

**Descriptions —Marketing and Supply Chain Management
of
Courses**

**932. Transportation and Distribution
Development Policy**

Fall of even-numbered years. 3(3-0)

P: MSC 805. R: Open only to Ph.D. students.

The interaction of government, carrier, and user logistics and distribution strategies, particularly at the macro-corporate and national policy levels.

SA: ML 932

940. International Business Theory

Fall of even-numbered years. 3(3-0)

P: MSC 860 or MSC 862. R: Open only to Ph.D. students.

Theories explaining international business phenomena. Varying perspectives on international business activities, concepts, and frameworks.

SA: ML 940

941. International Business Research Issues

Spring of odd-numbered years. 3(3-0)

P: MSC 940. R: Open only to Ph.D. students.

Scientific methods of research on international business. Topics include cultural bias and organizing multi-country studies.

SA: ML 941

990. Independent Study

Fall, Spring. 1 to 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course.

R: Open only to Ph.D. students.

Intensive reading and research on a marketing topic of mutual interest to a faculty member and a Ph.D. student.

SA: ML 924

995. Directed Research Paper

Fall, Spring, Summer. 1(1-0)

R: Open only to Ph.D. students in the Department of Marketing and Supply Chain Management.

Production of research paper under the direction of a senior faculty member.

SA: ML 995

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

**MATERIALS SCIENCE AND
MECHANICS**

MSM

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

160. Engineering Communications

Fall, Spring. 3(2-3)

P: MTH 116 or concurrently.

Computer-aided design and drafting. Freehand sketching. Two and three dimensional visualization. Preparation of spread sheets and technical reports.

205. Statics

Fall, Spring. 3(3-0)

P: MTH 132.

Vector description of forces and moments. Two and three dimensional equilibrium of particles and rigid bodies. Analysis of trusses, frames and machines. Coulomb friction.

211. Mechanics of Deformable Solids

Fall, Spring. 3(3-2)

P: MSM 205, MTH 133 or concurrently.

Tension compression and shear stresses. Axially loaded bars. Torsion of circular shafts. Beam theory. Combined stresses. Mohr's circles. Columns.

250. Materials Science and Engineering

Fall, Spring. 3(3-2)

P: CEM 141 or CEM 151.

Structure of metals, ceramics and polymers. Phase diagrams, thermomechanical treatments, physical and mechanical properties, diffusion, microstructure studies, environmental effects.

306. Dynamics

Fall, Spring. 3(3-0)

P: MSM 205, MTH 235. R: Open only to College of Engineering students.

Kinematics of particles, rigid bodies, and mass moments of inertia. Kinetics of particles and rigid bodies. Energy and momentum principles.

351. Thermochemistry of Materials

Fall. 3(3-0)

P: CEM 151. C: MTH 234 concurrently.

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: MSM 250, MSM 351. R: Open only to Materials Science and Engineering majors or approval of department.

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: MSM 211, MSM 250. R: Open only to Materials Science and Engineering, Mechanics, Mechanical Engineering majors or approval of department.

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: MSM 355. R: Open only to Materials Science and Engineering majors.

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: MSM 250; MSM 351 or concurrently. R: Open only to Materials Science and Engineering, and Mechanics majors or approval of department.

Complex binary and ternary phase diagrams. Solidification. Recovery, recrystallization and grain growth. Phase transformations.

366. Physical Metallurgy II

Spring of even-numbered years. 3(3-0)

P: MSM 365. R: Open only to Materials Science and Engineering majors.

Theory of alloy phases. Surfaces and interfaces. Diffusion controlled phase transformations in ferrous and non-ferrous alloys. Martensitic transformation. Amorphous structures.

375. Materials Science Laboratory I

Fall. 1 credit.

P: MSM 355 or concurrently, MSM 365 or concurrently. R: Open only to Materials Science and Engineering, and Mechanics majors.

Phase transformations. Recrystallization. Precipitation and aging. Microscopy. Structure-property relations.

376. Materials Science Laboratory II

Spring. 1 credit.

P: MSM 355. R: Open only to Materials Science and Engineering, and Mechanics majors.

Strengthening. Yielding, creep, and fracture. Plasticity. Thermal activation. Damping. Martensite and shape memory.

380. Polymeric Materials

Spring. 3(3-0)

P: CEM 152. R: Open only to Materials Science and Engineering majors.

Polymers and engineering plastics. Chemical, physical and mechanical properties. Environmental effects on polymers. Manufacturing processes. Coatings.

**401. Intermediate Mechanics of Deformable
Solids**

Fall. 3(3-0)

P: MSM 211. R: Open only to College of Engineering majors.

Stress, strain and linearly elastic behavior. Plane stress and plane strain. Torsion. Yield criteria. Elastoplastic behavior of beams, shafts and cylinders. Unsymmetrical bending. Curved beams.

402. Computational Mechanics

Spring. 3(3-0)

P: MSM 401 or ME 471. R: Open only to College of Engineering majors.

Energy methods with applications. Finite element methods. Buckling and stability. Green's functions.

403. Intermediate Dynamics

Fall of even-numbered years. 3(3-0)

P: MSM 306. R: Open only to College of Engineering majors.

Kinematics and kinetics of particle and rigid body systems. Virtual work, Lagrangian method, and Euler equations. Basic vibrations of discrete and continuous systems. Elementary wave propagation.

405. Experimental Mechanics

Fall of odd-numbered years. 3(2-3)

P: MSM 211. R: Open only to College of Engineering majors.

Measurement of stress, strain, vibration, and motion using strain gauges, accelerometers, photoelasticity, holography, Moire patterns, laser speckle and electronic imaging. Transducer design.

410. Product Innovation and Management

Fall. 3 credits. Interdepartmental with Marketing and Supply Chain Management. Administered by Marketing and Supply Chain Management.

P: MSC 300. R: Open only to juniors or seniors.

Analytic, decision-making, and planning concepts and tools available to product managers. New product policy and development, organizational issues, and product modification and deletion.

SA: ML 410

420. New Product Design and Development

Spring. 3 credits. Interdepartmental with Marketing and Supply Chain Management. Administered by Marketing and Supply Chain Management.

R: Open only to seniors in the College of Business or College of Engineering.

Practical training and experiences in design and testing of new products.

424. Biomaterials and Biocompatibility

Spring of even-numbered years. 3(3-0) Interdepartmental with Biomedical Engineering. Administered by Biomedical Engineering.

P: MSM 250, PSL 250.

Materials science of human implants. Design requirements imposed by the body's milieu and the need to protect the body.

- 441. Tissue Mechanics**
Spring of odd-numbered years. 3(3-0) Interdepartmental with Biomedical Engineering. Administered by Biomedical Engineering.
P: MSM 211.
Application of solid mechanics to understanding mechanical responses of biological tissues. Microstructure and biological function for soft and hard connective tissues and muscle.
- 444. Introduction to Composite Materials**
Spring. 3(3-0)
P: MSM 211. R: Open only to Materials Science and Engineering or Mechanics majors or approval of department.
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: MSM 250, PHY 184. R: Open only to Materials Science and Engineering seniors and graduate students.
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: MSM 365. R: Open only to Materials Science and Engineering majors.
Ceramic and glassy materials. High temperature processes. Mechanical and physical properties of technical ceramics.
- 455. Theory of Solids**
Spring. 3(3-0)
P: MSM 250, PHY 184. R: Open only to Materials Science and Engineering majors or approval of department.
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: MSM 355, MSM 365. 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.
- 466. Failure Analysis**
Spring. 3(3-0)
P: MSM 355. 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.
- 475. Deformation Processing of Materials**
Fall of odd-numbered years. 3(3-0)
P: MSM 355. R: Open only to Material 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.
- 476. Physical Processing of Materials**
Fall of even-numbered years. 3(3-0)
P: MSM 365. R: Open only to College of Engineering majors.
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.
- 480. Chemical Processing of Materials**
Fall of even-numbered years. 3(3-0)
P: MSM 352, or CHE 312. R: Open only to Materials Science and Engineering, and Chemical Engineering seniors and graduate students.
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.
- 481. Manufacturing Systems I**
Fall. 3(3-0)
P: MSM 205, MSM 250. R: Open only to juniors or seniors in the Materials Science and Engineering or Engineering Arts or Manufacturing Engineering major. Completion of Tier I writing requirement.
Manufacturing process planning and design. Discrete parts and assembly processes. Producibility, cost estimation, time standards, materials handling, plant layout principles.
- 482. Manufacturing Systems II**
Spring. 3(3-0)
P: MSM 481. R: Open only to juniors or seniors in the Materials Science and Engineering or Engineering Arts or Manufacturing Engineering major. Completion of Tier I writing requirement.
Operations scheduling and control. Applications of artificial intelligence. Optimization of multiple stage manufacturing activities. Manufacturing resource planning. Principles of synchronous manufacturing.
- 483. Environmental Effects on Materials**
Fall of odd-numbered years. 3(3-0)
P: MSM 352. R: Open only to Materials Science and Engineering majors.
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 Materials Science and Engineering majors. Approval of department.
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 majors in Materials Science and Engineering or in Mechanics.
Topics in materials science or mechanics of current interest.
- 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.
R: Open only to seniors in the Materials Science and Engineering or Engineering Arts or Mechanics major. Completion of Tier I writing requirement. Approval of department.
Design and analysis to solve materials and/or mechanics related problem. Preparation of written report, oral presentation, and defense of the project.
- 801. Advanced Dynamics**
Fall. 3(3-0)
Dynamics of systems of particles and rigid bodies. Energy and momentum principles. Lagrangian and Hamiltonian methods. Euler angles. Applications in system dynamics and vibrations.
- 805. Experimental Mechanics**
Spring. 3(2-3)
R: Approval of department.
Measurement of strain, displacement, velocity, acceleration using resistance strain gages, accelerometers, and related methods. Detailed study of strain gages and accelerometers. Transducer design. Basic modal analysis.
- 809. Finite Element Method**
Fall, Spring. 3(3-0) Interdepartmental with Biosystems Engineering, Civil Engineering, and Mechanical Engineering.
Theory and application of the finite element method to the solution of continuum type problems in heat transfer, fluid mechanics, and stress analysis.
- 810. Continuum Mechanics**
Fall. 3(3-0)
Mathematical tools of continuum mechanics, stress principles, kinematics of deformation and motion, fundamental laws and equations. Applications in linear elasticity and classical fluids.
- 813. Linear Elasticity**
Spring. 3(3-0)
P: MSM 810.
Fundamentals of isotropic linear elasticity. Solution of plane elasticity problems. St. Venant bending and torsion. Singular solutions. Basic three-dimensional solutions.
- 814. Mechanics of Composite Materials (MTC)**
Fall. 3(3-0) A student may earn a maximum of 6 credits in all enrollments for this course.
Applications of anisotropic elasticity theory, and the inhomogeneity approach, to systems such as macroscopic laminated structures and microscopic fiber-matrix interactions.
- 815. Advanced Strength of Materials**
Spring of odd-numbered years. 3(3-0)
General theory of torsion, nonsymmetric bending, transverse shear, thin-walled beams, beams on elastic foundations, thick-walled cylinders. Basic contact mechanics. Failure criteria for solids.
- 816. Fracture Mechanics and Fatigue**
Spring of even-numbered years. 3(3-0)
P: MSM 813.
Brittle and ductile fracture. Elastic stress fields near cracks. Elastic-plastic analysis of crack extension. Plastic instability. Cyclic crack propagation. Models of cyclic deformation and fatigue failure. Environmental effects. Case studies.
- 817. Plasticity**
Spring of odd-numbered years. 3(3-0)
P: MSM 813.
Yield conditions, stress-strain relations, plastic potential, hardening theories, torsion, bending. Thick walled shells under internal pressure. Limit analysis. Slip line theory.
- 820. Energy Methods in Mechanics**
Spring of even-numbered years. 3(3-0)
P: MSM 813.
Calculus of variations. Variational principles in mechanics. Approximate methods. Energy criteria for stability. Applications to structural dynamics.

Descriptions —Materials Science and Mechanics of Courses

- 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 and nonelastic solids.
- 840. Plates and Shells**
Fall of even-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.
- 851. Thermodynamics of Solids**
Fall. 3(3-0)
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)
P: MSM 851.
Review of Fick's Laws. Atomistic aspects of diffusion. Defects in solids. Probabilistic basis of random walk. Green's function solutions.
- 860. Theory of Vibrations**
Fall. 3 credits. Interdepartmental with Mechanical Engineering. Administered by Mechanical Engineering.
Discrete systems and continua. Analytical mechanics. Variational principles. Modal analysis. Function spaces. Eigenfunction expansions. Integral transforms. Stability. Approximations. Perturbations.
- 862. Dislocation Theory**
Fall. 3(3-0)
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)
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 a Materials Science major or approval of department.
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-numbered years. 3(3-0)
P: CEM 362 or MSM 351. R: Open only to graduate students in the Chemical Engineering or Materials Science or Chemistry or Packaging major.
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.
SA: CHE 871
- 875. Engineering Ceramics**
Fall of odd-numbered years. 3(3-0)
P: MSM 851.
Physical properties of engineering ceramics. Transport properties of ceramics, especially in ferrites and garnets. Optical ceramic materials.
- 876. Advanced Polymeric Materials**
Fall of even-numbered years. 3(3-0)
C: MSM 810 concurrently.
Advanced topics in polymer structure and properties. Thermoplastics, thermosets, polyblends and elastomers. Processing techniques. Deformation and mechanical properties. Thermal, optical and chemical properties. Composites.
- 881. Advanced Manufacturing Systems**
Fall. 3(3-0)
P: MSM 482. R: Open only to juniors or seniors in the Manufacturing Engineering major or to students in the Business Management of Manufacturing major.
Computer Integrated Manufacturing. Information systems, communication, networking, databases, flexible manufacturing systems, manufacturing simulation.
- 885. Seminar**
Fall, Spring. 1(1-0)
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.
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.
Special topics in materials science or mechanics of current importance.
- 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.
- 902. Random Vibration of Structural and Mechanical Systems**
Spring of odd-numbered years. 3(3-0) Interdepartmental with Civil Engineering and Mechanical Engineering. Administered by Civil Engineering.
P: CE 802 or ME 860; CE 810.
Probabilistic modeling of random excitations (e.g., earthquake, aerodynamic, and ocean wave loadings). Response of single and multiple degree-of-freedom systems to random excitation. Designing against failure. Nonstationary and nonlinear problems.
- 905. Optical Methods of Measurement**
Fall of even-numbered years. 3(2-3)
R: Approval of department.
Measurement of dimension, position, motion, strain, using optical methods including holography, speckle interferometry, Moire, photoelasticity, laser Doppler, electronic imaging, model analysis. Relevant optics theory.
- 909. Boundary Element Method**
Spring of odd-numbered years. 3(3-0)
P: MSM 813.
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.
- 915. Nonlinear Elasticity**
Spring of odd-numbered years. 3(3-0)
P: MSM 813.
Kinematics and kinetics of large deformations. Incompressible and compressible finite elasticity. Solution of basic problems. Nonuniqueness, stability and buckling. Singular fields near cracks and flaws.
- 918. Thermoelasticity and Viscoelasticity**
Spring of even-numbered years. 3(3-0)
P: MSM 810, MTH 443.
Thermomechanics of solids. Theory of thermoelasticity. Boundary value problems in thermoelasticity. Linear and nonlinear viscoelasticity. Model representation. Boltzmann superposition. Correspondence principle.
- 922. Micromechanics**
Spring of even-numbered years. 3(3-0)
P: MSM 813.
Models of microstructures. Inclusion problems. Eigenstrain method. Upper and lower bounds. Methods of statistical elasticity. Approximate methods. Mechanics of random networks. Percolation models of damage.
- 964. Advanced Physical and Mechanical Properties of Materials I (MTC)**
Fall of even-numbered years. 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 anisotropic crystalline properties and displacive phase transformations.
SA: MSM 960
- 965. Advanced Analytical Techniques (MTC)**
Fall of odd-numbered years. 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 environmental effects on materials and advanced techniques in electron microscopy.
SA: MSM 970
- 974. Advanced Physical and Mechanical Properties of Materials II (MTC)**
Spring of even-numbered years. 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, or high temperature deformation and processing.
SA: MSM 960
- 975. Advanced Processing Techniques (MTC)**
Spring of odd-numbered years. 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 laser and plasma processing and ceramic processing.
SA: MSM 980
- 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.
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.
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.

MATHEMATICS MTH

**Department of Mathematics
College of Natural Science**

103. College Algebra
Fall, Spring, Summer. 3(3-0)
P: MTH 1825 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; functions and relations; exponents and logarithms; elementary theory of equations; inequalities; and systems of equations.

104. Trigonometry
Fall, Spring, Summer. 3(3-0)
P: MTH 103 or MTH 110 R: 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, law of sines, law of cosines, vectors in the plane, and polar coordinates.

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

116. College Algebra and Trigonometry
Fall, Spring, Summer. 5(5-0)
P: MTH 1825 or designated score on mathematics placement test. R: Not open to students with credit in MTH 103 or MTH 110 or MTH 116 or LBS 117.
Functions and graphs. Equations and inequalities. Exponential and logarithmic functions. Trigonometric functions. Systems of equations. Binomial theorem.

120. Algebra and a Survey of Calculus
Fall, Spring, Summer. 5(5-0)
P: MTH 1825 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.
Functions and graphs. Equations and inequalities. Systems of equations. Limits. Continuous functions. Derivatives. Applications of derivatives. Integrals. Fundamental theorem of calculus.

124. Survey of Calculus with Applications I
Fall, Spring, Summer. 3(3-0)
P: Designated score on mathematics placement test or MTH 103. R: Not open to students with credit in MTH 120 or MTH 132 or MTH 152H or LBS 118.
Study of limits, continuous functions, derivatives, integrals and their applications.

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 133 or MTH 153H.
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 152H or LBS 118.
Limits, continuous functions, derivatives and their applications. Integrals and the fundamental theorem of calculus.

133. Calculus II
Fall, Spring, Summer. 4(4-0)
P: MTH 132 or MTH 152H. R: Not open to students with credit in MTH 126 or MTH 153H or LBS 118 or LBS 119.
Applications of the integral and methods of integration. Improper integrals. Polar coordinates and parametric curves. Sequences and series. Power series.

152H. Honors Calculus I
Fall. 3(3-0)
R: Honors College student or approval of department. Not open to students with credit in MTH 120 or MTH 124 or MTH 132 or LBS 118.
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. R: Honors College student or approval of department. Not open to students with credit in MTH 133 or MTH 126.
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)
R: Designated score on mathematics placement test. Not open to students with credit in MTH 0823.
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.
Problem solving in doing mathematics: collecting data, searching for patterns, conjecturing, verification (reasoning), application, and finding connections.

202. Mathematical Investigations II
Fall, Spring, Summer. 3(3-0)
P: MTH 201.
A continuation of MTH 201.

234. Multivariable Calculus
Fall, Spring, Summer. 4(4-0)
P: MTH 133 or MTH 153H. R: 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: MTH 234 or MTH 254H. R: Not open to students with credit in MTH 255H.
Topics chosen from separable and exact equations, linear equations and variation of parameters, series solutions, higher order linear equations, Laplace transforms, systems of first order linear equations, nonlinear equations and stability, introduction to partial differential equations.

254H. Honors Multivariable Calculus
Fall. 3(3-0)
P: MTH 153H. R: Honors College student or approval of department. Not open to students with credit in MTH 234.
Vectors in space. Functions of several variables and partial differentiation. Multiple integrals. Line and surface integrals. Green's and Stokes's Theorems.

255H. Honors Differential Equations
Spring. 3(3-0)
P: MTH 254H. R: Honors College student or approval of department. Not open to students with credit in MTH 235.
Topics chosen from separable and exact equations, linear equations and variation of parameters, series solutions, higher order linear equations, Laplace transforms, systems of first order linear equations, nonlinear equations and stability, introduction to partial differential equations.

290. Directed Study
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course.
Faculty directed study of selected mathematical topics.

310. Abstract Algebra I and Number Theory
Fall, Spring, Summer. 3(3-0)
P: MTH 133 or MTH 153H. R: Completion of Tier I writing requirement.
A writing course with an emphasis on proofs. Structure of the integers, congruences, polynomial rings, ideals and fields.

314. Linear Algebra I
Fall, Spring, Summer. 3(3-0)
P: MTH 234 or MTH 254H.
Vectors, matrices, and linear transformations. Operations on matrices, inner products, dimension, eigenvalues and eigenvectors. Applications to systems of equations and to geometry.

320. Analysis I
Fall, Spring, Summer. 3(3-0)
P: MTH 234 or MTH 254H, MTH 310. R: Not open to students with credit in MTH 424.
Convergence of sequences and series. Upper and lower limits, completeness, limits and continuity. Derivatives. Uniform convergence.

330. Higher Geometry
Fall. 3(3-0)
P: MTH 310.
Topics in transformations: isometries, similarities, inversion. Advanced Euclidean geometry: theorems of Menelaus, Ceva, and Desargues. Cross ratio, harmonic points, analytic, metric and vector methods, convexity.

351. Elements of Numerical Analysis
Fall. 3(3-0)
P: MTH 235 or MTH 255H. R: Not open to Mathematics majors. Not open to students with credit in MTH 451.
Techniques and elementary theory of numerical analysis for engineering and science students.

411. Abstract Algebra II
Fall, Spring. 3(3-0)
P: MTH 310. R: Not open to students with credit in MTH 418H.
Continuation of MTH 310. Permutation groups, groups of transformations, normal subgroups, homomorphism theorems, modules. Principal ideal rings, unique factorization domains, noncommutative rings, rings of fractions, ideals.

412. Topics in Algebra
Spring. 3(3-0)
P: MTH 411. R: Completion of Tier I writing requirement. Not open to students with credit in MTH 419H.
A capstone course. Sylow theory, solvable groups, permutation groups. Extension fields, Galois groups, the classification of finite fields, constructibility. Applications to classical geometry and polynomial equations.