METALLURGY, MECHANICS AND MATERIALS SCIENCE

College of Engineering

201. Introduction to Engineering Mechanics
Fall, 4(4-0) PHY 237, Interdepartmental with the Engineering Department.
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) 205 or statics; MTH 215.
Deformable solids, stress and strain, principal axes, material behavior (elastic, plastic, viscoelastic, temperature dependent). Boundary value problems, torsion, beams. Instability, columns.

215. Materials Testing Laboratory
Fall, Winter, Spring, Summer. 1(0-3)
Physical properties of engineering materials, resistance to primary types of static loading.

230. Introduction to Materials Science
Spring. 4(4-0) Sophomore.
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.

308. Mechanics II
(206.) Fall, Winter, Spring, Summer. 4(4-0) 205, MTH 215 or concurrently.
Dynamics of particles and particle systems. Energy and momentum principles. Two and three dimensional rigid body dynamics.

320. Analytical Mechanics I
Fall. 3(3-0) MTH 215; PHY 259.
Measures of point motion, indicial notation, vector spaces and time transformations. Newton's, Lagrange's and Hamilton's equations. Motions of point objects; limiting wave forms.

340. Materials Chemistry I
Fall. 4(4-0) CEM 153.
An integrated treatment of the physical chemistry of metals and other engineering materials is presented by 340, 341 and 342. Physicochemical systems; thermodynamics and thermochemistry; equilibrium; solutions and phase equilibria; electrochemistry; corrosion; reaction kinetics in condensed phases; diffusion; surface phenomena.

341. Materials Chemistry II
Winter. 4(4-0) 340 or approval of department.
Continuation of 340.

342. Materials Chemistry III
Spring. 4(4-0) 341.
Continuation of 340, 341.

350. Structural Development I
Fall, Winter, Spring, Summer. 4(4-0) 342, MTH 223, 230.
An introduction to the physical properties of metals, and properties of melts; study of influences of microstructural properties of metals on their mechanical properties; preliminary study of solidification processes and their influence on the properties of metals.

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 hetereogeneous systems, cold work, recrystallization, and grain growth. Emphasis on the important commercial metals and alloys.

361. Physical Metallurgy II
Winter. 4(4-0) 360. Continuation of 360.

370. Metals and Alloys I
Fall, Winter. 4(3-2) 370.
Principles of physical metallurgy applied to engineering metals and alloys.

371. Metals and Alloys II
Winter. 3(3-0) 370. Continuation of 370.

372. Metals and Alloys III
Spring. 3(3-0) 371.
Continuation of 371.

375. Failure Analysis
Spring. 3(3-0) Juniors and 211.
Modes and causes of failure of mechanical components. Steps in analyzing failures are illustrated through individual projects. Field trip required.

380. Physical Metallurgy Laboratory I
Fall. 1(0-3) 360 or concurrently.
First of an integrated sequence of laboratory courses designed to illustrate the parallel theory courses. Introduction to metallurgy, pyrometry, and testing of metals.

381. Physical Metallurgy Laboratory II
Winter. 1(0-3) 360; 361 concurrently.
Continuation of 380.

382. Physical Metallurgy Laboratory III
Spring. 1(0-3) 381.
Continuation of 381.

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

404. Dynamics of Mechanical Systems
Fall. 3(3-0) 306.

411. Mechanics of Deformable Solids II
Spring. 3(3-0) 211.
Continuation of 211. Unsymmetrical bending, curved beams, torsion of non-circular shapes, shear center, beam stiffness. Introduction to energy theorems with applications to determine and indeterminate beams, and rings.

413. Applied Solid Mechanics
Winter. 3(3-0) 311.
Methods of solution of problems in elasticity, plasticity, and viscoelasticity. One- and two-dimensional mathematical models will be considered.

414. Principles and Techniques of Experimental Solid Mechanics
Spring. 3(3-0) 211.
Fundamental concepts and current technology for static and dynamic measurement of strain and acceleration. Main topics discussed are resistance strain gauges, photoelasticity, accelerometers; brittle coatings, Moire patterns, and holography.

430. X-Ray Crystallography
Fall. 4(3-3) 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
Fall. 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.

455. Advanced Physical Metallurgy I
Winter. 5(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) 455.

460. Metallurgical Engineering I
Fall. 4(3-2) Approval of department.

461. Metallurgical Engineering II
Winter. 4(3-2) 460 or approval of department.

482. Metallurgical Engineering III
Spring. 4(3-2) 461 or approval of department.

470. The Cast Alloys
Winter. 4(4-0) 362, or 372.
475.  Alloy Development and Application  
Fall, 4(4-0) 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, wear-resistant steels and alloys, high-temperature alloys.

800.  Special Problems  
Fall, Winter, Spring. 1 to 6 credits.  
May re-enroll 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) 306 or 320.  
Principles of classical dynamics, Lagrangian equations for electromechanical systems; Hamiltonian formulation; matrix treatment of vibrations.

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

803.  Advanced Engineering Mechanics III  
Spring. 3(3-0) Approval of department.  
Variational methods for point objects; wave motion. Schrödinger's equation and particle motions in potential fields. Continuum, quantum and statistical models of particle systems.

805.  Strain and Motion Measurement  
Spring, Summer. 4(3-3) 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 Strain Measurement  
Winter of even-numbered years. 4(3-3) Approval of department.  
Whole-field techniques such as photelasticity, photelastic coatings, Moiré techniques, and brittle coating. Interferometers and model analysis. Necessary theory of optics is presented.

809.  Finite Element Method  
Spring. 3(3-0) Approval of department. Interdepartmental with the Department of Agricultural Engineering and Civil 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) 811; MTH 481 concurrently or approval of department.  

813.  Theory of Elasticity I  
Winter. 4(4-0) 810; MTH 492 or approval of department.  

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

816.  Advanced Strength of Materials II  
Winter. 3(3-0) 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) 810; MTH 492 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.

822.  Theory of Vibrations I  
Fall. 4(4-0) M E 455. Interdepartmental with and administered by the Mechanical Engineering Department.  
Discrete and continuous parameter systems with linear and non-linear 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 and the intensity of diffracted X-rays; Weissenberg method, crystal structure analysis.

832.  Electron Microscopy  
Spring. 4(3-3) 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 properties, e.g., electrical polarization, magnetic induction, pyro- and piezo-electricity, elasticity, transport properties and birefringence.

850.  Modern Ceramic Materials I  
Fall. 3(3-0) CEM 465; 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) 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) 851.  
Applications of ceramic materials. Glasses, ceramics, nuclear fuel elements, hot-pressed translucent oxides, pyrolytic ceramics, ceramic coatings, pyrolytic materials.

860.  Theoretical Metallurgy I  
Fall. 3(3-0) 342.  
Metallurgical thermodynamics, introduction to statistical thermodynamics, kinetics of metallurgical processes.

861.  Theoretical Metallurgy II  
Winter. 3(3-0) 860.  
Introduction to quantum theory of metals, physical properties of metals and alloys.

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

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

876.  Nonferrous Process Metallurgy  
Winter. 3(3-0) 463.  
Stoichiometric material and heat balance calculation in nonferrous extractive metallurgy.

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

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

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

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

890.  Selected Topics  
Fall, Winter, Spring, Summer. 3(3-0)  
May re-enroll 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.  Research  
(ECR 699.) Fall, Winter, Spring.  
Variable credit. Approval of department.

900.  Special Problems  
Fall, Winter, Spring. 1 to 6 credits.  
May re-enroll 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) 815 or C E 804 or approval of department; MTH 421. Interdepartmental with and administered by the Civil Engineering Department. 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. 4.even-numbered years. (4-4-0)
Modern nonlinear theories of continua. Equations of balance and constitutive equations. Topics selected from finite elasticity, nonlinear viscoelasticity and viscoelastcity, electroelasticity. General tensors are introduced and used throughout.

911. Theory of Elastic Stability
Fall of odd-numbered years. (4-4-0) 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) S10 or C E 804 or approval of department; MTH 422. Interdepartmental with the Mechanical Engineering Department. 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.

913. Theory of Elasticity II
Spring. (3-3-0) 813 or approval of department. Saint-Venant bending and torsion. Problems in three-dimensional linear elasticity using the Galerkin vector and Nuber-Pupkovich functions.

914. Theory of Viscoelasticity
Fall of even-numbered years. (3-3-0) 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.

915. Theory of Vibrations I
Winter of odd-numbered years. (4-4-0) MTH 422; M E 523 or approval of department. Interdepartmental with the Mechanical Engineering Department. Vibrations of one, two, and three-dimensional models of elastic and inelastic continua. Interaction phenomena. Stability. Variational methods. Applications to aeronautics, aerospace, and underwater technology.

916. Theory of Vibrations II
Winter of odd-numbered years. (4-4-0) MTH 422; M E 523 or approval of department. Interdepartmental with the Mechanical Engineering Department. Linear and nonlinear oscillations; Resonance; subharmonics; self-sustained motion; stability. Methods of Poincare, van der Pol, etc. Random vibrations. Parametric excitations; stochastic processes; power spectra. Applications.

917. Advanced Topics in Mechanical Metallurgy
Fall of even-numbered years; Winter and Spring of odd-numbered years. (3-3-0) May re-enroll for a maximum of 9 credits. Various aspects of dislocation theory and its application to the mechanical and physical properties of solids.

918. Advanced Topics in the Kinetics of Phase Transformation
Fall of odd-numbered years, Winter and Spring of even-numbered years. (3-3-0) May re-enroll for a maximum of 9 credits.

919. Research
(EGR 999) Fall, Winter, Spring. 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

100. Preview of Microbiology
Winter. 2(2-0) Freshmen and Sophomores only.
Science and scientists of microbiology, presented in historical perspective and carried to the forefront of current research. A rigorous preview for students seriously curious about microbiology.

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. 3(2-0) Three terms of Natural Science. Primarily for Nursing students.
Survey of immunology and microbiology with emphasis on pathogenic microorganisms, antimicrobial agents, and laboratory diagnosis.

301. Introductory Microbiology Laboratory
Fall, Spring. 3(3-0) B S 212; BCH 200.
Fundamentals of microbiology with emphasis on bacteriology of common groups of microorganisms, their distribution and activities.

302. Introductory Microbiology Laboratory
Fall, Spring. 2(1-4) 301 or concurrently.
Laboratory based on the subject matter of 301.

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 re-enroll for a maximum of 8 credits. Approval of department. A four-term research project with thesis.

401. General Microbiology
Fall. 8(6-0) BCH 401 or 451 concurrently.
Comparative biology of microorganisms: viruses, rickettsiae, bacteria, fungi, algae, and protozoa.

402. General Microbiology Laboratory
Fall. 3(1-6) 401 concurrently. Laboratory based on the subject matter of 401.

406. Medical Mycology
Fall, Spring. (3-6) ROT 402 or approval of department. Interdepartmental with and administered by the Botany and Plant Pathology Department. 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) 427 or concurrently. Physical, chemical, and biological properties of the viruses.

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

416. General Parasitology
Winter. Summer at W. K. Kellogg Biological Station. 3(3-0) B S 212. Life history, host-parasite relationships (including physiology, immunology, immunopathology and pathology) and epidemiology of selected groups and species of protozoan, nematode, trematode, and nematode parasites.

417. General Parasitology Laboratory
Winter. 2(0-4) B S 212, or LBC 140, 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
(426.) 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 arthropods with emphasis on the interrelationships of host-parasite associations with the natural environments.

421. Microbial Physiology
Winter. 3(3-0) 401, 402. Cell structure and function, growth and death, and metabolism of microorganisms.

422. Microbial Physiology Laboratory
Winter. (2-6) 421 concurrently. Laboratory work based upon the subject matter in 421.

423. Microbial Genetics
Spring. (3-0) BCH 401; ZOL 441 recommended. Fundamental genetic concepts as exemplified in microorganisms.

424. Microbial Genetics Laboratory
Spring. (2-0) 423 concurrently. Laboratory work based upon the subject matter in 423.