928. Harmonic Analysis II
Winter of odd-numbered years. 3(3-0) MTH 920.
Fourier transforms on Rn and R. Tempered distribution, inversion formula, Plancherel Theorem, pseudo-measures, almost-periodic functions, spectral properties, Wiener Tauberian Theorem, Paley-Wiener Theorems.

929. Harmonic Analysis III
Spring of odd-numbered years. 3(3-0) MTH 928.
Selected topics from Fourier analysis on compact groups, singular integrals, harmonic analysis in Rn, Hp theory in one and several variables or differentiation of integrals.

931. Non-Associative Algebras I
Fall of odd-numbered years. 3(3-0) MTH 836.
Non-associative algebras, radicals, idempotent decomposition of simple algebras.

932. Non-Associative Algebras II
Winter of even-numbered years. 3(3-0) MTH 931.
Continuation of MTH 931. Nil algebras, structure and representations, Lie algebras.

933. Non-Associative Algebras III
Spring of even-numbered years. 3(3-0) MTH 932.
Continuation of MTH 932. Relations between non-associative algebras, representations and cohomology theory.

934. Advanced Group Theory I
Fall. 3(3-0) MTH 836.
Permutation groups, characters, ⅛-properties, automorphisms, lattices of subgroups, classes of infinite groups, linear groups, recent literature.

935. Advanced Group Theory II
Winter. 3(3-0) MTH 934.
Continuation of MTH 934.

936. Advanced Group Theory III
Spring. 3(3-0) MTH 935.
Continuation of MTH 935.

937. Commutative Algebra I
Fall of even-numbered years. 3(3-0) MTH 836.
Algebraic number theory, Noetherian rings, Dedekind domains and classical ideal theory, valuation theory, power series rings, local rings.

938. Commutative Algebra II
Winter of odd-numbered years. 3(3-0) MTH 937.
Continuation of MTH 937.

939. Commutative Algebra III
Spring of odd-numbered years. 3(3-0) MTH 938.
Continuation of MTH 938.

948. Fluid Dynamics III
Spring of odd-numbered years. 3(3-0) MTH 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) MTH 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) MTH 951.
Continuation of MTH 951. Generalized methods of measuring error; Approximation in Li, and Lp 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) MTH 952.
Continuation of MTH 952.

961. Topological Groups
Winter of even-numbered years. 3(3-0) MTH 862.
General properties of topological groups, classical groups and Lie groups.

962. Point Set Topology
Fall of odd-numbered years. 3(3-0) MTH 823, MTH 861.
Hausdorff continua, Hahn-Mazurkiewicz cyclic element theory, monotone decompositions, indecomposable continua, homogeneity.

964. Algebraic Topology I
Fall. 3(3-0) MTH 834, MTH 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) MTH 964.
Continuation of MTH 964 including category and functor theory, general coefficient and cohomology theory.

966. Algebraic Topology III
Spring. 3(3-0) MTH 965.
Continuation of MTH 965 including homology groups of products. Eilenberg-Zilber theorems, cohomology products, differential topology.

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. 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
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.

255. Computer Models in Science and Engineering
Spring. 3(3-0) CPS 110 or CPS 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.

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.

315. Thermodynamics Laboratory I
Fall, Winter, Spring. 1(0-3) M E 311 concurrently.
Laboratory experiments applying the basic laws of themodynamics.

316. Thermodynamics Laboratory II
Winter, Spring. 1(0-3) M E 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.
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
Spring. 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.

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 satistical 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.

442. Industrial Engineering
Spring. 4(3-2) MMM 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
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 Assisted Design
Spring. 3(2-2) M E 332, M E 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 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 departmemt 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.

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.

840. *Intermediate Fluid Mechanics*

Fall. 3(3-0) M E 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) 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*

Fall, 4(4-0) M E 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*

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.

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.

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 or 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 reenroll for a maximum of 10 credits. Approval of department.

Independent study including assigned reading and reviews of appropriate scientific periodicals.