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 experience.

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 covering four aspects of chest disease: 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 at 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 review of basic therapeutics 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. 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 infectious 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. Statics of frames and machines. Friction, shear and moments in beams and shafts.

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

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, viscous, 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) Sophomores. 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.

320. Analytical Mechanics I
Fall. 3(3-0) MTH 215, PHY 289. Measures of point motion, indiual 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.

322. Analytical Mechanics III
Spring. 3(3-0) 321. Quantum and statistical models of particle systems; the Maxwell-Boltzmann, Einstein-Boose and Fermi-Dirac distributions; analysis of ideal atomic, electron and photon gases; properties of dense gases and liquids; thermal, elastic and electrical properties of crystals.

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 thermochromy; equilibrium; solutions and phases; equilibrium; 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. Principles of physical metallurgy applied to engineering metals and alloys.

370. Metals and Alloys I
Fall, Winter. 4(3-0) 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.

380. Physical Metallurgy Laboratory I
Fall. 1(0-3) 380 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) 380, 381 concurrently. Continuation of 380.

382. Physical Metallurgy Laboratory III
Spring. 1(0-3) 381, 382 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
Fall. 3(3-0) 206. Principles of Newtonian dynamics. Lagrangian dynamics of rigid-body systems. Introductory orbital mechanics. Euler's dynamical equations and gyroscopic motion. Engineering applications.

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  
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(3-3) 342 or approval of department.  
Symmetry, elementary crystallography, general properties of x-rays, introduction to radiation safety, interpretation of x-rays diffractions 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 their color notation and classification; colored materials.

455. 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.

456. Advanced Physical Metallurgy II  
Spring. 3(3-0) 455.  

540. Metallurgical Engineering I  
Fall. 4(3-2) 626 or approval of department.  

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

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

470. The Cast Alloys  
Winter. 4(4-0) 382, or 372.  

475. Alloy Development and Application  
Fall. 4(4-0) 381, 382, 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) 206 or 380.  
Principles of elasticity and 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 gyroscope; 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. 4(3-3) Approval of department.  
Resistence 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  
Fall. of even-numbered years. 4(3-3) Approval of department.  
Whole-field techniques such as photoelasticity, photoelastic coatings, Moire techniques, and brittle coating. Interferometers 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 451 concurrently or approval of department.  

813. Theory of Elasticity I  
Winter. 4(4-0) 810; MTH 422 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 425.  
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 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.

823. Theory of Vibrations I  
Fall. 4(4-0) M E 455. Interdepartmental 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 of the intensity of diffracted X-rays; Weisenberg 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 462; PHY 460; 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. Glass-ceramics, nuclear fuel elements, hot-pressed translucent oxides, pre-stressed 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.
Impedance 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) 462.
Stoichiometric material and heat balance calculation in nonferrous extractive metallurgy.

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

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

885. Seminar
Fall, Winter, Spring. 1 credit. 859 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.

899. Research
(EGR 899.) 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.

909. Elastic Thin Shells
Spring. 4(4-0) 815 or C E 804 or approval of department, MTH 491. Interdepartmental with and administered by Civil Engineering.

910. Nonlinear Continua
Winter of even-numbered years. 4(4-0)
Modern nonlinear theories of continua. Equations of balance and constitutive theories. Topics selected from finite elasticity, nonlinear viscoelasticity and electrodynamics. General tensors are introduced and used throughout.

911. Theory of Elastic Stability
Fall of odd-numbered years. 4(4-0) 615 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) 815 or C E 804 or approval of department; MTH 492. 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.

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

920. Theory of Vibrations II
Winter of odd-numbered years. 4(4-0)
MTH 422, M E 823 or approval of department.
Interdepartmental with the Mechanical Engineering Department.

921. Theory of Vibrations III
Spring of odd-numbered years, Summer. 4(4-0) 920 or approval of department.
Interdepartmental with the Mechanical Engineering Department.

933. Advanced Elasticity
Spring of even-number of years. 3(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(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(3-0) May re-enroll for a maximum of 9 credits.

999. Research
(EGR 999.) Fall, Winter, Spring, Summer. Variable credit. Approval of department.