

- 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. Not open to students with credit in MSE 352.  
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. Not open to students with credit in MSE 365 or MSE 380.  
Physical processing of powders. Mixing; 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(1-2) 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. Not open to students with credit in MSE 376.  
X-ray and infrared spectroscopic analysis laboratory for characterizing 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.
- 426 Introduction to Composite Materials**  
Spring. 3(3-0) Interdepartmental with Mechanical Engineering. P:M: (ME 222) R: Open only to students in the Department of Chemical Engineering and Materials Science. SA: MSM 444  
Constituents and interfacial bonding. Manufacturing techniques. Microstructure and micromechanics. Theory of anisotropy. Classical laminate theory. Material characterization. Failure and damage. Composite structure design.
- 451 Microscopic and Diffraction Analysis of Materials**  
Spring. 3(2-3) P:M: (MSE 350 and MSE 381) and (PHY 184 or concurrently or PHY 184B or concurrently) R: Open only to seniors or graduate students in the Materials Science and Engineering major. SA: MSM 451  
General properties, generation and detection of x-rays. Interaction with solids. Crystallography, reciprocal lattice, diffraction analysis and techniques. Single crystal methods, stereographic projection. X-ray microanalysis.
- 454 Ceramic and Refractory Materials**  
Fall. 3(3-0) P:M: (MSE 310 or concurrently and MSE 320) RB: (MSE 381) R: Open only to juniors or 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 Fracture and Failure Analysis**  
Fall. 3(2-3) P:M: (MSE 331) RB: (MSE 381) R: Open only to juniors or seniors 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:M: (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:M: (ME 222 and MSE 250) and completion of Tier I writing requirement. R: Open only to students in the Engineering Arts, Engineering Mechanics, Manufacturing Engineering and Materials Science and Engineering majors. SA: MSM 481  
Fundamentals of manufacturing processes such as casting, heat treating, particulate processing, forming, machining, joining and surface processing. Selection of manufacturing processes based on design and materials.
- 490 Independent Study**  
Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Open only to juniors or seniors in the College of Engineering. Approval of department. SA: MSM 490  
Individualized reading and research.
- 491 Selected Topics**  
Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Open only to students in the Department of Chemical Engineering and Materials Science. SA: MSM 491  
Topics of current interest in materials science or engineering.
- 499 Senior Research and Design Project (W)**  
Fall, Spring, Summer. 2 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course. P:M: Completion of Tier I writing requirement. R: Open only to seniors in the Materials Science and Engineering or Engineering Arts major. Approval of department. SA: MSM 499  
Design and analysis to solve materials and/or mechanics related problem. Preparation of written report, oral presentation, and defense of the project.

## MATHEMATICS MTH

### Department of Mathematics College of Natural Science

- 1005 Fundamentals of Algebra**  
Summer. 1(1-0)  
Factoring. Rational and exponential expressions. Linear and quadratic relations. Fractions and distributive laws. Functions
- 100E Intermediate Algebra Workshop for the Mathematics Enrichment Program**  
Fall, Spring. 1(0-4) R: Approval of department. C: MTH 1825 concurrently.  
Enrichment topics in intermediate algebra for students in the Mathematics Enrichment Program.
- 103 College Algebra**  
Fall, Spring, Summer. 3(3-0) P:M: (MTH 1825) or designated score on Mathematics placement test. Not open to students with credit in LBS 117 or MTH 116.  
Number systems; functions and relations; exponents and logarithms; elementary theory of equations; inequalities; and systems of equations.
- 103E College Algebra Workshop for the Mathematics Enrichment Program**  
Fall, Spring. 1(0-4) R: Approval of department. C: MTH 103 concurrently.  
Enrichment topics in college algebra for students in the Mathematics Enrichment Program.
- 106 The Significance of Mathematics**  
Fall, Spring, Summer. 3(3-0) P:M: (MTH 103) or designated score on Mathematics placement test.  
Numbers and numeracy, geometry, growth patterns, and statistics. Selected applications to the arts, sciences, and social sciences.

## Mathematics—MTH

- 106E The Significance of Mathematics Workshop for the Mathematics Enrichment Program**  
Spring, 1(0-4) R: Approval of department C: MTH 106 concurrently.  
Enrichment topics in The Significance of Mathematics for the Math Enrichment Program.
- 110 Finite Mathematics and Elements of College Algebra**  
Fall, Spring, Summer, 5(5-0) P:M: (MTH 1825) or designated score on Mathematics placement test.  
Functions and graphs. Equations and inequalities. Systems of equations. Matrices. Linear programming. Simplex algorithm. Probability and statistics.
- 114 Trigonometry**  
Fall, Spring, Summer, 3(3-0) P:M: (MTH 103) SA: MTH 104 Not open to students with credit in MTH 116.  
Radian and degree measure of angles. Definitions and graphs of trigonometric functions and their inverses. Solving trigonometric equations. Applications including identities, indirect measurement and trigonometric modeling.
- 116 College Algebra and Trigonometry**  
Fall, Spring, Summer, 5(5-0) P:M: (MTH 1825) or designated score on Mathematics placement test. Not open to students with credit in LBS 117 or MTH 103.  
Functions and graphs. Equations and inequalities. Exponential and logarithmic functions. Trigonometric functions. Systems of equations. Binomial theorem.
- 116E Precalculus Workshop for the Emerging Scholars Program**  
Fall, 1(0-4) R: Approval of department. C: MTH 116 concurrently.  
Enrichment topics in precalculus for students in the Emerging Scholars Program.
- 124 Survey of Calculus I**  
Fall, Spring, Summer, 3(3-0) P:M: (MTH 103 or MTH 116 or LBS 117) or designated score on Mathematics placement test. Not open to students with credit in LBS 118 or MTH 132 or MTH 152H.  
Study of limits, continuous functions, derivatives, integrals and their applications.
- 124E Survey of Calculus with Applications I Mathematics Enrichment Workshop**  
Fall, 1(0-4) R: Approval of mathematics department C: MTH 124 concurrently.  
Enrichment topics in Survey of Calculus with Applications for students in the Mathematics Enrichment Program.
- 126 Survey of Calculus II**  
Fall, Spring, Summer, 3(3-0) P:M: (MTH 124) Not open to students with credit in MTH 133 or MTH 153H.  
Application of partial derivatives, integrals, optimization of functions of several variables and differential equations.
- 132 Calculus I**  
Fall, Spring, Summer, 3(3-0) P:M: (MTH 103 and MTH 114) or (MTH 116 or LBS 117) or designated score on Mathematics placement test. Not open to students with credit in LBS 118 or MTH 152H.  
Limits, continuous functions, derivatives and their applications. Integrals and the fundamental theorem of calculus.
- 132E Calculus I Workshop for the Emerging Scholars Program**  
Fall, Spring, 2(0-6) R: Approval of department. C: MTH 132 concurrently.  
Enrichment topics in Calculus I for students in the Emerging Scholars Program.
- 133 Calculus II**  
Fall, Spring, Summer, 4(4-0) P:M: (MTH 132 or MTH 152H) Not open to students with credit in LBS 118 or LBS 119 or MTH 153H.  
Applications of the integral and methods of integration. Improper integrals. Polar coordinates and parametric curves. Sequences and series. Power series.
- 133E Calculus II Workshop for the Emerging Scholars Program**  
Fall, Spring, 1(0-4) R: Approval of department. C: MTH 133 concurrently.  
Enrichment topics in Calculus II for students in the Emerging Scholars Program.
- 152H Honors Calculus I**  
Fall, 3(3-0) R: Honors College student or approval of department. Not open to students with credit in LBS 118 or MTH 132.  
Limits, continuous functions, derivatives, integrals, fundamental theorem of calculus. Special emphasis on concepts and theory.
- 153H Honors Calculus II**  
Fall, Spring, 3(3-0) P:M: (MTH 152H) Not open to students with credit in LBS 119 or MTH 133.  
The integral. Improper integrals. Polar coordinates and parametric curves. Sequences and series. Power and Taylor series. Special emphasis on concepts and theory.
- 1825 Intermediate Algebra**  
Fall, Spring, Summer, 3(3-0)  
Properties of real numbers. Factoring. Roots and radicals. First and second degree equations. Linear inequalities. Polynomials. Systems of equations.
- 201 Mathematical Investigations I**  
Fall, Spring, Summer, 3(3-0) P:M: (MTH 103 or MTH 110 or MTH 116 or LBS 117 or MTH 124 or MTH 132 or MTH 152H or LBS 118) or designated score on Mathematics placement test. R: Open only to students in the Education major or Special Education major whose area of emphasis is emotional impairment or deaf education or learning disabilities or visual impairment or General Science-Interdepartmental major or Child Development major or Teacher Certification Internship-Year Studies program.  
Mathematics for prospective elementary teachers. Numbers, problem solving, geometry, functions, statistics and probability.
- 202 Mathematical Investigations II**  
Fall, Spring, Summer, 3(3-0) P:M: (MTH 201) R: Open only to students in the Education major or Special Education major whose area of emphasis is emotional impairment or deaf education or learning disabilities or visual impairment or General Science-Interdepartmental major or Child Development major or Teacher Certification Internship-Year Studies program.  
A continuation of MTH 201.
- 234 Multivariable Calculus**  
Fall, Spring, Summer, 4(4-0) P:M: (MTH 133 or MTH 153H or LBS 119) Not open to students with credit in MTH 254H.  
Vectors in space. Functions of several variables and partial differentiation. Multiple integrals. Line and surface integrals. Green's and Stokes's theorems.
- 235 Differential Equations**  
Fall, Spring, Summer, 3(3-0) P:M: (MTH 234 or MTH 254H) Not open to students with credit in MTH 255H.  
Separable and exact equations, linear equations and variation of parameters, series solutions, higher order linear equations, systems of first order linear equations, introduction to partial differential equations and Fourier Series.
- 254H Honors Multivariable Calculus**  
Fall, Spring, 3(3-0) P:M: (MTH 153H) Not open to students with credit in LBS 220 or 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**  
Fall, Spring, 3(3-0) P:M: (MTH 254H) 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.
- 309 Linear Algebra I**  
Fall, Spring, Summer, 3(3-0) P:M: (MTH 234 or MTH 254H or LBS 220) and completion of Tier I writing requirement.  
Matrices, systems of linear equations, vector spaces, linear transformations, inner products and orthogonal spaces, eigenvalues and eigenvectors, and applications to geometry. A writing course with emphasis on proofs.
- 310 Abstract Algebra I and Number Theory**  
Fall, Spring, Summer, 3(3-0) P:M: (MTH 309) and completion of Tier I writing requirement.  
Structure of the integers, congruences, polynomial rings, and ideals. A writing course with emphasis on proofs.
- 314 Matrix Algebra with Applications**  
Fall, Spring, Summer, 3(3-0) P:M: (MTH 234 or MTH 254H or LBS 220) R: Not open to students in the Department of Mathematics or to students in Lyman Briggs Mathematics or Lyman Briggs Computational Mathematics.  
Problem-solving and applications in matrix algebra for scientists and engineers. Vectors, matrices, linear transformations, inner products, dimension, eigenvalues and eigenvectors. Applications to systems of equations and to geometry.

- 320 Analysis I**  
Fall, Spring, Summer. 3(3-0) P:M: (MTH 234 or MTH 254H or LBS 220) and (MTH 309)  
Not open to students with credit in MTH 428H.  
Convergence of sequences and series. Upper and lower limits, completeness, limits and continuity. Derivatives. Uniform convergence.
- 330 Higher Geometry**  
Fall. 3(3-0) P:M: (MTH 309)  
Topics in transformations: isometries, similarities, inversion. Advanced Euclidean geometry: theorems of Menelaus, Ceva, and Desargue. Cross ratio, harmonic points, analytic, metric and vector methods, convexity.
- 340 Ordinary Differential Equations I**  
Fall, Spring, Summer. 3(3-0) P:M: (MTH 309)  
Techniques for solving differential equations, existence and uniqueness theorems, qualitative theory, Fourier series and applications.
- 360 Theory of Mathematical Interest**  
Fall. 3(3-0) P:M: (MTH 234 or concurrently)  
Measurement of interest rates, basic problems in interest theory, basic annuities, continuous and varying annuities, yield rates, amortization, bonds and other securities, practical applications, and stochastic approaches to interest.
- 411 Abstract Algebra II**  
Fall, Spring. 3(3-0) P:M: (MTH 310) 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.
- 414 Linear Algebra II**  
Fall. 3(3-0) P:M: (MTH 309 or MTH 314) Not open to students with credit in MTH 415.  
Linear transformations on finite dimensional vector spaces. Invariant subspaces, rank, eigenvalues and eigenvectors. Canonical forms. Bilinear and multi-linear forms.
- 415 Applied Linear Algebra**  
Fall, Spring, Summer. 3(3-0) P:M: (MTH 235 or MTH 255H or LBS 220) R: Not open to students in the Mathematics major. Not open to students with credit in MTH 414.  
Matrices and linear algebra. General linear systems of equations, least squares minimization techniques. Eigenvalues and eigenvectors, spectral decompositions, exponentials.
- 416 Introduction to Algebraic Coding**  
Fall. 3(3-0) P:M: (MTH 309)  
Concepts and techniques of abstract algebra applied to the design of communication systems for use in imperfect circumstances. Theory of codes designed by algebraic means.
- 417 Topics in Number Theory**  
Spring of even years. 3(3-0) P:M: (MTH 310)  
Congruences of higher degree, primitive roots and quadratic reciprocity. Number-theoretic functions, algebraic numbers. Dirichlet Series, p-order expansion, continued fractions.
- 418H Honors Algebra I**  
Fall. 3(3-0) P:M: Completion of Tier I writing requirement. RB: (MTH 309) R: Approval of department. Not open to students with credit in MTH 411.  
Theory of groups, Sylow theory, the structure of finite Abelian groups, ring theory, ideals, homomorphisms, and polynomial rings.
- 419H Honors Algebra II**  
Spring. 3(3-0) P:M: (MTH 418H) R: Approval of department.  
Algebraic field extensions, Galois theory. Classification of finite fields. Fundamental Theorem of Algebra.
- 421 Analysis II**  
Fall, Spring, Summer. 3(3-0) P:M: (MTH 320) Not open to students with credit in MTH 424 or MTH 429H.  
Continuation of MTH 320. Euclidean spaces: differentiation and integration in higher dimensions. Convergence of sequences of functions.
- 424 Applied Advanced Calculus**  
Spring, Summer. 3(3-0) P:M: (MTH 235 or MTH 255H or LBS 220) R: Not open to students in the Department of Mathematics. Not open to students with credit in MTH 421 or MTH 429H.  
Vector analysis for scientists and engineers. Inverse and implicit function theorems, divergence and curl, Stokes's theorem. Sequences and series, uniform convergence.
- 425 Complex Analysis**  
Fall, Spring. 3(3-0) P:M: (MTH 234 or MTH 254H or LBS 220)  
Analytic functions of a complex variable: Cauchy integral theorem, conformal maps, bilinear transformation, harmonic functions. Classification of singularities, residues, conformal mappings.
- 428H Honors Analysis I**  
Fall. 3(3-0) R: Approval of department. Not open to students with credit in MTH 320.  
Honors analysis with emphasis on metric topology, differentiation, and integration in higher dimensional settings. Convergence of sequences of functions.
- 429H Honors Analysis II**  
Spring. 3(3-0) P:M: (MTH 428H) R: Approval of department. Not open to students with credit in MTH 421 or MTH 424.  
Continuation of MTH 428H. Convergence of sequences of functions, inverse and implicit function theorems, integration in higher dimensional settings.
- 432 Axiomatic Geometry**  
Spring. 3(3-0) P:M: (MTH 309)  
Axiomatic systems and finite geometries: axioms of Euclidean and hyperbolic geometry, the Poincare model, independence of the parallel postulate. Classical constructions and the impossibility of angle trisection.
- 441 Ordinary Differential Equations II**  
Fall. 3(3-0) P:M: (MTH 235 or MTH 255H or LBS 220 or MTH 340) and (MTH 309 or MTH 415 or MTH 314)  
Existence and uniqueness theorems, linearization, stability theory, and phase space analysis.
- 442 Partial Differential Equations**  
Spring. 3(3-0) P:M: (MTH 235 or MTH 255H or LBS 220 or MTH 340)  
Classification and canonical forms for second order partial differential equations. Well posed boundary and initial value problems for the wave equation, the heat equation and the Laplace equation.
- 443 Boundary Value Problems for Engineers**  
Fall. 3(3-0) P:M: (MTH 235 or MTH 255H or LBS 220) R: Not open to students in the Department of Mathematics.  
Fourier series and orthogonal functions, method of separation of variables for partial differential equations, Sturm-Liouville problems.
- 451 Numerical Analysis I**  
Fall. 3(3-0) P:M: (CSE 101 or CSE 131 or CSE 231) and (MTH 309 or MTH 314 or MTH 415) and (MTH 235 or MTH 255H or LBS 220 or MTH 340) Not open to students with credit in MTH 351.  
Numerical solution of linear and nonlinear algebraic equations and eigenvalue problems. Curve fitting. Interpolation theory. Numerical integration, differentiation and solution of differential equations. Algorithms and computer programming.
- 452 Numerical Analysis II**  
Spring. 3(3-0) P:M: (MTH 451)  
A continuation of MTH 451.
- 455 Actuarial Models**  
Spring. 3(3-0) Interdepartmental with Statistics and Probability. Administered by Department of Statistics and Probability. RB: (STT 441)  
Stochastic models used in insurance. Survival distributions, life insurance, life annuities, benefit premiums, benefit reserves, analysis of benefit reserves.
- 461 Metric and Topological Spaces**  
Fall. 3(3-0) P:M: (MTH 320 or MTH 428H)  
Set theory, metric spaces, topological spaces, maps, product and quotient topologies. Connected and compact spaces, separation axioms, pointwise and uniform convergence.
- 472 Mathematical Logic**  
Spring. 3(3-0) P:M: (MTH 234 or MTH 254H or LBS 220)  
Logics and formal systems, syntax and semantics. Completeness and axiomatizability. Decidable and undecidable theories and Goedel's theorems. Peano arithmetic.
- 481 Discrete Mathematics I**  
Fall, Spring. 3(3-0) P:M: (MTH 309)  
Binomial and multinomial theorems. Graphs and digraphs, graph coloring. Generating functions, asymptotic analysis, trees. Representing graphs in computers.
- 482 Discrete Mathematics II**  
Spring. 3(3-0) P:M: (MTH 481) RB: (MTH 310)  
Recurrence and generating functions, Ramsey theory. Block designs, Latin squares, Eulerian and Hamiltonian paths. Minimum spanning trees, network flows.
- 490 Directed Studies**  
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 9 credits in all enrollments for this course. R: Approval of department.  
Faculty directed study in a selected mathematical topic.

## Mathematics—MTH

- 496 Capstone in Mathematics**  
Fall, Spring. 3(3-0) R: Completion of Tier I writing requirement. Approval of department.  
A capstone course integrating several areas of mathematics.

## MECHANICAL ENGINEERING ME

### Department of Mechanical Engineering College of Engineering

- 180 Engineering Graphic Communications**  
Fall, Spring. 3(1-4) P:M: (MTH 116 or concurrently or LBS 117 or concurrently or MTH 132 or concurrently or MTH 152H or concurrently) or (MTH 103 and MTH 114 or concurrently) SA: MSM 160  
Computer-aided design and drafting. Freehand sketching. Two and three dimensional visualization. Blueprint reading. Geometric dimensioning and tolerancing. Introduction to engineering design.
- 201 Thermodynamics**  
Fall, Spring. 3(3-0) P:M: (CEM 141 or CEM 151 or CEM 181H or LBS 171) and (MTH 234 or concurrently or MTH 254H or concurrently or LBS 220 or concurrently) Not open to students with credit in CHE 321 or MSE 351 or BE 351.  
Basic concepts of thermodynamics. Property evaluation of ideal gases and compressible substances. Theory and application of the first and second laws of thermodynamics. Entropy and Carnot efficiency.
- 220 Introduction to Solid Mechanics**  
Spring. 4(4-0) P:M: (MTH 133 or MTH 153H or LBS 119) R: Not open to students in the Civil Engineering or Engineering Arts or Engineering Mechanics or Manufacturing Engineering or Materials Science and Engineering or Mechanical Engineering major. SA: MSM 206 Not open to students with credit in ME 221 or ME 222.  
Statics: moment and force resultants, equilibrium. Mechanics of deformable bodies: stress and strain, classification of material behavior, generalized Hooke's law. Engineering applications: axial loads, torsion of circular rods and tubes, bending and shear stresses in beams, deflection of beams, combined stresses, stress and strain transformation.
- 221 Statics**  
Fall, Spring. 3(3-0) P:M: (PHY 183) and (MTH 234 or concurrently or LBS 220 or concurrently or MTH 254H or concurrently) SA: MSM 205  
Vector description of forces and moments. Two and three dimensional equilibrium of particles and rigid bodies. Analysis of trusses, frames and machines. Coulomb friction.
- 222 Mechanics of Deformable Solids**  
Fall, Spring. 4(3-2) P:M: (ME 221) SA: MSM 211  
Tension compression and shear stresses. Axially loaded bars. Torsion of circular shafts. Beam theory. Combined stresses. Mohr's circles. Columns.

- 285 Computer Aided Design Tools**  
Spring. 3(1-4) P:M: (ME 180) R: Open only to students in Manufacturing Engineering and Engineering Arts-Product Design cognate. SA: MSM 260  
Advanced 3-D solid modeling, CNC programming, and rapid prototyping.

- 332 Fluid Mechanics**  
Fall, Spring. 4(3-3) P:M: (ME 361) and (CHE 311 or ME 201 or MSE351) and (ME 391 or concurrently) and completion of Tier I writing requirement. R: Open only to juniors or seniors in the Mechanical Engineering or Engineering Mechanics major.  
Statics, control volume equations, similitude, exact fluid solutions. Turbulence, pipe flow, boundary layer flow, compressible flow, and Navier-Stokes equations.

- 361 Dynamics**  
Fall, Spring. 3(3-0) P:M: (ME 221) and (MTH 235 or MTH 255H or LBS 220) R: Open only to students in the College of Engineering. SA: MSM 306  
Kinematics of particles, rigid bodies, and mass moments of inertia. Kinetics of particles and rigid bodies. Energy and momentum principles.

- 371 Mechanical Design I**  
Fall, Spring. 3(3-0) P:M: (ME 361 or concurrently) R: Open only to juniors or seniors in the Mechanical Engineering or Manufacturing Engineering major.  
Analysis of displacement, velocity and acceleration in mechanical linkages. Kinematics and dynamics of machines.

- 372 Machine Tool Laboratory**  
Fall, Spring. 1(0-2)  
Principles and practice of machine tools. Safety, terminology, measurement, and working procedures for hand and machine tools.

- 385 Introduction to Product Design**  
Fall. 3(1-4) P:M: (STA 110) R: Open only to students in Manufacturing Engineering and Engineering Arts-Product Design cognate. SA: MSM 360  
Ideation methods, design methodology, 3-D model building, small-scale group and individual projects. Project presentations.

- 386 Computer Aided Product Design**  
Spring. 3(1-4) P:M: (ME 285 or concurrently and ME 385) R: Open only to students in Manufacturing Engineering and Engineering Arts-Product Design cognate. SA: MSM 361  
Freeform modeling techniques. Top down product design. Use of computer tools to assist in the development of products.

- 391 Mechanical Engineering Analysis**  
Fall, Spring. 3(3-0) P:M: (MTH 235 or MTH 255H or LBS 220) R: Open only to juniors or seniors in the Mechanical Engineering or Biosystems Engineering or Engineering Mechanics major.  
Analytical and numerical methods for the modeling and analysis of mechanical engineering systems. Applications to vibrating elements, heat transfer, linear springs, and coupled spring-mass systems.

- 410 Heat Transfer**  
Fall, Spring. 3(3-0) P:M: (ME 332 or CE 321 or CHE 311) and (ME 391) and completion of Tier I writing requirement. R: Open only to juniors or seniors in the Mechanical Engineering or Engineering Mechanics major.  
Steady state and transient heat conduction. Natural and forced convection based on boundary layer theory. Application of Nusselt number correlations. Radiant heat transfer principles and applications including radiation networks.

- 412 Heat Transfer Laboratory**  
Fall, Spring. 2(1-2) P:M: (ME 410) and completion of Tier I writing requirement. R: Open only to juniors or seniors in the Mechanical Engineering or Engineering Mechanics major.  
Practices and measurement techniques for heat transfer and thermal systems. Experimental problem solving applied to heat transfer.

- 414 Vehicle Thermal System Design**  
Spring. 3(2-2) Spring: Engineering Building. P:M: (ME 410) R: Open only to seniors in the Mechanical Engineering major.  
Analysis and design of general heat exchange systems applied to automotive vehicle systems including heaters, air conditioning, electronic, and cabin systems. Students will work in teams to design, build, and test heat exchanger systems. A global engineering experience via the internet may be included.

- 416 Computer Assisted Design of Thermal Systems**  
Fall. 3(4-0) P:M: (ME 410 or concurrently) R: Open only to juniors or seniors in the Mechanical Engineering major.  
Classifying, cataloging and processing design information. Modeling of thermal equipment. Simulation and optimization of thermal systems. Computer based design projects.

- 422 Introduction to Combustion**  
Fall. 3(3-0) P:M: (ME 332 or concurrently) R: Open only to juniors or seniors in the Mechanical Engineering major.  
Thermodynamics, chemistry, fluid mechanics, and heat transfer principles applied to combustion.

- 423 Intermediate Mechanics of Deformable Solids**  
Fall. 3(3-0) P:M: (ME 222) R: Open only to students in the College of Engineering. SA: MSM 401  
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.

- 424 Computational Mechanics**  
Spring. 3(3-0) P:M: (ME 423 or ME 471) R: Open only to students in the College of Engineering. SA: MSM 402  
Energy methods with applications. Finite element methods. Buckling and stability. Green's functions.

- 425 Experimental Mechanics**  
Fall of odd years. 3(2-3) P:M: (ME 222) R: Open only to students in the College of Engineering. SA: MSM 405  
Measurement of stress, strain, vibration, and motion using strain gauges, accelerometers, photoelasticity, holography, Moire patterns, laser speckle and electronic imaging. Transducer design.