609. Hematology Clerkship  
Fall, Winter, Spring, Summer, 2 to 12 credits. May reenroll for a maximum of 12 credits. MED 608. Development of skills in data collection, problem solving and management related to common hematologic disorders of children and adults.

610. Oncology Clerkship  
Fall, Winter, Spring, Summer, 2 to 12 credits. May reenroll for a maximum of 12 credits. MED 608. Development of skills in data collection, problem solving and management of the more prevalent cancers in children and adults.

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. Integrated concepts of renal physiology and pathophysiology of renal disease. Clinical experience.

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. Referral patients with gastrointestinal problems are seen as 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 will provide the student with an opportunity to learn the concepts of evaluation and management of neurological disease.

618. Infectious Disease Clerkship  
Fall, Winter, Spring, Summer, 2 to 12 credits. May reenroll for a maximum of 12 credits. MED 608, Interdepartmental with the Department of Microbiology and Public Health. The clerkship emphasizes acquisition of depth of knowledge and skills essential in solution of clinical problems in infectious and immunologic diseases. Integrated basic science input is afforded through relevant seminars.

620. 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.

628. Advanced Internal Medicine Clerkship  
Fall, Winter, Spring, Summer, 2 to 18 credits. May reenroll for a maximum of 30 credits. MED 608. Clinical experiences which refine diagnostic and management skills in general internal medicine.

630. Emergency Medicine Clerkship  
Fall, Winter, Spring, Summer, 2 to 18 credits. May reenroll for a maximum of 18 credits. MED 608. 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

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-aided 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 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) CPM 205, MTH 310 concurrently, MTH 225 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  
Fall, Winter, Spring, 3(3-0) MMM 160, CPM 120 or approval of department. Use of computer controlled display systems for the solution of multidimensional problems.

255. 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. Approved through Winter 1989.

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

330. Metallurgical Thermochemistry  

340. Computer Aided Manufacturing  
(M E 341) Spring, 4(4-3) CPS 115 or CPS 251 or LBS 134. Interdepartmental with the Department of Computer Science. APT and COMPACT numerical control languages. Group technology and computer-aided process planning. Introduction to manufacturing robotics. Approved through Winter 1986.
350. Mechanical Properties of Materials I
Fall. 3(3-0) MMM 211, MMM 215, MMM 220.

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

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

353. 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.

354. Physical Metallurgy II
Spring. 3(3-0) MMM 350.

355. Physical Metallurgy Laboratory
Spring. 1(0-3) MMM 360.

356. Special Problems
Fall, Winter, Spring, Summer. 1 to 3 credits. May not exceed a maximum of 9 credits. Approval of department.

357. Experimental Mechanics
Fall. 3(3-0) MMM 211, MMM 215 or approval of department.

358. Structural Analysis with Aerospace Applications
Winter. 3(3-0) MMM 211.

359. Engineering Mechanics
Fall. 3(3-0) MMM 211.

360. Mechanics of Deformable Solids III
Winter. 3(3-0) MMM 410 or approval of department.

361. Dynamics and Stability of Continuous Systems
Spring. 3(3-0) MMM 211, MMM 300.
Stability, response and vibration of finite degree of freedom systems, beams and plates. Direct and energy approaches.

362. 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.

363. Manufacturing Productivity and Process Planning
Fall. 4(3-2) MMM 380, MMM 201 or MMM 225, MMM 220.
Manufacturing processes and process planning for the manufacturing of discrete parts and assemblies. Productivity and cost estimation as an interface with design.

364. 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.

365. Computer-Aided Manufacturing
Spring. 4(3-2) CPS 150, MMM 220 or approval of department.
Application of computer-controlled elements in manufacturing systems, including NC tools, robots, process and production control, group technology and flexible manufacturing systems and interface of these with management software.

366. X-Ray Crystallography
Winter. 4(3-3) MMM 330.
Symmetry, elementary crystallography, general properties of X-rays and their application to radiation safety, interaction of X-rays with matter, application of X-ray diffraction to metals problems.

367. Corrosion and Oxidation of Metals
Fall. 3(3-0) MMM 330 or CEM 361.

368. Industrial Engineering
(M E 442) Winter. 3(3-0) MMM 280.
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.

369. Diffusion in Metals and Alloys
Spring of odd-numbered years. 3(3-0) MMM 220.

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

371. 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.

372. Strengthening Mechanisms in Solids
Spring. 3(3-0) MMM 331.

373. Heat Treatment and Properties of Ferrous Alloys
Spring. 3(3-0) MMM 360.
Relation 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 diagrams, carburizing, case hardening. Design of a heat-treating process for an alloy.

374. Metal Fabrication
Spring. 3(3-0) MMM 350, MMM 360.

375. Welding Metallurgy
Fall. 4(3-2) MMM 350 or concurrently.

376. Failure Analysis and Prevention
Winter. 4(3-3) MMM 211, MMM 215, MMM 250.
Modifications and causes of failures of mechanical components. Analysis illustrated through student projects requiring integration of knowledge from several areas.

377. 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 nonferrous alloys. Economic analysis of alloy development.

378. Process Metallurgy
Winter. 3(3-0) MMM 330.
451. Powder Metallurgy  
Spring of even-numbered years. 3(3-0)  
MMM 360.  

499. Senior Research and Design Project  
Fall, Winter, Spring, Summer. 2 or 3 credits. May reenroll for a maximum of 6 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.

500. 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.

501. Advanced Engineering Mechanics  
Fall, Summer. 4(4-0) MMM 306.  
Principles of classical dynamics for particles and rigid body systems. Lagrangian and Hamiltonian methods. Applications to engineering problems.

505. Strain and Motion Measurement  
Spring. 4(3-3) Graduate students or approval of department.  
Resistances 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.

506. 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, Moiré, photoelasticity, coherent optical processing, model analysis, brittle and photoelastic coatings, classical interferometry. Necessary optics theory presented.

509. 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 continuous type problems in heat transfer, fluid mechanics and stress analysis.

510. Introduction to the Mechanics of a Continuous Medium  
Fall, Summer. 4(4-0) MMM 211; MTH 421 concurrently or approval of department.  

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

514. Mechanics of Composite Materials I  
Winter. 3(3-0) MTH 610, MTH 813 or concurrently.  
Composite materials and their applications. Anisotropic elasticity theory. Micromechanics and micromechanics of composites. Applications in the mechanics of composite structures.

515. Advanced Strength of Materials  
Fall, Summer. 3(3-0) MTH 441.  

517. Plasticity  
Spring of odd-numbered years. 4(4-0) MTH 810; MTH 423 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.

520. 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.

523. 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.

524. Theory of Vibrations II  
(MMM 820.) 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.

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

530. Modern Ceramic Materials I  
Fall. 3(3-0) MTH 462; PHYS 540; or approval of department.  
Crystalline macrostructure and microstructure of ceramics and glasses; dependence of microstructure on amount, size, shape, and distribution of phase; modification of microstructure by control of reaction and growth; composite materials.

531. 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.

532. Modern Ceramic Materials III  
Spring. 3(3-0) MMM 851.  
Applications of ceramic materials. Glass-ceramics, nuclear fuel elements, hot-pressed transparent oxides, pre-stressed ceramics, ceramic coating, pyrolytic materials.

533. Advanced Topics in Oxidation and Corrosion  
Winter of even-numbered years. 3(3-0) MMM 431 or approval of department.  
Effects of metallurgical and environmental factors on the kinetics of aqueous and solution of ceramic, chemical corrosion and solvent-less metal redox reactions.

561. Theory of Metals  
Fall of odd-numbered years. 3(3-0) MMM 822.  
Metallic bonding, 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.

563. Advanced Rate Theory and Diffusion  
Fall of even-numbered years. 3(3-0) MMM 825 or approval of department.  

571. Advanced Physical Metallurgy  
Spring of even-numbered years. 3(3-0) MMM 825 or approval of department.  
Quasicheoretical theory of alloy phases, crystal defects, ordering and second order transitions, thermal effects, surface tension, solid state reactions, nucleation, recovery, recrystallization, grain growth, crystallographic transformations, solidification, interfaces.

572. Advanced Mechanical Metallurgy  
Spring of odd-numbered years. 3(3-0) MMM 825 or approval of department.  
Dislocation-obstacle interactions, thermally-activated dislocation motion, recovery and recrystallization, deformation of polycrystals, Taylor-theory, deformation and recrystallization textures, dynamic effects, high temperature deformation, radiation effects.

855. Seminar  
Spring. 1(1-0) May reenroll for a maximum of 3 credits. MMM graduate student.  
Detailed library investigation of a specialized aspect of materials science or presentation of own research projects. Participation generally required each term of residence.

850. Selected Topics  
Fall, Winter, Spring, Summer. 3(3-0) May reenroll for a maximum of 16 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.
900. Special Problems
Fall, Winter, Spring, Summer. 1 to 6 credits. May reenroll for a maximum of 6 credits. Approval of department.

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, Euler'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 bars, 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.

914. Theory of Elasticity II
Spring of even-numbered years. 3(0-0) MMM 815 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(0-0) MMM 815 or approval of department. Introduction to finite elasticity. Kinematics of large deformations, kinetics, constitutive relation - general theory and particular models, solution of equations. Non-uniqueness. Singular fields near crack tips. Material stability.

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


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


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


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

941. Crystal Defects
Winter of even-numbered years. 3(3-0) MMM 825 or approval of department.

Defects in thermodynamic equilibrium, vacancies, interstitials, color centers. Role of defects in 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) MMM 825 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

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 applications in industry, and their control in public health.

234. Elementary Medical Microbiology
Fall. 3(4-4) CEM 120, 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, Summer. Given at W. K. Kellogg Biological Station Summer term.

302. Introductory Microbiology Laboratory
Fall, Spring, Summer. Given at W. K. Kellogg Biological Station Summer term.

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.

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 6 credits. Approval of department.

A four-term research project with thesis.