611. Cardiology Clerkship  
Fall, Winter, Spring, Summer. 2 to 12 credits. May reenroll for a maximum of 12 credits. MED 608.  
A clinical clerkship in which students evaluate in depth patients with cardiac diseases. This includes experiences with special diagnostic procedures including cardiac catheterization, phonocardiography, echocardiography and electrocardiography.

612. Nephrology Clerkship  
Fall, Winter, Spring, Summer. 2 to 12 credits. May reenroll for a maximum of 12 credits. MED 608.  

613. Dermatology Clerkship  
Fall, Winter, Spring, Summer. 2 to 12 credits. May reenroll for a maximum of 12 credits. MED 608.  
Office based experience with a dermatologist to learn clinical skills in dermatology and develop observational and diagnostic skills in skin disease.

614. Medical Chest Clerkship  
Fall, Winter, Spring, Summer. 2 to 12 credits. May reenroll for a maximum of 12 credits. MED 608.  
A clerkship covering four aspects of chest diseases: tuberculosis, diagnosis, pulmonary function, and physiology. The student works with medical residents, utilizing outpatient and hospital facilities.

615. Gastroenterology Clerkship  
Fall, Winter, Spring, Summer. 2 to 12 credits. May reenroll for a maximum of 12 credits. MED 608.  
Referred patients with gastrointestinal problems are seen at either inpatients or outpatients. Many long term problems are followed. Patients with psychosocial problems are seen conjointly with Social Service.

616. Allergy Clerkship  
Fall, Winter, Spring, Summer. 2 to 12 credits. May reenroll for a maximum of 12 credits. MED 608.  
Office and hospital based experience to learn and develop diagnostic skills in allergy with a review of basic therapeutics as they relate to allergic diseases.

617. Neurology Clerkship  
Fall, Winter, Spring, Summer. 2 to 12 credits. May reenroll for a maximum of 12 credits. MED 608.  
A combined office and inpatient experience that manages patients with neurological diseases. Many long term problems are followed. Observation and diagnostic skills in areas of neurological disease.

621. Endocrinology and Metabolism Clerkship  
Fall, Winter, Spring, Summer. 2 to 12 credits. May reenroll for a maximum of 12 credits. MED 608.  
Clinical and/or clinical-research clerkship to allow the student to work closely with patients having endocrine diseases, electrolyte abnormalities, endocrine hypertension or diabetes mellitus.

626. Physical Medicine and Rehabilitation Clerkship  
Fall, Winter, Spring, Summer. 2 to 12 credits. May reenroll for a maximum of 12 credits. MED 608.  
Experience in prescription writing for physical medicine procedures, occupational therapy and rehabilitation skills.

627. Rheumatology Clerkship  
Fall, Winter, Spring, Summer. 2 to 12 credits. May reenroll for a maximum of 12 credits. MED 608.  
Combined office and hospital consultative clerkship which develops diagnostic skills in areas of rheumatic diseases.

METALLURGY, MECHANICS, AND MATERIALS SCIENCE  

College of Engineering

160. Engineering Communications  
Fall, Winter, Spring. 4(3-3) MTH 108 or MTH 111 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  
Fall. 4(4-0) PHY 237.  
Laws of mechanics governing the behavior of rigid and deformable bodies emphasizing theorems involving design engineering. Extensive use of demonstrations.

205. Mechanics I  
Fall, Winter, Spring. 4(4-0) MTH 215 or concurrently.  

211. Mechanics of Deformable Solids I  
Fall, Winter, Spring. 4(4-0) MTH 205; MTH 310 concurrently, MTH 215 concurrently.  

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

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

330. Metallurgical Thermodynamics  
Fall. 3(3-0) CEM 112 or approval of department.  

350. Mechanical Properties of Materials I  
Fall, Winter. 3(3-0) MMM 211, MMM 250.  

351. Mechanical Properties of Materials II  
Winter. 3(3-0) MMM 350.  

352. Mechanical Property Laboratory  
Spring. 1(0-3) MMM 350.  
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.  
362. Physical Metallurgy Laboratory
Spring, 3(0-3) MMM 360.

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.

401. Introduction to Elasticity and Plasticity
(MMM 410.) Fall. 3(3-0) MMM 211.

402. Energy Methods and Finite Elements in Solid Mechanics
(MMM 411.) Winter. 3(3-0) MMM 401 or approval of department.

403. Dynamics and Stability in Solid Mechanics
(MMM 412.) Spring. 3(3-0) MMM 211, MMM 306.

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 more techniques.

420. Ceramics and Refractory Materials
Fall. 3(0-3) 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.

421. Manufacturing Productivity and Process Planning
Fall. 4(3-2) MMM 201 or MMM 205, MMM 230 or MMM 250.
Manufacturing processes and process planning for the manufacturing of discrete parts and assemblies. Productivity and cost estimation as an interface with design.

422. Design of Manufacturing Systems
Winter. 3(3-0) MMM 421.
Operation scheduling and control. Optimization of discrete unit single-stage and multiple-stage manufacturing systems. Applications of artificial intelligence.

423. Computer-Aided Manufacturing
Spring. 4(3-2) CPS 120, MMM 421 or approval of department.
Application of computer-controlled elements in manufacturing. Integrating NC tools, robots, process and production control, group technology and flexible manufacturing systems and interface of these with management software.

425. Nondestructive Evaluation and Quality Control
Spring. 3(2-2) MMM 421, STT 315, E E 345.
Nondestructive evaluation techniques, sampling, reliability, product liability. Ultrasonic eddy-current, X-ray, dye penetrant inspection.

430. X-Ray Crystallography
Winter. 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.

431. Corrosion and Oxidation
Fall. 3(3-0) MMM 330 or GEM 236.

442. Industrial Engineering
Winter. 3(3-0) MMM 250 or MMM 300.
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.

444. Nonmetallic Composite Materials
Winter. 3(3-0) MMM 350.

452. Diffusion in Solids
Winter. 3(3-0) MMM 330.

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

454. Electron Theory of Solids
Fall. 3(3-0) PHY 289, MMM 430.
Atomic theory of metals and alloys, free electron theory of metals, electrons in a periodic field and electromagnetic behavior.

456. Strengthening Mechanisms in Solids
Spring. 3(3-0) MMM 351.

461. Heat Treatment and Properties of Ferrous Alloys
Winter. 3(3-0) MMM 260.
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.

463. Welding Metallurgy
Fall. 4(3-3) MMM 350 or concurrently.

465. Failure Analysis and Prevention
Spring. 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 320 or concurrently.
Fundamental properties which determine the structure and application of ferrous and non-ferrous alloys. Economic analysis of alloy development.

480. Process Metallurgy
Winter. 3(3-0) MMM 330.

481. Powder Technology
Spring of even-numbered years. 3(3-0) MMM 250.

499. Senior Research and Design Project
Fall, Winter, Spring, Summer. 2 or 3 credits. May reenroll for a maximum of 9 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 Dynamics
Spring of even-numbered years. 4(4-0) MMM 308.
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.
Resistors, 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, birefringence and photoelastic coatings, classical interferometry. Necessary optics theory presented.

807. Random Vibrations of Structural
and Mechanical Systems
Spring, of odd-numbered years. 3(3-0) C E 802 or M E 825, MTH 431 or approval of department. Interdepartmental with Civil Engineering and the Department of Mechanical Engineering. Administered by Civil Engineering.
Probabilistic modeling of random excitation (e.g. earthquake, aerodynamic and ocean wave loadings); response of single and multiple-degree-of-freedom systems to random excitation, designing against failure; nonstationary and nonlinear problems.

808. Finite Element Method
Fall, Winter, Spring. 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. Continuum Mechanics
Fall, Summer. 4(4-0) MME 811; MTH 431 or 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

814. Mechanics of Composite Materials I
Winter of odd-numbered years. 3(3-0) MME 810, MME 813 or concurrently.
Composite materials and their applications. Anisotropic elasticity theory. Macro mechanics and micro mechanics of composites. Applications in the mechanics of composite structures.

815. Advanced Strength of Materials
Fall, Summer. 3(3-0) MME 411.

817. Plasticity
Spring of odd-numbered years. 4(4-0) MME 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.

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; conservation of motion. Matrices, quadratic forms; self-adjoint operators; eigenvalues. Transient and random excitations. Theory developed through physical problems.

824. Theory of Vibrations II
(MME 920.) Winter of odd-numbered years. 4(4-0) MTH 422; M E 825 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 underwater technology.

825. Thermodynamics of Solids
Fall. 3(3-0) MME 330 or approval of department.
Mathematical tools: Jacobians, Lagrange multipliers. Thermodynamic functions and laws, phase transformations, thermoelastic solids, crystal defects, surfaces and interfaces, solution thermodynamics, ideal and regular solution models.

832. Electron Microscopy
Spring. 4(3-0) MME 430 or approval of department.
Theory of image formation in electron microscopy and intensity of electron diffraction. Transmission and replica microscopy.

849. Engineering Ceramics
Winter of odd-numbered years. 3(3-0) MME 420, MME 441.
Physical properties of engineering ceramics. Transport properties of ceramics, with special attention to ferrites and garnets. Optical ceramic materials.

853. Advanced Topics in Oxidation and Corrosion
Spring of even-numbered years. 3(3-0) MME 431 or approval of department.
Effects of metallurgical and environmental factors on the kinetics of aqueous and solution of electrochemical corrosion and solvent less metal redox reactions.

861. Theory of Metals
Fall of odd-numbered years. 3(3-0) MME 825.
Metallurgical, wave aspects of electrons, Schrodinger equation, free-electron model, zone theory of metals, Brillouin zones, band structure, Fermi surfaces, electrical and thermal conductivity, specific heat, magnetism, superconductivity.
912. Theory of Plates
Winter. 4(4-0) MME 615 or C E 604 or approval of department. MTH 422. Interdepartment 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.

914. Theory of Elasticity II
Spring of odd-numbered years. 3(3-0) MME 813 or approval of department.
Further topics in linear elasticity including complex variable solutions, elastodynamics, variational principles, St. Venant's principle, anisotropic material behavior.

915. Theory of Elasticity III
Spring of even-numbered years, 3(3-0) MME 813 or approval of department.

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

917. Fatigue of Engineering Structures
Fall of odd-numbered years. 3(3-0) MME 411 or approval of department.

918. Theory of Viscoelasticity
Winter of even-numbered years, 3(3-0) MME 810; MTH 422 or approval of department. Further topics in viscoelastic stress-strain relations. Model representation. Three dimensional and general deformation laws. Correspondence principle. Quasi-static, dynamic and buckling problems.

940. Modern Problems in Materials Science
Fall. Spring. 3(3-0) May reenroll for a maximum of 9 credits. Approval of department.
Course focuses on research in ceramics, martensitic transformations, oxidation and corrosion, electron microscopy, reorientation and textures.

941. Crystal Defects
Winter of even-numbered years, 3(3-0) MME 535 or approval of department.
Defects in thermodynamic equilibrium. Vacancies, interstitials, color centers. Role of defects in diffusion, radiation damage. Geometrical and elastic properties of dislocations, dislocation reactions, grain boundary structures and kinetics.

942. Advanced Topics in Phase Transformations
Winter of odd-numbered years, 3(3-0) MME 525 or approval of department.
Precipitation and ripening, gradient energy terms, spinodal decomposition, surface and strain effects, allotropic and polytropic transformations, martensitic transformations, electronic effects, charge density waves, thermoelastic and shape memory alloys.

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

MICROBIOLOGY AND PUBLIC HEALTH

College of Human Medicine

College of Osteopathic Medicine

College of Veterinary Medicine

101. Preview of Microbiology
Winter. 3(1-0) Open only to freshmen or sophomores without previous coursework in Microbiology.
Overview of modern microbiology, emphasizing impact on society.

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, antibiotics, and laboratory diagnosis.

301. Introductory Microbiology
Fall. Spring. 3(3-0) CEM 242, CEM 244 or BCH 451.
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.

305. 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 443. Interdepartmental with and administered by the Department of Food Science.
Effects of food handling, preparation and service on food safety. Microorganisms in foods, sanitation, foodborne disease and food service regulations.

390. Current Topics in Microbiology
Winter. 3(2-0) May reenroll for a maximum of 6 credits. MPH 303, MPH 304, BCH 451, BCH 452 or concurrently, or approval of department.
Students read, present and discuss journal papers treating microbial physiology, ecology or genetics, molecular biology, virology, immunology or host-microbe interactions.

400H. Honors Research
Fall, Winter, Spring, Summer. 2 credits. May reenroll for a maximum of 6 credits. Approval of department.
A four-term research project with thesis.

403. Elements of Cell Function and Structure
(MPH 403). Spring. 4(4-0) MPH 407.
Evidences of the major classes of viruses; viral diseases; cell biology of eukaryotic cells, with emphasis on the molecular mechanisms that underlie cellular processes.

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 fungi and fungi-like organisms. Emphasis on laboratory techniques and morphological characteristics of the various mycoses.

407. Microbial Genetics
Winter. 4(4-0) MPH 303; BCH 452 or concurrently.
Genetics and molecular biology of bacteria and viruses with emphasis on the genetic principles developed from their study.

413. Virology
Fall. 3(3-0) MPH 407.
Viruses and modern molecular biology, stressing principles of viral replication and gene expression of the major classes of viruses; viral diseases; some elements of epidemiology of viral infections.

416. General Parasitology
Fall. Summer of odd-numbered years.
Given at W. K. Kellogg Biological Station Summer of odd-numbered years. Fall, 3(3-0) Summer of odd-numbered years: 3 credits. B S 210, B S 211, or B S 212 or LBS 141. Interdepartmental with the Department of Zoology.
Life history, host-parasite relationships (including physiology, immunology, immunopathology and pathology) and epidemiology of selected groups and species of protozoa, trematode, cestode and nematode parasites.

418. General Parasitology Laboratory
(MPH 417). Fall. Summer of odd-numbered years.
Given at W. K. Kellogg Biological Station Summer of odd-numbered years. Fall. 2(0-4) Summer of odd-numbered years: 2 credits. MPH 416 or concurrently or approval of department. Interdepartmental with the Department of Zoology.
Identification and life histories of representative species of major groups of animal parasites. Selected concepts of host-parasite associations will be tested experimentally.