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 Automotive Engineering and in Pulp and Paper Engineering. Minors are offered in Tribology, Business Engineering and Technology, and in Automotive Engineering and Manufacturing.

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.

Major

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

Minor

- Automotive Engineering and Manufacturing (http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmtofindustrialandsystemsengineering/automotiveeng_manufacturing_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. Pr. CHEM 1030. Technologies for sustainable energy production and storage, renewable energy conversion, associated materials challenges.

**MATL 2220 MATERIALS AND THE ENVIRONMENT (1)** LEC. 1. Pr. CHEM 1030. Environmental impact of the production, use and disposal of materials.

**MATL 2230 MINERAL RESOURCES: PROCESSING AND AVAILABILITY (1)** LEC. 1. Pr. CHEM 1030. 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 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 4997 HONORS THESIS (1-6)** IND. Pr. Honors College. Departmental approval. Individual student directed research and writing of honors thesis. Course may be repeated for a maximum of 6 credit hours.

**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 CRYSTALLOGRAPHY (2)** LEC. 2. Pr. PHYS 1610 or PHYS 1617. Departmental approval. Principles of crystallography, reciprocal lattice X-ray diffraction techniques.

**MATL 5201 X-RAY DIFFRACTION LABORATORY (1)** LAB. 3. Coreq. MATL 5200. Laboratory on the use of x-ray diffraction 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 5720 BIOMED APPS OF POLYMERS (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 6100/6106 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 6200/6206 CRYSTALLOGRAPHY (2) LEC. 2. Departmental approval. Principles of crystallography, reciprocal lattice X-ray diffraction techniques.

MATL 6201 X-RAY DIFFRACTION LABORATORY (1) LAB. 3. Coreq. MATL 6200. Laboratory on the use of x-ray diffraction for materials characterization.

MATL 6300/6306 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 6400/6406 PHYSICS OF SOLIDS (3) LEC. 3. Departmental approval. The physics of solid-state materials, including the electronic, optical, and magnetic properties of materials.

MATL 6500/6506 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 6720/6726 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 6750 MICROSTRUCTURE AND MECHANICS OF SKELETAL TISSUES (3) LEC. 3. Departmental approval. 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 6970/6976 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 7050/7056 DEFORMATION AND FAILURE OF ENGINEERING MATERIALS (3) LEC. 3. Departmental approval. Theoretical presentation of the fundamental principles of deformation and failure in materials systems.
MATL 7110/7116 PHYSICAL METALLURGY AND APPLICATIONS IN METAL FABRICATION (3) LEC. 3. Departmental approval. The physical metallurgy underlying processing-structure-property relationships in metals and alloys, with examples from joining processes.

MATL 7120/7126 ADVANCED CERAMIC MATERIALS (3) LEC. 3. Departmental approval. Processing, structure-property relationships and applications of advanced ceramics. Structural and functional applications of ceramics.

MATL 7130/7136 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 7140/7146 ADVANCED COMPOSITE MATERIALS (3) LEC. 3. Departmental approval. Processing, mechanics structure and properties of composite materials. Emphasis will be placed on an understanding of processing-structure-property relationships in polymer-, ceramic-, and metal-matrix composites.


MATL 7210/7216 PLASTIC DEFORMATION AND STRENGTHENING OF METALLIC MATERIALS (3) LEC. 3. Departmental approval. Mechanisms of plastic deformation and strengthening in metals and alloys. The role of dislocations in plastic deformation.

MATL 7220/7226 RADIATION EFFECTS ON MATERIALS (3) LEC. 3. Departmental approval. Theoretical and experimental treatment of the radiation effects and damage in materials as related to the nuclear industry.

MATL 7230/7236 HIGH TEMPERATURE MATERIALS PERFORMANCE (3) LEC. 3. Departmental approval. Theoretical and experimental treatment of the behavior of metals at high temperature.

MATL 7310/7316 SOLIDIFICATION PROCESSING (3) LEC. 3. Departmental approval. Theoretical science and engineering principles that apply to semiconductor crystal growth, ingot solidification, metal casting, welding and rapid solidification processes.

MATL 7320/7326 THIN FILM SCIENCE AND TECHNOLOGY (3) LEC. 3. Departmental approval. Structure, properties, characterization, processing and application of thin films.

MATL 7410/7416 CHEMICAL SENSORS (3) LEC. 3. Departmental approval. Fundamentals and application of chemical sensors. Includes electrolyte, semiconductor and acoustic wave-based sensors.

MATL 7420/7426 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 7430/7436 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 7440/7446 MATERIALS PROCESSES MICRO AND NANOSYSTEMS (3) LEC. 3. Departmental approval. Materials, processes, and principles involved in manufacturing of micro and nanoelectromechanical systems. Properties of materials used in micromachined transducers as a related to current and potential micro and nanofabrication processes.

MATL 7450/7456 HIGH TEMPERATURE ELECTROCHEMICAL DEVICES (3) LEC. 3. Departmental approval. Principles of solid-state electrochemistry, application to temperature devices including chemical sensors, fuel cells and batteries.

MATL 7510/7516 ELECTRON MICROSCOPY (3) LEC. 3. Departmental approval. Theory, instrumentation, techniques and applications of scanning and transmission electron microscopy.

MATL 7511 ELECTRON MICROSCOPY LABORATORY (1) LAB. 3. Coreq. MATL 7510. Laboratory on the use of electron microscopy for materials characterization.

### Mechanical Engineering Courses

**MATL 7610/7616 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 7620/7626 NANO/MICRO FLUIDIC SYSTEMS (3)** LEC. 3. Departmental approval. Basic understanding of nano/microfluidics (typical volumes are nanoliters or picoliters) and practical applications in materials science and engineering, biotechnology, and other interdisciplinary fields of engineering and science.

**MATL 7630/7636 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 7960/7966 DIRECTED READINGS IN MATERIALS ENGINEERING (1-6)** 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 7970/7976 SPECIAL TOPICS IN MATERIALS ENGINEERING (1-3)** LEC. 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 7980/7986 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 7990/7996 RESEARCH AND THESIS (1-15)** MST. Individual master's thesis research. Course may be repeated with change in topics.

**MATL 8990/8996 RESEARCH AND DISSERTATION (1-15)** DSR. Individual doctoral dissertation research. Course may be repeated with change in topics.

### Mechanical Engineering Courses

**MECH 2110 STATICS AND DYNAMICS (4)** LEC. 3. LAB. 3. Pr. (MATH 1620 or MATH 1623 or MATH 1627) and (PHYS 1600 or PHYS 1607). Vectors, forces, moments and free body diagrams. Systems in mechanical equilibrium. Particles in motion.

**MECH 2120 KINEMATICS AND DYNAMICS OF MACHINES (4)** LEC. 3. LAB. 3. Pr. (MATH 2630 or MATH 2637) and MECH 2110. Kinematics and kinetics of rigid bodies. Kinematics and dynamics of mechanisms, cams and gears.

**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.


**MECH 3030 FLUID MECHANICS (3)** LEC. 3. Pr. MECH 2110 and ENGR 2010 and MATH 2650 and P/C MECH 3130. Fluid properties; fluid statics; mass conservation; momentum equation; external and internal flows; Euler and Bernoulli equations; dimensional analysis; viscous flows; boundary layers; compressible flow.


**MECH 3050 MEASUREMENT AND INSTRUMENTATION (3)** LEC. 2. LAB. 3. Pr. MECH 3030 and P/C ELEC 3810 and P/C MECH 3040. Theory and practice of modern sensors and computer-based data acquisition techniques, uncertainty analysis, results reporting, filtering and signal processing.
MECH 3130 MECHANICS OF MATERIALS (4) LEC. 3. LAB. 1. Pr. MECH 2110 and MATL 2100 and MATH 2650 and MATH 2660 and (MECH 2220 or MECH 3220). 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, strain energy, impact loading, cyclic loading.

MECH 3140 SYSTEM DYNAMICS AND CONTROLS (3) LEC. 3. Pr. MECH 2120 and MATH 2650. System dynamics and automatic control theory.

MECH 3200 CONCEPTS IN DESIGN AND MANUFACTURING (2) LEC. 2. Pr. MECH 2110 and (P/C MECH 2220 or P/C MECH 3220). The mechanical design process, project based, with teamwork, project management and communication. Users' needs, engineering requirements, concept generation and selection, design development.

MECH 3210 DESIGN AND MANUFACTURING LAB (1) LAB. 1. Manufacturing safety lab for introduction to manufacturing processes associated with cutting, forming, and joining of metals and other materials.

MECH 3230 MACHINE DESIGN (3) LEC. 3. Pr. MECH 3130 and (MECH 3210 or MECH 2210) and (MECH 3200 or MECH 2210) and (MECH 2220 or MECH 3220). 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.

MECH 4240 COMPREHENSIVE DESIGN I (2) LEC. 1. LAB. 3. Pr. (MECH 3AA0 and MECH 3230 and MECH 3040 and P/C MECH 3050 and P/C MECH 3140) or (MECH 3AA0 and MECH 3230 and P/C MECH 3040 and MECH 3050 and P/C MECH 3140) or (MECH 3AA0 and MECH 3230 and P/C MECH 3040 and P/C MECH 3050 and 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. ENGR 2100 or ENGR 2350 or MECH 2120. 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 or MECH 2120. 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 4410 or MECH 5830 and MECH 4420) or (MECH 4410 and MECH 4430) or (MECH 4420 and MECH 4430). 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 4510 INDUSTRIAL AND ENVIRONMENTAL NOISE CONTROL (3) LEC. 3. Pr. MECH 2120 and MECH 3220. Sources of industrial and community noise, criteria for control, noise measuring instrumentation, issues involved in the design of machinery for minimum noise, noise ordinances and regulations.
MECH 4520 MACHINERY NOISE AND VIBRATION DIAGNOSTICS (3) LEC. 3. Pr. MECH 2120 and MECH 3220. An introduction to machinery diagnostics through noise and vibration signatures. Fundamental principles and applications of predictive maintenance of machinery.

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 (1-3) 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 3 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. 2.5. 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. May count one of: MECH 5050, MECH 6050, MECH 6056.

MECH 5110 INTERMEDIATE HEAT TRANSFER (3) LEC. 3. Pr. MECH 3040. Introduction to the analytical treatment of heat transfer by conduction, convection, and radiation. Suitable for those that require general coverage of advanced theory but whose primary research interest may lie elsewhere.

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 and MECH 3230 or INSY 3800. 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 5270 METALWORKING AND MANUFACTURING TRIBOLOGY (3) LEC. 3. Pr. MECH 3210. 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 3130. 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 PACK (3) LEC. 3. Pr. MECH 3130 and ELEC 3810. Stress and strain analysis of microelectronic packages and electronic assemblies using analytical, experimental and numerical methods.

MECH 5390 FUNDAMENTALS OF THE FINITE ELEMENT METHOD (3) LEC. 2. LAB. 3. Pr. MECH 3040 and MECH 3130 and MATH 2660. Introduction to the fundamentals of the finite element method.
MECH 5410 DYNAMICS OF ROTATING MACHINERY (3) LEC. 3. Pr. MECH 3140. Issues involved in the analysis and design of high-speed rotating machinery. Modeling, resonance, balancing, bearings, condition monitoring.

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 3130. Basic concepts, fabrication and operation of micromachined semiconductor, piezoelectric, piezoresistive, capacitive and fiber-optic sensors.


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 5610 MECHANICAL VIBRATION (3) LEC. 3. Pr. MECH 2120 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 2120 and ELEC 3810. Introduction to the integration of mechanisms, sensors, controllers and actuators for machines, and design of automatic machinery.

MECH 5820 INTRODUCTION TO OPTIMAL SYSTEMS (3) LEC. 3. Introduction to the mathematical fundamentals of optimization. Application to multiple solution engineering problems in thermo-fluid and mechanical systems.

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, thermochernistry, unsteady multi-phase fluid dynamics, stresses, vibration, noise, mechanisms.

MECH 5970 INTERMEDIATE SPECIAL TOPICS IN MECHANICAL ENGINEERING (1-3) LEC. 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 6 credit hours.

MECH 6010/6016 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. 2.5. An overview of renewable energy options with an emphasis on available resources, advantages & disadvantages, and design principles.

MECH 6110/6116 INTERMEDIATE HEAT TRANSFER (3) LEC. 3. Introduction to the analytical treatment of heat transfer by conduction, convection, and radiation. Suitable for those that require general coverage of advanced theory but whose primary research interest may lie elsewhere.

MECH 6120/6126 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 6210/6216 ELECTRONICS THERMAL MANAGEMENT (3) LEC. 3. 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 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 6230/6236 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 6240/6246 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 components in order to control friction and wear.

MECH 6270/6276 METALWORKING AND MANUFACTURING TRIBOLOGY (3) LEC. 3. Pr. MECH 3210. 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 6300/6306 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 6390/6396 FUNDAMENTALS OF THE FINITE ELEMENT METHOD (3) LEC. 2. LAB. 3. Introduction to the fundamentals of the finite element method.

MECH 6410/6416 DYNAMICS OF ROTATING MACHINERY (3) LEC. 3. Issues involved in the analysis and design of high-speed rotating machinery. Modeling, resonance, balancing, bearings, condition monitoring.

MECH 6420/6426 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 6430/6436 BASICS OF SENSOR APPLICATIONS (3) LEC. 3. Basic concepts, fabrication and operation of micro machined semiconductor, piezoelectric, piezoresistive, capacitive and fiber-optic sensors.


MECH 6510/6516 ENGINEERING ACOUSTICS (3) LEC. 3. The fundamentals of acoustics. Vibration of strings, bars, plates. Acoustic plane waves, architectural acoustics, and, noise control will be emphasized.

MECH 6610/6616 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 6620/6626 STABILITY AND VIBRATION OF DISCRETE SYSTEMS (3) LEC. 3. Pr. MECH 6610 or MECH 6616. Principles of advanced dynamics, linear systems with multiple degrees of freedom, stability and boundedness, free and forced response of linear systems, parameter identification.

MECH 6710/6716 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 6720/6726 CONTROL OF ROBOTIC MOTION (3) LEC. 3. Application of various algorithms for robot manipulators.

MECH 6810/6816 MECHATRONICS (3) LEC. 3. Introduction to the integration of mechanisms, sensors, controllers and actuators for machines and design of automatic machinery.

MECH 6820/6826 INTRODUCTION TO OPTIMAL SYSTEMS (3) LEC. 3. Introduction to the mathematical fundamentals of optimization. Application to multiple solution engineering problems in thermo-fluid and mechanical systems.

MECH 6830/6836 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 6930/6936 INTERMEDIATE DIRECTED STUDIES IN MECHANICAL ENGINEERING (1-3) LEC. 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 6970/6976 INTERMEDIATE SPECIAL TOPICS IN MECHANICAL ENGINEERING (1-3) LEC. 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 7010/7016 ADVANCED THERMODYNAMICS (3) LEC. 3. Classical and statistical treatment of the laws and properties of thermodynamic systems; applications.


MECH 7120/7126 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 7130/7136 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 7140/7146 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 7150/7156 FLUID MECHANICS OF PROCESSING (3) LEC. 3. Pr. MECH 7130 or MECH 7136. Properties of Fluids; Governing Equations; Dimensional analysis; Particle-Laden Flows; Applications to specific processing problems such as liquid metal flows, polymers, surface deposition.

MECH 7210/7216 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 7220/7226 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 7230/7236 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 7240/7246 NUMERICAL METHODS IN HEAT TRANSFER (3) LEC. 3. Advanced topics in finite element and finite difference methods; solution techniques, stability and convergence.


MECH 7300/7306 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 7310/7316 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 7320/7326 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.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Prerequisites</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MECH 7340/7346</td>
<td>INELASTIC STRESS ANALYSIS (3) LEC. 3. Pr. MECH 6300 or MECH 6306.</td>
<td>3</td>
<td>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.</td>
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<tr>
<td>MECH 7360/7366</td>
<td>MECHANICS OF COMPOSITE MATERIALS (3) LEC. 3.</td>
<td>3</td>
<td>Introduction to modeling material behavior of fiber-reinforced composite materials. Anisotropic stress-strain relations, orthotropic elasticity and laminated plate theories, failure criteria, applications.</td>
<td></td>
</tr>
<tr>
<td>MECH 7370/7376</td>
<td>ANALYSIS OF PLATES AND SHELLS (3) LEC. 3.</td>
<td>3</td>
<td>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.</td>
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</tr>
<tr>
<td>MECH 7410/7416</td>
<td>OPTICAL METHODS IN MECHANICS (3) LEC. 3.</td>
<td>3</td>
<td>Measurement of stresses, strains, and deformations using optical methods; optical interference; Fourier optics; optical spatial filtering, white light methods; coherent optical methods.</td>
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<tr>
<td>MECH 7430/7436</td>
<td>OPTICAL PROPERTIES OF ADVANCED MATERIALS (3) LEC. 3. Pr. MECH 6430 or MECH 6436 or PHYS 7200.</td>
<td>3</td>
<td>Linear and nonlinear optical properties, correlation with material-structure, electro-optic effects, lasers, frequency conversion, fiber-optics, technological applications.</td>
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</tr>
<tr>
<td>MECH 7510/7516</td>
<td>ADVANCED ENGINEERING ACOUSTICS (3) LEC. 3. Pr. MECH 6510 or MECH 6516.</td>
<td>3</td>
<td>The fundamentals of advanced acoustics theory. Wave equation derivation from Navier-Stokes equations, spherical waves, monopoles, dipoles, quadrupoles. Duct Acoustics, Statistical Energy Analysis.</td>
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<tr>
<td>MECH 7610/7616</td>
<td>ADVANCED DYNAMICS (3) LEC. 3.</td>
<td>3</td>
<td>Dynamics of particles and systems of particles applied to engineering problems. Work-energy and impulse-momentum principles. Lagrange's equations and Hamilton's Principle.</td>
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<tr>
<td>MECH 7620/7626</td>
<td>NONLINEAR SYSTEMS (3) LEC. 3.</td>
<td>3</td>
<td>Introduction, geometrical concepts, analytical methods, Poincaré’ maps, strange attractors, bifurcation, normal forms, center manifold theory, Liapunov stability, Liapunov exponents, linearization about periodic orbits, Floquet theory, bifurcation analysis.</td>
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<tr>
<td>MECH 7630/7636</td>
<td>MECHANICAL IMPACT (3) LEC. 3.</td>
<td>3</td>
<td>Departmental approval. Investigation of the fundamental concepts used to solve collision problems with friction.</td>
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<tr>
<td>MECH 7650/7656</td>
<td>RANDOM VIBRATION (3) LEC. 3. Pr. MECH 6610 or MECH 6616.</td>
<td>3</td>
<td>Properties of random processes, review of linear systems with single and multiple degrees of freedom. Vibration of single and multiple degrees of freedom systems subjected to random excitations, design of structures subjected to random excitation. Parameter estimation.</td>
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<tr>
<td>MECH 7710/7716</td>
<td>CONTROL SYSTEMS ANALYSIS AND DESIGN (3) LEC. 3.</td>
<td>3</td>
<td>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.</td>
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<tr>
<td>MECH 7930</td>
<td>ADVANCED DIRECTED STUDIES IN MECHANICAL ENGINEERING (1-3) IND.</td>
<td>1-3</td>
<td>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.</td>
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<tr>
<td>MECH 7950</td>
<td>GRADUATE SEMINAR (1) SEM.</td>
<td>1</td>
<td>SU.</td>
<td>Topics may vary. Will not fulfill degree requirements. Course may be repeated with change in topics.</td>
</tr>
<tr>
<td>MECH 7970/7976</td>
<td>ADVANCED SPECIAL TOPICS IN MECHANICAL ENGINEERING (1-3) LEC.</td>
<td>1-3</td>
<td>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.</td>
<td></td>
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<tr>
<td>MECH 7990</td>
<td>RESEARCH &amp; THESIS (1-12) MST.</td>
<td>1-12</td>
<td>Individual Master’s thesis research. May be repeated for credit. Course may be repeated with change in topics.</td>
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MECH 8990 RESEARCH & DISSERTATION (1-12) DSR. Individual Doctoral dissertation research. May be repeated for credit. Course may be repeated with change in topics.