994. **Advanced Topics in Applied Mathematics**
Fall, Winter, Spring, Summer. Variable credit. Approval of department.
Nonlinear differential equations, asymptotic theory in differential equations, existence theorem, diffraction theory, Wiener-Hopf techniques.

996. **Advanced Topics in Topology**
Fall, Winter, Spring, Summer. Variable credit. Approval of department.
Topological groups, topology of Euclidean spaces, axiomatic homology theory, homotopy theory, function spaces.

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

MECHANICAL ENGINEERING　　　M E

College of Engineering

201. **The Science of Sound I: Rock, Bach and Oscillators (N)**
Winter. 3(3-0) or 4(4-0) Interdepartmental with and administered by the Department of Physics.
Man-sound relationship. Production, propagation, detection of sounds. Voice hearing, scales, timbre, musical instruments. Room acoustics. Electronic reproduction and synthesis of music. Demonstrations emphasized.

202. **The Science of Sound II**
Spring. 3(3-0) or 4(4-0) PHY 201. Interdepartmental with the Department of Physics.
Nature, generation, and progagation of sound. Acoustical phenomenon and measurements. Storage and manipulation of sound in numerical form. Music programming.

300. **Technology and Utilization of Energy**
Winter. 3(3-0) Initial course in any sequence of courses in the Department of Natural Science. Interdepartmental with the Department of Engineering.
Problems of energy technology and its impact: energy sources, conversions, waste and environmental effects, future outlook for mankind.

303. **Thermal-Fluid Phenomena**
Spring. 3(3-0) MMM 201 or approval of department.
Concepts and principles used to describe, predict, or explain thermal and fluid-flow phenomena. Constraints, approximations, engineering problem solving. Application to socio-technical questions.

311. **Thermodynamics I**
Fall, Winter, Spring. 3(3-0) MTH 215 or concurrently.
Zeroth, first and second laws of thermodynamics. General energy equation. Process relations. Concepts of equilibrium, reversibility, and irreversibility. Applications of these to systems describable by two independent properties.

312. **Thermodynamics II**
Winter, Spring. 3(3-0) M E 311.
Continuation of M E 311. Gas and vapor relations, reactive and non-reactive mixtures. Thermodynamic principle as applied to gas and vapor power and refrigeration cycles for reciprocating and turbo machinery.

320. **Kinematics of Machines I**
Fall, Spring, Summer. 4(3-3) EGR 260; MMM 306 or concurrently.
Analysis of displacement, velocity, and acceleration in mechanical linkages; cam analysis and design; analysis of spur, helical, bevel, and worm gears, including planetary systems.

332. **Fluid Mechanics I**
Winter, Spring. 4(3-3) M E 311; M E 351 or concurrently; MMM 306.
Fluid statics; Bernoulli equation; nondeformable control volume applied to conservation of mass, momentum and energy; derivation of differential equations of continuity and momentum; similtude.

333. **Fluid Mechanics II**
Fall, Spring, Summer. 4(3-3) M E 332.
Fluid flow phenomena; laminar flow; turbulent flow, pipe flow, inviscid flows; boundary layers; external flow; an introduction to compressible flow.

341. **Computer Aided Manufacturing**
Fall. 4(3-2) CPS 110 or CPS 120. Interdepartmental with the Department of Computer Science.
Numerical control, Computer-Aided Numerical Control, Direct Numerical Control, and adaptive control applied in present day manufacturing. Use of the APT language to control NC machines.

346. **Mechanical Engineering Measurements Laboratory**
Winter, Spring. 2(1-3) E E 345.
Mechanical engineering experiments including accuracy, data reduction, and the measurement of pressure, velocity, temperature, heat flow and vibration.

347. **Thermosciences and Energy Systems Laboratory**
Fall, Spring, Summer. 2(1-3) M E 311, M E 346, M E 312 or concurrently.
Properties of pure substances; first law energy balances and second law analyses applied to a pump, turbine, refrigerator and combustion process.

351. **Mechanical Engineering Anlysis**
Fall, Winter, Summer. 4(4-0) CPS 120 or concurrently, MTH 310.
Application of analytical and numerical methods to the solution of problems encountered in mechanical engineering.

352. **Introduction to Systems and Control**
Winter, Spring. 4(4-0) PHY 288, MTH 310.
Modeling of a variety of physical systems, using state-variable concepts. Time and frequency response of low-order linear systems. Primary applications to mechanics and hydraulics.

406. **Automotive Engines**
Spring. 3(2-3) M E 312.
Analysis of internal combustion engines for vehicular propulsion.

407. **Automotive Vehicles**
Fall. 3(3-0) MMM 306.
Analysis of the propulsion, braking, steering, and suspension requirements.

410. **Thermomechanical Continua**
Fall. 3(3-0) MMM 211.
Reexamination of the continuum concept in the modeling of the deformation of solids and the flow of fluids. Cartesian tensor formulation of the basic physical laws involving stress and strain.

411. **Heat Transfer I**
Fall, Summer. 3(3-0) M E 311.
Analysis of steady-state and transient heat conduction; numerical solutions. Radiant heat transfer; principles and applications including radiation networks. Gaseous radiation exchange.

412. **Heat Transfer II**
Winter, Spring. 3(3-0) M E 333.
Natural and forced convection based on boundary layer theory. Heat transfer in fluids with phase change. Heat exchangers, mass transfer.

414. **Energy Conversion**
Winter. 3(3-0) M E 312.
Fundamental principles of energy conversion systems. Direct energy conversion. Thermoelectric, thermionic, nuclear, fuel cells, magnetohydrodynamic, and other methods of power generation.

415. **Solar Energy Conversion**
Fall. 4(4-0) M E 311 or approval of department.
Principles of solar radiation. Calculations of terrestrial difuse and direct-beam insolation. Analyses of flat-plate and focusing collectors and energy storage systems. Solar-assisted heat pumps. Photovoltaics. Biomass conversion.

416. **Statistical Thermodynamics**
(313.) Spring. 3(3-0) M E 311.
Kinetic theory, classical statistical mechanics, and quantum statistical mechanics. Derivation of transport coefficients. Applications of statistical mechanics.

417. **Propulsion**
Spring. 3(3-0) M E 333.
Thermodynamics and fluid mechanics will be used to study rockets, turbojets, reciprocating engines, propellors, turboprops, and turbofans; a specific propulsion system will be designed.

421. **Mechanical Design**
Fall, Winter. 3(3-0) MMM 211.
Introduction to design, the design process, design considerations and design procedures. Application of design principles to machine elements.

422. **Mechanical Design Projects**
Winter, Spring. 3(3-0) M E 421.
Application of design concepts, such as optimization, economics and reliability, through several projects drawn from the basic areas of mechanical engineering (thermodynamics, heat transfer, fluid and solid mechanics).

424. **Dynamics of Machines**
Winter. 3(3-0) M E 320.
Analysis of static and dynamic forces in mechanical linkages; balancing of rotating and reciprocating machinery; flywheel requirements, gyroscopic forces, critical speeds.

432. Aerodynamics
Winter. 3(3-0) M E 333.
Fundamentals of fluid mechanics, potential flows about bodies and airfoils, compressible flow, perturbation methods, viscous flow, boundary layers on airfoils, transition, turbulence, separation, aerodynamics of wings and bodies.

436. Cooling Processes
Winter. 3(3-0) M E 312.
Thermodynamic principles applied to the design of cooling systems in range of normal temperatures to ultra-low cryogenic temperature conditions. Psychrometric principles as applied to air conditioning and evaporating systems.

455. Mechanical Vibrations
Fall, Winter. 4(4-0) MMM 306.
Oscillatory phenomena for linear systems with one and two degrees of freedom, nonlinear systems, time varying systems with deterministic excitation, and time invariant systems with non-deterministic excitations.

458. Control Theory
Winter, Spring. 4(4-0) M E 352.
Closed-loop control systems; application of transfer function analysis; design for a definite degree of stability; on-and-off controllers.

463. Computer-Aided Design I
Winter. 3(2-2) CPS 120, MTH 334.
Three-dimensional transformations, perspectives, contour surface layout for design and manufacturing, an introduction to finite element applications.

464. Computer-Aided Design II
Spring. 3(2-2) M E 455, M E 463 and approval of department.
Modal analysis of dynamic systems; identification of modal characteristics from input-output data; computer techniques: including graphics, eigenvalue and Fourier transform computations.

471. Flight Dynamics
Fall. 3(3-0) MMM 306.
Particle and rigid body dynamics; orbit theory; aerodynamic forces; propulsion; longitudinal, directional and lateral stability and control; range; payload; a specific vehicle will be designed.

490. Special Topics
Fall, Winter, Spring, Summer. 1 to 4 credits. May reenroll for a maximum of 8 credits. Approval of department.
Special topics in mechanical engineering of current interest and importance.

499. Independent Study
Fall, Winter, Spring, Summer. 1 to 6 credits. May reenroll for a maximum of 9 credits. Approval of department.

810. Intermediate Heat/Mass Transfer
Fall. 4(4-0) Approval of department.
Diffusion of heat and mass in stationary and moving media. Steady-state and transient processes. Combined heat and mass transfer. Radiant heat transfer.

813. Convective Heat Transfer
Winter. 3(3-0) M E 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) M E 416; MTH 422 or MTH 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) M E 411, M E 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) M E 455. Interdepartmental with the Department of Metallurgy, Mechanics and Materials Science.
Discrete and continous 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.

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

827. Machine Design III
Spring, Summer. 3(3-0) M E 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) M E 421.
Application of design theory to the synthesis of complete mechnical and hydraulic systems. Stress waves due to impact loading. Critical speed.

829. Fluid Transients
Spring of odd-numbered years. 4(4-0) C E 828 or approval of department. Interdepartmental with and administered by Civil Engineering.
Application of unsteady flow concepts and wave mechanics to hydraulic engineering; method of characteristics; surges and waterhammer in piping systems; unsteady open channel flow; oscillatory waves; similitude and models.

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

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

841. Advanced Gas Dynamics
Spring. 3(3-0) M E 432; MTH 322 or MTH 422 or MTH 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 MTH 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, isotroic and shear flows, phenominological theories and hotwire anemometry.

851. Modeling of Engineering Systems I
Fall, 3(3-0) M E 458 or E E 415. Interdepartmental with Systems Science.
Modeling of engineering components and dynamic systems; mechanical, electrical, fluid, thermal, and transducer effects. Linear statespace responses, impedance methods. Simulation of linear models. Design project.

852. Modeling of Engineering Systems II
Winter. 3(3-0) M E 851. Interdepartmental with Systems Science.
Continuation of M E 851. Modeling of nonlinear dynamic systems. Applications of phase-plane and linearization methods. Simulation of nonlinear systems. Design project.

853. Finite Dimensional Dynamical Systems
Spring. 3(3-0) M E 851 or SYS 826 or approval of department.
Transition matrices and matrix exponentials, periodicity and reducibility; controllability and observability, weighting patterns, realizations and minimal realizations, least squares theory, free and fixed endpoint problems, canonical equations, conjugate and focal points.

854. Optimization Theory and Applications
(862.) Winter. 4(4-0) MTH 424 or approval of department.
Formulation of optimization problems; projection methods and least squares theory; elementary fundamentals of calculus of variations; techniques applied to problems in dynamics, optimization of airfoil shapes, and fuel consumption.

860. Topics in Parameter Estimation
Spring. 4(4-0) May reenroll for a maximum of 8 credits when different topics are taken. STT 421 or STT 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.

870. Wave Motion in Continous Media I
Winter of even-numbered years. 4(4-0) MTH 422, MMM 810 or approval of department.
Linear and nonlinear waves in bounded and unbounded media. Reflection, refraction, diffraction. Dispersion. Shock and acceleration waves. Waveguides. acoustical and optical analogies. Application to elastic, visoelastic, plastic and fluid media.

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

899. Master's Thesis Research
Fall, Winter, Spring, Summer. Variable credit. 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 and administered by the Department of Metallurgy, Mechanics and Materials Science.
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
Spring of odd-numbered years, Summer. 4(4-0) MMM 920 or approval of department. Interdepartmental with and administered by the Department of Metallurgy, Mechanics and Materials Science.
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 reenroll 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.

970. Wave Motion in Continous Media II
Spring of even-numbered years. 4(4-0) M E 870 or approval of instructor.
Continuation of M E 870.

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

MEDICAL TECHNOLOGY M T

College of Natural Science

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 reenroll for a maximum of 10 credits. Approval of department.
Independent study including assigned reading and reviews of appropriate scientific periodicals.

MEDICINE MED

College of Human Medicine

512. Infectious Diseases
Winter. 4(3-3) MPH 511, or approval of department. Interdepartmental with and administered by the Department of Microbiology and Public Health.
Infectious diseases of humans, including biology of the causative microorganism, epidemiology, pathogenesis, host-parasite relationships, clinical and laboratory diagnosis, and clinical management.

520. Biology of Blood Diseases
Spring. 2(2-0) Enrollment in a college of medicine or a graduate program in a biological science.
Correlates basic science and clinical concepts of hematology.

590. Special Problems in Medicine
Fall, Winter, Spring, Summer. 1 to 6 credits. May reenroll for a maximum of 12 credits. Human Medicine students or approval of department.
Each student will work under direction of a staff member on an experimental, theoretical or applied problem.

607. Ambulatory Care Clerkship
Fall, Winter, Spring, Summer. 1 to 3 credits. May reenroll for a maximum of 9 credits. H M 602. Interdepartmental with the departments of Community Health Science, Family Practice, and Pediatrics and Human Development. Administered by the Department of Family Practice.
Outpatient experience, lasting an equivalent of 48 half days over a period of six months or more, emphasizing continuous and comprehensive patient care under the supervision of appropriate physicians.

608. Senior Medical Clerkship
Fall, Winter, Spring, Summer. 1 to 17 credits. May reenroll for a maximum of 43 credits. Primary clerkship, third year Human Medicine students.
Based in community hospitals, this clerkship will stress interviewing skills, history, physical examination, along with problem solving and therapy, and care of the whole patient leading to independence in patient management.

609. Hematology Clerkship
Fall, Winter, Spring, Summer. 1 to 17 credits. May reenroll for a maximum of 34 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. 1 to 17 credits. May reenroll for a maximum of 34 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. 1 to 17 credits. May reenroll 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 cuticularization, phonocardiography, echocardiography and electrocardiography.

612. Nephrology/Urology Clerkship
Fall, Winter, Spring, Summer. 1 to 17 credits. May reenroll 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 reenroll 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 reenroll for a maximum of 34 credits. H M 602.
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. 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.