Department of Mechanical

Engineering

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OVERVIEW

The Department of Mechanical Engineering is dedicated to delivering up-to-date, high-quality courses across a broad range of the discipline to meet the needs of both part- and full-time graduate students. These courses are concentrated in five technical areas: (1) design and analysis of thermofluid systems; (2) analysis and control of dynamic systems; (3) robotics and mechatronic systems; (4) mechanical design; and (5) materials engineering. Educational efforts are channeled to expand the skills of prospective and practicing engineers not only in understanding fundamentals, but also in developing competence in analyzing engineering systems. The department offers graduate degrees at the master's, engineer's, and doctorate levels, as well as certificates.

MASTER OF SCIENCE PROGRAMS

All students in the M.S. Mechanical Engineering Program are required to take MECH 202 at the beginning of their program of studies and must complete at least one sequence of two courses in applied mathematics. All students must also satisfy the requirements of the graduate core (details may be found in Chapter 3).

Students must select one of the five options and develop a program of studies with an advisor (names of faculty available under each option are listed after the program title). The requirements for all options may be adjusted on the basis of the student's previous work; however, any adjustment must be approved by the departmental advisor.

All full-time students are required to complete a thesis or Capstone project for their

degree.

Dynamics and Controls (Ayoubi)

The program of studies for the dynamics and controls option must include the following courses:

- MECH 203 and 204 Analytical Dynamics I and II or MECH 214, 215, and

216 Advanced Dynamics I, II, and III

- MECH 305 Advanced Vibrations I or MECH 141 Mechanical Vibrations
- MECH 217 Introduction to Control and MECH 218 Guidance and Control I, or MECH 142 Control Systems, Analysis and Design
- MECH 266 Fundamentals of Fluid Mechanics

In addition, the program must include at least four of the following sequences of courses:

- MECH 203 and 204 Analytical Dynamics I and II
- MECH 214, 215, and 216 Advanced Dynamics I, II, and III
- MECH 301 Noise and Vibration Control and Monitoring I
- MECH 315 and 316 Digital Control Systems I and II
- MECH 323 and 324 Modern Control System I and II or ELEN 236 Linear Control Systems, and ELEN 237 Optimal Control
- MECH 337 and 338 Robotics I and II
- MECH 429 and 430 Optimal Control I and II
- MECH 431 and 432 Spacecraft Dynamics I and II

Materials Engineering (Wright)

The program of studies for the materials engineering option must include the following courses:

- MECH 256 Introduction to Biomaterials
- MECH 281 Fracture Mechanics and Fatigue
- MECH 299 Thesis or 290 Capstone Project
- MECH 330 Atomic Arrangment, Defects, and Mechanical Behavior
- MECH 331 Phase Equilibria and Transformations
- MECH 332 Electronic Structure and Properties
- MECH 333 Experiments in Materials Science
- MECH 345 Modern Instrumentation and Experimentation

The following courses are recommended for this option:

- MECH 273 Designing with Plastic Materials
- MECH 274 Processing Plastic Materials
- MECH 277 Injection Mold Tool Design
- MECH 350 and 351 Composite Materials I and II
- AMTH 210 Introduction to Probability I and AMTH 211 Continuous Probability
- AMTH 217 Design of Scientific Experiments and AMTH 219 Analysis of Scientific Experiments
- AMTH 218 Process Troubleshooting and Control
- ELEN 271 Microsensors: Components and Systems
- ELEN 274 and 275 Integrated Circuit Fabrication Processes I and II
- ELEN 276 Integrated Circuits Devices and Technology
- ELEN 277 IC Assembly and Packaging Technology
- ELEN 390 Semiconductor Device Technology Reliability
- CENG 205, 206, and 207 Finite Element Methods I, II, and III
- CENG 211 Advanced Strength of Materials

Mechanical Design (Hight, Shoup)

The program of studies for the mechanical design option must include the following courses:

- CENG 205, 206, and 207 Finite Element Methods I, II, and III
- MECH 275 Design for Competitiveness
- MECH 285 Computer-Aided Design of Mechanisms
- MECH 325 Computational Geometry for Computer-Aided Design and Manufacture
- MECH 415 Optimization in Mechanical Design

The following courses are recommended sequences for this option:

- MECH 207, 208, and 209 Advanced Mechatronics I, II, and III
- MECH 273 and 274 Designing with Plastic Materials and Processing Plastic Materials
- MECH 281 Fracture Mechanics and Fatigue I
- MECH 330 Atomic Arrangements, Defects and Mechanical Behavior
- MECH 331 Phase Equilibria and Transformations
- MECH 332 Electronic Structure and Properties
- MECH 371 and 372 Space Systems Design and Engineering I and II

Robotics and Mechatronic Systems (Kitts)

The program of studies for the robotics and mechatronics option must include the following courses:

- MECH 207, 208, and 209 Advanced Mechatronics I, II, III
- MECH 337 and 338 Robotics I, II
- MECH 299 Thesis or 290 Capstone Project

The student must also choose one of the following two-course sequences:

- MECH 218 and 219 Guidance and Control I, II
- MECH 315 and 316 Digital Control Systems I, II
- MECH 323 and 324 Modern Control System I, II

The student shall also select four of the following elective courses:

- MECH 339 Robotics III
- MECH 345 Modern Instrumentation and Experimentation
- MECH 218 Guidance and Control I
- MECH 219 Guidance and Control II
- MECH 315 Advanced Digital Control Systems I

- MECH 316 Advanced Digital Control Systems II
- MECH 323 Modern Control System Design I
- MECH 324 Modern Control System Design II
- MECH 275 Design for Competitiveness
- MECH 311 Modeling and Control of Telerobotic Systems
- MECH 329 Introduction to Intelligent Control

Thermofluids (Fabris)

The program of studies for the thermofluids option must also include the following courses:

- MECH 225 Gas Dynamics I
- MECH 228 Equilibrium Thermodynamics
- MECH 238 Convective Heat and Mass Transfer I
- MECH 266 Fundamentals of Fluid Mechanics
- MECH 270 Viscous Flow I

The student shall also select any five of the following courses:

- MECH 226 Gas Dynamics II
- MECH 230 Statistical Thermodynamics
- MECH 236 Conduction Heat Transfer
- MECH 239 Convective Heat and Mass Transfer II
- MECH 240 Radiation Heat Transfer I
- MECH 268 Computational Fluid Mechanics I
- MECH 269 Computational Fluid Mechanics II
- MECH 271 Viscous Flow II

DOCTOR OF PHILOSOPHY PROGRAM

The doctor of philosophy degree is conferred by the School of Engineering primarily in recognition of competence in the subject field and the ability to investigate engineering problems independently, resulting in a new contribution to knowledge in the field.

See the section on Academic Regulations for details on admission and general degree requirements. The following departmental information augments the general School requirements.

Academic Advisor

A temporary academic advisor will be provided to the student upon admission. The student and advisor must meet prior to registration for the second quarter to complete a preliminary program of studies, which will be determined largely by the coursework needed preparatory to the preliminary exam.

Preliminary Exam

A preliminary written exam is offered at least once per year by the School of Engineering as needed. The purpose is to ascertain the depth and breadth of the student's preparation and suitability for Ph.D. work. Each student in mechanical engineering must take an exam in mathematics, as well as in four areas from the following list Fluid Mechanics, Heat Transfer, Strength of Materials, Dynamics, Design, Controls, Vibrations, Finite Element Analysis, Material Science, and Thermodynamics.

Engineer's Degree Program

The Department of Mechanical Engineering offers an engineer's degree program. Details on admissions and requirements are shown in the Academic Regulations section. Students interested in this program should seek individual advice from the department chair prior to applying.

CERTIFICATE PROGRAMS

Controls

Objective:

The Controls Certificate is intended for working engineers in mechanical and closely related fields of engineering. The certificate will provide a foundation in contemporary control theory and methods. The Controls Certificate covers classical and modern control system design and analysis. Specialization in digital controls, mechatronic, robotic, or aerospace applications is possible with a suitable choice of electives. Completion of the certificate will allow the student to design and analyze modern control systems.

Admission:

Applicants must have completed an accredited bachelor’s degree program in mechanical or a closely related field of engineering. They are expected to have prior coursework in undergraduate mathematics. No prior control courses are required.

Program Requirements:

Students must complete a total of 16 units as described below, with a minimum GPA of 3.0 and a grade of C or better in each course.

Required Courses (8 units)

- MECH 217 Introduction to Control (2 units)
- MECH 218 Guidance and Control I (2 units)
- MECH 323 Modern Control System Design I (2 units)
- MECH 324 Modern Control System Design II (2 units)

Elective Courses (8 units)

- AMTH 245 Linear Algebra I (2 units)
- AMTH 246 Linear Algebra II (2 units)
- MECH 207 Advanced Mechatronics I (2 units)
- MECH 208 Advanced Mechatronics II (2 units)
- MECH 209 Advanced Mechatronics III (2 units)
- MECH 301 Noise and Vibration Control and Monitoring I (2 units)
- MECH 302 Noise and Vibration Control and Monitoring II (2 units)
- MECH 219 Guidance and Control II (2 units)
- MECH 315 Advanced Digital Control Systems I (2 units)
- MECH 316 Advanced Digital Control Systems II (2 units)
- MECH 329 Introduction to Intelligent Control (2 units)
- MECH 337 Robotics I (2 units)
- MECH 338 Robotics II (2 units)
- MECH 339 Robotics III (2 units)

- MECH 429 Optimal Control I (2 units)
- MECH 430 Optimal Control II (2 units)
- MECH 431 Aircraft Flight Dynamics and Performance (2 units)
- MECH 432 Rocket and Spacecraft Dynamics (2 units)

Dynamics

Objective:

The Dynamics Certificate is intended for working engineers in mechanical and related fields of engineering. The certificate will provide a fundamental and broad background in engineering dynamics. The Dynamics Certificate includes a strong foundational base in dynamics and applications in optimization, robotics, mechatronics, or dynamics of aircraft or spacecraft (depending on the chosen elective courses). Completion of the certificate will allow the student to formulate and solve the complex dynamics problems that arise in such fields as robotics and space flight.

Admission:

Applicants must have completed an accredited bachelor’s degree program in mechanical or a closely related field of engineering. They are expected to have prior coursework in undergraduate dynamics and mathematics.

Program Requirements:

Students must complete a total of 16 units as described below, with a minimum GPA of 3.0 and a grade of C or better in each course.

Required Courses (14 units)

- MECH 203 Analytical Dynamics I (2 units)
- MECH 204 Analytical Dynamics II (2 units)
- MECH 214 Advanced Dynamics I (2 units)
- MECH 215 Advanced Dynamics II (2 units)
- MECH 216 Advanced Dynamics III (2 units)
- MECH 305 Advanced Vibrations I (2 units)
- MECH 306 Advanced Vibrations II (2 units)

Elective Courses (4 units)

- MECH 205 and 206 Aircraft Flight Dynamics I and II (4 units)
- MECH 431 and 432 Spacecraft Dynamics I and II (4 units)

Materials Engineering

Objective:

The Materials Engineering Certificate is intended for working engineers in mechanical, materials, or manufacturing engineering. The certificate will provide either an upgrade in materials understanding, or advanced study in a particular aspect of the subject. Completion of the certificate will allow the student to develop a deeper understanding of materials and their applications in design and manufacturing.

Admission:

Applicants must have completed an accredited bachelor’s degree program in mechanical or a related engineering discipline. They are expected to have prior coursework in basic materials science and strength of materials.

Program Requirements:

Students must complete a total of 16 units as described below, with a minimum GPA of 3.0 and a grade of C or better in each course.

Required Courses (12 units)

- MECH 330 Atomic Arrangements, Defects, and Mechanical Behavior (2 units)
- MECH 331 Phase Equilibria and Transformations (2 units)
- MECH 332 Electronic Structure and Properties (2 units)
- MECH 281 Fracture Mechanics and Fatigue (2 units)
- MECH 333 Experiments in Materials Science (2 units)
- MECH 345 Modern Instrumentation and Control (2 units)

Elective Courses (4 units)

- MECH 273 Designing with Plastic Materials (2 units)
- MECH 274 Processing Plastic Materials (2 units)
- MECH 277 Injection Mold Tool Design (2 units)

- MECH 350 and 351 Composite Materials I and II (2 units each)
- AMTH 210 Introduction to Probability I and AMTH 211 Continuous Probability (2 units each)
- AMTH 217 Design of Scientific Experiments and AMTH 219 Analysis of Scientific Experiments (2 units each)
- ENGR 260 Nanoscale Science and Technology
- ENGR 262 Nanomaterials
- CENG 211 Advanced Strength of Materials

Mechanical Design Analysis

Objective:

The Mechanical Design Analysis Certificate is intended for working engineers in mechanical or structural engineering. The certificate will provide a succinct upgrade in knowledge and skills that will allow the student to gain a deeper understanding of CAD and FEA principles and practices. Completion of the certificate will allow the student to pursue more advanced design and analysis tasks.

Admission:

Applicants must have completed an accredited bachelor's degree program in mechanical, civil, aerospace, or related field. They are expected to have prior coursework in strength of materials, thermodynamics, fluid mechanics, and mathematics through differential equations.

Program Requirements:

Students must complete a total of 16 units as described below, with a minimum GPA of 3.0 and a grade of C or better in each course.

Required Courses (10 units)

- CENG 205 Finite Element Methods I (2 units)
- CENG 206 Finite Element Methods II (2 units)
- CENG 207 Finite Element Methods III (2 units)
- MECH 325 Computational Geometry for Computer-Aided Design and Manufacture (2 units)

- MECH 415 Optimization in Mechanical Design (2 units)

Elective Courses (6 units)

- AMTH 220 Numerical Analysis I (2 units)
- AMTH 221 Numerical Analysis II (2 units)
- AMTH 308 Mathematical Modeling I (2 units)
- AMTH 309 Mathematical Modeling II (2 units)
- AMTH 370 Optimization Techniques I (2 units)
- AMTH 371 Optimization Techniques II (2 units)
- CENG 211 Advanced Strength of Materials (4 units)
- CENG 214 Theory of Elasticity (4 units)
- CENG 222 Advanced Structural Analysis (4 units)
- MECH 268 Computational Fluid Mechanics I (2 units)
- MECH 269 Computational Fluid Mechanics II (2 units)

Mechatronics Systems Engineering

Objective:

The Mechatronics Systems Engineering Certificate is intended for working engineers in mechanical engineering and related fields. The certificate program introduces students to the primary technologies, analysis techniques, and implementation methodologies relevant to the detailed design of electro-mechanical devices. Completion of the certificate will allow the student to develop systems that involve the sensing, actuation and control of the physical world. Knowledge such as this is vital to engineers in the modern aerospace, robotics and motion control industries.

Admission:

Applicants must have completed an accredited bachelor’s degree program in mechanical, aerospace, electrical, engineering physics, or a related field. They are expected to have prior coursework in mathematics through differential equations, introductory linear control theory, and introductory electronics and programming.

Program Requirements:

Students must complete a total of 16 units as described below, with a minimum GPA of 3.0 and a grade of C or better in each course.

Required Courses (8 units)

- MECH 207 Advanced Mechatronics I (2 units)
- MECH 208 Advanced Mechatronics II (2 units)
- MECH 209 Advanced Mechatronics III (2 units)
- MECH 217 Introduction to Control (2 units)

Elective Courses (8 units)

- MECH 310 Advanced Mechatronics IV (2 units)
- MECH 337 Robotics I (2 units)
- MECH 338 Robotics II (2 units)
- MECH 339 Robotics III (2 units)
- MECH 345 Modern Instrumentation (2 units)
- MECH 218 Guidance and Control I (2 units)
- MECH 219 Guidance and Control II (2 units)
- MECH 315 Digital Control Systems I (2 units)
- MECH 316 Digital Control Systems II (2 units)
- MECH 323 Modern Control System I (2 units)
- MECH 324 Modern Control System II (2 units)
- MECH 275 Design for Competitiveness (2 units)
- MECH 311 Modeling and Control of Telerobotic Systems (4 units)
- MECH 329 Intelligent Control (2 units)

An independent study or Capstone course would be suitable as one of the electives. In addition, other courses may serve as electives at the discretion of the program advisor.

Thermofluids

Objective:

The Thermofluids Certificate is intended for working engineers in mechanical, chemical, or a closely related field of engineering. The certificate will provide fundamental theoretical and analytic background, as well as exposure to modern topics and applications. Specialization in fluid mechanics, thermodynamics, or heat transfer is possible with suitable choice of electives. Completion of the certificate will allow the student to design heat transfer and fluid solutions for a range of modern applications.

Admission:

Applicants must have completed an accredited bachelor's degree program in mechanical or a closely related field of engineering. They are expected to have prior undergraduate coursework in fluid mechanics, thermodynamics, and heat transfer.

Program Requirements:

Students must complete a total of 16 units as described below, with a minimum GPA of 3.0 and a grade of C or better in each course.

Required Courses (10 units)

- MECH 225 Gas Dynamics I (2 units)
- MECH 228 Equilibrium Thermodynamics (2 units)
- MECH 238 Convective Heat Transfer I (2 units)
- MECH 266 Fundamentals of Fluid Mechanics (2 units)
- MECH 270 Viscous Flow I (2 units)

Elective Courses (6 units)

- MECH 202 Mathematical Methods in Mechanical Engineering (4 units)
- MECH 226 Gas Dynamics II (2 units)
- MECH 230 Statistical Thermodynamics (2 units)
- MECH 236 Conduction Heat Transfer (2 units)
- MECH 239 Convective Heat Transfer II (2 units)
- MECH 240 Radiation Heat Transfer I (2 units)
- MECH 271 Viscous Flow II (2 units)
- MECH 268 Computational Fluid Mechanics I (2 units)
- MECH 288 Energy Conversion I (2 units)
- MECH 289 Energy Conversion II (2 units)

Technology Jump-Start Certificate

Objective:

The Technology Jump-Start Certificate is particularly suitable for persons who need to complete the program in two full-time quarters in order to gain new skills and competencies quickly and to “Jump Start” their careers. This program is highly flexible and becomes a customized program for each student, developed through close consultation between the student and an academic advisor, and is subject to the particular courses available at the time. It is intended for experienced engineers in mechanical or related engineering fields. The certificate will provide a quick retooling of skills and knowledge. Completion of the certificate will allow the student to significantly upgrade competencies, and/or change career

directions.

Admission:

Applicants must have completed an accredited bachelor’s degree program in mechanical engineering or a related field. They are expected to have prior coursework relevant to the program that has been designed for them, and mathematics through differential equations.

Program Requirements:

Students must complete a total of 16 units of graduate coursework with at least 12 units from the Department of Mechanical Engineering and at most 4 units from the Department of Engineering Management. The coursework must be completed with a minimum GPA of 3.0 and a grade of C or better in each course.

MECHANICAL ENGINEERING LABORATORIES

The mechanical engineering laboratories contain facilities for instruction and research in the fields of manufacturing, materials science, fluid mechanics, thermodynamics, heat and mass transfer, combustion, instrumentation, vibration and control systems, and robotic

systems.

The Nanomechanics Lab houses a nanoindenter, a mechanical test instrument with nanometer displacement resolution and micro-Newton load resolution. In addition to measuring mechanical properties such as hardness and elastic modulus with high spatial resolution, the tip of the nanoindenter may be used to perform mechanical testing on MEMS devices.

The CAM and Prototyping Lab consists of two machine shops and a prototyping area. One machine shop is dedicated for student use for design and research projects. The second is a teaching lab used for undergraduate and graduate instruction. Both are equipped with modern machine tools, such as lathes and milling machines. The teaching lab also houses both 2-axis and 3-axis Computer Numerically Controlled (CNC) vertical milling machines, as well as a CNC lathe. Currentommercial CAM software is available for ease of programming. The prototyping area is equipped with a Stratasys FDM 3000 rapid prototyping system that utilizes fused deposition modeling to create plastic prototypes from CAD generated models. Also available are a Cyberware laser scanner and a Microscribe touch scanner for capturing 3D data points to facilitate reverse engineering or data acquisition from existing components.

The Engine Lab contains a variety of internal combustion engines installed on dynamometer stands that can be used for studies of diesel and spark-ignition engines. The facilities include a chassis dynamometer, and instrumentation for evaluating engine performance, measuring exhaust gas emissions, and measuring noise. Studies can be conducted using a variety of fuels.

The Fluid Dynamics/Thermal Science Lab contains equipment to illustrate the principles of fluid flow and heat transfer, and to familiarize students with hydraulic machines, refrigeration cycles, and their instrumentation. The lab also contains a subsonic wind tunnel equipped with an axial flow fan with adjustable pitch blades to study aerodynamics. Research tools include modern non-intrusive flow measurement systems. The Instrumentation Lab contains seven computer stations equipped with state-of-the-art, PC-based data acquisition hardware and software systems. A variety of transducers and test experiments for making mechanical, thermal, and fluid measurements are part of this lab.

The Materials Laboratory contains equipment for metallography and optical examination of the microstructure of materials as well as instruments for mechanical properties characterization including tension, compression, hardness, and impact testing. The Materials Laboratory also has a tube furnace for heat treating and a specialized bell-jar furnace for pour casting and suction casting of metallic glasses and novel alloy compositions.

The Robotic Systems Laboratory is an interdisciplinary laboratory specializing in the design, control, and teleoperation of highly capable robotic systems for scientific discovery, technology validation, and engineering education. Laboratory students develop and operate systems that include spacecraft, underwater robots, aircraft, and land rovers. These projects serve as ideal testbeds for learning and conducting research in mechatronic system design, guidance and navigation, command and control systems, and human-machine

interfaces.

The Vibrations and Control Systems Lab is equipped with two flexible test systems. One is capable of single or multi DOF modes, free or forced motion, and adjustable damping. The other is an inverted pendulum. Both systems can be controlled by a wide variety of control algorithms and are fully computer connected for data acquisition and control.

COURSE DESCRIPTIONS

Undergraduate Courses

MECH 10. Graphical

Communication in Design

Introduction to the design process and graphical communications tools used by engineers. Documentation of design through freehand sketching and engineering drawings. Basic descriptive geometry. Computer-aided design as a design tool. Conceptual design of individual projects presented in poster format. Computer laboratory.

(5 units)

MECH 11. Materials and

Manufacturing Processes

Manufacturing processes and their use in the production of mechanical components. Prerequisites: MECH 10, MECH 15. (4 units)

MECH 15. Introduction to

Material Science

Physical basis of the electrical, optical,

mechanical, and thermal behavior of solids. Relations between atomic structure and physical properties. Prerequisite: CHEM 11. (5 units)

MECH 102. Introduction to

Mathematical Methods in

Mechanical Engineering

The application of mathematical methods to the solution of practical engineering problems. A review of fundamental mathematical methods and calculus of a single variable, multivariable calculus, ordinary differential equations, numerical methods, and basics of linear algebra. (4 units)

MECH 114. Machine Design I

Analysis and design of mechanical systems for safe operation. Stress and deflection analysis. Failure theories for static loading and fatigue failure criteria. Team design projects begun. Formal conceptual design reports required. Prerequisites: MECH 15 and CENG 43. (4 units)

MECH 114L. Machining Lab

Practical experience with manual machine tools such as mills, lathes, drill press, sheet metal tools, etc. Basic training in safe and proper use of the equipment associated with simple mechanical projects. Laboratory. Must be taken in conjunction with MECH 114. P/NP. (1 unit)

MECH 115. Machine Design II

Continuation of MECH 114. Treatment of basic machine elements (e.g., bolts, springs, gears, bearings). Design and analysis of machine elements for static and fatigue loading. Team design projects completed. Design prototypes and formal final report required. Prerequisite: MECH 114. (4 units)

MECH 121. Thermodynamics I

Definitions of work, heat, and energy. First and second laws of thermodynamics. Properties of pure substances. Application to fixed mass systems and control volumes. Irreversibility and availability. Prerequisite: PHYS 33. (4 units)

MECH 122. Fluid Mechanics I

Fluid properties and definitions. Fluid statics, forces on submerged surfaces, manometry. Streamlines and the description of flow fields. Euler's and Bernoulli's equations. Mass, momentum, and energy analysis with a control volume. Laminar and turbulent flows. Losses in pipes and ducts. Dimensional analysis and similitude. Laboratory. Co-requisite: MECH 140. (5 units)

MECH 123. Heat Transfer

Introduction to the concepts of conduction, convection, and radiation heat transfer. Application of these concepts to engineering problems. Laboratory. Prerequisites: MECH 121 and 122. (5 units)

MECH 125. Thermal Systems Design

Analysis, design, and simulation of fluids and thermal engineering systems. Application of optimization techniques, life cycle and sustainability concepts in these systems. Prerequisite: MECH 123. (4 units)

MECH 131. Thermodynamics II

Thermodynamic potentials and availability concepts. Thermodynamic cycles. Nonreactive mixtures. Reactive mixtures with emphasis on the thermodynamics of combustion and chemical equilibrium. Laboratory. Prerequisite: MECH 121. (5 units)

MECH 132. Fluid Mechanics II

Introduction to gas dynamics. Concepts of lift and drag. Mechanics of laminar and turbulent flow. Introduction to boundarylayer theory. Application to selected topics in lubrication theory, aerodynamics, turbomachinery, and pipe networks. Offered every other year. Prerequisites: MECH 121 and 122. (4 units)

140. Dynamics

Kinematics of particles in rectlinear and curvelinear motion. Kinetics of particles, Newton's second law, energy and momentum methods. Systems of particles. Kinematics and plane motion of rigid bodies, forces and accelerations, energy and momentum methods. Introduction to three-dimensional dynamics of rigid bodies. Prerequisites: CENG 41 and AMTH 106 (4 units)

141. Mechanical Vibrations

Fundamentals of vibration, free and force vibration of (undamped / damped) single degree of freedom systems systems. Vibration under general forcing conditions. Free and force vibration of (undamped / damped) two degree of freedom systems. Determination of natural frequencies and mode shapes.Laboratory. Prerequisite: MECH 140. (5 units)

142. Control Systems, Analysis and Design

Introduction to system theory, including transfer functions and state space modeling of physical systems. Analysis and design of control systems in time and frequency domains, including root locus Bode diagrams, and nyquist plots. Laboratory. Prerequisite: MECH 141. (5 units)

MECH 143. Mechatronics

Introduction to the behavior, design, and integration of electromechanical components and systems. Review of appropriate electronic components/circuitry, mechanism configurations, and programming

constructs. Use and integration of transducers, microcontrollers, and actuators. (Also listed as ELEN 123.) Prerequisite: ELEN 50. (5 units)

MECH 145. Introduction to

Aerospace Engineering

Basic design and analysis of atmospheric flight vehicles. Principles of aerodynamics, propulsion, structures and materials, flight dynamics, stability and control, mission analysis, and performance estimation. Introduction to orbital dynamics. Offered every other year. Prerequisites: MECH 121, 122, and 140. (4 units)

MECH 146. Mechanism Design

Kinematic analysis and synthesis of planar mechanisms. Graphical synthesis of linkages and cams. Graphical and analytical techniques for the displacement, velocity, and acceleration analysis of mechanisms. Computer-aided design of mechanisms. Three or four individual mechanism design projects. Offered every other year. Prerequisite: Junior standing in mechanical engineering. (4 units)

MECH 151. Finite Element Theory

and Applications

Basic introduction to finite elements; direct and variational basis for the governing equations; elements and interpolating functions. Applications to general field problems-elasticity, fluid mechanics, and heat transfer. Extensive use of software packages. Offered every other year. Prerequisites: COEN 44 and AMTH 106. (4 units)

MECH 156. Introduction to Nanotechnology

Introduction to the field of nanoscience and nanotechnology. Properties of nanomaterials and devices. Nanoelectronics: from silicon and beyond. Measurements of nanosystems. Application and implications. Laboratory experience is an integral part of the course. This course is part of the Mechanical Engineering Program and should be suitable for juniors and seniors in engineering and first-year graduate students. Also listed as ELEN 156. *Prerequisite: PHYS 33* (5 units).

MECH 160. Modern Instrumentation for Engineers

Introduction to engineering instrumentation, computer data acquisition hardware and software, sampling theory, statistics, and error analysis. Laboratory work spans the disciplines of mechanical engineering: dynamics, fluids, heat transfer, controls, with an emphasis on report writing and experimental design. Prerequisites: MECH 122 and senior standing. (5 units)

MECH 188. Co-op Education

Practical experience in a planned program designed to give students work experience related to their academic field of study and career objectives. Satisfactory completion of the assignment includes preparation of a summary report on co-op activities. P/NP grading. May be taken twice. May be taken for graduate credit. Additional fees required. (2 units)

MECH 189. Co-op Technical Report

Credit given for a technical report on a specific activity, such as a design or a research project, etc., after completing the co-op assignment. Approval of department co-op advisor required. Letter grades based on content and presentation quality of report. May be taken twice. May be taken for graduate credit. (2 units)

MECH 190. Independent Study

Investigation of a mechanical engineering problem and presentation of the results. Arrangement with a faculty advisor is

required. Prerequisite: Senior standing.

(2-4 units)

MECH 192. Technical Writing for

Mechanical Engineers

Organization of engineering proposals and reports. General aspects of technical communications. Content and organization of written contract documents. Development of oral presentation skills and strategies. Prerequisites: ENGL 2 and concurrent enrollment in MECH 194. (2 units)

MECH 194. Advanced Design I: Tools

Design tools basic to all aspects of mechanical engineering, including design methodology, computer design tools, CAD, finite element method, simulation, CAM/robotics, engineering economics, and decision making. Senior design projects begun. Elements of technical writing. Prerequisite: MECH 115. (3 units)

MECH 195. Advanced Design II:

Implementation

Implementation of design strategy. Detail design and fabrication of senior design projects. Quality control, testing and evaluation, standards and specifications, and human factors. Prerequisite: MECH 194. (4 units)

MECH 196. Advanced Design III:

Completion and

Evaluation

Design projects completed, assembled, tested, evaluated, and judged with opportunities for detailed re-evaluation by the designers. Elements of technical writing. Final written report required. Prerequisite: MECH 195. (3 units)

MECH 199. Directed Research

Investigation of an engineering problem and writing an acceptable thesis. Conferences as required. Prerequisite: Senior standing in mechanical engineering. (2-4 units)

Graduate Courses

MECH 202. Mathematical Methods in

Analytic solution of ordinary differential equations. Fourier series. Analytic solution of linear partial differential equations by separation of variables. Numerical solution of ordinary differential equations by iterative and direct methods. Review of vectors and introduction to vector calculus. Introduction to complex variables. (Also listed as AMTH 202.) (2 units)

MECH 203. Analytical Dynamics I

Virtual displacement and virtual work, D'Alembert's principle, Hamilton's principle, generalized coordinates, Lagrange's equations, treatment of constraints. Applications to central force motion, gyrodynamics, and other mechanical systems. Prerequisite: MECH 140. (2 units)

MECH 204. Analytical Dynamics II

Variational principles, Gibbs-Appell equations, Hamilton's equations, Hamilton-

Jacobi theorem. Stability of motion. Impulsive motion. Systems with varying mass, special relativity, and other advanced topics. Applications to mechanical systems. Prerequisite: MECH 203. (2 units)

MECH 205. Aircraft Flight Dynamics I

Review of basic aerodynamics, and propulsion. Aircraft performance including equations of motion for flight in vertical plane, gliding, level, and climbing flight, range and endurance, turning flight, take off and landing.

Prerequisite: MECH 140. (2 units)

MECH 206. Aircraft Flight Dynamics II

Developing a nonlinear six-degrees-of-freedom aircraft model, longitudinal and lateral static stability and trim, Linearized longitudinal dynamics including short period and phugoid modes. Linearized lateral-directional dynamics including roll, spiral, and Dutch roll modes. Aircraft handling qualities and introduction to flight control systems.

Prerequisite: MECH 140 or MECH 205. (2 units)

MECH 207. Advanced Mechatronics I

Theory of operation, analysis, and implementation of fundamental physical and electrical device components: basic circuit elements, transistors, op-amps, sensors, electro-mechanical actuators. Application to the development of simple devices. (Also listed as ELEN 460.) Prerequisite: MECH 141 or ELEN 100. (3 units)

MECH 208. Advanced Mechatronics II

Theory of operation, analysis, and implementation of fundamental controller implementations: analog computers, digital state machines, microcontrollers. Application to the development of closed-loop control systems. (Also listed as ELEN 461.) Prerequisites: MECH 207 and 217. (3 units)

MECH 209. Advanced Mechatronics III

Electro-mechanical modeling and system development. Introduction to mechatronic support subsystems: power, communications. Fabrication techniques. Functional implementation of hybrid systems involving dynamic control and command logic. Prerequisite: MECH 208. (2 units)

MECH 214. Advanced Dynamics I

Partial differentiation of vector functions in a reference frame. Configuration constraints. Generalized speeds. Motion constraints. Partial angular velocities and partial linear velocities. Inertia scalars, vectors, matrices, and dyadics; principal moments of inertia. Prerequisites: MECH 140 and AMTH 106. (2 units)

MECH 215. Advanced Dynamics II

Generalized active forces. Contributing and noncontributing interaction forces. Generalized inertia forces. Relationship between generalized active forces and potential energy; generalized inertia forces and kinetic energy. Prerequisite: MECH 214. (2 units)

MECH 216. Advanced Dynamics III

Dynamical equations of motion. Linearization. Steady motion and motions resembling states of rest. Integrals of equations of motion. Determination of constraint forces and constraint torques. Prerequisite: MECH 215. (2 units)

MECH 217. Introduction to Control

Laplace transforms, block diagrams, modeling of control system components and kinematics and dynamics of control systems, and compensation. Frequency domain techniques, such as root-locus, gain-phase, Nyquist and Nichols diagrams used to analyze control systems applications. Prerequisite: AMTH 106. (2 units)

MECH 218. Guidance and Control I

Modern and classical concepts for synthesis and analysis of guidance and control systems. Frequency and time domain methods for both continuous-time and sampled data systems. Compensation techniques for continuous-time and discrete-time control systems. Prerequisite: MECH 217, 142, or consent of instructor. (2 units)

MECH 219. Guidance and Control II

Continuation of MECH 218. Design and synthesis of digital and continuous-time control systems. Nonlinear control system design using phase plane and describing functions. Relay and modulator controllers. (Also listed as ELEN 462.) Prerequisite: MECH 218. (2 units)

MECH 225. Gas Dynamics I

Flow of compressible fluids. One-dimensional isentropic flow, normal shock waves, frictional flow. Prerequisites: MECH 121 and 132. (2 units)

MECH 226. Gas Dynamics II

Continuation of MECH 225. Flow with heat interaction and generalized one-dimensional flow. Oblique shock waves and unsteady wave motion. Prerequisite: MECH 225. (2 units)

MECH 228. Equilibrium

Thermodynamics

Principles of thermodynamic equilibrium. Equations of state, thermodynamic potentials, phase transitions, and thermodynamic stability. Prerequisite: MECH 131 or equivalent. (2 units)

MECH 230. Statistical

Thermodynamics

Kinetic theory of gases. Maxwell-Boltzmann distributions, thermodynamic properties in terms of partition functions, quantum statistics, and applications. Prerequisites: AMTH 106 and MECH 121.

(2 units)

MECH 234. Combustion Technology

Theory of combustion processes. Reaction kinetics, flame propagation theories.

Emphasis on factors influencing pollution. Prerequisites: AMTH 106 and MECH 131. (2 units)

MECH 236. Conduction

Heat Transfer

Flow of heat through solid and porous media for steady and transient conditions. Consideration of stationary and moving heat sources. Prerequisites: AMTH 106 and MECH 123. (2 units)

MECH 238. Convective Heat

and Mass Transfer I

Solutions of basic problems in convective heat and mass transfer, including boundary layers and flow in pipes. Prerequisites: MECH 123 and 266. (2 units)

MECH 239. Convective Heat

and Mass Transfer II

Application of transfer theory to reacting boundary layers, ablating and reacting surfaces, multicomponent diffusion. Introduction of modern turbulence theory to predict fluctuations and other flow properties. Prerequisite: MECH 238. (2 units)

MECH 240. Radiation Heat

Transfer I

Introduction to concepts of quantum mechanics, black body behavior, and radiant heat exchange between bodies. Prerequisite: MECH 123. (2 units)

MECH 241. Radiation Heat

Transfer II

Treatment of gaseous radiation in enclosures. Solutions of transfer equation in various limits and for different molecular radiation models. Gray and nongray applications. Mathematical techniques of solutions. Prerequisite: MECH 240. (2 units)

MECH 254. Introduction to

Biomechanics

Overview of basic human anatomy, physiology, and anthropometry. Applications of mechanical engineering to the analysis of human motion, function, and injury.

Review of issues related to designing devices for use in, or around, the human body including safety, biocompatibility, ethics, and FDA regulations. Offered every other year. (4 units)

MECH 256. Introduction to

Biomaterials

Introduction to each class of biomaterial. Exploration of research, commercial, and regulatory literature. Written and oral reports by students on a selected application requiring one or more biomaterials.

(2 units)

MECH 266. Fundamentals of

Fluid Mechanics

Mathematical formulation of the conservation laws and theorems applied to flow fields. Analytical solutions. The viscous boundary layer. Prerequisite: MECH 122. (2 units)

MECH 268. Computational Fluid

Mechanics I

Introduction to numerical solution of fluid flow. Application to general and simplified forms of the fluid dynamics equations. Discretization methods, numerical grid generation, and numerical algorithms based on finite difference techniques. Prerequisite: MECH 266. (2 units)

MECH 269. Computational Fluid

Mechanics II

Continuation of MECH 268. Generalized coordinate systems. Multidimensional compressible flow problems, turbulence modeling. Prerequisite: MECH 268. (2 units)

MECH 270. Viscous Flow I

Derivation of the Navier-Stokes equations. The boundary layer approximations for high Reynolds number flow. Exact and approximate solutions of laminar flows. Prerequisite: MECH 266. (2 units)

MECH 271. Viscous Flow II

Continuation of MECH 270. Similarity solutions of laminar flows. Separated flows. Fundamentals of turbulence. Introduction to numerical methods in fluid mechanics. Prerequisite: MECH 270. (2 units)

MECH 273. Designing with

Plastic Materials

Mechanical, chemical, and thermal properties of engineering plastics and elastomers. Materials evaluation. Design of plastic bearings, gears, and housings. Design for creep. Prerequisite: CENG 43 or equivalent.

(2 units)

MECH 274. Processing Plastic

Materials

Casting, compression, and transfer molding of thermoset plastics. Thermoforming, extrusion, rotational, and injection molding of thermoplastics. Secondary operations for plastics. Design for manufacturing of plastics. Prerequisite: MECH 273. (2 units)

MECH 275. Design for

Competitiveness

Overview of current design techniques aimed at improving global competitiveness. Design strategies and specific techniques. Group design projects in order to put these design ideas into simulated practice.

(2 units)

MECH 277. Injection Mold

Tool Design

Molds and mold bases, mold materials, sizes and presses, moldability of plastics, effect of tooling on plastic part design. Prerequisites: MECH 273 and 274. (2 units)

MECH 279. Introduction to CNC I

Introduction to CNC (Computer Numeric Control) machining. Principles of conventional and CNC machining. Process identification and practical application using conventional machine tools. Job planning logic and program development for CNC. Set-up and basic operation of CNC machine through “hands-on” exercises. Introduction to CAM software, conversational programming, verification software, and file transfers. The class is lab intensive; the topics will be presented primarily by demonstration or student use of the equipment.

(3 units)

MECH 280. Introduction to CNC II

Builds on foundation provided by MECH 279. Emphasis on CNC programming. Overview of controllers, features of CNC machines, manual and computer-aided programming, G-code basics, advanced cycles and codes. Lab projects will consist of “hands-on” operation of CNC milling machines, programming tools, and verification software. Lab component. Prerequisite: MECH 279 or consent of instructor. (3 units)

MECH 281. Fracture Mechanics

and Fatigue

Fracture mechanics evaluation of structures containing defects. Theoretical development of stress intensity factors. Fracture toughness testing. Relationships among stress, flaw size, and material toughness. Emphasis on design applications with examples from aerospace, nuclear, and structural components. Prerequisite: Consent of instructor. (2 units)

MECH 282: Failure Analysis

This course will examine how and why engineering structures fail, and will provide the student with the tools to identify failure mechanisms and perform a failure analysis. Students will review several case studies, and will conduct independent failure analysis investigations of actual engineering systems and parts using state-of-the-art tools. (2 units)

MECH 285. Computer-Aided Design

of Mechanisms

Kinematic synthesis of mechanisms. Graphical and analytical mechanism synthesis techniques for motion generation, function generation, and path generation problems. Overview of various computer software packages available for mechanism design.

(2 units)

MECH 288. Energy Conversion I

Introduction to nonconventional methods of power generation using solar energy, thermoelectric effect, and fuel cells. Description of the physical phenomena involved, analysis of device performance, and assessment of potential for future use. Prerequisite: MECH 121. (2 units)

MECH 289. Energy Conversion II

Discussion of magnetohydrodynamic power generation, thermionic converters, and thermonuclear fusion. (MECH 288 is not a prerequisite.) (2 units)

MECH 290. Capstone Project

Research and analysis of a manufacturing problem and reporting of results. Prerequisite: Must have completed required courses in master's manufacturing option. (2-6 units)

MECH 292. Theory and Design

of Turbomachinery

Theory, operation, and elements of the design of turbomachinery that performs by the dynamic interaction of fluid stream with a bladed rotor. Emphasis on the design and efficient energy transfer between fluid stream and mechanical elements of turbomachines, including compressors, pumps, and turbines. Prerequisites: MECH 121 and 122. (2 units)

MECH 293. Special Topics in

Manufacturing and

Materials

(2 units)

MECH 294. Special Topics in

Mechanical Design

(2 units)

MECH 295. Special Topics in

Thermofluid Sciences

(2 units)

MECH 296. Special Topics in

Dynamics and Control

(2 units)

MECH 297. Seminar

Discrete lectures on current problems and progress in fields related to mechanical engineering. P/NP grading. (1 unit)

MECH 298. Individual Study

By arrangement. (1-6 units)

MECH 299. Thesis

By arrangement. (1-9 units)

MECH 301. Noise and Vibration

Control and Monitoring

Analysis of noise and vibration generation; effects on people and machinery. Applications to design of noise reduction systems. Prerequisite: MECH 141 or 305. (2 units)

MECH 302. Noise and Vibration

Control and Monitoring II

Continuation of MECH 301. Prerequisite: MECH 301. (2 units)

MECH 304. Design and Mechanics

Problems in the

Computer Industry

Design and mechanics problems related to computer peripherals. Dynamics of disk interface, stresses, and vibrations in rotating disks and flexible disks. Actuator design, impact and nonimpact printing, materials and design for manufacturability, role of CAD/CAM in design. Prerequisite: Consent of instructor. (2 units)

MECH 305. Advanced Vibrations I

Response of single and two-degree-of-freedom systems to initial, periodic, nonperiodic excitations. Reviewing the elements of analytical dynamics, including the principle of virtual work, the Hamilton's principle and Lagrange's equations. Response of multi-degree-of-freedom systems. Modeling and dynamic response of discrete vibrating elastic bodies. Analytical techniques for solving dynamic and vibration problems. Prerequisite: MECH 141. (2 units)

MECH 306. Advanced Vibrations II

Vector-tensor-matrix formulation with practical applications to computer simulation. Dynamic response of continuous elastic systems. Strings, membranes, beams, and plates exposed to various dynamic loading. Applications to aero-elastic systems and mechanical systems. Modal analysis and finite element methods applied to vibrating systems. Prerequisite: MECH 305. (2 units)

MECH 308. Thermal Control of

Electronic Equipment

Heat transfer methods to cool electronic equipment. Contact resistance, cooling fins, immersion cooling, boiling, and direct air cooling. Use of heat exchangers, cold plates, and heat pipes. Applications involving transistor cooling, printed circuit boards, and microelectronics. Prerequisites: MECH 122 and 123. (2 units)

MECH 310. Advanced

Mechatronics IV

Application of mechatronics knowledge and skills to the development of an industry- or laboratory-sponsored mechatronics device/ system. Systems engineering, concurrent design, and project management techniques. Performance assessment, verification, and validation. Advanced technical topics appropriate to the project may include robotic teleoperation, human-machine interfaces, multi-robot collaboration, and other advanced applications. Prerequisite: MECH 209. (2 units)

MECH 311. Modeling and Control of

Telerobotic Systems

Case studies of telerobotic devices and mission control architectures. Analysis and control techniques relevant to the remote operation of devices, vehicles, and facilities. Development of a significant research project involving modeling, simulation, or experimentation, and leading to the publication of results. Prerequisite: Consent of instructor. (4 units)

MECH 315. Digital

Control Systems I

Introduction to digital control systems design. Mini- and microcomputer application in industrial control. Analog-to-digital and digital-to-analog converters. Discrete time systems, state-space representation, stability. Digital control algorithms, optimal tuning of controller gains. Finite-time settling control. Controllability and observability of discrete-time systems. Prerequisite: MECH 142 or 217. (2 units)

MECH 316. Digital

Control Systems II

Continuation of MECH 315. Linear state vector feedback control, linear quadratic optimal control. State variable estimators, observers. System identification, model reference adaptive systems, pole-placement control. Minimum variance control, tracking, and regulation problems. Adaptive control. Prerequisite: MECH 315. (2 units)

MECH 323. Modern Control

System I

State space fundamentals, observer and controller canonical forms, controllability, Observability, minimum realization, stability theory, stablizability, and tracking problem of continuous systems. Prerequisite: MECH 142 or 217. (2 units)

MECH 324. Modern Control

System II

Shaping the dynamic response, pole placement, reduced-order observers, LQG/LTR, introduction to random process and Kalman filters. Prerequisite: MECH 323. (2 units)

(2 units)

MECH 325. Computational

Geometry for Computer-

Aided Design and

Manufacture

Analytic basis for description of points, curves, and surfaces in three-dimensional space. Generation of surfaces for numerically driven machine tools. Plane coordinate geometry, three-dimensional geometry and vector algebra, coordinate transformations, three-dimensional curve and surface geometry, and curve and surface design. Prerequisite: Consent of instructor. (2 units)

MECH 329. Introduction to

Intelligent Control

Intelligent control, AI, and system science. Adaptive control and learning systems. Artificial neural networks and Hopfield model. Supervised and unsupervised learning in neural networks. Fuzzy sets and fuzzy control. (Also listed as ELEN 329.) Prerequisite: MECH 324. (2 units)

MECH 330. Atomic Arrangements,

Defects, and Mechanical

Behavior

Structure of crystalline and non-crystalline materials and the relationship between structure, defects, and mechanical properties. For all engineering disciplines. (2 units)

MECH 331. Phase Equilibria and

Transformations

Thermodynamics of multi-component systems and phase diagrams. Diffusion and phase transformations. For all engineering disciplines. (2 units)

MECH 332. Electronic Structure

and Properties

Band structure and electrical conductivity of metals, semiconductors, and insulators with applications to electronic devices such as the p-n junction and materials characterization techniques utilizing electron-solid interactions. For all engineering disciplines. (2 units)

MECH 333. Experiments in

Materials Science

This course will focus on experimental techniques and data analysis for three experiments involving the characterization of metallic and polymeric systems in bulk and thin film form. Potential topics include

tension testing of composite materials, nanoindentation, and scanning electron microscopy. Written laboratory reports will be assigned. (2 units)

MECH 335. Adaptive Control I

Overview of adaptive control, Lyapunov stability theory, direct and indirect model-reference adaptive control, least-squares system identification technique, neural network approximation, and neural-network adaptive control. Prerequisites: MECH 324, ELEN 237, and knowledge of Matlab/Simulink.

Mech 336 Adaptive Control II
Stability and robustness of adaptive controller, robust modification, bounded linear stability analysis, metrics-driven adaptive control, constraint-based optimal adaptive control, and advanced topics in adaptive control. Prerequisites: MECH 335 or instructor's permission, ELEN 237.

MECH 337. Robotics I

Overview of robotic systems and applications. Components. Homogeneous transforms. Denavit-Hartenberg representation. Forward and inverse kinematics. Manipulator Jacobian. Singular configurations. (Also listed as ELEN 337.) Prerequisites: AMTH 245 and MECH 217. (2 units)

MECH 338. Robotics II

Newton-Euler Dynamics. Trajectory planning. Linear manipulator control. Nonlinear manipulator control. Joint space control. Cartesian space control. Hybrid force/position control. Obstacle avoidance. Robotic simulation. (Also listed as ELEN 338.) Prerequisite: MECH 337. (2 units)

MECH 339. Robotics III

Advanced topics: parallel manipulators,

redundant manipulators, underactuated manipulators, coupled manipulator/

platform dynamics and control, hardware experimentation and control, dextrous

manipulation, multi-robot manipulation, current research in robotic manipulation. (Also listed as ELEN 339.) Prerequisite: MECH 338. (2 units)

MECH 340. Introduction to Direct

Access Storage Devices

Introduction to direct access storage devices, including flexible and rigid disk drives. Overview of magnetic and optical recording technology emphasizing their similarity

and differences and basic principles of operation. Device components technology, including head, disk, positioning actuator, drive mechanism, drive interface, and controller. Prerequisite: Consent of instructor.

(2 units)

MECH 345. Modern Instrumentation

and Experimentation

Overview of sensors and experimental techniques. Fundamentals of computer-based data acquisition and control, principles of operation of components in a data acquisitions system. Design and analysis of engineering experiments with emphasis on practical applications. Characterization of experimental accuracy, error analysis, and statistical analysis. Experiments involving measurements and control of equipment.

(2 units)

MECH 350. Composite Materials I

Design, analysis, and manufacturing of composite materials. Characterization of composites at the materials and substructural levels. Hyperselection. Manufacturing technology and its impact on design. Prerequisite: Consent of instructor. (2 units)

MECH 351. Composite Materials II

Composite material design at the structural level. Fabrication methods. Design for damage tolerance, durability, and safety. Transfer of loads. Prerequisite: MECH 350. (2 units)

MECH 371. Space Systems Design

and Engineering I

A review of the engineering principles, technical subsystems, and design processes that serve as the foundation of developing and operating spacecraft systems. This course focuses on subsystems and analyses relating to orbital mechanics, power, command and data handling, and attitude determination and control. Note: MECH 371 and 372 may be taken in any order. (Also listed as ENGR 371.) (4 units)

MECH 372. Space Systems Design

and Engineering II

A review of the engineering principles, technical subsystems, and design processes that serve as the foundation of developing and operating spacecraft systems. This course focuses on subsystems and analyses relating to mechanical, thermal, software, and sensing elements. Note: MECH 371 and 372 may be taken in any order. (Also listed as ENGR 372.) (4 units)

MECH 379. Satellite Operations

Laboratory

This course introduces analysis and control topics relating to the operation of on-orbit spacecraft. Several teaching modules address conceptual topics to include mission and orbit planning, antenna tracking, command and telemetry operations, resource allocation, and anomaly management. Students will become certified to operate real spacecraft and will participate in the operation of both orbiting satellites and ground prototype systems. (1 unit)

MECH 415. Optimization in

Mechanical Design

Introduction to optimization: design and performance criteria. Application of optimization techniques in engineering design, including case studies. Functions of single and multiple variables. Optimization with constraints. Prerequisites: AMTH 106 and 245. (2 units)

MECH 416. System Design and

Project Operation

An overview of the tools and processes of systems design as it applies to complex projects involving mechanical engineering and multidisciplinary engineering. Traditional lectures by the faculty coordinator, as well as special presentations by selected industry speakers. (2 units)

MECH 429. Optimal Control I

Review of ordinary extrema. Calculus of variations. Maximum principle, optimal control of nonlinear systems, state regulators. Prerequisites: MECH 140 and AMTH 106. (2 units)

MECH 430. Optimal Control II

Continuation of MECH 429. Singular control, perturbation techniques, numerical methods. Differential games. Applications to mechanical engineering systems. Prerequisite: MECH 429. (2 units)

MECH 431. Spacecraft Dynamics I

Equations of motion of aircraft flight under various assumptions. Quasi-static performance measures for various aircraft. Flightpath optimization. Prerequisites: MECH 140 and AMTH 106. (2 units)

MECH 432. Spacecraft Dynamics II

Equations of motion for vehicles with rapidly changing mass. Orbital mechanics. Optimization of trajectories and orbital transfers. Elementary orbit perturbation theory. Prerequisites: MECH 140 and AMTH 106. (2 units)