615. Gastroenterology Clerkship
Fall, Winter, Spring, Summer. 1 to 17 credits. May reenroll for a maximum of 34 credits. H M 602.
Referred 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. 1 to 17 credits. May reenroll for a maximum of 34 credits. MED 608 and H M 602 or PHD 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. 1 to 17 credits. May reenroll for a maximum of 34 credits. H M 602.
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. 1 to 17 credits. May reenroll for a maximum of 34 credits. H M 602.
The clerkship emphasizes acquisition in 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. 4 to 8 credits. May reenroll for a maximum of 16 credits. H M 602.
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.

621. Diabetes and Metabolism Clerkship
Fall, Winter, Spring, Summer. 4 credits. H M 602; MED 608 and PHD 608.
Clinical experience with diabetic patients and other related endocrine disorders.

626. Physical Medicine and Rehabilitation Clerkship
Fall, Winter, Spring, Summer. 4 to 8 credits. May reenroll for a maximum of 34 credits. H M 602; MED 608 and PHD 608.
Experience in prescription writing for physical medicine procedures, occupational therapy and rehabilitation skills.

627. Rheumatology Clerkship
Fall, Winter, Spring, Summer. 4 credits. H M 602; MED 608 and PHD 608.
Combined office and hospital consultative clerkship which develops diagnostic skills in areas of rheumatic diseases.

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

616. Engineering Communications
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
Fall. 4(4-0) PHY 257.
Laws of mechanics governing the behavior of rigid and deformable bodies including these laws influence engineering design. Extensive use of demonstrations.

205. Mechanics I
Fall, Winter, Spring, Summer. 4(4-0) PHY 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) MED 205; MTH 310 concurrently, MED 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. 1(0-2) MED 215 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, Summer. 4(3-3) GEM 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
Fall. 3(3-0) MTH 190, CPS 120 and approval of department.
Use of computer controlled display systems for the solution of multidimensional problems.

280. Manufacturing Processes
Fall, Spring. 3(3-3)
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) MED 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 153 or approval of department.

340. Computer Aided Manufacturing
Fall. 3(3-0) MED 320 or CPS 351 or CEM 143. Interdepartmental 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) MED 211, MED 215, MED 250.

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

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

360. Physical Metallurgy I
Winter. 3(3-0) MED 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) MED 260.
400. Special Problems
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(0-3) MMM 211, MMM 215 or approval of department.
Techniques to measure stress, strain, vibration, motion. Includes strain gauges, accelerometers, photoelasticity, holography and moiré techniques.

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

410. Mechanics of Deformable Solids II
Fall. 3(3-0) MMM 211.

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

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 350 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.

431. Corrosion and Oxidation of Metals
Fall. 3(3-0) MMM 330 or CEM 381.

442. Industrial Engineering
(M E 442.) Winter. 3(3-0) MMM 380.
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.

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

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.

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 diagrams, carburizing, case hardening. Design of a heat-treating process for an alloy.

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

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

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

481. 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.

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.

505. Strain and Motion Measurement
Spring. 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, bristle 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 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.

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

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.

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

850. Modern Ceramic Materials I
Fall. 3(3-0) CEM 468; PHY 840; or approval of department.
Crystalline microstructure 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 855.
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) MTH 860.
Introduction to quantum theory of metals, physical properties of metals and alloys.

900. 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.

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

910. 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.

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

917. Fatigue
Spring of odd-numbered years. 3(3-0) MTH 811 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.

920. Theory of Vibrations II
Winter of odd-numbered years. 4(4-0) MTH 422; M E 833 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.

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

MICROBIOLOGY AND PUBLIC HEALTH

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.