611. Cardiology Clerkship
Fall, Winter, Spring, Summer. 1 to 17 credits. May re-enroll for a maximum of 34 credits. H M 602.
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/Urology Clerkship
Fall, Winter, Spring, Summer. 1 to 17 credits. May re-enroll for a maximum of 34 credits. H M 602.
Integrated concepts of renal physiology and pathophysiology of renal disease. Clinical experiences with special diagnostic procedures including renal biopsies, radiographic and ultrasound examinations. Preparation for independent work in the medical aspects of nephrology and urology.

613. Dermatology Clerkship
Fall, Winter, Spring, Summer. 1 to 17 credits. May re-enroll for a maximum of 34 credits. H M 602.
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. 1 to 17 credits. May re-enroll for a maximum of 34 credits. H M 602.
A clerkship involving 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. 1 to 17 credits. May re-enroll for a maximum of 34 credits. H M 602.
Referred patients with gastrointestinal problems are seen as either in- or out-patients. 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 re-enroll for a maximum of 34 credits. H M 602.
A clerkship involving four aspects of allergy and allergy to basic therapeutic agents as they relate to allergic diseases.

617. Neurology Clerkship
Fall, Winter, Spring, Summer. 1 to 17 credits. May re-enroll for a maximum of 34 credits. H M 602.
A combined office and in-patient 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 re-enroll for a maximum of 34 credits. H M 602 and MED 608 or H D 608.
Interdepartmental with the Microbiology and Public Health Department. The clerkship emphasizes acquisition in depth of knowledge and skills essential in solution of clinical problems in infection and immunologic diseases. Integrated basic science input is afforded through relevant seminars.

METALLURGY, MECHANICS AND MATERIALS SCIENCE

College of Engineering

201. Introduction to Engineering Mechanics
Winter. 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. Studies of frames and machines. Friction. Shear and moments in beams and shafts.

211. Mechanics of Deformable Solids
Fall, Winter, Spring, Summer. 4(4-0) or statically 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. 4(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.

306. Mechanics II
Spring. 4(4-0) or statically MTH 215 or concurrently.
Energy and momentum principles. Two and three dimensional rigid body dynamics.

320. Analytical Mechanics I
Fall. 3(3-0) MTH 215, PHY 289.
Measures of point motion, inertial notation, vector space and time transformations. Newton's, Lagrange's and Hamilton's equations. Motions of point objects; limiting wave forms.

321. Analytical Mechanics II
Winter. 3(3-0) 320.
Schrödinger's equation. Particle motions in various potentials; hydrogen-like atoms and molecules. Continuum models of particle systems; tensor properties, rigid and elastic solids, transfer of heat and electricity, flow relations.

340. Materials Chemistry I
Fall. 4(4-0) MTH 153.
An integrated treatment of the physical chemistry of metals and other engineering materials is presented by 340, 341 and 342. Physical-chemical systems; thermodynamics and thermodynamics; equilibrium; solutions and p h a s e e quilibrium; 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.

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) 340.
Continuation of 340.

362. Physical Metallurgy III
Spring. 4(4-0) 360, 361.
Continuation of 360, 361.

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

371. Metals and Alloys II
Winter. 3(0-0) 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 industrial projects. Field trip required.

380. Physical Metallurgy Laboratory
Fall. 1(0-3) 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) 380; 361 concurrently.
Continuation of 380.

382. Physical Metallurgy Laboratory III
Spring. 1(0-3) 381; 362 concurrently.
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

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 columns. Introduction to energy theorems with applications to determinate and indeterminate beams, and rings.

413. Applied Solid Mechanics
Winter, 3(3-0) 211. 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 gages, photoelasticity, accelerometers, brittle coatings, Moire patterns, and holography.

430. X-Ray Crystallography
Fall, 4(3-2) 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.

445. 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.

446. Advanced Physical Metallurgy II

460. Metallurgical Engineering I
Fall, 4(3-2) 362 or approval of department. Extractive metallurgy. Mineral dressing, benefication, and physical processing of ores. Chemical metal and ore reduction. Production of iron and steel, copper, aluminum, magnesium, nickel, lead and zinc. Stoichiometric heat, and material balances. Combustion of fuels.

461. Metallurgical Engineering II

462. Metallurgical Engineering III
Spring, 4(3-0) 401 or approval of department. Mechanical processing of metals. Forming, shaping and fabricating operations. Rolling mills, extrusion presses, forging practices, and welding systems. Powder metallurgy processes. Selection of materials and equipment. Quality control.

470. The Cast Alloys
Winter, 4(4-0) 362, or 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.

475. Alloy Development and Application
Fall, 4(4-0) 361, 362, 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, managing steels, corrosion-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 329. Principles of classical dynamics; Lagrangian equations for electromechanical systems; Hamiltonian formulation; matrix treatment of vibrations.

802. Advanced Engineering Mechanics II
Winter, 3(3-0) 301. 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. Schrodinger's equation and particle motions in potential wells. 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 photoelasticity, photoelastic coatings, Moire techniques, and brittle coating. Interferometry and model analysis. Necessary theory of optics is presented.

810. Introduction to the Mechanics of a Continuous Medium
Fall, Summer. 4(4-0) 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) 510; 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) 211. Elasticity, energy methods, general bending of straight bars, curved beams, shear center, torsion.

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

823. Theory of Vibrations I
Fall, 3(4-0) M.E. 453. 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. Mechanical, quadratic forms; self-adjoint operators; eigenvalues. Transient and random excitations. Theory developed through practical problems.

831. Advanced X-Ray Metallurgy
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(3-2) 931 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. (3-0) CEM 462; PHY 846; or approval of department.  
Crystalline macrostructure and microstructure of ceramics and glasses; dependence of microstructure on amount, size, shape, and distribution of phases; modification of microstructure by control of nucleation and growth; composite materials.

851. Modern Ceramic Materials II  
Winter. (3-0) 850.  
Properties of ceramic materials with specific reference to mechanical, optical, electrical, magnetic and thermal properties.

852. Modern Ceramic Materials III  
Spring. (3-0) 851.  
Application of ceramic materials. Glass-ceramics, nuclear fuel elements, hot-pressed translucent oxides, pre-stressed ceramics, ceramic coatings, pyrolytic materials.

860. Theoretical Metallurgy I  
Fall. (3-0) 424.  
Metallurgical thermodynamics, introduction to statistical thermodynamics, kinetics of metallurgical processes.

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

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

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

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

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

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

882. Metals and Alloys III  
Spring. (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. (3-0)  
May re-enroll 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.

899. Research  
(EGR 896.) Fall, Winter, Spring, Summer. Variable credit. Approval of department.

900. Special Problems  
Fall, Winter, Spring Summer. 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) 415 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. (4-0) 810.  
Modern nonlinear theories of continua. Equations of balance and constitutive equations. Topics selected from finite elasticity, nonlinear viscoelasticity, electroelasticity. General tensors are introduced and used throughout.

911. Theory of Elastic Stability  
Fall of odd-numbered years. (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) 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. (3-0) 813 or approval of department.  
Saint-Venant bending and torsion. Problems in three-dimensional linear elasticity using the Galerkin vector and Neuber-Papkovitch functions.

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

920. Theory of Vibrations II  
Winter of odd-numbered years. (4-4) MTH 422; M E 833 or approval of department. Interdepartmental with the Mechanical Engineering Department.  

921. Theory of Vibrations III  
Spring of odd-numbered years, Summer. (4-4) 920 or approval of department. Interdepartmental with the Mechanical Engineering Department.  

933. Advanced Elasticity  
Spring of even-numbered years. (3-0) 813, 910 or approval of department.  
Selected topics in non-linear elasticity.

941. Advanced Topics in Mechanical Metallurgy  
Fall of even-numbered years; Winter and Spring of odd-numbered years. (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.

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

999. Research  
(EGR 999.) 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

100. Preview of Microbiology  
Winter. (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. (4-2) 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. (3-4) Three terms of Natural Science. Primary for 3rd-year students. Survey of immunology and microbiology with emphasis on pathogenic microorganisms, anti-microbial agents, and laboratory diagnosis.

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

302. Introductory Microbiology Laboratory  
Fall, Spring. (1-0-4) 301 or concurrently. Laboratory based on the subject matter of 301.