

628. Internal Medicine Clerkship
Fall, Winter, Spring, Summer. 4 to 16 credits. May reenroll for a maximum of 16 credits. H M 602; MED 608 and PHD 608. Elective experiences in internal medicine.

630. Emergency Medicine Clerkship
Fall, Winter, Spring, Summer. 4 to 8 credits. May reenroll for a maximum of 8 credits. MED 608, PHD 608 or SUR 608; H M 602. Pathophysiology and other basic concepts will be used to explain the development of emergent conditions. Clinical diagnosis and treatment of emergencies seen in community emergency departments will be discussed.

**METALLURGY, MECHANICS,
AND MATERIALS
SCIENCE** **MMM**

College of Engineering

160. Engineering Communications
(EGR 160.) Fall, Winter, Spring. 4(3-4) MTH 108 or MTH 111 or concurrently. Engineering graphics, descriptive geometry, freehand sketching, graphical, numerical and computer problem solutions. Written technical reports and oral technical presentations.

201. Introduction to Engineering Mechanics
Winter. 4(4-0) PHY 237. Laws of mechanics governing the behavior of rigid and deformable bodies emphasizing how these laws influence engineering design. Extensive use of demonstrations.

205. Mechanics I
Fall, Winter, Spring, Summer. 4(4-0) MTH 215 or concurrently. Vector description of forces and moments. Two and three dimensional equilibrium problems. Statics of frames and machines. Friction. Shear and moments in beams and shafts.

211. Mechanics of Deformable Solids I
Fall, Winter, Spring, Summer. 4(4-0) MMM 205; MTH 310 concurrently. MMM 215 concurrently. Deformable solids, stress and strain, principal axes, material behavior (elastic, plastic, viscoelastic, temperature dependent). Boundary value problems, torsion, beams. Instability, columns.

215. Solid Mechanics Laboratory
Fall, Winter, Spring, Summer. 1(0-2) MMM 211 concurrently. Instrumentation, physical properties of materials, comparison of experiment and theory.

230. Introduction to Materials Science
Spring. 4(4-0) Non-Materials Science majors only. A qualitative survey of metals, ceramics, and polymers, and the relationship of electronic, molecular, and crystal structure to the physical, mechanical, thermal, electrical and magnetic properties.

250. Introduction to Metallurgy
(370.) Fall, Winter, Summer. 4(3-3) CEM 141A, MTH 113. Structure-property relationship in metals and alloys. Mechanical properties, crystal structure, phase diagrams, iron-carbon system. Laboratory includes mechanical property tests, heat-treatment, microstructural observations.

270. Computer Graphics
(EGR 270.) Spring. 3(3-0) MMM 160, CPS 120 or approval of department. Use of computer controlled display systems for the solution of multidimensional problems.

280. Manufacturing Processes
Fall, Spring. 3(2-3) An introduction to the materials and processes used in manufacturing, to convert ideas into products, machines, and structures for the use of people. Extensive use is made of audiovisual techniques. Field trips required.

306. Mechanics II
Fall, Winter, Spring, Summer. 4(4-0) MMM 205, MTH 310. Dynamics of particles and particle systems. Energy and momentum principles. Two and three dimensional rigid body dynamics.

330. Metallurgical Thermochemistry
Fall. 3(3-0) CEM 152 or approval of department. Laws of thermodynamics. Free energy of heterogeneous reactions. Gibb's phase rule. Solutions. Quasichemical theory of solutions. Thermodynamics of surfaces and interfaces. Thermodynamics of defects.

340. Computer Aided Manufacturing
(M E 341.) Spring. 4(3-2) CPS 115 or CPS 120 or CPS 251 or LBS 124. Inter-departmental with the Department of Computer Science. APT and COMPACT numerical control languages. Group technology and computer-aided process planning. Introduction to manufacturing robotics.

350. Mechanical Properties of Materials I
Fall. 3(3-0) MMM 211, MMM 215, MMM 250. Mechanical properties in tension, compression direct shear, torsion, flexure. True stress-strain. Cold work constants. Hardness, impact, fatigue properties. Effect of temperature on mechanical behavior, creep, stress rupture.

351. Mechanical Properties of Materials II
Winter. 3(3-0) MMM 350. Mechanism of slip, slip systems, critical resolved shear stress, mechanical twinning. Deformation in polycrystalline materials. Impurity effect and yield point phenomenon. Dislocation reactions, multiplication, movement under force.

352. Mechanical Property Laboratory
Fall. 1(0-3) MMM 350 or concurrently. Laboratory experiments related to the topics covered in MMM 350.

360. Physical Metallurgy I
Winter. 3(3-0) MMM 250. Complex binary and ternary phase diagrams. Solidification structures, precipitation, clustering, order-disorder transformation. Recovery, recrystallization and grain growth.

361. Physical Metallurgy II
Spring. 3(3-0) MMM 360. Structure and theory of metallic phases. Diffusion in metals and alloys. Martensitic transformation, spinodal decomposition. Role of defects in physical metallurgy. Surfaces and interfaces.

362. Physical Metallurgy Laboratory
Spring. 1(0-3) MMM 360. Metallographic and electropolishing preparation of ferrous and non-ferrous alloy samples. Macro-etching and sulphur prints. Heat treatment of steel. Structure-property relationships.

400. Special Problems
Fall, Winter, Spring, Summer. 1 to 3 credits. May reenroll for a maximum of 9 credits. Approval of department. Individualized reading and research.

405. Experimental Mechanics
Spring. 3(3-0) MMM 211, MMM 215 or approval of department. Techniques to measure stress, strain, vibration, motion. Includes strain gauges, accelerometers, photoelasticity, holography and moire techniques.

409. Structural Analysis with Aerospace Applications
Winter. 3(3-0) MMM 211. Review of elementary beam theory. Unsymmetrical bending. Shear stresses in thin-walled open and closed sections due to twisting and transverse loading. Sheet and stringer construction. Aerospace and other applications. Design.

410. Mechanics of Deformable Solids II
Fall. 3(3-0) MMM 211. Stress, strain and linearly elastic material behavior. Plane strain and plane stress. Solution of two-dimensional problems. Stress concentration. Torsion. Yield criteria. Elastoplastic behavior of beams, shafts and pressurized cylinders.

411. Mechanics of Deformable Solids III
Winter. 3(3-0) MMM 410 or approval of department. Energy methods. Application to determinate and indeterminate problems. Introduction to the finite element method. Computational assignments.

412. Dynamics and Stability of Continuous Systems
Spring. 3(3-0) MMM 211, MMM 306. Stability, response and vibration of finite degree of freedom systems, beams and plates. Direct and energy approaches.

420. Ceramics and Refractory Materials
Fall. 3(3-0) MMM 250 or approval of department. Ceramics and glass materials as applied to high temperature and practical service. Mechanical and physical properties of industrial ceramics.

430. X-Ray Crystallography
Spring. 4(3-3) MMM 330. Symmetry, elementary crystallography, general properties of X-rays, introduction to radiation safety, interaction of X-rays with matter, application of X-ray diffraction to materials problems.

**of
Courses**

431. Corrosion and Oxidation of Metals

Fall. 3(3-0) MMM 330 or CEM 361.

Fundamental principles of electro-metallurgical processes. Electrode potential and over-voltage. Electrode kinetic. Electroplating. Corrosion and stress corrosion. Corrosion protection. High temperature oxidation of metals and alloys.

442. Industrial Engineering

(M E 442.) Spring. 3(3-0) MMM 280, EGR 390.

Theory and techniques used by industry in planning for manufacturing. Process selection and design, work methods planning, production time standards, materials handling, and plant layout planning.

452. Diffusion in Metals and Alloys

Spring of odd-numbered years. 3(3-0) MMM 330.

Fick's first and second laws of diffusion. Analysis of diffusion equation, concept of uphill diffusion, chemical potential, introduction to multiphase diffusion, analysis of diffuse interface.

453. Phase Transformations

Spring of even-numbered years, Winter of odd-numbered years. 3(3-0) MMM 330, MMM 361.

Mechanism of phase transformation by nucleation and growth, precipitation, massive, cellular transformation. Thermodynamics and kinetics of transformations. Crystallography of martensitic transformations.

454. Electron Theory of Metals

Fall. 3(3-0) MMM 361, MMM 430.

Atomic theory of metals and alloys, free electron theories of metals, electrons in a periodic field and electromagnetic behavior.

456. Strengthening Mechanisms in Solids

Winter. 3(3-0) MMM 351.

Theory of alloy strengthening. Role of solute distribution on dislocation movement in binary and complex alloys. Multiphase aggregate strengthening. Composite materials and unidirectionally solidified eutectics. Thermomechanical processing and strength. High temperature effects.

461. Heat Treatment and Properties of Ferrous Alloys

Spring. 3(3-0) MMM 360.

Relations between microstructure, mechanical or physical properties of steels; effect of alloying elements, high-strength low-alloy steel, tool steels, stainless steels, hardenability of steels, T-T-T diagrams, carburizing, case hardening. Design of a heat-treating process for an alloy.

462. Metal Fabrication

Spring. 3(3-0) MMM 350, MMM 360.

Metallurgical principles of metal fabrication. Forging, rolling, extrusion and wire drawing. Hot and cold forging. Fabrication defects. Elasticity and plasticity theory applied to metal fabrication. Analysis of formability of competing materials.

463. Welding Metallurgy

Fall. 3(3-0) MMM 350 or concurrently.

Theory and applications of arc, gas, resistance, and Thermit welding. Examinations of micro- and macro-structure of welds and adjacent areas. Solid-phase bonding, electron beam, laser welding. Design of a welding process.

465. Failure Analysis and Prevention

Winter. 4(3-3) MMM 211, MMM 215, MMM 250.

Modes and causes of failures of mechanical components. Analysis illustrated through student projects requiring integration of knowledge from several areas.

476. Alloy Development and Design

Winter of even-numbered years. 3(3-0) MMM 360 or concurrently.

Fundamental principles which determine the structure and application of ferrous and non-ferrous alloys. Economic analysis of alloy development.

480. Process Metallurgy

(460.) Winter. 3(3-0) MMM 330.

Metallurgy of iron, steel, and principal non-ferrous metals. Cases in steel. Reduction and oxidation, slag-metal reaction. Kinetics of heterogeneous reactions. Material and energy balances.

481. Powder Metallurgy

Spring of even-numbered years. 3(3-0) MMM 360.

Characteristics of metal powders. Basic principles of compacting. Porous and dense products. Micro-structures. Factors affecting physical and mechanical properties of powder blending, compacting, sintering. Relationship between sintering process and properties of powder products.

499. Senior Research and Design Project

Fall, Winter, Spring, Summer. 2 or 3 credits. May reenroll for a maximum of 8 credits. Approval of department.

Investigation on subject approved by a faculty member. Results to show student's ability to solve problems pertaining to metallurgy and materials science. Regular conferences and final examination.

800. Special Problems

Fall, Winter, Spring. 1 to 6 credits. May reenroll for a maximum of 6 credits. Approval of department.

Individualized reading and research compatible with the student's interest and ability.

801. Advanced Engineering Mechanics

Fall, Summer. 4(4-0) MMM 306.

Principles of classical dynamics for particle and rigid body systems. Lagrangian and Hamiltonian methods. Applications to engineering problems.

805. Strain and Motion Measurement

Spring. 4(3-3) Graduate students or approval of department.

Resistance strain gages and accelerometers are examined in detail with particular regard to the analysis and design of the whole measuring system. Student project involving transducer design. Other motion measurement techniques.

806. Optical Methods of Metrology

Winter of even-numbered years. 4(3-3) Graduate students or approval of department.

Measurement of dimensions, motion, strain by precise optical methods including holography, speckle interferometry, Moire, photoelasticity, coherent optical processing, model analysis, brittle and photoelastic coatings, classical interferometry. Necessary optics theory presented.

809. Finite Element Method

Fall. 4(4-0) Approval of department. Interdepartmental with Civil Engineering and the department of Agricultural 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. Introduction to the Mechanics of a Continuous Medium

Fall, Summer. 4(4-0) MMM 211; MTH 421 concurrently or approval of department.

Stress, deformation and rate-of-deformation tensors. Balance of mass, momentum, and energy. Field equations. Examples of constitutive equations. Selected special solutions in elasticity and Newtonian fluids.

813. Theory of Elasticity I

Winter. 4(4-0) MMM 810; MTH 422 or approval of department.

Fundamentals of linear elasticity. Solution of plane elasticity problems. St. Venant bending and torsion. Basic singular solutions. Variational methods.

814. Mechanics of Composite Materials I

Winter. 3(3-0) MMM 810, MMM 813 or concurrently.

Composite materials and their applications. Anisotropic elasticity theory. Macromechanics and micromechanics of composites. Applications in the mechanics of composite structures.

815. Advanced Strength of Materials

Fall, Summer. 3(3-0) MMM 411.

General theory of torsion, unsymmetrical bending, shear flow. Curved beams. Thick-walled cylinders. Beams on elastic foundations. Bending of plates.

817. Plasticity

Spring of odd-numbered years. 4(4-0) MMM 810; MTH 422 or approval of department.

Yield conditions, stress-strain relations, plastic potential, hardening theories; torsion, bending, thick-walled spherical and cylindrical shells under internal pressure; plane strain of perfectly plastic material.

820. Energy Methods in Applied Mechanics

Fall of odd-numbered years. 3(3-0) MTH 422 or approval of department.

Energy and variational formulations in solid mechanics. Approximate methods (Ritz, Galerkin) based on energy approach. Applications to vibration and stability problems.

823. Theory of Vibrations I

Fall. 4(4-0) M E 455. Interdepartmental with and administered by the Department of Mechanical Engineering.

Discrete and continuous parameter systems with linear and nonlinear characteristics. Variational principles; equations of motion. Matrices, quadratic forms; self-adjoint operators; eigenvalues. Transient and random excitations. Theory developed through physical problems.

832. Electron Microscopy

Spring. 4(3-3) MMM 831 or approval of department.

Theory of image formation in electron microscopy and intensity of electron diffraction. Transmission and replica microscopy.

850. Modern Ceramic Materials I
Fall. 3(3-0) CEM 462; PHY 840; or approval of department.

Crystalline macrostructure and microstructure of ceramics and glasses; dependence of microstructure on amounts, size, shape, and distribution of phases; modification of microstructure by control of nucleation and growth; composite materials.

851. Modern Ceramic Materials II
Winter. 3(3-0) MMM 850.

Properties of ceramic materials with specific reference to mechanical, optical, electrical, magnetic and thermal properties.

852. Modern Ceramic Materials III
Spring. 3(3-0) MMM 851.

Applications of ceramic materials. Glass-ceramics, nuclear fuel elements, hot-pressed translucent oxides, pre-stressed ceramics, ceramic coating, pyrolytic materials.

860. Theoretical Metallurgy I
Fall. 3(3-0) MMM 330 or approval of department.

Metallurgical thermodynamics, introduction to statistical thermodynamics, kinetics of metallurgical processes.

861. Theoretical Metallurgy II
Winter. 3(3-0) MMM 860.

Introduction to quantum theory of metals, physical properties of metals and alloys.

890. Selected Topics

Fall, Winter, Spring, Summer. 3(3-0)
May reenroll for a maximum of 18 credits if a different topic is taken. Approval of department.

A newly developing area in metallurgy, mechanics, or materials science selected by the department for offering each term. Information on the specific topic to be covered should be obtained from the department office before registration.

899. Master's Thesis Research
Fall, Winter, Spring, Summer. Variable credit. Approval of department.

900. Special Problems
Fall, Winter, Spring, Summer. 1 to 6 credits. May reenroll for a maximum of 6 credits. Approval of department.

Individualized reading and research compatible with the student's interest and ability.

909. Elastic Thin Shells
Spring. 4(4-0) MMM 815 or C E 804 or approval of department; MTH 421. Interdepartmental with and administered by Civil Engineering.

Elements of differential geometry, membrane theory of shells, Pucher's stress function, deformation and bending of shells of revolution and shallow shells.

911. Theory of Elastic Stability
Winter of odd-numbered years. 4(4-0) MMM 815 or approval of department.

Theory and methods of determining buckling strength and post-buckling behavior of bar, plate and shell elements and of elastic systems.

912. Theory of Plates
Winter. 4(4-0) MMM 815 or C E 804 or approval of department; MTH 422. Interdepartmental with Civil Engineering.

Bending of thin elastic plates with various shapes and boundary conditions; application of energy principles and approximate methods of solution; thick plates; large deflection theory; sandwich plates.

915. Theory of Elasticity II
Spring. 3(3-0) MMM 813 or approval of department.

Further topics in linear elasticity. Introduction to finite elasticity and solutions of some basic problems. Nonlinear crack problems.

916. Fracture Mechanics
Fall of even-numbered years. 3(3-0) MMM 813.

Brittle and ductile fracture in structural materials. Elastic stress fields near cracks, theories of brittle fracture, elastic fracture mechanics. Elastic-plastic analysis of crack extension. Plastic instability. Running cracks.

917. Fatigue
Spring of even-numbered years. 3(3-0) MMM 411 or approval of department.

Theories of cyclic deformation and fatigue. Macro and micro failure. Notched components. Combined loading. High temperature fatigue, environmental effects. Case studies.

918. Theory of Viscoelasticity
Fall of even-numbered years. 3(3-0) MMM 810; MTH 422 or approval of department.

Fundamental linear viscoelastic stress-strain relations. Model representation. Three dimensional and general deformation laws. Correspondence principle. Quasi-static, dynamic and buckling problems.

920. Theory of Vibrations II
Winter of odd-numbered years. 4(4-0) MTH 422; M E 823 or approval of department. Interdepartmental with the Department of Mechanical Engineering.

Vibrations of one, two, and three dimensional models of elastic and inelastic continua. Interaction phenomena. Stability. Variational methods. Applications to aeronautics, aerospace, and undersea technology.

999. Doctoral Dissertation Research
Fall, Winter, Spring, Summer. Variable credit. Approval of department.

MICROBIOLOGY AND PUBLIC HEALTH MPH

**College of Human Medicine
College of Natural Science
College of Osteopathic Medicine
College of Veterinary Medicine**

200. Elementary Microbiology
Fall, Winter. 4(3-2) Three terms of Natural Science. Primarily for majors outside the College of Natural Science.

Description of bacteria and related forms of microorganisms, their growth and nature, their application in industry, and their control in public health.

234. Elementary Medical Microbiology
Fall. 5(4-4) CEM 130, B S 211, approval of department.

Survey of immunology and microbiology with emphasis on pathogenic microorganisms, antimicrobial agents, and laboratory diagnosis.

301. Introductory Microbiology
Fall, Spring. 3(3-0) CEM 242, CEM 244 or BCH 200.

Fundamentals of microbiology. Ranges of cell structure and activities; nutrition, growth, and importance of major microbial groups.

302. Introductory Microbiology Laboratory
Fall, Spring. 2(0-4) MPH 301 or concurrently.

Methodology of microbiology including microscopy, staining, asepsis, cultural media and quantification.

303. Microbiology I: General
Fall. 4(4-0) BCH 451 or concurrently.

Principles of microbiology emphasizing cell structure and function, metabolism, growth and death, differentiation, diversity, and microbial interaction.

304. General Microbiology Laboratory I
Fall. 3(1-5) MPH 303 or concurrently.

Techniques and procedures of general microbiology emphasizing the isolation and identification of bacteria, the qualitative aspects of growth and death, and bacterial interactions.

306. General Microbiology Laboratory II
Spring. 3(1-5) MPH 304.

Continuation of MPH 304 with emphasis on immunologic and genetic techniques and procedures.

310. Food Safety and Microbiology
Fall. 4(3-3) CEM 143 or concurrently or approval of department. Not open to students with credit in FSC 440. Interdepartmental with and administered by Food Science.

Effects of food handling, preparation and service on food safety. Microorganisms in foods, sanitation, food borne disease and food service regulations.

400H. Honors Research
Fall, Winter, Spring, Summer. 2 credits. May reenroll for a maximum of 8 credits. Approval of department.
A four-term research project with thesis.

405. Microbiology II: Immunobiology/Cell Biology
(427.) Winter. 4(4-0) MPH 303; BCH 452 or concurrently. Students may not receive credit in both MPH 405 and MPH 462.

Cell biology of eukaryotic cells with immune system as model. Emphasize structure-function relationships in subcellular organelles, antigen metabolism and regulatory mechanisms of immune responsiveness.

406. Medical Mycology
Fall, Spring. 4(2-6) BOT 402 or approval of department. Interdepartmental with and administered by the Department of Botany and Plant Pathology.

Characteristics, habits, and laboratory identification of fungus diseases infecting humans. Emphasis on laboratory techniques and morphological characteristics of the various mycoses.

407. Microbiology III: Microbial Genetics
(423.) Spring. 4(4-0) MPH 405; BCH 453 or concurrently.

Genetics and molecular biology of bacteria and viruses with emphasis on the genetic principles developed from their study.