### 939. *Commutative Algebra III*

*Spring of odd-numbered years. 3(3-0) 938.*

Continuation of 938.

### 948. *Fluid Dynamics III*

*Spring of odd-numbered years. 3(3-0) 885.*

General theory of perfect fluids including motion of incompressible fluids in two and three dimensions and applications to problems of wing profiles. Viscous and compressible fluids discussed briefly.

### 951. *Approximation Theory I*

*Fall of odd-numbered years. 3(3-0) 823 or approval of department.*

Tchebycheff, approximation with polynomials, rational functions and general linear families; the Uncity problem; degree of approximation; Berstein Polynomials; Remes algorithm, uniform approximation with constraints.

### 952. *Approximation Theory II*

*Winter of even-numbered years. 3(3-0) 951.*

Continuation of 951. Generalized methods of measuring error: Approximation in $L^1$ and $L^p$ norms, least-square approximation and orthogonal functions; spline functions; approximation in normed linear spaces.

### 953. *Approximation Theory III*

*Spring of even-numbered years. 3(3-0) 952.*

Continuation of 952.

### 961. *Topological Groups*

*Winter of even-numbered years. 3(3-0) 862.*

General properties of topological groups, classical groups and Lie groups.

### 962. *Point Set Topology*

*Fall of odd-numbered years. 3(3-0) 823, 861.*

Hausdorff continua, Hahn-Mazurkiewicz cyclic element theory, monotone decompositions, indecomposable continua, homogeneity.

### 964. *Algebraic Topology I*

*Fall. 3(3-0) 834, 862.*

Simplicial and singular homotopy theory, Eilenberg-Steenrod axioms, chain complexes, cell complexes, applications to Euclidean spaces.

### 965. *Algebraic Topology II*

*Winter. 3(3-0) 964.*

Continuation of 964 including category and functor theory, general coefficient and cohomology theory.

### 966. *Algebraic Topology III*

*Spring. 3(3-0) 965.*

Continuation of 965 including homology groups of products, Eilenberg-Zilber theorems, cohomology products, differential topology.

### 982. *Methods of Complex Analysis II*

*Winter of odd-numbered years. 3(3-0)*

### 983. *Methods of Complex Analysis III*

*Spring of odd-numbered years. 3(3-0) 982.*

Continuation of 982.

### 991. *Advanced Topics in Geometry*

*Fall, Winter, Spring, Summer. Variable credit.*

### 992. *Advanced Topics in Analysis*

*Fall, Winter, Spring, Summer. Variable credit.*

### 993. *Advanced Topics in Algebra*

*Fall, Winter, Spring, Summer. Variable credit. Approval of department.*

Structure of rings and algebras, Lie algebras, Jordan algebras, advanced algebraic number theory, advanced matrix theory, and advanced topics in group theory, Lattice theory.

### 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. *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*

*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 propagation of sound. Acoustical phenomenon and measurements. Storage and manipulation of sound in numerical form. Music programming.

### 255. *Computer Models in Science and Engineering*

*Spring. 3(3-0) CPS 110 or 120 or equivalent FORTRAN. Interdepartmental with the Department of Computer Science.*

Problem-solving; development of student's ability to formulate computable models based on finite physical elements, examples from statics, dynamics, electrical resistance, and conduction heat transfer.

### 280. *Manufacturing Processes*

*Fall, Winter, Spring. 3(3-0)*

An introduction to the materials and processes used in manufacturing, to convert ideas into products, machines, and structures for the use of mankind. Extensive use is made of audio-visual techniques.

### 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, Summer. 3(3-0) MTH 215 or concurrently.*

Zeröth, 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) 311.*

Continuation of 311. Gas and vapor relations, reactive and non-reactive mixtures. Thermodynamic principles as applied to gas and vapor power and refrigeration cycles for reciprocating and turbo machinery.

### 315. *Thermodynamics Laboratory I*

*Fall, Winter, Summer. 1(0-3) 311 concurrently.*

Laboratory experiments applying the basic laws of thermodynamics.

### 316. *Thermodynamics Laboratory II*

*Winter, Spring. 1(0-3) 312 concurrently.*

Laboratory experiments investigating gases and liquid behavior and combustion from a thermodynamic viewpoint.

### 320. *Kinematics of Machines I*

*Fall, Spring, Summer. 4(3-3) EGR 260; MMM 306 or concurrently.*

Absolute and relative displacements, velocities, and accelerations in rigid body systems; analysis and synthesis of multi-bar linkages and rotational mechanisms.

### 332. *Fluid Mechanics I*

*Winter, Spring. 4(3-3) 311; 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; similitude.

### 333. *Fluid Mechanics II*

*Fall, Spring. 4(3-3) 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*

*Spring. 4(3-2) CPS 110 or 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.

### 351. Mechanical Engineering Analysis
*Fall, Winter, Summer. 4(4-0) CPS 120 or concurrently, MTH 215.*

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) MTH 215 or concurrently.*

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) 312.*

Analysis of internal combustion engines for vehicular propulsion.

### 407. Automotive Vehicles
*Fall. 3(2-3) 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. 3(3-0) 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) 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) 312.*

Fundamental principles of energy conversion systems. Direct energy conversion. Thermoelectric, thermionic, nuclear, fuel cells, magnetohydrodynamic, and other methods of power generation.

### 416. Statistical Thermodynamics
*(313.) Spring. 3(3-0) 311.*

Kinetic theory, classical statistical mechanics, and quantum statistical mechanics. Derivation of transport coefficients. Applications of statistical mechanics.

### 417. Propulsion
*Winter. 3(3-0) 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. 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. 3(3-0) 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) 320.*

Analysis of static and dynamic forces in rigid body systems; balancing of rotating and reciprocating system elements; inertial guidance; critical speeds.

### 432. Aerodynamics
*Spring. 3(3-0) 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) 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.

### 442. Industrial Engineering
*Spring. 4(3-2) 280.*

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.

### 455. Mechanical Vibrations
*Winter, Summer. 4(4-0) MMM 306.*

Oscillatory phenomena for linear systems with one and two degrees of freedom, non-linear systems, time varying systems with deterministic excitation, and time invariant systems with non-deterministic excitations.

### 458. Control Theory
*Spring. 4(4-0) 352.*

Closed-loop control systems; application of transfer function analysis; design for a definite degree of stability; on-and-off controllers.

### 463. Computer Assisted Design
*Spring. 3(2-2) 332, 411.*

Mechanical engineering group projects. Computer-aided design and engineering research. Problem formulation. Optimization.

### 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 re-enroll 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 re-enroll for a maximum of 12 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) 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 Department of Metallurgy, Mechanics and Materials Science.*

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. Interdepartmental with Systems Science.*

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*

*Fall, Winter, Spring, Summer. Variable credit. Approval of department.*

### 920. *Theory of Vibrations II*

*Winter of odd-numbered years. 4(4-0) MTH 422; 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 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*

*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.

## MEDICINE MED

### College of Human Medicine

### 512. *Infectious Diseases*

*Fall. 4(3-3) MPH 511, or approval of department. Interdepartmental with and administered by the Department of Microbiology and Public Health.*

Infectious diseases of man, including biology of the causative microorganism, epidemiology, pathogenesis, host-parasite relationships, clinical and laboratory diagnosis, and clinical management.

### 590. *Special Problems in Medicine*

*Fall, Winter, Spring, Summer. 1 to 6 credits. May re-enroll 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.

### 608. *Senior Medical Clerkship*

*Fall, Winter, Spring, Summer. 1 to 17 credits. May re-enroll 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 re-enroll for a maximum of 34 credits. 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 re-enroll for a maximum of 34 credits. 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 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 cuticularization, 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.