visualization. Preparation of spread sheets and technical reports.
QP: MMM 160

205. Statics
Fall, Spring. 3(3-0)
P: MTH 130.
Vector description of forces and moments. Two and three dimensional equilibrium of particles and rigid bodies. Analysis of trusses, frames and machines. Coulomb friction.
QP: MTH 216 QA: MMM 205

211. Mechanics of Deformable Solids
Fall, Spring. 3(3-0)
P: MSM 205. R: Open only to Materials Science and Engineering majors.
QP: MSM 206, MTH 310, MIM 215 QA: MIM 215

250. Materials Science and Engineering
Fall, Spring. 3(3-2)
P: CEM 141, MTH 133, MTH 234. R: Open only to Materials Science and Engineering majors.
Structure of metals, ceramics and polymers. Phase diagrams, thermomechanical treatments, physical and mechanical properties, diffusion, microstructure studies, environmental effects.
QP: CEM 141, MTH 115 QA: MMM 250, MIM 230

306. Dynamics
Fall, Spring. 3(3-0)
P: MSM 205, MTH 235. R: Open only to College of Engineering students.
QP: MMM 206, MTH 310 QA: MMM 306

351. Thermochemistry of Materials
Fall. 3(3-0)
P: CEM 152, MTH 234. R: Open only to Materials Science and Engineering majors.
Not open to students with credit in CEM 151, MTH 201. State variables, laws of thermodynamics, phase and chemical equilibria. Gas and condensed phase relationships, solutions, interfaces, point defects, electrochemistry.
QP: CEM 152, MTH 215 QA: MMM 330

352. Diffusion in Solids
Spring. 3(3-0)
P: MSM 252. R: Open only to Materials Science and Engineering majors.
QP: MMM 330 QA: MMM 452

355. Kinematic Behavior of Materials
Fall. 3(3-0)
P: MSM 211, MIM 250, C: MSM 375 R: Open only to Materials Science and Engineering, Mechanical Engineering majors.
Stress and strain, crystal plasticity, anisotropy and viscoelasticity. Mechanical properties in tension and torsion. Crystallographic aspects of plasticity.
QP: MSM 211, MIM 250 QA: MMM 350, MMM 351

356. Deformation Mechanisms
Spring. 3(3-0)
P: MSM 255. R: Open only to Materials Science and Engineering majors.
QP: MMM 350, MMM 351 QA: MMM 351, MMM 456

365. Physical Metallurgy I
Fall. 3(3-0)
P: MSM 250, MMM 351 or concurrently. C: MSM 375 R: Open only to Materials Science and Engineering majors.
QP: MSM 250, MIM 330, MIM 360 QA: MMM 360, MMM 301

366. Physical Metallurgy II
Spring. 3(3-0)
P: MSM 365. C: MSM 376 R: Open only to Materials Science and Engineering majors.
QP: MMM 360, MMM 390 QA: MMM 453, MMM 361

375. Materials Science Laboratory I
Fall. 10(3)
P: MSM 355; C: MSM 365 R: Open only to Materials Science and Engineering majors.
QP: MMM 350, MMM 380 QA: MMM 382

376. Materials Science Laboratory II
Spring. 10(3)
P: MSM 356 or concurrently. C: Open only to Materials Science and Engineering majors.
QP: MMM 350, MMM 360 QA: MMM 382

380. Polymeric Materials
Spring. 3(3-0)
P: CEM 152. R: Open only to Materials Science and Engineering majors.
QP: CEM 152

Fall. 3(3-0)
P: MSM 211. R: Open only to College of Engineering majors.
QP: MTH 211 QA: MMM 401

402. Computational Mechanics
Spring. 3(3-0)
P: MSM 300. R: Open only to College of Engineering majors.
QP: MMM 401 QA: MMM 402

403. Intermediate Dynamics
Fall of odd-numbered years. 3(3-0)
P: MSM 300. R: Open only to College of Engineering majors.
QP: MMM 306 QA: MMM 403

405. Experimental Mechanics
Fall of odd-numbered years. 3(2-3)
P: MSM 211, MSM 306. R: Open only to College of Engineering majors.
Measurement of stress, strain, vibration, and motion using strain gauges, accelerometers, photelasticity, holography, Moire patterns, laser speckle and electronic imaging. Transducer design.
QP: MSM 211, MSM 305 QA: MMM 405

444. Introduction to Composite Materials
Spring. 3(3-0)
P: MSM 211. R: Open only to Materials Science and Engineering majors or approval of department.
QP: MSM 211 QA: MMM 444

451. X-Ray Crystallography
Fall. 3(3-2)
P: MSM 250. R: Open only to Materials Science and Engineering majors or graduate students.
QP: MMM 250 QA: MMM 430
454. Ceramic and Refractory Materials
Fall (3-3-0)
P: MSM 250, MSM 351. R: Open only to Materials Science and Engineering majors.
Ceramic and glassy materials. High temperature processes. Chemical and physical properties of technical ceramics.
QP: MMM 250 QA: MMM 420

455. Theory of Solids
Spring (3-3-0)
P: MSM 451. R: Open only to Materials Science and Engineering majors.
QP: MMM 450, PHY 289 QA: MMM 454

465. Design and Application of Engineering Materials
Spring (3-3-0)
P: MSM 355, MSM 356. R: Open only to Materials Science and Engineering majors.
Fundamental principles of strengthening: toughening, specific strength and stiffness. Material development based on environmental, temperature, wear, damping, fatigue and economic considerations.
QP: MMM 330, MMM 456 QA: MMM 476

466. Failure Analysis
Spring (3-3-0)
P: MSM 211, MSM 250. R: Open only to Materials Science and Engineering or Mechanics majors or approval of department.
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.
QP: MMM 211, MMM 215, MMM 250 QA: MMM 425, MMM 455

475. Deformation Processing of Materials
Fall of odd-numbered years (3-3-0)
P: MSM 355. R: Open only to Materials Science and Engineering, Mechanical Engineering majors.
Theories of metal forming. Forging, rolling, extrusion, wire drawing, sheet metal forming, machining, powder pressing, sintering, hot pressing, composite processing.
QP: MMM 350 QA: MMM 482, MMM 481

476. Physical Processing of Materials
Spring of odd-numbered years (3-3-0)
P: MSM 385, R: Open only to College of Engineering majors.
QP: MMM 360, MMM 360 QA: MMM 461, MMM 463

490. Chemical Processing of Materials
Fall (3-3-0)
P: MSM 352, or CHE 312. R: Open only to Materials Science and Engineering, and Chemical Engineering seniors and graduate students.
QP: MMM 330 QA: MMM 480

481. Manufacturing Systems I
Fall (3-3-0)
P: MSM 205, MSM 250. R: Open only to Materials Science and Engineering or Engineering Arts majors.
Manufacturing process planning and design. Discrete parts and assembly processes. Productibility, cost estimation, time standards, materials handling, plant layout principles.
QP: MMM 201, MMM 205, MMM 230, MMM 250 QA: MMM 421, MMM 442

482. Manufacturing Systems II
Spring (3-3-0)
P: MSM 381. R: Open only to Materials Science and Engineering or Engineering Arts majors.
QP: MMM 205, MMM 421 QA: MMM 442, MMM 444

483. Environmental Effects on Materials
Spring of odd-numbered years (3-3-0)
P: MSM 352. R: Open only to Materials Science and Engineering majors.
QP: MMM 350 QA: MMM 431

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 Materials Science and Engineering majors. Approval of department. Individualized reading and research.
QA: MMM 490

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 majors in Materials Science and Engineering or in Mechanics.
Topics in materials science or mechanics of current interest.
QP: MMM 499

499. Senior Research and Design Project
Fall, Spring, Summer. 2 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course.
R: Open only to seniors in Materials Science and Engineering, Engineering Arts, and Mechanics. Approval of department. Design and analysis to solve a materials related problem.
QA: MMM 499

801. Advanced Dynamics
Fall (3-3-0)
P: MSM 463.
Dynamics of systems of particles and rigid bodies. Energy and momentum principles. Lagrangian and Hamiltonian mechanics. Angular motion, central forces. Applications in system dynamics and vibrations.
QP: MMM 366 QA: MMM 801

805. Experimental Mechanics
Spring (3-3-0)
P: MSM 356 QA: MMM 805
R: Approval of department.
QA: MMM 805

809. Finite Element Method
Fall (3-3-0) Interdepartmental with Agricultural Engineering, Civil Engineering, and Mechanical Engineering.
R: Approval of department.
Theory and application of the finite element method to the solution of continuum type problems in heat transfer, fluid mechanics, and stress analysis.
QA: MMM 806

810. Continuum Mechanics
Fall (3-3-0)
P: MSM 401, MTH 424.
Mathematical tools of continuum mechanics, stress principles, kinematics of deformation and motion, fundamental laws and equations. Applications in linear elasticity and classical fluids.
QP: MMM 401, MTH 421 QA: MMM 810

813. Linear Elasticity
Spring (3-3-0)
P: MSM 810.
QP: MMM 810 QA: MMM 813

814. Mechanics of Composite Materials (MTC)
Fall (3-3-0)
P: MSM 381.
A student may earn a maximum of 6 credits in all enrollments for this course. Topics vary each semester. Topics such as fiber-reinforced composite materials or laminated composite structures.
QP: MMM 813 QA: MMM 814

815. Advanced Strength of Materials
Spring of even-numbered years (3-3-0)
P: MSM 401.
General theory of torsion, non-symmetrical bending, transverse shear, thin-walled beams, beams on elastic foundations, thick-walled cylinders. Basic contact mechanics, fatigue, and failure for solids.
QP: MMM 401 QA: MMM 815

816. Fracture Mechanics and Fatigue
Spring of odd-numbered years (3-3-0)
P: MSM 813.
QP: MMM 813 QA: MMM 816, MMM 917

820. Energy Methods in Mechanics
Spring of odd-numbered years (3-3-0)
P: MSM 815.
QP: MMM 813 QA: MMM 820

835. Wave Propagation in Solids
Fall of odd-numbered years (3-3-0)
P: MSM 810.
Plane waves in elastic media, reflection of waves at interfaces. Surface waves, waveguides. Application to nondestructive evaluation. Introduction to wave propagation in anisotropic, birefringent, and inelastic solids.
QP: MMM 810

840. Plates and Shells
Fall of odd-numbered years (3-3-0) Interdepartmental with Civil Engineering.
P: MSM 815.
Deformation and stress analysis of plates and shells with different types of geometry, thickness, and boundary conditions.
QP: MMM 815 QA: MMM 912, C E 909

851. Thermodynamics of Solids
Fall (3-3-0)
P: MSM 351.
QP: MMM 330 QA: MMM 825

855. Advanced Rate Theory and Diffusion
Spring (3-3-0)
P: MSM 351.
QP: MMM 825 QA: MMM 863

862. Dislocation Theory
Fall (3-3-0)
P: MSM 351.
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.
QP: MMM 430 QA: MMM 872
855. Advanced Theory of Solids
P: MSM 851.
Spring: 3(3-0)
QA: MTH 852 QA: MTHM 861

870. Electron Microscopy in Materials Science
P: MSM 451. R: Open only to majors in Materials Science.
Spring: 3(2-3)
QA: MMM 430 QA: MMM 852

875. Engineering Ceramics
P: MSM 454, MSM 455.
Fall of odd-numbered years: 3(3-0)
Physical properties of engineering ceramics. Transport properties of ceramics, especially in ferrites and perovskites. Optical properties of ceramic materials.
QA: MMM 420, MMM 445 QA: MTH 849

876. Advanced Polymeric Materials
P: MSM 380.
Fall of even-numbered years: 3(3-0)
Advanced topics in polymer structure and properties. Thermoplasitics, thermoplasts, polyol and elastomers. Processing techniques. Deformation and mechanical properties. Thermal, optical and chemical properties. Composites.
QA: MMM 440 QA: MMM 800

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

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.
Individualized reading and research of student's interest.
QA: MMM 800

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.
Special topics in materials science or mechanics of current importance.
QA: MMM 880

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.
QA: MMM 899

905. Optical Methods of Measurement
P: MSM 105.
Fall of even-numbered years: 3(2-3)
R: Approval of department.
Measurement of position, motion, strain, using optical methods including holography, speckle interferometry, Moiré, photoelasticity, laser Doppler, electronic imaging, model analysis. Relevant optical theories.
QA: MMM 806

909. Boundary Element Method
P: MSM 813.
Spring of even-numbered years: 3(3-0)
Theory and application of the boundary element method to the solution of continuum type problems in heat transfer, fluid mechanics and stress analysis. Computer applications.
QA: MMM 813

915. Nonlinear Elasticity
P: MSM 813.
Spring of odd-numbered years: 3(3-0)
QA: MMM 813 QA: MTH M 815

918. Thermooelasticity and Viscoelasticity
P: MSM 810, MTH 443.
Spring of odd-numbered years: 3(3-0)
QA: MTHM 810 QA: MTHM 812 QA: MMM 818

922. Micromechanics
P: MSM 813.
Spring of even-numbered years: 3(3-0)
QA: MMM 819

960. Advanced Physical and Mechanical Properties of Materials (MTC)
Fall: 3(3-0)
A student may earn a maximum of 9 credits in all enrollments for this course. Topics vary each semester. Topics such as microcracking in brittle materials, anisotropic crystallographic properties, or surfaces, interfaces and thin film structures.

970. Advanced Analytical Techniques (MTC)
Spring: 3(3-0)
A student may earn a maximum of 9 credits in all enrollments for this course. Topics vary each semester. Topics such as advanced techniques in electron microscopy, advanced analytical methods in materials science, or advanced X-ray methods.

980. Advanced Processing Techniques (MTC)
Spring: 3(3-0)
A student may earn a maximum of 9 credits in all enrollments for this course. Topics vary each semester. Topics such as ceramic processing, or high temperature deformation and processing, or laser and plasma processing.

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.
R: Approval of department.
Individualized reading and research of student's interest.
QA: MTH 900

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.
Special topics in materials science or mechanics of current importance.
QA: MTH 980

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.
QA: MMM 999

MATHMATICS

Department of Mathematics
College of Natural Science

103. College Algebra
Fall, Spring, Summer: 3(3-0)
P: MTH 1025 or designated score on mathematics placement test. R: Not open to students with credit in MTH 110 or MTH 116 or MTH 120 or LBS 117.
Number systems; variables; functions and relations; elementary theory of equations; binomial theorem; determinants, matrices, and systems of equations.
QP: MTH 062 QA: MTH 106, MTH 111

110. College Algebra and Finite Mathematics
Fall, Spring, Summer: 5(5-0)
P: MTH 1025 or designated score on mathematics placement test. R: Not open to students with credit in MTH 103 or MTH 116 or MTH 120 or LBS 117.
QA: MTH 106 QA: MTH 110, MTH 108

116. College Algebra and Trigonometry
Fall, Spring, Summer: 5(5-0)
P: MTH 1025 or designated score on mathematics placement test. R: Not open to students with credit in MTH 103 or MTH 116 or MTH 120 or LBS 117.
QP: MTH 108 QA: MTH 111, MTH 109, MTH 108

120. Algebra and a Survey of Calculus
Fall, Spring, Summer: 3(3-0)
P: MTH 1025 or designated score on mathematics placement test. R: Not open to students with credit in MTH 103 or MTH 110 or MTH 116 or MTH 124 or LBS 117.
Study of limits, continuous functions, derivatives, integrals, fundamental theorem of calculus.
QA: MTH 106 or MTH 111

124. Survey of Calculus with Applications I
Fall, Spring, Summer: 3(3-0)
P: MTH 1025 or designated score on mathematics placement test. R: Not open to students with credit in MTH 103 or MTH 110 or MTH 116 or MTH 124 or LBS 117.
Study of limits, continuous functions, derivatives, integrals and their applications.
QA: MTH 106 or MTH 111

126. Survey of Calculus with Applications II
Fall, Spring, Summer: 3(3-0)
P: MTH 120 or MTH 124. R: Not open to students with credit in MTH 103 or MTH 110 or MTH 116 or MTH 124 or LBS 117.
Application of partial derivatives, integrals, optimization of functions of several variables and infinite series.

132. Calculus I
Fall, Spring, Summer: 3(3-0)
P: MTH 116 or designated score on mathematics placement test. R: Not open to students with credit in MTH 120 or MTH 124 or MTH 125H or LBS 117.
Limits, continuous functions, derivatives and their applications. Integrals and the fundamental theorem of calculus.
QP: MTH 108 or MTH 111 QA: MTH 112, MTH 122

133. Calculus II
Fall, Spring, Summer: 4(4-0)
P: MTH 120 or MTH 125H. R: Not open to students with credit in MTH 120 or MTH 125H.
Application of integral and methods of integration, improper integrals. Polar coordinates and parametric curves.
QA: MTH 115, MTH 123

152H. Honors Calculus I
Fall: 3(3-0)
R: Open only to Honors College students.
Not open to students with credit in MTH 120 or MTH 125H or MTH 126.
Limits, continuous functions, derivatives and their applications. Integrals and the fundamental theorem of calculus. Special emphasis on concepts and theory.
QA: MTH 112

152H. Honors Calculus II
Spring: 3(0-0)
P: MTH 125H. R: Honors College student. Not open to students with credit in MTH 120 or MTH 125H or MTH 126.
The integral. Improper integrals. Polar coordinates and parametric curves. Special emphasis on concepts and theory.
QA: MTH 119