499.   Senior Problems
     Fall, Winter, Spring, Summer. 1 to 6 credits. May re-enroll for a maximum of 12 credits. Approval of department.

813.   Convective Heat Transfer
     Winter. 3(3-0)   412; MTH 421.
Analysis of convective transfer of heat, mass and momentum in boundary layers and inducted flows. Heat transfer with phase change of fluids.

814.   Radiative Heat Transfer
     Spring. 3(3-0)   Approval of department.
Statistical mechanics and thermodynamics of radiation. Study of spectral properties. Radiative transfer in media. Selected applications.

**815.   Advanced Classical
         Thermodynamics**
     Fall of odd-numbered years. 3(3-0) 416; MTH 422 or 424 or concurrently.
Postulational treatment of the laws of thermodynamics. Equilibrium and maximum entropy postulates. Development of formal relationships. Principles for general systems. Applications to chemical, magnetic, electric and elastic systems.

817.   Conductive Heat Transfer
     Fall. 3(3-0)   411, 351.
Theory of steady and unsteady heat conduction in isotropic and anisotropic media. Derivation of various describing equations and boundary conditions. Numerical methods. Nonlinear problems. Heat sources. Extended surfaces. Duhamel's integral.

823.   Theory of Vibrations I
     Fall. 4(4-0)   455. Interdepartmental with the Metallurgy, Mechanics and Materials Science 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.

826.   Kinematics of Machines II
     Fall. 3(3-0)   320.
Analysis and synthesis of mechanisms using complex variables. Euler-Savary equation. Polynomial cam design. Synthesis of function generators. Computer mechanisms.

827.   Machine Design III
     Spring, Summer. 3(3-0)   421.
Strain energy method for analyzing statically indeterminate machine members, theories of failure, fatigue, use of statistics in selection of tolerances for parts in mass production. Optimum design.

828.   Machine Design IV
     Winter. 3(3-0)   421.
Application of design theory to the synthesis of complete mechanical and hydraulic systems. Stress waves due to impact loading. Critical speed.

832.   Refrigeration
     Spring. 3(3-0)   436.
Characteristics of refrigerants; application details pertaining to comfort cooling, food refrigeration, and ultra-low temperature units; refrigeration controls, and control systems.

840.   Intermediate Fluid Mechanics
     Fall. 3(3-0)   332 or C E 321.
Deformable control volumes, Navier-Stokes equations, dimensionless variables, vorticity and circulation, turbulent flow, inviscid flow, and boundary layer theory.

841.   Advanced Gas Dynamics
     Spring. 3(3-0)   432; MTH 322 or 422 or 424 or approval of department.
Compressible subsonic and supersonic flow, shock waves, expansion fans, inviscid equations, perturbation theory, similarity rules, methods of measurement, method of characteristics, hodograph methods.

842.   Inviscid Fluids
     Spring. 3(3-0)   MMM 810; MTH 322 or 423.
Kinematics; dynamical equations; potential flows, transformations, Helmholtz flows; added masses, forces and moments; vortex motion; wave motion.

843.   Turbulence
     Winter, Summer. 4(4-0)   MMM 810 or approval of department.
Basic equations of turbulent motions including momentum, kinetic energy, scalar contaminants, correlation and spectrum functions. Basic elements of statistical descriptions, isotropic and shear flows, phenomenological theories and hot-wire anemometry.

**850.   Advanced Space and Orbit
         Ballistics**
     Fall of odd-numbered years. 3(3-0) MMM 306; MTH 215, 309.
Particle motion; missile trajectories; motion of a rocket; orbits; effects of oblateness on satellite orbit; orbital lifetime; rendezvous transfer in earth-moon system; optimization; low thrust space propulsion systems; trip to Mars.

851.   Modeling of Engineering Systems
     Fall. 4(4-0)   458 or E E 415.
Modeling of engineering devices and components; assembly into systems; bond graph representation; prediction of dynamic behavior by linear, nonlinear and simulation methods; applications to mechanical, electrical, fluid, thermal systems.

860.   Topics in Parameter Estimation
     (818.) Spring. 4(4-0) May re-enroll for a maximum of 8 credits when different topics are taken. STT 421 or 441 recommended.
Nonlinear estimation of parameters in ordinary and partial differential equations. Related concepts in probability and statistics. Least squares, maximum likelihood and other estimators. Sequential methods. Optimum experiment design. Model-building.

**862.   Mechanical and Aerospace
         Optimization**
     Winter. 3(3-0)   MTH 424.
Elementary fundamentals of calculus of variations, maximum principle. Optimization techniques applied to fluids, gas dynamics, optimization of airfoil shapes, fuel consumption, heat transfer, wave propagation in solids and physical properties in plasmas.

890.   Special Topics
     Fall, Winter, Spring, Summer. 2 to 4 credits. May re-enroll for a maximum of 9 credits. Approval of department.
Special topics in mechanical engineering of current interest and importance.

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

920.   Theory of Vibrations II
     (MMM 904.) Winter of odd-numbered years. 4(4-0) MTH 422; 823 or approval of department. Interdepartmental with and administered by the Metallurgy, Mechanics and Materials Science Department.
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.

921.   Theory of Vibrations III
     (MMM 903.) Spring of odd-numbered years, Summer. 4(4-0) MMM 920 or approval of department. Interdepartmental with and administered by the Metallurgy, Mechanics and Materials Science Department.
Nonlinear oscillations. Resonance; subharmonics; self-sustained motions; stability. Methods of Poincare, van der Pol, etc. Random vibrations. Parametric excitations; stochastic processes; power spectra. Applications.

**925.   Mechanical Engineering
         Problems**
     Fall, Winter, Spring, Summer. Variable credit. May re-enroll for a maximum of 9 credits. Approval of department.
Analysis of advanced engineering problems involving design, thermodynamics, fluid dynamics, gas dynamics, space.

942.   Viscous Fluids
     Fall of even-numbered years. 3(3-0) MMM 810 or CHE 841.
Exact solutions of Navier-Stokes equations, i.e., Oscillatory Motion, Laminar Jet, Converging Channel, etc.; Hydrodynamic Stability including free convection, surface tension, gravitational and free-surface instabilities, and Tollmien-Schlichting waves.

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

MEDICAL
TECHNOLOGY   M T

College of Human Medicine
College of Osteopathic Medicine

201.   Medical Technology
     Fall. 1(1-0)   Approval of school.
Relationship of medical technology to medicine and research, and the necessary interaction with other paramedical sciences.

401.   Seminar in Medical Technology
     Spring. 1 credit. Juniors.
Acquaints students with the operation and administration of a hospital, the philosophy and understanding of the entire profession of medical technology.

495.   Independent Study
     Fall, Winter, Spring, Summer. 1 to 5 credits. May re-enroll for a maximum of 10 credits. Approval of department.
Independent study including assigned reading and reviews of appropriate scientific periodicals.