942. Foundations of Applied Mathematics I
Fall. 3(3-0) P: MTH 848, MTH 849.
Modeling in classical applied mathematics. Newtonian and continuum mechanics. Special mathematical techniques.

943. Foundations of Applied Mathematics II
Spring. 3(3-0) P: MTH 942.
Continuation of MTH 942.

960. Algebraic Topology I
Fall. 3(3-0) P: MTH 869.
Cohomology, products, duality, basic homotopy theory, bundles, obstruction theory, spectral sequences, characteristic classes, and other related topics.

961. Algebraic Topology II
Spring. 3(3-0) P: MTH 960.
Continuation of MTH 960.

990. Reading in Mathematics
Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 8 credits in all enrollments for this course. R: Approval of department.
Individualized study for doctoral level students.

991. Special Topics in Algebra
Fall, Spring. 3 to 6 credits. A student may earn a maximum of 18 credits in all enrollments for this course. R: Approval of department.
Advanced topics in algebra.

992. Special Topics in Analysis
Fall, Spring. 3 to 6 credits. A student may earn a maximum of 18 credits in all enrollments for this course. R: Approval of department.
Advanced topics in analysis.

993. Special Topics in Geometry
Fall, Spring. 3 to 6 credits. A student may earn a maximum of 18 credits in all enrollments for this course. R: Approval of department.
Advanced topics in geometry.

994. Special Topics in Applied Mathematics
Fall, Spring. 3 to 6 credits. A student may earn a maximum of 18 credits in all enrollments for this course. R: Approval of department.
Advanced topics in applied mathematics.

995. Special Topics in Numerical Analysis and Operations Research
Fall, Spring. 3 to 6 credits. A student may earn a maximum of 18 credits in all enrollments for this course. R: Approval of department.
Advanced topics in numerical analysis or operations research.

996. Special Topics in Topology
Fall, Spring. 3 to 6 credits. A student may earn a maximum of 18 credits in all enrollments for this course. R: Approval of department.
Advanced topics in topology.

998. Special Topics in Combinatorics and Graph Theory
Fall, Spring. 3 to 6 credits. A student may earn amaximum of 18 credits in all enrollments for this course. R: Approval of department.
Advanced topics in combinatorics and graph theory.

999. Doctoral Dissertation Research
Fall, Spring, Summer. 1 to 24 credits. A student may earn a maximum of 99 credits in all enrollments for this course. R: Approval of department.

MECHANICAL ENGINEERING ME

Department of Mechanical Engineering
College of Engineering

201. Thermodynamics
Fall, Spring. 3(3-0) P: (CEM 141) and (MTH 234) Not open to students with credit in CHE 311 or MSM 351.
Basic concepts of thermodynamics. Property evaluation of ideal gases and compressible substances. Theory and application of the first and second laws of thermodynamics. Entropy and Carnot efficiency.

332. Fluid Mechanics
Fall, Spring. 4(3-3) P: (MSM 306) and (CHE 311 or ME 201 or MSM 351) and (ME 391 or concurrently) and completion of Tier I writing requirement. R: Open only to juniors or seniors in the Department of Mechanical Engineering or in the Engineering Mechanics major.
Statics, control volume equations, similitude, exact fluid solutions. Turbulence, pipe flow, boundary layer flow, compressible flow, and Navier-Stokes equations.

371. Mechanical Design I
Fall, Spring. 3(3-0) P: (MSM 306 or concurrently) R: Open only to juniors or seniors in the Department of Mechanical Engineering or in the Engineering Mechanics major.
Analysis of displacement, velocity and acceleration in mechanical linkages. Kinematics and dynamics of machines.

391. Mechanical Engineering Analysis
Fall, Spring. 3(3-0) P: (MTH 235) R: Open only to juniors or seniors in the Department of Mechanical Engineering or in the Biosystems Engineering or Engineering Mechanics major.
Analytical and numerical methods for the modeling and analysis of mechanical engineering systems. Applications to vibrating elements, heat transfer, linear springs, and coupled spring-mass systems.

410. Heat Transfer
Fall, Spring. 3(3-0) P: (ME 332 or CE 321 or CHE 311) and (ME 391) and completion of Tier I writing requirement. R: Open only to juniors or seniors in the Department of Mechanical Engineering or in the Biosystems Engineering or Engineering Mechanics major.
Steady state and transient heat conduction. Natural and forced convection based on boundary layer theory. Application of Nusselt number correlations. Radiant heat transfer principles and applications including radiation networks.

412. Heat Transfer Laboratory
Fall, Spring. 1(1-2) P: (ME 410) and completion of Tier I writing requirement. R: Open only to juniors or seniors in the Department of Mechanical Engineering.
Practices and measurement techniques for heat transfer and thermal systems. Experimental problem solving applied to heat transfer.

414. Vehicle Thermal System Design
Spring. 3(2-2) P: (ME 410) R: Open only to seniors in the College of Engineering.
Analysis and design of general heat exchange systems applied to automotive vehicle systems including heaters, air conditioning, electronic, and cabin systems. Students will work in teams to design, build, and test heat exchanger systems. A global engineering experience via the internet may be included.

416. Computer Assisted Design of Thermal Systems
Fall. 3(4-0) P: (ME 410 or concurrently) R: Open only to juniors or seniors in the Department of Mechanical Engineering or in the Biosystems Engineering major.
Classifying, cataloging and processing design information. Modeling of thermal equipment. Simulation and optimization of thermal systems. Computer based design projects.

422. Introduction to Combustion
Fall. 3(3-0) P: (ME 332 or concurrently) R: Open only to juniors or seniors in the Department of Mechanical Engineering.
Thermodynamics, chemistry, fluid mechanics, and heat transfer principles applied to combustion.

432. Intermediate Fluid Mechanics
Spring. 3(3-0) P: (ME 332) R: Open only to juniors or seniors in the Department of Mechanical Engineering or in the Engineering Mechanics major.
Deformable control volumes, Navier-Stokes equations, vorticity and circulation. Exact solutions. Turbulence, boundary layer flows, compressible flows.

433. Intermediate Fluid Mechanics Laboratory
Spring. 1(0-3) P: (ME 432 or concurrently) R: Open only to juniors or seniors in the Department of Mechanical Engineering.
Visualization and measurement of flow, jets and wakes. Flow separation and boundary layers.

440. Aerospace Engineering Fundamentals
Fall. 3(3-0) P: (ME 332 or concurrently) R: Open only to juniors or seniors in the Department of Mechanical Engineering or in the Engineering Mechanics major.
Aerodynamics, propulsion and flight mechanics. Vehicle and propulsion engine performance and design characteristics.

441. Aerospace Engineering Design
Spring. 3(3-0) P: (ME 332) R: Open only to juniors or seniors in the Department of Mechanical Engineering or in the Engineering Mechanics major.
Computer analysis experiments associated with aerospace vehicle design. Application of aerospace engineering principles in design such as propulsion, aerodynamics, stability and control.

442. Turbomachinery
Spring. 3(2-3) P: (ME 332) R: Open only to juniors or seniors in the Department of Mechanical Engineering.
Applying energy, momentum, and continuity equations of thermo-fluids to turbomachinery. Blade geometry and aerodynamics. Performance and design parameters. Turbomachine design.

444. Automotive Engines
Spring. 3(3-0) P: (ME 410 or concurrently) R: Open only to juniors or seniors in the College of Engineering.
Design and development of internal and external combustion engines for vehicular propulsion.

445. Automotive Powertrain Design
Spring. 3(3-0) P: (ME 444) R: Open only to juniors or seniors in the Department of Mechanical Engineering.
Design of powertrain systems including piston ring assembly, combustion and induction systems, and transmissions. Performance emission tradeoffs with emphasis on emission control. Detailed design study required.

451. Control Systems
Fall, Spring. 4(3-3) P: (MSM 306 and ECE 345) and completion of Tier I writing requirement. R: Open only to juniors or seniors in the Department of Mechanical Engineering or in the Engineering Mechanics major.
Mathematical modeling of dynamic systems. Standard feedback control formulation. Transient and sinusoidal steady state analysis. Time and frequency domain controller synthesis.

461. Mechanical Vibrations
Fall, Spring. 4(3-3) P: (ME 451) and completion of Tier I writing requirement. R: Open only to juniors or seniors in the Department of Mechanical Engineering or in the Engineering Mechanics major.
Modeling and analysis of oscillatory phenomena found in linear discrete and continuous mechanical systems.

463. Computer Aided Design of Dynamic Systems
Spring. 3(3-0) P: (ME 451) R: Open only to juniors or seniors in the Department of Mechanical Engineering or in the Engineering Mechanics major.
Modeling and design of mechanical and mixed-energy dynamic systems. State-space equation representation. Simulation methods.

465. Computer Aided Optimal Design
Fall. 3(3-0) P: (ME 471 or concurrently) R: Open only to juniors or seniors in the Department of Mechanical Engineering.
Modeling for mechanical design optimization. Algorithms for constrained and unconstrained optimization. Optimality criteria. Optimization using finite element models. Design projects.

471. Mechanical Design II
Fall, Spring. 3(3-0) P: (ME 371) and (ME 391) and (MSM 211) R: Open only to juniors or seniors in the Department of Mechanical Engineering or in the Engineering Mechanics major.
Engineering design of machine elements and mechanical systems. Computer based analysis in support of design. Design for static and fatigue strength, deflection and reliability.

475. Computer Aided Design of Automotive Structures
Fall. 3(2-2) P: (ME 471 or concurrently) R: Open only to seniors in the Department of Mechanical Engineering.
Computational methods for analysis, design, and optimization of automotive structural components. Basic concepts in geometric modeling, finite element analysis, and structural optimization.

481. Mechanical Engineering Design Projects
Fall, Spring. 3(1-6) P: (ME 410) and (ME 471) and completion of Tier I writing requirement. R: Open only to juniors or seniors in the Department of Mechanical Engineering.
Application of design concepts in mechanical engineering. Problem definition, design specifications. Modeling and analysis methods. Design optimization, economics, reliability. Manufacturing considerations in design. Capstone design projects.

490. Independent Study in Mechanical Engineering
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Open only to juniors or seniors in the Department of Mechanical Engineering. Approval of department.
Independent study in mechanical engineering.

491. Selected Topics in Mechanical Engineering
Fall, Spring. 1 to 4 credits. A student may earn a maximum of 8 credits in all enrollments for this course. R: Open only to juniors or seniors in the Department of Mechanical Engineering. Approval of department.
Topics selected to supplement and enrich existing courses.

802. Advanced Classical Thermodynamics
Fall. 3(3-0) P: ME 391, ME 411.
Postulational treatment of the laws of thermodynamics. Equilibrium and maximum entropy postulates. Principles for general systems.

804. Micro-Scale Fluid Mechanics and Heat Transfer
Spring of odd years. 3(3-0) P: (ME 361 and ME 332 and ME 410)
Basic concepts of micro-scale processes. Molecular derivation of the conservation equations of fluid dynamics, Boltzmann equation and Monte-Carlo methods of modern micro-applied science. Theory of micro-scale heat transfer. Applications to fluid mechanics, heat transfer, combustion.

809. Finite Element Method
Fall, Spring. 3(3-0) Interdepartmental with Materials Science and Mechanics; Civil Engineering; and Biosystems Engineering. Administered by Materials Science and Mechanics.
Theory and application of the finite element method to the solution of continuum type problems in heat transfer, fluid mechanics, and stress analysis.
SA: AE 809

812. Conductive Heat Transfer
Fall. 3(3-0) P: ME 391, ME 411.
Theory of steady and unsteady heat conduction. Derivation of describing equations and boundary conditions. Numerical methods. Nonlinear problems.

814. Convective Heat Transfer
Spring. 3(3-0)
Analysis of convective transfer of heat, mass and momentum in boundary layers and ducts. Thermal instability. Free convection.

822. Combustion
Spring. 3(3-1) P: ME 490, ME 802.
Thermodynamics and chemical kinetics. Multicomponent systems. Premixed and diffusion flames, flame radiation.

830. Fluid Mechanics I
Fall. 3(3-0)
Integral and differential conservation laws, Navier-Stokes' equations, and exact solutions. Laminar boundary layer theory, similarity solutions, and approximate methods. Thermal effects and instability phenomena.

832. Fluid Mechanics II
Spring of even years. 3(3-0) P: ME 830, MTH 425.
Inviscid flow, vortex motion, flow past bodies. Complex variables and conformal mapping. One-dimensional steady and unsteady compressible flow, shock waves and Prandtl-Meyer expansion. Small perturbations theory and method of characteristics.

834. Fundamentals of Turbulence
Fall of odd years. 3(3-0)
Statistical descriptions of turbulent flows: isotropic, free shear and wall bounded. Correlation and spectral descriptions. Conditional probabilities and coherent motions. Experimental methods. Scaling relationships.

836. Experimental Methods in Fluid Mechanics
Fall of even years. 3(1-4)
Modern techniques of fluid mechanics measurement and data analysis. Pressure, temperature and velocity measurement techniques. Optical diagnostics.

840. Computational Fluid Dynamics and Heat Transfer
Spring. 3(3-0) P: ME 410, ME 830 or ME 814, programming experience.
Theory and application of finite difference and finite volume methods to selected fluid mechanics and heat transfer models including the full potential flow model, the systems of Euler and Navier-Stokes equations, and turbulence. Grid generation techniques.

842. Advanced Turbomachinery
Spring of even years. 3(3-0) P: ME 442 R: Open only to seniors and graduate students in Mechanical Engineering and Chemical Engineering.
Application of energy, momentum, continuity and heat transfer equations to energy transfer and transformation in turbomachinery.

852. Intermediate Control Systems
Spring. 3(3-0) P: ME 451.
Design of controllers for dynamic systems in mechanical engineering. Modeling, analysis and simulation.

855. Digital Data Acquisition and Control
Spring of odd years. 3(2-3) P: ME 451.
Real-time digital measurement and control programming for mechanical engineering systems. Analog-to digital and digital-to-analog converters, timer/counters, and instrument interfaces. Open-loop and closed-loop control. Laboratory projects.

857. Modeling and Simulation of Dynamic Systems
Fall. 3(3-0) P: ME 451.
Energy-based methods for modeling dynamic engineering components and systems. Systematic formulation of nonlinear state-space equations. Qualitative aspects of response: equilibrium points, linearization. Simulation techniques and design projects.

860. Theory of Vibrations
Fall. 3(3-0) Interdepartmental with Materials Science and Mechanics.
Discrete systems and continua. Analytical mechanics. Variational principles. Modal analysis. Function spaces. Eigenfunction expansions. Integral transforms. Stability. Approximations. Perturbations.

863. Nonlinear Vibrations
Spring of even years. 3(3-0) P: ME 461.
Perturbation methods. Weakly nonlinear partial and ordinary differential equations. Modal interactions, internal tuning, saturation, sub/super/combination resonances, jump phenomenon. Nonlinear normal modes.

871. Elastodynamics of Machinery and Robotic Systems
Fall of even years. 3(3-0)
Rigid-body kinematic analysis. Linkage synthesis. Variational formulations, nonlinear phenomena, composites and smart materials.

875. Optimal Design of Mechanical Systems
Spring of even years. 3(3-0) P: ME 461.
Optimal design for static and dynamic response of mechanical and structural systems. Necessary and sufficient conditions for optimality. Discrete and continuous parameter problems. Sensitivity of response to design variations. Algorithms.

892. Parameter Estimation
Fall of odd years. 3(3-0) P: STT 421 or STT 441.
Nonlinear estimation of parameters in ordinary and partial differential equations. Related concepts in probability and statistics. Least squares and other estimators. Sequential methods. Optimum experiment design.

898. Master's Project Research
Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 7 credits in all enrollments for this course. R: Open only to master's students in the Mechanical Engineering major. Approval of department.
Master's degree Plan B individual student project: original research, research replication, or survey and reporting on a topic such as system design and development, or system conversion of installation.

899. Master's Thesis Research
Fall, Spring, Summer. 1 to 8 credits. A student may earn a maximum of 24 credits in all enrollments for this course.

913. Advanced Heat Conduction
Fall of even years. 3(3-0) P: ME 812 or MTH 849.
Inverse and ill-posed problems in heat transfer: function estimation, regularization, and adjoint methods in conduction.

930. Selected Topics in Fluid Mechanics
Fall. 1 to 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course. P: ME 830.
Current topics in fluid mechanics will be presented.

940. Selected Topics in Thermal Science
Spring. 1 to 3 credits. A student may earn a maximum of 12 credits in all enrollments for this course. P: ME 812, ME 814, ME 816. R: Open only to Mechanical Engineering majors.
Conduction, convection, radiation, phase change and interactive combined modes of heat transfer. Mass transfer. Irreversible thermodynamics.

960. Selected Topics in Vibrations
Fall. 1 to 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course. P: ME 860.
Current topics of interest to the student and faculty.

961. Nonlinear Dynamics and Chaos
Fall of even years. 3(3-0) P: (ME 857 or ME 860 or ECE 826 or MTH 441)
Qualitative theory of dynamical systems applied to physical system models. Bifurcation theory for continuous and discrete-time systems, chaos, the Smale horseshoe, Melnikov's method, and nonlinear data analysis.

990. Independent Study in Mechanical Engineering
Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course.
Individualized study of a current problem in mechanical engineering.

999. Doctoral Dissertation Research
Fall, Spring, Summer. 1 to 24 credits. A student may earn a maximum of 72 credits in all enrollments for this course.

MEDICAL TECHNOLOGY MT

Medical Technology Program
College of Natural Science

212. Fundamentals of Laboratory Analysis
Fall, Summer. 3(3-0) P: (MTH 103 or MTH 116 or LBS 117) RB: (BS 111L)
Chemical, biological and instrumental concepts in laboratory analyses: quality assurance, laboratory mathematics, safety, health care systems and regulatory issues.

213. Application of Clinical Laboratory Principles
Fall, Summer. 1(0-3) P: (MT 212 or concurrently) RB: (BS 111L) R: Open only to students in Clinical Laboratory Sciences or Medical Technology or Human Biology major or LBS Medical Technology coordinate major.
Lab safety and standards of good laboratory practice including specimen handling and processing. Application of technologies and techniques to the performance of clinical diagnostic testing.

414. Clinical Chemistry I: Laboratory Analysis and Practice
Spring. 3(3-0) P: (STT 200 or STT 201 or STT 231 or STT 351 or STT 421) (MT 212 and MT 213) RB: (PHY 231 And PHY 232)
Concepts and principles of analytic methods commonly used in the clinical laboratory are presented. Emphasis on qualitative and quantitative features of instrumental analysis. Issues of QC, QA, method evaluation and standards of laboratory practice.

415. Clinical Chemistry and Body Fluid Analysis Laboratory
Spring. 1(0-3) P: (MT 213) R: Open only to students in the Clinical Laboratory Sciences major. C: MT 414 concurrently.
Quantitative analysis of blood and body fluids. Spectophotometry, electrophoresis, chromatography, enzymatic assays, and immunoassays.

416. Clinical Chemistry II: Pathophysiology and Body Fluid Analysis
Fall. 5(5-0) P: (MT 212) and (BCH 401 or BCH 462) and (PSL 250) or (PSL 431 and PSL 432) RB: (MT 414)
Correlation of laboratory test results with normal physiology and biochemistry and with disease states. Emphasis on metobolic and endocrine systems, and acquired and inherited diseases. Therapeutic drug monitoring, toxicology and urinalysis.

422. Hematology and Hemostasis
Fall. 4(4-0) P: (MT 212 or concurrently) (PSL 250) RB: (BS 111 And BS 111L And BCH 401)
Structure and function of normal blood cells with changes seen in benign and malignant diseases and acquired and hereditary disorders. Mechanisms of hemostasis, fibrinolysis and hemostatic control.

423. Hematology and Hemostasis Laboratory
Fall. 1(0-3) P: (MT 213 or concurrently) R: Open only to students in the Clinical Laboratory Sciences major. C: MT 422 concurrently.
Diagnostic assessment of blood cells and hemostatic function.

432. Clinical Immunology and Immunohematology
Spring. 5(5-0) P: (MT 212 and BS 111 and BS 111L) (MT 422) RB: (PSL 250)
Cellular and humoral immunity and diseases of immunity. Clinical serology and immunology, blood group serology, and transfusion practices.