METALLURGY, MECHANICS AND MATERIALS SCIENCE MMM

College of Engineering

201. Introduction to Engineering Mechanics

Winter. 4(4-0) PHY 237. Interdepartmental with the Department of Engineering.

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 214 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

Fall, Winter, Spring, Summer. 4(4-0) MMM 205; MTH 215, MMM 215 concurrently, for A E, C E, M E majors.

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) Sophomores.

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.

280. Manufacturing Processes

(M E 280.) Fall, Winter, 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 215.

Dynamics of particles and particle systems. Energy and momentum principles. Two and three dimensional rigid body dymanics.

341. Materials Chemistry II

Winter. 4(4-0) CEM 361 or M E 311.

An integrated treatment of the physical chemistry of metals and engineering materials is presented in MMM 341 and MMM 342. Thermochemistry, solutions, phase equilibria; electrochemistry; corrosion; reaction kinetics in liquids and solids; diffusion; surface phenomena.

342. Materials Chemistry III

Spring. 4(4-0) MMM 341.

Continuation of MMM 341.

360. Physical Metallurgy I

Fall. 4(4-0) CEM 153 or approval of department.

Relationship of properties to microstructure as affected by solidification transformations in heterogeneous systems, cold work, recrystallization, and grain growth. Emphasis on the important commercial metals and alloys.

361. Physical Metallurgy II

Winter. 4(4-0) MMM 360.

Continuation of MMM 360.

370. Metals and Alloys I

Fall, Winter. 4(3-3) Approval of department.

Structure and properties of unalloyed metals, deformation hardening and annealing, phase diagrams, solid solution hardening, precipitation hardening, martensitic transformation and tempering in iron carbon alloys.

371. Metals and Alloys II

Winter. 3(3-0) MMM 370 or approval of department.

Plain carbon steels, alloy steels, stainless steels; tool materials; cast irons; non-ferrous physical metallurgy with specific emphasis on copper, aluminum, titanium, magnesium, zirconium alloys.

380. Physical Metallurgy Laboratory I

Fall. 1(0-3) MMM 360 or concurrently.

First of an integrated sequence of laboratory courses designed to illustrate the parallel theory courses. Introduction to metallography, pyrometry, and testing of metals.

381. Physical Metallurgy Laboratory II

Winter. 1(0-3) MMM 380; MMM 361 concurrently.

Continuation of MMM 380.

382. Physical Metallurgy Laboratory III

Spring. 1(0-3) MMM 381.

Continuation of MMM 381.

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.

404. Dynamics of Mechanical Systems

Fall. 3(3-0) MMM 306.

Principles of Newtonian dynamics. Lagrangian dynamics of rigid-body systems. Introductory orbital mechanics. Euler's dynamical equations and gyroscopic notion. Engineering applications.

411. Mechanics of Deformable Solids II

Spring. 3(3-0) MMM 211.

Continuation of MMM 211. Unsymmetrical bending, curved beams, torsion of non-circular shapes, shear center, beam columns. Introduction to energy theorems with applications to determinate and indeterminate beams, and rings.

414. Principles and Techniques of Experimental Solid Mechanics

Spring. 3(3-0) MMM 211.

Fundamental concepts and current technology for static and dynamic measurement of strain and acceleration. Main topics discussed are resistance strain gages, photoelasticity, accelerometers, brittle coatings, Moire patterns, and holography.

430. X-Ray Cyrstallography

Fall. 4(3-3) MMM 342 or approval of department.

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.

440. Color and Appearance of Materials

Spring. 3(3-0) Approval of department.

Color in art and technology; light and its interaction with colored materials; light sources and illuminants; color notation and classification; colored materials.

450. Introduction to Theoretical Metallurgy

Fall. 3(3-0) MMM 370 or approval of department.

Mechanism of solidification, segregation, dislocation theory, deformation of metals, role of grain boundaries, failure of materials, physical properties.

455. Advanced Physical Metallurgy I

Winter. 3(3-0) PHY 364 or approval of department.

Atomic theory of metals and alloys. Nature of chemical and metallic bonds. Lattice vibration and specific-heat theory. Relation of electron energy bands in metals to cohesion, structure, electrical and magnetic properties.

456. Advanced Physical Metallurgy II

Spring. 3(3-0) MMM 455.

Nature of interfaces. Driving forces and kinetics of phase transformation. Plastic deformation of single crystals and relationship to mechanical properties of metals and alloys. Strengthening mechanisms.

461. Metallurgical Engineering I

Winter. 3(3-0) MMM 370 or approval of department.

Metallurgical furnaces and refractories. Commercial process for carburizing, cyaniding and nitriding. Ceramic coating on metals, powder metallurgy, composites.

462. Metallurgical Engineering II

Spring. 3(3-0) MMM 461, MMM 450 or approval of department.

Mechanical processing of metals, rolling, forging, welding, extrusion, machining processes, texture, material selection and equipments, quality control.

465. Mechanical Failure Analysis

Spring. 3(3-0) MMM 211, MMM 215, MMM 230 or MMM 370 or approval of department.

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

470. The Cast Alloys
Winter. 4(4-0) MMM 372.
Physical metallurgy of the cast alloys. Solidification and transformation. Nucleation and inoculation. Mode of solidification as influencing foundry properties in ferrous and nonferrous alloys. Casting design as related to foundry practice.

471. Metals and Alloys III
(372.) Spring. 3(3-0) MMM 371 or approval of department.
Experimental methods for physical examination of metals, alloy design, special ferrous and nonferrous alloys, multicomponent eutectics and eutectoids, corrosion, metallic glasses.

475. Alloy Development and Application
Fall. 4(4-0) MMM 361, or approval of department.
Physical metallurgy, development, and applications of special steels and alloys: the high-strength structural steels, machine steels, ultra high-strength steels, maraging steels, corrosion-resistant steels and alloys, high-temperature alloys.

480. Extractive Metallurgy
(460.) Fall. 4(3-2) Approval of department.
Extractive metallurgy. Mineral dressing, beneficiation, and physical processing of ores. Chemical metallurgy of ore reduction. Production of iron and steel, copper, aluminum, magnesium, nickel, lead and zinc. Stoichiometric heat. Material balances. Combustion of fuels.

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 I
Fall, Summer. 3(3-0) MMM 306.
Principles of classical dynamics; Lagrangian equations for electromechanical systems; Hamiltonian formulation; matrix treatment of vibrations.

802. Advanced Engineering Mechanics II
Winter. 3(3-0) MMM 801.
Rigid-body mechanics; the gyroscope; canonical transformations; Hamilton-Jacobi theory; engineering applications of advanced mechanics.

805. Strain and Motion Measurement
Spring, Summer. 4(3-3) Approval of department.
Resistance strain gages and acclerometers 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 Strain Measurement
Winter of even-numbered years. 4(3-3) Approval of department.
Whole-field techniques such as photoelasticity, photoelastic coatings, Moire techniques, and brittle coating. Interferometers and model analysis. Necessary theory of optics is 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 by use of Airy's stress functions, complex-function theory, variational methods, and finite differences.

815. Advanced Strength of Materials I
Fall, Summer. 3(3-0) MMM 211.
Elasticity, energy methods, general bending of straight bars, curved beams, shear center, torsion.

816. Advanced Strength of Materials II
Winter. 3(3-0) MMM 815; MTH 215.
Beams on elastic support, beam columns, axially symmetric stress distribution, symmetrical bending of circular plates, introduction to theory of elasticity.

817. Plasticity
Spring. 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.

823. Theory of Vibrations I
Fall. 4(4-0) M E 455. Interdepartmental with and administered by the Department of Mechanical Engineering.
Discrete and continous 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.

831. Advanced X-Ray Metallography
Winter. 3(3-0) Approval of department.
Development of crystallographic space groups, theory of the intensity of diffracted X-rays; Weissenberg method, crystal structure analysis.

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.

840. Symmetry and the Properties of Crystals
Winter. 3(3-0)
Point-group theory and symmetry in tensor properties of crystals; systematic treatment of propteries, e.g., electrical polarization, magnetic induction, pyro- and peizo-electricity, elasticity, transport properties and berefringence.

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 342.
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.

862. Theoretical Metallurgy III
Spring. 3(3-0) MMM 861.
Imperfection in crystalline solids, dislocation theory and mechanical properties of metals and alloys.

875. Ferrous Metallurgy
Fall. 3(3-0) MMM 462.
Stoichiometric material and heat balance calculations of the blast furnace, open hearth and electic furnace processes.

876. Nonferrous Process Metallurgy
Winter. 3(3-0) MMM 462.
Stoichiometric material and heat balance calculation in nonferrous extractive metallurgy.

880. Metals and Alloys I
Fall. 3(3-0) MMM 372.
Topics in engineering properties and application of wrought steels for engineers other than metallurgical.

881. Metals and Alloys II
Winter. 3(3-0) MMM 372.
Similar to MMM 845, but with reference to nonferrous alloys.

882. Metals and Alloys III
Spring. 3(3-0) MMM 372.
Similar to MMM 845 but with reference to cast alloys.

885. Seminar
Fall, Winter, Spring. 1 credit. MMM 899 concurrently.

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.

910. Nonlinear Continua

Winter of even-numbered years. 4(4-0) MMM 810.
Modern nonlinear theories of continua. Equations of balance and constitutive equations. Topics selected from finite elasticity, nonlinear viscosity and viscoelasticity, electroelasticity. General tensors are introduced and used throughout.

911. Theory of Elastic Stability

Fall 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.
Saint-Venant bending and torsion. Problems in three-dimensional linear elasticity using the Galerkin vector and Neuber-Papkovich functions.

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.

921. Theory of Vibrations III

Spring of odd-numbered years, Summer. 4(4-0) MMM 920 or approval of department. Interdepartmental with the Department of Mechanical Engineering.
Nonlinear oscillations. Resonance; subharmonics; self-sustained motions; stability. Methods of Poincare, van der Pol, etc. Random vibrations. Parametric excitations; stochastic processes; power spectra. Applications.

942. Advanced Topics in the Kinetics of Phase Transformation

Fall of odd-numbered years; Winter and Spring of even-numbered years. 3(3-0) May reenroll for a maximum of 9 credits.

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, Winter, 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, Winter, Spring. 2(0-4) MPH 301 or concurrently.
Methodology of microbiology including microscopy, staining, asepsis, cultural media and quantification.

310. Food Safety and Microbiology

Fall. 4(3-3) Juniors; CEM 132 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.

400. Bacteriology for High School Science

Summer. 4(4-4) Bachelor's degree and teaching certificate.
Fundamental concepts, experiments, and projects useful in secondary school science courses.

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.

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.

413. General Virology

Winter. 3(3-0) MPH 427 or concurrently.
Physical, chemical, and biological properties of the viruses.

414. General Virology Laboratory

Winter. 1(0-4) MPH 413 or concurrently.
Laboratory procedures employed for cultivation and identification of viruses.

416. General Parasitology

Fall. 3(3-0) B S 210, B S 211, B S 212 or LBC 141.
Life history, host-parasite relationships (including physiology, immunology, immunopathology and pathology) and epidemiology of selected groups and species of protozoan, tremotode, cestode and nematode parasites.

417. General Parasitology Laboratory

Fall. 2(0-4) MPH 416 or concurrently or approval of department.
Identification and life histories of representative species of major groups of animal parasites. Selected concepts of host-parasite associations will be tested experimentally.

420. Ecology of Animal Parasites

Summer. 6 credits. B S 212 or approval of department. Given at W. K. Kellogg Biological Station. Interdepartmental with the departments of Fisheries and Wildlife, and Zoology.
Parasitism of animals by protozoa, helminths and anthropods with emphasis on the interrelationships of host-parasite associations with the natural environments.

421. Microbial Physiology

Winter. 3(3-0) MPH 301, MPH 302; BCH 401 or BCH 452 or concurrently.
Cell structure and function, macromolecular synthesis and control.

422. Microbial Physiology Laboratory

Winter. 2(0-6) MPH 421 or concurrently.
Laboratory work based upon the subject matter in MPH 421.