924. **Fluid Dynamics II**
Winter of odd-numbered years. 3(3-0)
MTH 884.
Continuation of MTH 884.

925. **Functional Analysis**
Fall of even-numbered years. 3(3-0)
MTH 823, MTH 862 or approval of department.

926. **Functional Analysis II**
Winter of even-numbered years. 3(3-0)
MTH 924 or approval of department.
Continuation of MTH 924.

927. **Theory of Measure and Integration**
Spring. 3(3-0) MTH 823. Interdepartmental with the Department of Statistics and Probability.
Introduction to the theory of integration over abstract spaces. Topics include: measure spaces, measurable and integrable functions; modes of convergence, theorems of Egoroff, Lusin, Riesz-Fisher, Lebesgue absolute continuity, and the Radon-Nikodym theorem; product measures and Fubini's theorem. Applications to some of the classical theories of integration and summability.

928. **Harmonic Analysis II**
Winter of odd-numbered years. 3(3-0)
MTH 920.

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.

930. **Advanced Group Theory I**
Fall. 3(3-0) MTH 836.
Permutation groups, characters, π-irreducibles, automorphisms, lattices of subgroups, classes of infinite groups, linear groups, recent literature.

931. **Advanced Group Theory II**
Winter. 3(3-0) MTH 934.
Continuation of MTH 834.

932. **Advanced Group Theory III**
Spring. 3(3-0) MTH 935.
Continuation of MTH 934.

933. **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.

934. **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 Uncertainty principle; degree of approximation; Bernstein Polynomials, Remez algorithm, uniform approximation with constraints.

935. **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-squares approximation and orthogonal functions; spline functions; approximation in normed linear spaces.

936. **Approximation Theory III**
Spring of even-numbered years. 3(3-0)
MTH 952.
Continuation of MTH 952.

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

938. **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.

939. **Algebraic Topology II**
Winter. 3(3-0) MTH 964.
Continuation of MTH 964 including category and functor theory, general coefficient and cohomology theory.

940. **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.

941. **Advanced Topics in Geometry**
Fall, Winter, Spring, Summer. Variable credit.

942. **Advanced Topics in Analysis**
Fall, Winter, Spring, Summer. Variable credit.

943. **Advanced Topics in Algebra**
Fall, Winter, Spring, Summer. Variable credit. Approval of department.

944. **Advanced Topics in Applied Mathematics**
Fall, Winter, Spring, Summer. Variable credit. Approval of department.

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

MECHANICAL ENGINEERING
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) ME 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) MME 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. 3(3-3) M E 311; M E 351 or concurrently MME 306. Fluid statics; Bernoulli equation; nondeformable control volume applied to conservation of mass, momentum and energy; derivation of differential equations of continuity and momentum; similarity.

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

346. Mechanical Engineering Measurements Laboratory  
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. Thermoelectrics 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, refrigeration and combustion processes.

351. Mechanical Engineering Analysis  
Fall, Winter, Summer. 4(4-0) CPS 120 or concurrently MTH 1010. Application of analytical and numerical methods to the solution of problems encountered in mechanical engineering.

352. Introduction to Systems and Controls  
Fall, Winter, Spring. 4(4-0) PHY 268, MTH 310. Modeling of a variety of physical systems, using state-variable concepts. Time and frequency responses 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) MME 306. Analysis of the propulsion, braking, steering, and suspension requirements.

410. Thermomechanical Continua  
Fall. 3(3-0) MME 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. Gas phase 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  

416. Statistical Thermodynamics  

421. Mechanical Design  
Fall, Winter. 3(3-0) MME 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. Aerospace Engineering I  
Fall. 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.
814. Radiative Heat Transfer  
Spring, 3(3-0) Approval of department.  

815. Advanced Classical Thermodynamics  
Fall, 3(3-0) M E 312; MTH 422 or MTH 424.  

817. Conductive Heat Transfer  
Fall, 3(3-0) M E 411.  

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

826. Kinematics of Machines II  
Fall, 3(3-0) M E 320.  

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 mechanical and hydraulic systems. Stress waves due to impact loading. Critical speed.

829. Fluid Transients  
Spring of odd-numbered years, 4(4-0) C E 528 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; similarity and models.

830. Intermediate Fluid Mechanics  
(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) M M 810; MTH 322 or MTH 423.  
Kinematics; dynamical equations; potential flows, transformations, Heimholz flows; added masses, forces and moments; vortex motion, wave motion.

851. Modeling of Engineering Systems I  
Fall, 3(3-0) M E 438 or E E 415. Interdepartmental with Systems Science.  
Modeling of engineering components and dynamic systems; mechanical, electrical, fluid, thermal, and transducer effects. Linear state-space 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 856 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 local points.

854. Optimization Theory and Applications  
(Fall) 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. MTH 421 or ST T 441 recommended.  

870. Wave Motion in Continuous Media  
Winter of even-numbered years, 4(4-0) MTH 429, MTH 810 or approval of department.  

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.

902. Theory of Vibrations II  
Winter of odd-numbered years, 4(4-0) MTH 432; M E 852 or approval of department. Interdepartmental with and administered by the Department of Metallurgy, Mechanics and Materials Science.  

921. Theory of Vibrations III  
Spring of odd-numbered years, Summer, 4(4-0) M MM 920 or approval of department. Interdepartmental with and administered by the Department of Metallurgy, Mechanics and Materials Science.  
Nonlinear oscillations, resonances; subharmonics; self-sustained motions; stability. Methods of Poissons, van der Pol, etc. Random vibrations, parameter, 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.

970. Wave Motion in Continuous 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.