Department of Mechanical Engineering

The curriculum in Mechanical Engineering focuses on the analysis, design, manufacturing, and maintenance of mechanical components and systems. Emphasis is placed on the fundamental concepts of engineering science and design needed in a variety of industries, including automotive, aerospace, biotechnology, material and chemical processing, microsystems and sensors, nanotechnology, machinery and robotics, pharmaceutical, energy production and distribution, heating and refrigeration, food production and processing, entertainment, pulp and paper, weapons systems, and many others. Mechanical engineering students take courses in several areas of engineering including: mechanics of rigid and deformable solids, thermo-fluid sciences, energy systems, dynamic systems and controls, design and manufacturing, materials, and electronics.

In compliance with the Engineering Accreditation Commission (EAC) of ABET, the Department of Mechanical Engineering at Auburn University has developed and maintained a well-defined set of Program Educational Objectives to assure the quality of our program and graduates. These objectives are broad statements that describe the career and professional accomplishments that the mechanical engineering degree program is preparing the graduates to achieve a few years after graduation. The objectives are consistent with the needs and expectations of the program constituencies, and are reviewed and updated regularly using an annual assessment process. The current program educational objectives are:

- Our graduates have rewarding careers where they use their technical proficiency and mechanical engineering education for the professional practice of mechanical engineering or any other career path they choose.
- Our graduates contribute to their chosen field by effectively leveraging a broad array of professional skills such as oral and written communication, leadership, and teamwork.
- Our graduates are life-long learners through a variety of means including self study, continuing education courses, and graduate level education.
- Our graduates maintain awareness of a broad range of contemporary issues and global concerns especially as they relate to the field of mechanical engineering.

Students are able to concentrate on areas of special interest through technical elective courses taken in the senior year. In addition, specialized concentrations are offered in Additive Manufacturing, Automotive Engineering, and Pulp and Paper Engineering. Minors are offered in Tribology, Business Engineering and Technology, Materials Engineering, and Materials Science.

Materials Engineering

The curriculum in Materials Engineering (MATL) is structured to address problems associated with the design of materials and materials processes to meet specific needs for a variety of industries. Emphasis is on the basic sciences and principles of engineering with applications of these principles to materials behavior. The student must obtain a broad foundation in chemistry, physics and mathematics, which is applied in engineering courses. Within materials engineering courses, students obtain a foundation in the major areas of materials science and to the major classes of engineering materials, which is applied in courses in materials properties and selection, computational methods and in a capstone design course. Students gain in-depth experience in another engineering discipline through coordinated technical elective sequences. Students may design alternative cross-disciplinary sequences, but they must be coordinated and approved by the Materials Engineering Curriculum Committee. The objective of the MATL program is to produce graduates who are engaged in careers through which they apply materials engineering proficiency, effective communication and lifelong learning to provide technical, economic, or other benefits to society.

Majors

- Materials Engineering (http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmentofmechanicalengineering/materialsengineering_major/)
- Mechanical Engineering (http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmentofmechanicalengineering/mechanicalengineering_major/)

Minors

- Material Science Minor (http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmentofmechanicalengineering/materialsscience_minor/)
- Materials Engineering Minor (http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmentofmechanicalengineering/materialengineering_minor/)
- Nuclear Power Generation Systems (http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmentofmechanicalengineering/nuclearpowergensystems_minor/)

- Tribology (http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmentofmechanicalengineering/tribology_minor/)

Materials Engineering Courses

MATL 2100 INTRODUCTION TO MATERIALS SCIENCE (3) LEC. 3. The science of solid materials and the relationship between this science and material properties.

MATL 2210 MATERIALS FOR SUSTAINABLE ENERGY PRODUCTION AND STORAGE (1) LEC. 1. Technologies for sustainable energy production and storage, renewable energy conversion, associated materials challenges.

MATL 2220 MATERIALS AND THE ENVIRONMENT (1) LEC. 1. Environmental impact of the production, use and disposal of materials.

MATL 2230 MINERAL RESOURCES: PROCESSING AND AVAILABILITY (1) LEC. 1. Mineral resources for engineering materials; processing and availability of mineral resources.

MATL 3100 ENGINEERING MATERIALS - METALS (3) LEC. 3. Pr. MATL 2100. The relationship among processing, microstructure, properties and engineering applications of metallic materials.

MATL 3101 METALLOGRAPHY LABORATORY (1) LAB. 3. Coreq. MATL 3100. The use of microstructural characterization to understand the relationship between microstructure and properties of metallic materials.

MATL 3200 ENGINEERING MATERIALS POLYMERS (3) LEC. 3. Pr. CHEM 1040. The synthesis, processing, structure and properties of polymers and polymer matrix composites.

MATL 3201 POLYMER AND COMPOSITES LABORATORY (1) LAB. 3. Coreq. MATL 3200. A hands-on lab course on the synthesis, processing, structure and properties of polymers and polymer matrix composites.

MATL 3300 ENGINEERING MATERIALS - CERAMICS (3) LEC. 3. Pr. MATL 2100. The engineering of ceramic materials. Structural property relationships of crystalline and glassy ceramics will be included.

MATL 4100 THERMODYNAMICS AND KINETICS OF MATERIALS (3) LEC. 3. Pr. CHEM 1040 and ENGR 2200. Laws of thermodynamics to describe phase equilibria and phase transformations in one-component and multi-component systems, mechanisms of diffusion, the interplay of thermodynamic driving forces and kinetics of mass transfer in materials systems

MATL 4500 MATERIALS PROPERTIES AND SELECTION (4) LEC. 3. LAB. 3. Pr. ENGR 2070 and MATL 3100 and MATL 3200. Methods for microstructure control. Design of processing sequences, statistical and economical analysis.

MATL 4930 DIRECTED STUDIES (1-6) IND. SU. Departmental approval. Areas of interest within Materials Engineering. Course may be repeated for a maximum of 6 credit hours.

MATL 4980 SENIOR DESIGN PROJECT (3) LEC. 1. LAB. 6. Students select, design, schedule, fabricate and perform an engineering design project related to Materials Engineering.

MATL 5100 THERMODYNAMICS OF MATERIALS SYSTEMS (3) LEC. 3. Pr. CHEM 1040 and ENGR 2200. Departmental approval. Application of thermodynamics to describe phase stability, crystal imperfections, solubility, oxidation, surface, and interface energy and transformations.

MATL 5200 MATERIALS CHARACTERIZATION (2) LEC. 2. Pr. PHYS 1610 or PHYS 1617. Principles of materials characterization including x-ray diffraction, optical and electron microscopy, and other advanced analytical methods for materials design.

MATL 5201 MATERIALS CHARACTERIZATION LABORATORY (1) LAB. 3. Coreq. MATL 5200. Laboratory on the use of x-ray diffraction, metallography, and optical/electron microscopy for materials characterization.

MATL 5300 PHASE TRANSFORMATIONS IN MATERIAL PROCESSING (3) LEC. 3. Pr. MATH 2650 and ENGR 2200. Departmental approval. Principles that govern phase transformations in materials systems and control of nucleation and growth, microstructure and morphology.

MATL 5400 PHYSICS OF SOLIDS (3) LEC. 3. Pr. PHYS 1610 or PHYS 1617. Departmental approval. The physics of solid-state materials, including the electronic, optical and magnetic properties of materials.

MATL 5500 NUMERICAL SIMULATION OF MATERIALS PROCESSING (3) LEC. 3. Pr. MATL 5100 and P/C MATL 5300. Departmental approval. Fundamental principles and applications of computer-aided simulation of transport phenomena in materials processing systems.

MATL 5600 CORROSION (3) LEC. 3. Pr. CHEM 1040. Fundamentals of chemical degradation of materials. Types and methods for prevention and minimization of corrosion.

MATL 5700 BIOMATERIALS (3) LEC. 3. Departmental approval. Interactions between materials and proteins, cells, and tissue as related to medicine and biotechnology including tissue culture, cardiovascular, drug delivery, tissue engineering and other applications. Thermodynamics of protein adsorption. Cell biology of adhesion. Analytical methods, sterilization, and regulations.

MATL 5720 BIOMEDICAL APPLICATIONS OF POLYMERIC MATERIALS (3) LEC. 3. LAB. 13. Pr. P/C BIOL 1030 or P/C CHEM 2070. Study of polymers used in the body for the purposes of aiding healing, correcting abnormalities, and restoring lost function.

MATL 5750 MICROSTRUCTURE AND MECHANICS OF SKELETAL TISSUES (3) LEC. 3. Pr. MATL 2100 and (ENGR 2070 or MECH 3130). Molecular and cellular microstructural influence over the viscoelastic deformation of the skeletal tissues of bone muscle, ligament, tendon and cartilage; mechanics of failure and biomechanical injury mechanisms; consideration of the physiological processes of adaptive remodeling and healing of tissues; recent developments in orthopedic implant materials.

MATL 5970 INTERMEDIATE SPECIAL TOPICS (1-3) LEC. 1-3. Departmental approval. Regular course addressing an advanced specialized area of Materials Engineering not covered by regularly offered courses. Course may be repeated with change in topics.

MATL 6100 THERMODYNAMICS OF MATERIALS SYSTEMS (3) LEC. 3. Departmental approval. Application of thermodynamics to describe phase stability, crystal imperfections, solubility, oxidation, surface and interface energy and transformations.

MATL 6200 MATERIALS CHARACTERIZATION (2) LEC. 2. Principles of materials characterization including x-ray diffraction, optical and electron microscopy, and other advanced analytical methods for materials design.

MATL 6201 MATERIALS CHARACTERIZATION LABORATORY (1) LAB. 3. Coreq. MATL 6200. Laboratory on the use of x-ray diffraction, metallography, and optical/electron microscopy for materials characterization.

MATL 6300 PHASE TRANSFORMATIONS IN MATERIAL PROCESSING (3) LEC. 3. Departmental approval. Principles that govern phase transformations in materials systems and control of nucleation and growth, microstructure, and morphology.

MATL 6400 PHYSICS OF SOLIDS (3) LEC. 3. Departmental approval. The physics of solid-state materials, including the electronic, optical, and magnetic properties of materials.

MATL 6500 NUMERICAL SIMULATION OF MATERIALS PROCESSING (3) LEC. 3. Departmental approval. Fundamental principles and applications of computer-aided simulation of transport phenomena in materials processing systems.

MATL 6600 CORROSION (3) LEC. 3. Pr. CHEM 1040. Fundamentals of chemical degradation of materials. Types and methods for prevention and minimization of corrosion.

MATL 6700 BIOMATERIALS (3) LEC. 3. Departmental approval. Interactions between materials and proteins, cells, and tissue as related to medicine and biotechnology including tissue culture, cardiovascular, drug delivery, tissue engineering and other applications. Thermodynamics of protein adsorption. Cell biology of adhesion. Analytical methods, sterilization and regulations.

MATL 6720 BIOMEDICAL APPLICATIONS OF POLYMERIC MATERIALS (3) LEC. 3. LAB. 13. Study of polymers used in the body for the purposes of aiding healing, correcting abnormalities, and restoring lost function.

MATL 6970 INTERMEDIATE SPECIAL TOPICS IN MATERIALS ENGINEERING (1-3) LEC. 3. Departmental approval. Regular course addressing an advanced specialized area of Materials Engineering not covered by regularly offered courses. Course may be repeated with change in topics.

MATL 7050 DEFORMATION AND FAILURE OF ENGINEERING MATERIALS (3) LEC. 3. Departmental approval. Coreq. MATL 6200. Theoretical presentation of the fundamental principles of deformation and failure in materials systems.

MATL 7120 ADVANCED CERAMIC MATERIALS (3) LEC. 3. Departmental approval. Processing, structure-property relationships and applications of advanced ceramics. Structural and functional applications of ceramics.

MATL 7130 ADVANCED POLYMER SCIENCE AND TECHNOLOGY (3) LEC. 3. Departmental approval. Recent developments in both functional and structural polymers including approaches to synthesis, processing techniques, high-strength materials, electronic polymers, optic polymers, and medical polymers.

MATL 7320 THIN FILM SCIENCE AND TECHNOLOGY (3) LEC. 3. Departmental approval. Structure, properties, characterization, processing and application of thin films.

MATL 7330 MATERIALS FOR ENERGY STORAGE (3) LEC. 3. Introduction of various electrochemical energy storage devices (Batteries, Supercapacitor, etc) and discussion of advancement in development of materials for these devices. Instructor's consent required for prerequisites.

MATL 7420 SMART MATERIALS AND STRUCTURES (3) LEC. 3. Departmental approval. An introduction to the principles and applications of various sensor, actuator and functionality smart material systems and structures.

MATL 7430 DIELECTRIC MATERIALS AND DEVICES (3) LEC. 3. Pr. (MATL 6100 or MATL 6106) and (MATL 6400 or MATL 6406). Departmental approval. Processing, structure, properties, and application of dielectrics, including physics of dielectrics, material/ device design/fabrication processes, and application of dielectric materials in high-technological industry.

MATL 7610 ENGINEERING ASPECTS OF BIOLOGICAL AND CHEMICAL DETECTION (3) LEC. 3. Departmental approval. Biological and chemical scientific concepts related to biological and chemical threat agents. Existing and developing detection technologies, trends and needs for the future detection systems. Physical principles behind the detection technologies. Evaluation of detection device or system performance.

MATL 7630 NANOMATERIALS FOR BIOTECHNOLOGY (3) LEC. 3. Departmental approval. Basic understanding of nanobiotechnology and practical applications in the interdisciplinary fields of Materials Science and Engineering and biotechnology/ medicine including nanostructured biomolecules and bioarrays as well as biomolecular nanoelectronics.

MATL 7950 MATERIALS ENGINEERING SEMINAR (0) SEM. SU. Required during each semester of residency, but cannot be used toward minimum requirements for graduate degree in Materials Engineering. Content changes each semester and consists of off-campus speakers and presentations by graduate students and faculty.

MATL 7960 DIRECTED READINGS IN MATERIALS ENGINEERING (1-6) DSL/IND. SU. Departmental approval. May be taken more than one semester. Up to 6 hours may count toward the minimum degree requirements. Course may be repeated with change in topics.

MATL 7970 SPECIAL TOPICS IN MATERIALS ENGINEERING (1-3) DSL. Departmental approval. Regular course addressing an advanced specialized area of Materials Engineering not covered by regularly offered courses. Course may be repeated with change in topics.

MATL 7980 MASTER MATERIALS ENGINEERING PROJECT (3) LEC. 3. SU. Special design project report directed by major faculty. Topics to be determined by the student's graduate committee.

MATL 7990 RESEARCH AND THESIS (1-15) MST. Individual mater's thesis research. Course may be repeated with change in topics.

MATL 8990 RESEARCH AND DISSERTATION (1-15) DSL/DSR. Individual doctoral dissertation research. Course may be repeated with change in topics.

Mechanical Engineering Courses

MECH 2020 MANUFACTURING TECHNOLOGY LAB (2) LEC. 3. LAB. 1. Manufacturing technology lab for introduction of processes such as cutting, forming, machining, and joining of metals and other materials. Basic and applied machine shop and manufacturing floor safety.

MECH 2130 MECHANICAL ENGINEERING STATICS (3) LEC. 2.5. Pr. (MATH 1620 or MATH 1627) and (PHYS 1600 or PHYS 1607). Forces, vectors, moments and free body diagrams. Systems in mechanical equilibrium.

MECH 2140 KINEMATICS AND DYNAMICS (3) LEC. 3. Pr. (MATH 2630 or MATH 2637) and MECH 2130. Kinematics and kinetics of particles and rigid bodies with an emphasis on mechanical engineering applications such as machines, mechanisms, cams, gears and vibrations. MECH 2130 with a grade of C or higher.

MECH 2220 COMPUTER-AIDED ENGINEERING (3) LEC. 2. LAB. 3. Pr. (ENGR 1110 or ENGR 1113) and COMP 1200 and P/C MATH 2650. The computer as a tool in mechanical engineering.

MECH 2AA0 MECHANICAL ENGINEERING PROGRESS ASSESSMENT I (0) TST. SU. Progress Assessment Examination in: multivariate calculus, differential equations, chemistry, physics, statics, dynamics. Course may be repeated with change in topics.

MECH 3020 THERMODYNAMICS II (3) LEC. 3. Pr. ENGR 2010. Gas and Vapor power cycles, Refrigeration cycles, Gas and gas-vapor mixtures, Chemical reactions, Chemical and phase equilibrium, Thermodynamic property relations. Pr. ENGR 2010 with a grade of C or higher.

MECH 3030 FLUID MECHANICS (3) LEC. Pr. MECH 2130 and ENGR 2010 and MATH 2650 and P/C MECH 3120. Fluid properties; fluid statics; mass conservation; momentum equation; external and internal flows; Euler and Bernoulli equations; dimensional analysis; viscous flows; boundary layers; compressible flow. Pr. MECH 2130 with a grade of C or higher, and ENGR 2010 with a grade of C or higher.

MECH 3040 HEAT TRANSFER (3) LEC. 3. Pr. MECH 3020 and MECH 3030. Fundamentals of heat transfer by conduction, convection, and radiation. Introduction to heat exchangers.

MECH 3050 MEASUREMENT AND INSTRUMENTATION (3) LEC. 2. LAB. 3. Pr. MECH 3030 and P/C ELEC 3810. Theory and practice of modern sensors and computer-based data acquisition techniques, uncertainty analysis, results reporting, filtering and signal processing.

MECH 3120 MECHANICS OF MATERIALS (3) LEC. 3. Pr. MECH 2130 and MECH 2220 and MATL 2100 and MATH 2650 and MATH 2660. Stress and strain concepts, stress-strain relationships, applications, uniaxially loaded members, torsion, normal and shear stresses in beams, beam deflections, buckling, stress concentration, combined loading, failure theories (Grade of C or higher required in MECH 2130.)

MECH 3140 SYSTEM DYNAMICS AND CONTROLS (3) LEC. 3. Pr. MECH 2140 and MATH 2650. System dynamics and automatic control theory.

MECH 3150 DYNAMICS LAB (1) LAB. 2.5. Pr. MECH 2140 and MATL 2100. Laboratory experiences designed to enhance student understanding of engineering mechanics, including statics, dynamics, and kinematics.

MECH 3160 MECHANICS LAB (1) LAB. 2.5. Pr. MECH 3120. Laboratory experiences designed to enhance student understanding of engineering mechanics including statics, stresses, & strains.

MECH 3200 CONCEPTS IN MECHANICAL DESIGN (2) LEC. 1. LAB. 1. Pr. MECH 2130 and (P/C MECH 2220 or P/C MECH 3220). Introduction to the mechanical design process including identification of needs and engineering requirements, concept generation and selection, and design development. Students will work in teams to perform a design project, and will also be exposed to project management and communication skills. MECH 2130 with a grade of C or higher.

MECH 3230 MACHINE DESIGN (3) LEC. 3. Pr. MECH 3120 and MECH 2020 and MECH 3200. Design of systems containing a variety of mechanical elements.

MECH 3AA0 MECHANICAL ENGINEERING PROGRESS ASSESSMENT II (0) TST. SU. Pr. MECH 2AA0. Progress Assessment Examination in: Statistics, linear algebra, mechanical design, thermo-fluid design, social impact, contemporary issues. Course may be repeated with change in topics.

MECH 4240 COMPREHENSIVE DESIGN I (2) LEC. 1. LAB. 3. Pr. (MECH 3AA0 and MECH 3150 and MECH 3160 and MECH 3230 and P/C MECH 3040 and P/C MECH 3050 and MECH 3140) or (MECH 3AA0 and MECH 3150 and MECH 3160 and MECH 3230 and P/C MECH 3040 and MECH 3050 and P/C MECH 3140) or (MECH 3AA0 and MECH 3150 and MECH 3160 and MECH 3230 and MECH 3040 and P/C MECH 3050 and P/C MECH 3140). Capstone engineering design course based on a design project similar to those encountered by the engineer in industry involving thermal and mechanical design.

MECH 4250 COMPREHENSIVE DESIGN II (2) LEC. 1. LAB. 3. Pr. (MECH 4240 and MECH 3040 and MECH 3050 and P/C MECH 3140 and P/C INSY 3600) or (MECH 4240 and MECH 3050 and MECH 3140 and P/C MECH 3040 and P/C INSY 3600) or (MECH 4240 and MECH 3140 and MECH 3040 and P/C MECH 3050 and P/C INSY 3600). Continuation of MECH 4240. Detailed design, fabrication, communication, and presentation of a prototype machine for an industrial sponsor.

MECH 4300 MECHANICAL EQUIPMENT ENGINEERING (3) LEC. 3. Pr. MECH 3020 and MECH 3030. Operation, performance, maintenance, selection, design and optimization of mechanical equipment commonly found in industrial operations.

MECH 4310 HEATING, VENTILATING, AIR CONDITIONING AND REFRIGERATION (3) LEC. 3. Pr. MECH 3040. Theory and practice of modern heating, ventilation, air conditioning and refrigeration systems; concepts, equipment, and systems design.

MECH 4320 APPLIED CFD AND HEAT TRANSFER (3) LEC. 3. Pr. MECH 3040 and MATH 2660. Introduction to computational fluid dynamics and heat transfer techniques used to analyze thermal performance of devices and systems. Commercial software will be used.

MECH 4420 VEHICLE DYNAMICS (3) LEC. 3. Pr. MECH 3140. Ground vehicle resistance, propulsion, maneuvering, and control tires, suspensions, braking, aerodynamics, case studies.

MECH 4430 GROUND VEHICLE FUNDAMENTALS (3) LEC. 3. Pr. ENGR 2100 or ENGR 2350. Engineering fundamentals of ground vehicles and typical subsystems, including: power (engine and electrical); drivetrain; braking; steering; suspension; ergonomics; and structure.

MECH 4440 AUTOMOTIVE DESIGN EXPERIENCE I (2) LEC. 1. LAB. 3. Pr. MECH 3AA0 and MECH 3230 and P/C MECH 3040 and P/C MECH 3050 and P/C MECH 3140. Departmental Approval. Team-based design of a ground vehicle, both whole-vehicle and subsystem; design evaluation and modification; oral and written communication.

MECH 4450 AUTOMOTIVE DESIGN EXPERIENCE II (2) LEC. 1. LAB. 3. Pr. MECH 4440. Departmental approval. Team-based fabrication, testing, modification and operation of a ground vehicle; oral and written communication; project management.

MECH 4700 INTEGRATED ENGINEERING THEORY AND PRACTICE (3) LEC. 3. Pr. MECH 3200. Real world engineering management decision making, case studies from industry.

MECH 4930 DIRECTED STUDIES IN MECHANICAL ENGINEERING (1-3) IND/INT. Departmental approval. Individual or small group study of a specialized area of Mechanical Engineering under faculty direction. Course may be repeated for a maximum of 3 credit hours.

MECH 4970 SPECIAL TOPICS IN MECHANICAL ENGINEERING (3) LEC. Departmental approval. Regular course addressing a specialized area of Mechanical Engineering not covered by a regularly offered course. Topics may vary. Course may be repeated for a maximum of 9 credit hours.

MECH 4997 HONORS THESIS (1-6) IND. Pr. Honors College. Departmental approval. Individual student directed research and writing of an honors thesis. Course may be repeated for a maximum of 6 credit hours.

MECH 5010 COMPRESSIBLE FLUID FLOW (3) LEC. 3. Pr. MECH 3020 and MECH 3030. Properties of ideal gases; General one-dimensional wave motion; Isentropic flow with area change; Normal shock waves; Flow with friction (Fanno Flow) and heat transfer (Rayleigh Flow); Method of characteristics.

MECH 5050 RENEWABLE ENERGY RESOURCES AND APPLICATIONS (3) LEC. 3. Pr. ENGR 2010 or ENGR 2200. or permission of instructor. Overview of renewable energy options with an emphasis on available resources, advantages & disadvantages, and design principles.

MECH 5120 COMBUSTION (3) LEC. 3. Pr. MECH 3040. Thermodynamics and chemical kinetics of combustion processes, premixed and diffusion flames, ignition, characterization and combustion of gaseous, liquid, and solid fuels, environmental aspects of combustion.

MECH 5210 ELECTRONICS THERMAL MANAGEMENT (3) LEC. 3. Pr. MECH 3040 and ELEC 3810. Thermal issues in electronics, review of heat transfer thermal resistance networks, design of finned heat sinks, numerical analysis of electronics cooling, advanced thermal management strategies.

MECH 5220 VIRTUAL PROTOTYPING (3) LEC. 3. Departmental approval. Computer simulation of mechanical systems integrating computer-aided design, dynamic simulation and finite element software; application to two-dimensional and three dimensional simple and complex mechanical systems.

MECH 5230 FRICTION, WEAR AND LUBRICATION (3) LEC. 3. Pr. MECH 3030. Theory and techniques for considering friction, wear and lubrication, in the design of machine components, and other surface interactions.

MECH 5240 BOUNDARY AND FULL-FILM LUBRICATION (3) LEC. 3. Pr. MECH 3030. Theory and techniques for design and modeling of the different regimes of lubrication between surfaces and machine comments in order to control friction and wear.

MECH 5250 MULTISCALE CONTACT MECHANICS (3) LEC. 3. Pr. MECH 3120. Theory and techniques for considering contact between solid bodies and the effect on friction, wear, the design of machine components, and other surface interactions.

MECH 5270 METALWORKING AND MANUFACTURING TRIBOLOGY (3) LEC. 3. Pr. MECH 2020. Theory and optimization techniques for tool life and surface finish considering friction, wear and lubrication in manufacturing processes including both metalworking fluids and hard/dry machining.

MECH 5300 ADVANCED MECHANICS OF MATERIALS (3) LEC. 3. Pr. MECH 3120. Stress and strain analysis, plane stress and plane strain concepts, generalized Hooke's law, stress function approach applications to 2-D problems, axisymmetric problems bending of curved members, torsion of prismatic members, stress concentration problems.

MECH 5310 MECHANICS OF ELECTRONIC PACKAGING (3) LEC. 3. Pr. MECH 3120 and ELEC 3810. Stress and strain analysis of microelectronic packages and electronic assemblies using analytical, experimental and numerical methods.

MECH 5320 ENGINEERED FLEXIBLE STRUCTURES (3) LEC. 3. LAB. 0, LEC. 0. Pr. (MECH 3120 or AERO 3610 or CHEN 3090 or CIVL 3310 or MATL 3200). Fiber to fabric design, engineering, manufacturing, testing and applications. Principles of modern machinery and techniques for flexible material manufacturing.

MECH 5390 FUNDAMENTALS OF THE FINITE ELEMENT METHOD (3) LEC. 3. LAB. 0. Pr. MECH 3040 and MATH 2660. Introduction to the fundamentals of the finite element method.

MECH 5420 DYNAMICS OF MULTIBODY SYSTEMS (3) LEC. 3. Pr. MECH 3140. Concepts in dynamics of multibody systems such as kinematics analysis, Newton Euler, Lagrange and Kane equations of motion, collisions, and vibrations of flexible links.

MECH 5430 BASICS SENSOR APPLICATIONS (3) LEC. 3. Pr. MECH 3120. Basic concepts, fabrication and operation of micromachined semiconductor, piezoelectric, piezoresistive, capacitive and fiber-optic sensors.

MECH 5450 NON-DESTRUCTIVE EVALUATION OF MATERIALS AND STRUCTURES (3) LEC. 3. Pr. MECH 3120. Non-destructive testing fundamentals. Ultrasonic, acoustic, vibration strain analysis of microelectronic packages and electronic assemblies using analytical, experimental and numerical methods.

MECH 5510 ENGINEERING ACOUSTICS (3) LEC. 3. Pr. MATH 2650. The fundamentals of acoustics. Vibration of strings, bars, plates. Acoustic plane waves, architectural acoustics and noise control will be emphasized.

MECH 5520 MANUFACTURING OF POLYMERIC STRUCTURES (3) LEC. 3. LAB. 0, LEC. 0. Pr. MECH 3120 or AERO 3610 or CHEN 3090 or CIVL 3310 or MATL 3200. Characteristics and flow properties of polymers; film and fiber extrusion, compression and injection molding technology, polymer material selection and processing.

MECH 5610 MECHANICAL VIBRATION (3) LEC. 3. Pr. MECH 2140 and MATH 2650 and MATH 2660. Modeling of lumped dynamic systems, free and forced vibration of single degree freedom systems, response to arbitrary excitation, analysis of two and multiple degrees of freedom systems.

MECH 5710 KINEMATICS AND DYNAMICS OF ROBOTS (3) LEC. 3. Pr. MECH 3140. Basic concepts in robotics such as kinematic analysis, coordinate transformation, Lagrange and Newton Euler equations of motion.

MECH 5720 CONTROL OF ROBOTIC MOTION (3) LEC. 3. Pr. MECH 3140. Application of various algorithms for robot manipulators.

MECH 5810 MECHATRONICS (3) LEC. 3. Pr. MECH 2140 and ELEC 3810. Introduction to the integration of mechanisms, sensors, controllers and actuators for machines, and design of automatic machinery.

MECH 5830 ENGINES (3) LEC. 3. Pr. (ENGR 2010 and MECH 3030) or ENGR 2200. or (ENGR 2010 plus any one of (AERO 3110, CHEN 2610, CIVL 3110, MECH 3030)), Analysis, design, and application issues in internal combustion engines. Characteristics, thermodynamics, thermochemistry, unsteady multi-phase fluid dynamics, stresses, vibration, noise, mechanisms.

MECH 5840 APPLIED MECHATRONICS (3) LEC. 3. LAB. 0, LEC. 0. Pr. (P/C MECH 3140). Implementation basic circuits, power electronics, analog (continuous) and digital (discrete) control topics in multiple design projects.

MECH 5970 INTERMEDIATE SPECIAL TOPICS IN MECHANICAL ENGINEERING (1-3) LEC. 1-3. Departmental approval. Regular course addressing an advanced specialized area of Mechanical Engineering not covered by a regularly offered course. Topics may vary. Course may be repeated for a maximum of 9 credit hours.

MECH 6010 COMPRESSIBLE FLUID FLOW (3) LEC. 3. Properties of ideal gases; General one-dimensional wave motion; Isentropic flow with area change; Normal shock waves; Flow with friction (Fanno Flow) and heat transfer (Rayleigh Flow); Method of characteristics.

MECH 6050 RENEWABLE ENERGY RESOURCES AND APPLICATIONS (3) LEC. 3. An overview of renewable energy options with an emphasis on available resources, advantages & disadvantages, and design principles.

MECH 6120 COMBUSTION (3) LEC. 3. Thermodynamics and chemical kinetics of combustion processes, premixed and diffusion flames, ignition, characterization and combustion of gaseous, liquid, and solid fuels, environmental aspects of combustion.

MECH 6210 ELECTRONICS THERMAL MANAGEMENT (3) LEC. 3. Thermal issues in electronics, review of heat transfer hermal resistance networks, design of finned heat sinks, numerical analysis of electronics cooling, advanced thermal management strategies.

MECH 6220 VIRTUAL PROTOTYPING (3) LEC. 3. Departmental approval. Computer simulation of mechanical systems integrating computer-aided design, dynamic simulation and finite element software; application to two-dimensional and three dimensional simple and complex mechanical systems.

MECH 6230 FRICTION, WEAR AND LUBRICATION (3) LEC. 3. Friction, wear, and lubrication in design of machine components and other surface interactions, with emphasis on optimizing tribological performance.

MECH 6240 BOUNDARY AND FULL-FILM LUBRICATION (3) LEC. 3. Theory and techniques for design and modeling of the different regimes of lubrication between surfaces and machine comments in order to control friction and wear.

MECH 6250 MULTISCALE CONTACT MECHANICS (3) LEC. 3. Theory and techniques for considering contact between solid bodies and the effect on friction, wear, the design of machine components, and other surface interactions.

MECH 6300 ADVANCED MECHANICS OF MATERIALS (3) LEC. 3. Stress and strain analysis, plane stress and plane strain concepts, generalized Hooke's law, stress function approach applications to 2-D problem, axisymmetric problems, bending of curved members, torsion of prismatic members, stress concentration problems.

MECH 6310 MECHANICS OF ELECTRONIC PACKAGING (3) LEC. 3. Stress and strain analysis of Microelectronic packages and electronic assemblies using analytical, experimental and numerical methods.

MECH 6320 ENGINEERED FLEXIBLE STRUCTURES (3) LEC. 3. LAB. 0, DSL/LEC. 0. Fiber to fabric design, engineering, manufacturing, testing and applications. Principles of modern machinery and techniques for flexible material manufacturing.

MECH 6390 FUNDAMENTALS OF THE FINITE ELEMENT METHOD (3) LEC. 3. LAB. 0. Introduction to the fundamentals of the finite element method.

MECH 6420 DYNAMICS OF MULTIBODY SYSTEMS (3) LEC. 3. Concepts in dynamics of multibody systems such as kinematics analysis, Newton Euler, Lagrange and Kane equations of motion, collisions, and vibrations of flexible links.

MECH 6430 BASICS OF SENSOR APPLICATIONS (3) LEC. 3. Basic concepts, fabrication and operation of micro machined semiconductor, piezoelectric, piezoresistive, capacitive and fiber-optic sensors.

MECH 6450 NON-DESTRUCTIVE EVALUATION OF MATERIALS AND STRUCTURES (3) LEC. 3. Non-destructive testing fundamentals. Ultrasonic, acoustic, vibration, and eddy current techniques. Case studies.

MECH 6520 MANUFACTURING OF POLYMERIC STRUCTURES (3) LEC. 3. LAB. 0, DSL/LEC. 0. Characteristics and flow properties of polymers; film and fiber extrusion, compression and injection molding technology, polymer material selection and processing.

MECH 6610 MECHANICAL VIBRATION (3) LEC. 3. Modeling of lumped dynamic systems, free and forced vibration of single degree of freedom systems, response to arbitrary excitation, analysis of two and multiple degrees of freedom systems.

MECH 6710 KINEMATICS AND DYNAMICS OF ROBOTS (3) LEC. 3. Basic concepts in robotics such as kinematics analysis, coordinate, Lagrange and Newton Euler equations of motion.

MECH 6720 CONTROL OF ROBOTIC MOTION (3) LEC. 3. Application of various algorithms for robot manipulators.

MECH 6810 MECHATRONICS (3) LEC. 3. Introduction to the integration of mechanisms, sensors, controllers and actuators for machines and design of automatic machinery.

MECH 6830 ENGINES (3) LEC. 3. Analysis, design, and application issues in internal combustion engines. Characteristics, thermodynamics thermochemistry, unsteady multi-phase fluid dynamics, stresses, vibration, noise, mechanisms.

MECH 6840 APPLIED MECHATRONICS (3) LEC. 3. Implementation basic circuits, power electronics, analog (continuous) and digital (discrete) control topics in multiple design projects.

MECH 6930 INTERMEDIATE DIRECTED STUDIES IN MECHANICAL ENGINEERING (1-3) IND. Departmental approval. Individual or small group study of an advanced, specialized area of Mechanical Engineering under faculty direction. Course may be repeated for a maximum of 3 credit hours.

MECH 6970 INTERMEDIATE SPECIAL TOPICS IN MECHANICAL ENGINEERING (1-3) DSL. Departmental approval. Regular course addressing an advanced specialized area of Mechanical Engineering not covered by a regularly offered course. Topics may vary. Course may be repeated for a maximum of 3 credit hours.

MECH 7010 ADVANCED THERMODYNAMICS (3) LEC. 3. Classical and statistical treatment of the laws and properties of thermodynamic systems; applications.

MECH 7110 ADVANCED FLUID MECHANICS I (3) LEC. 3. Mass Conservation, Linear and Angular Momentum Equations; Energy Equation for Fluid Systems; Foundations of Inviscid Flows.

MECH 7120 ADVANCED FLUID MECHANICS II (3) LEC. 3. Pr. MECH 7110 or MECH 7116. Schwarz-Christoffel Transformation; Hodograph Method; Three-Dimensional Potential Flows; Interface Waves; Low Reynolds Number Solutions; Oseen Approximation; Stability of Laminar Flows.

MECH 7130 BOUNDARY LAYER THEORY (3) LEC. 3. Pr. MECH 7110 or MECH 7116. Mass Conservation; Momentum Equation; Energy Equation; Dimensional Analysis; Fully-Developed Laminar Flows; Similarity Solutions; Boundary layer Approximation; Stability of Laminar Flows.

MECH 7140 TURBULENCE (3) LEC. 3. Pr. MECH 7130 or MECH 7136. Properties of Turbulence; Governing Conservation, Momentum and Energy Equations; Time-averaging, Vorticity Equatiion; Turbulence Models; Shear Flows; Jets, Wakes and Boundary Layers; Experimental Techniques.

MECH 7210 DIFFUSIVE TRANSPORT (3) LEC. 3. Formulations and analytical solutions of steady, periodic, and unsteady heat and mass diffusion problems in one, two, and three dimensions.

MECH 7220 CONVECTION HEAT TRANSFER (3) LEC. 3. Advanced topics in free and forced convection transport within the laminar, transitional and turbulent regimes; confined and external flows.

MECH 7230 THERMAL RADIATION (3) LEC. 3. Fundamentals of thermal radiation heat transfer including: absorption, emission, and reflection from solids; absorption, emission, and scattering by gases; combined mode and conjugate heat transfer; exact and approximate solution methodologies.

MECH 7240 NUMERICAL METHODS IN HEAT TRANSFER (3) LEC. 3. Advanced topics in finite element and finite difference methods; solution techniques, stability and convergence.

MECH 7250 BOILING AND CONDENSATION (3) LEC. 3. Hydrodynamics of vapor-liquid flow, pool boiling, forced convective boiling, condensation, instabilities in two-phase systems, augmentation of boiling and condensation.

MECH 7300 FRACTURE MECHANICS (3) LEC. 3. Stress and strain analysis of cracked bodies, energy release rate, Griffith problem, modes of fracture, crack tip fields, stress intensity factors, small scale crack tip yielding, the J-integral, HRR equations, experimental and numerical methods for fracture parameter estimation.

MECH 7310 SOLID MECHANICS (3) LEC. 3. Stress and strain analysis in 3-D, constitutive behavior of elastic solids, orthotropy and isotropy, stress compatibility equations, Navier's equation, stress functions, applications.

MECH 7320 CONTINUUM MECHANICS AND TENSOR ANALYSIS (3) LEC. 3. Pr. MECH 6300 or MECH 6306. Cartesian and curvilinear tensor analysis with applications to the mechanics of continuous media. Constitutive equations for solids and fluids.

MECH 7330 EXPERIMENTAL MECHANICS (3) LEC. 3. Experimental methods for measurement of stress, strain and displacement. Strain gauges, transducers and brittle coatings. Transmission photoelasticity and photoelastic coatings. Introduction to moire' and coherent optical techniques.

MECH 7340 INELASTIC STRESS ANALYSIS (3) LEC. 3. Pr. MECH 6300 or MECH 6306. Introduction to modeling material behavior of non-elastic materials. Theories of plasticity, linear and non-linear viscoelasticity, and viscoplasticity. Applications to modern engineering materials and simple structural members.

MECH 7360 MECHANICS OF COMPOSITE MATERIALS (3) LEC. 3. Properties and mechanical behavior of fiber-reinforced composite materials. Anisotropic stress-strain relations, orthotropic elasticity and laminated plate theories, failure criteria, applications.

MECH 7370 ANALYSIS OF PLATES AND SHELLS (3) LEC. 3. Theories for the bending and stretching of plate and shell structures. Transverse loading, buckling, vibration, and thermal stress problems. Introduction to energy methods, numerical techniques, and large deflection theories.

MECH 7390 VARIATIONAL MECHANICS (3) LEC. 3. Energy methods in solid mechanics. Virtual work, stationary potential energy, and variational calculus. Elastic strain energy. Applications to bars, trusses, beams, frames, and plates. Castigliano's Theorem and the Ritz Method.

MECH 7410 OPTICAL METHODS IN MECHANICS (3) LEC. 3. Measurement of stresses, strains, and deformations using optical methods; optical interference; Fourier optics; optical spatial filtering, white light methods; coherent optical methods.

MECH 7430 OPTICAL PROPERTIES OF ADVANCED MATERIALS (3) LEC. 3. Pr. MECH 6430 or MECH 6436 or PHYS 7200. Linear and nonlinear optical properties, correlation with material-structure, electro-optic effects, lasers, frequency conversion, fiber-optics, technological applications.

MECH 7610 ADVANCED DYNAMICS (3) LEC. 3. Dynamics of particles and systems of particles applied to engineering problems. Work-energy and impulse-momentum principles. Lagrange's equations and Hamilton's Principle.

MECH 7620 NONLINEAR SYSTEMS (3) LEC. 3. Introduction, geometrical concepts, analytical methods, Poincare' maps, strange attractors, bifurcation, normal forms, center manifold theory, Liapunov stability, Liapunov exponents, linearization about periodic orbits, Floquet theory, bifurcation analysis.

MECH 7630 MECHANICAL IMPACT (3) LEC. 3. Departmental approval. Investigation of the fundamental concepts used to solve collision problems with friction.

MECH 7710 CONTROL SYSTEMS ANALYSIS AND DESIGN (3) LEC. 3. Topics from control theory are introduced in the context of control systems analysis and design, including state variable feedback, modal control, optimal control and adaptive control for both continuous and discrete systems.

MECH 7930 ADVANCED DIRECTED STUDIES IN MECHANICAL ENGINEERING (1-3) IND. Departmental approval. Individual or small group study of an advanced, specialized area of Mechanical Engineering under faculty direction. Course may be repeated for a maximum of 3 credit hours.

MECH 7950 GRADUATE SEMINAR (1) SEM. 1. SU. Topics may vary. Will not fulfill degree requirements. Course may be repeated with change in topics.

MECH 7970 ADVANCED SPECIAL TOPICS IN MECHANICAL ENGINEERING (1-3) DSL. Departmental approval. Regular course addressing an advanced specialized area of Mechanical Engineering not covered by regularly offered course. Topics may vary. Course may be repeated for a maximum of 3 credit hours.

MECH 7990 RESEARCH & THESIS (1-12) MST. Individual Master's thesis research. May be repeated for credit. Course may be repeated with change in topics.

MECH 8990 RESEARCH & DISSERTATION (1-12) DSR. Individual Doctoral dissertation research. May be repeated for credit. Course may be repeated with change in topics.