

# MECHANICAL ENGINEERING

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## Overview

### Mission Statement

The mission of the Department of Mechanical Engineering is to contribute to the economic development of the state of Colorado and the Denver metropolitan area by providing high-quality bachelor's, master's (MS and MEng) and PhD programs in mechanical engineering for a diverse group of working students.

### Program Objectives

The program offered by the Department of Mechanical Engineering of the University of Colorado Denver can be completed in the afternoon and evening hours to accommodate both working and traditional students. The department seeks to graduate a diverse population of students with a bachelor's degrees who within a few years of graduation are able to:

1. be employed by a diverse group of industries, research laboratories and educational institutions
2. pursue careers in engineering, interdisciplinary areas, research and education
3. pursue post-graduate education and advanced degrees.

## Undergraduate Information

The mechanical engineer is concerned with satisfying the needs of society using a combination of material, human and economic resources. Mechanical engineering covers a wide spectrum of activities in the engineering profession. These activities include the conversion and transmission of energy and associated power processes; the kinematic, dynamic, strength and wear considerations, as well as economic aspects of the development, design and use of materials, machines and processes; and the analysis, synthesis and control of entire engineering systems.

The mechanical engineering curriculum begins with a strong emphasis on mathematics, physics and chemistry. It continues with a concentration in engineering sciences, including solid and fluid mechanics; thermodynamics, heat and mass transport; materials; and systems analysis and control. It concludes with laboratory and design courses that demonstrate the ways in which scientific knowledge is applied in the design and development of useful devices and manufacturing processes.

The mechanical engineering program may be roughly subdivided into two-year groupings. In the first two years, the program emphasizes the fundamentals of mathematics and basic science that are essential for an understanding of most branches of engineering. In the last two years of the program, the curriculum emphasizes engineering science and design and provides technical electives in the following areas:

- thermodynamics
- heat transfer

- fluid mechanics
- solid mechanics
- motorsports engineering
- bioengineering
- dynamics and controls
- computer-aided design and manufacturing
- composite materials
- additive manufacturing
- computational solid and fluid mechanics
- design engineering and science

## Concurrent Bachelor's/Master's Degrees

In addition to the bachelor of science in mechanical engineering, the department offers a concurrent bachelor's/master's degree. Students wishing to obtain a BS degree with a major in mechanical engineering and either the MS or the MEng degree in mechanical engineering may do so with up to 6 semester hours of 5000-level or above courses applying to both degrees. The 5000-level courses must meet the degree requirements for the graduate degree sought and must be suitable technical electives for the undergraduate degree. This option is open only for students seeking both degrees at CU Denver. Students must meet admission requirements to be accepted into the graduate program. Completion of two 5000-level courses does not guarantee admission into the graduate program. Please see an advisor for restrictions and guidelines.

## Programs

- Mechanical Engineering, BS (<http://catalog.ucdenver.edu/cu-denver/undergraduate/schools-colleges-departments/college-engineering-design-computing/mechanical-engineering/mechanical-engineering-bs/>)

## Faculty

### Associate Professors:

**R. Dana Carpenter**, PhD, Stanford University

**Kannan N. Premnath**, PhD, Purdue University

**Ronald A. L. Rorrer**, PhD, Virginia Polytechnic Institute and State University, PE-Colorado

**Samuel W. J. Welch**, PhD, University of Colorado Boulder

**Christopher M. Yakacki**, PhD, University of Colorado Boulder

### Assistant Professors:

**Maryam Darbeheshti** (clinical teaching track), PhD, University of Denver

**Guoying Dong**, PhD, McGill University

**Brecca Gaffney**, PhD, University of Denver

**Kai Yu**, PhD, Georgia Tech University

### Senior Instructor:

**Joseph F. Cullen Jr.**, MS, University of Colorado

### Instructor:

**Douglas Gallagher**, BS engineering physics, Colorado School of Mines

### Professors Emeriti:

**James Gerdeen**, PhD, Stanford University

**Peter E. Jenkins**, PhD, Purdue, MBA, Pepperdine, Professional Engineer, PE-Texas

**J. Kenneth Ortega**, PhD, University of Colorado Boulder

**Associate Professor Emeritus:**

**B. Thomas Arnberg**, MS, University of Colorado

**Engineering (ENGR)**

**ENGR 1100 - Fundamentals of Computational Innovation (3 Credits)**  
Provides a foundation in computational thinking and practices. Students learn to take advantage of computational power in problem solving by writing simple programs, studying the underlying logic of hardware, and working with a variety of technologies. Cross-listed with IWKS 2300. Max hours: 3 Credits.  
Grading Basis: Letter Grade

**ENGR 1200 - Fundamentals of Engineering Design Innovation (3 Credits)**  
This course introduces concepts of engineering design innovation at a variety of scales and disciplines. Participants will experience and explore core technology and design themes including design principles, processes, methods, modes of thinking, and social and cultural aspects or design. Max hours: 3 Credits.  
Grading Basis: Letter Grade

**Mechanical Engineering (MECH)**

**MECH 1025 - CAD and Graphics for Mechanical Engineering (3 Credits)**  
Introduction to 3-D computer-aided design software, solid modeling, industry-standard engineering drawing practices, and engineering graphics. Applications to mechanical engineering. Prereq: High School Geometry and Algebra. Max Hours: 3 Credits.  
Grading Basis: Letter Grade

**MECH 1045 - Manufacturing Processes Design (3 Credits)**  
Basic manufacturing background will be provided to engineering students in order to: (1) apply manufacturing specifications to the design of mechanical devices, and (2) communicate with technical personnel in a production environment. Topics cover metal casting, bulk and sheet metal forming, material removal and joining and fastening processes. Prereq: MECH 1025 or CVEN 1025 with a C- or higher. Max Hours: 3 Credits.  
Grading Basis: Letter Grade  
Prereq: MECH 1025 or CVEN 1025 with a C- or higher

**MECH 1208 - Special Topics (1-3 Credits)**  
Subject matter to be selected from topics of current technological interest. Credit to be arranged. Repeatable. Max hours: 9 Credits.  
Grading Basis: Letter Grade  
Repeatable. Max Credits: 9.

**MECH 2023 - Statics (3 Credits)**  
A vector treatment of force systems and their resultants; equilibrium of trusses, beams, frames, and machines, including internal forces and three-dimensional configurations, static friction, properties of areas, distributed loads and hydrostatics. Prereq: PHYS 2311 with a C- or higher. Coreq: MATH 2411. Cross-listed with CVEN 2121. Max Hours: 3 Credits.  
Grading Basis: Letter Grade  
Prereq: PHYS 2311 with a grade of C- or higher Coreq: MATH 2411

**MECH 2024 - Introduction to Materials Science (3 Credits)**  
The development of the physical principles relating the structural features of materials to their observed properties. Prereq: ENGR 1130 or CHEM 1130 or (CHEM 2031 and CHEM 2038 and CHEM 1999AE). Max hours: 3 Credits.  
Grading Basis: Letter Grade  
Prereq: ENGR 1130 or CHEM 1130 or (CHEM 2031 and CHEM 2038 and CHEM 1999AE) with a C- or higher.

**MECH 2030 - Analysis Techniques in Mechanical Engineering (3 Credits)**  
Introduces experimental methods and mathematical analysis used in engineering. Spreadsheets are used to analyze engineering data and prepare tables and graphs. Introduction to computer programming using MATLAB. Prereq: MATH 1401 and MECH 1025 with a grade of C- or higher. Max Hours: 3 Credits.  
Grading Basis: Letter Grade  
Prereq: MATH 1401 and MECH 1025 with a C- or higher

**MECH 2033 - Dynamics (3 Credits)**  
A vector treatment of dynamics of particles and rigid bodies, including rectilinear translation, central-force, and general motion of particles, kinematics of rigid bodies, the inertia tensor, plane motion of rigid bodies, energy and momentum methods for particles, systems of particles, and rigid bodies. Prereq: MECH 2023 or CVEN 2121 with a C- or higher. Cross-listed with CVEN 3111. Max Hours: 3 Credits.  
Grading Basis: Letter Grade  
Prereq: MECH 2023 or CVEN 2121 with a C- or higher

**MECH 2034 - Properties of Engineering Materials (1 Credit)**  
Experiments to determine material properties and the effect of processing on properties important in mechanical design. Materials include metal, polymers, and composites. Loadings include tension, compression, and bending under static, dynamic impact and creep states. Coreq: MECH 2024. Max hours: 1 Credits.  
Grading Basis: Letter Grade  
Coreq: MECH 2024

**MECH 2208 - Special Topics: 2208-2298 (1-3 Credits)**  
Subject matter to be selected from topics of current technological interest. Credit to be arranged. Repeatable. Max Hours: 9 Credits.  
Grading Basis: Letter Grade  
Repeatable. Max Credits: 9.

**MECH 3010 - Elementary Numerical Methods and Programming (3 Credits)**  
A development of basic numerical methods used to solve engineering problems. Introduction to MATLAB to implement numerical simulations. Coreq: MATH 3195 (or MATH 3191 and MATH 3200). Restricted to majors in CEDC Mechanical Engineering. Max Hours: 3 Credits.  
Grading Basis: Letter Grade  
Coreq: MATH 3195 (or MATH 3191 and MATH 3200). Restricted to majors in CEDC Mechanical Engineering.

**MECH 3012 - Thermodynamics (3 Credits)**  
Introduces thermodynamic properties and state relationships, processes and cycles with work and heat transfer. Applications of the first and second laws to energy-related engineering systems. Prereq: MATH 1401 and PHYS 2311 with a C- or higher. Max Hours: 3 Credits.  
Grading Basis: Letter Grade  
Prereq: MATH 1401 and PHYS 2311 with a C- or higher

**MECH 3021 - Introduction to Fluid Mechanics (3 Credits)**  
Applies exact and approximate theories to engineering problems in fluids. Examples include potential flow theory, Euler's equations for inviscid fluids, Bernoulli's equations, Navier-Stokes equations, and pipe flow. Prereq: MECH 2033, MECH 3012 and MATH 2421 with a grade C- or higher. Restricted to majors in CEDC Mechanical Engineering. Max Hours: 3 Credits.  
Grading Basis: Letter Grade  
Prereq: MECH 2033, MECH 3012 and MATH 2421 with a grade C- or higher. Restricted to majors in CEDC Mechanical Engineering.

**MECH 3022 - Thermodynamics II (3 Credits)**

Generalized thermodynamic cycles; general thermodynamic cycle considerations, compressor, expander, heat exchanger processes, refrigeration cycles, mixtures and combustion. Prereq: MECH 3012 or ENGR 3012 and MATH 2421 with a C- or higher. Restriction: Restricted to majors in CEDC Mechanical Engineering. Max hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: (MECH 3012 or ENGR 3012) AND MATH 2421 with a C- or higher Restriction: Restricted to MECH majors within the College of Engineering, Design and Computing.

**MECH 3023 - System Dynamics I: Vibrations (3 Credits)**

Modeling of dynamical systems. Analysis of single and multiple degree of freedom systems. Introduction to continuous systems. Prereq: CVEN 3111 or MECH 2033 with C- or higher; MATH 3195 or MATH 3191 and MATH 3200 and MECH 3010 with a C- or higher. Coreq: CVEN 3121 or MECH 3043. Restriction: Restricted to majors in CEDC Mechanical Engineering. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: MECH 2033 or CVEN 3111 and (MATH 3195 or MATH 3191 and MATH 3200) and MECH 3010 with a grade of C- or higher Coreq: MECH 3043 or CVEN 3121 Restriction: Restricted to MECH majors within the College of Engineering, Design and Computing

**MECH 3027 - Measurements (3 Credits)**

Principles of digital and analog measurements; systems for sensing, transporting, modifying, and outputting information; systematic and random error analysis. The laboratory includes a variety of instruments and components illustrating fundamental experimental measurement techniques and methods. Prereq: MECH 3030 or ELEC 3030, MATH 3195 or (MATH 3191 & MATH 3200) with a C- or higher. Restriction: Restricted to majors in CEDC Mechanical Engineering. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: MECH 3030 or ELEC 3030, MATH 3195 or (MATH 3191 MATH 3200) with a C- or higher. Restricted to majors in CEDC Mechanical Engineering.

**MECH 3028 - Laboratory of Mechanical Measurements (1 Credit)**

Modern techniques for Mechanical measurements. Laboratory includes techniques for the calibration of transducers and analysis of Statistical uncertainty. Data Acquisition Systems used for Signal acquisition and measurement of common mechanical quantities, such as displacement, velocity, acceleration and force. Design and characterization of a second order measurement system based on strain gages. Coreq: MECH 3027. Max Hours: 1 Credit.

Grading Basis: Letter Grade

Coreq: MECH 3027

**MECH 3030 - Electric Circuits and Systems (3 Credits)**

Basic electrical engineering concepts for non-majors. Basic study of circuit analysis (RLC and Op-amps), transformers and motor equations, and simple electronic circuits (diodes and transistors). Prereq: MATH 2421 and PHYS 2331 with a C- or higher. Restriction: Restricted to majors in CEDC Mechanical Engineering. Cross-listed with ELEC 3030. Max hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: MATH 2421 and PHYS 2331 with a C- or higher Restriction: Restricted to MECH majors within the College of Engineering, Design and Computing

**MECH 3031 - Fluids/Thermal Laboratory (1 Credit)**

Laboratory exercise in compressible and incompressible fluid flow; steady state and transient heat transfer. Prereq: MECH 3012 with a grade of C- or higher. Coreq: MECH 3021 and CVEN 3313. Restriction: Restricted to majors in CEDC Mechanical Engineering. Max Hours: 1 Credits.

Grading Basis: Letter Grade

Prereq: MECH 3012 with a C- or higher Coreq: MECH 3021 or CVEN 3313 Restriction: Restricted to MECH majors within the College of Engineering, Design and Computing

**MECH 3032 - Electric Circuits and Systems Lab (1 Credit)**

Basic electrical engineering lab for MECH majors. Coreq: MECH 3030 or ELEC 3030. Restriction: Restricted to majors in CEDC Mechanical Engineering. Max Hours: 1 Credits.

Grading Basis: Letter Grade

Coreq: MECH 3030 or ELEC 3030 Restriction: Restricted to MECH majors within the College of Engineering, Design and Computing

**MECH 3035 - Design of Mechanical Elements (3 Credits)**

Review of mechanics of materials and stress analysis; detailed design of various machine elements such as fasteners, springs, brakes and gears. Includes design project. Prereq: MECH 2024 and MECH 3043 with a grade C- or higher. Restriction: Restricted to majors in CEDC Mechanical Engineering. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: MECH 2024 and MECH 3043 with a grade C- or higher. Restricted to majors in CEDC Mechanical Engineering.

**MECH 3042 - Heat Transfer (3 Credits)**

Basic laws of heat transfer by conduction, convection, and radiation with engineering design applications. Includes design project. Prereq: MECH 3021 with a grade C- or higher. Restriction: Restricted to majors in CEDC Mechanical Engineering. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: MECH 3021 with a C- or higher Restriction: Restricted to MECH majors within the College of Engineering, Design and Computing

**MECH 3043 - Strength of Materials (3 Credits)**

Application of exact and approximate theories of stress and displacement to engineering problems in solids. Examples include torsion of rods and bending of beams. Combined stresses, principal stresses and energy methods are examined. Prereq: MECH 2023 or CVEN 2121 with a C- or higher. Cross-listed with CVEN 3121. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: MECH 2023 or CVEN 2121 with a C- or higher

**MECH 3045 - Principles of Additive Manufacturing (3 Credits)**

This course will introduce students to additive manufacturing (AM) techniques and design for additive manufacturing (DfAM). Additive manufacturing is no longer thought of as simply "rapid prototyping," but is influencing the way manufacturing is performed at almost every level of the product lifecycle. It will influence practically every manufacturing system of the future. This course will cover the fundamentals, applications, and implications of AM such that students will understand why and when to use AM, as well as challenge their traditional thinking of design and what is possible. At the end of this course, students should be able to: (1) Describe the 7 processes of AM, and understand their advantages and limitations. (2) Have hands-on experience in using several different AM processes, including building, modifying, and repairing their own AM machine. (3) Understand the wide variety of AM applications beyond prototyping. This includes tooling, production, performance improvement, customization, art, and more. (4) Understand how AM can be used in a product's lifecycle from beginning to end. (5) Use "generative design software" and "topology optimization" to unlock complex designs to be created with AM. (6) Assess the cost and value of AM processes. Prereq: MECH 1045 and MECH 2024 with a grade of C- or higher. Max hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: MECH 1045 and MECH 2024 with a grade of C- or higher.

**MECH 3065 - Intermediate Dynamics (3 Credits)**

An in-depth study of Newtonian dynamics with constraints. Mechanism synthesis using graphical and analytic techniques. Prereq: MECH 2033 or CVEN 3111 and MECH 3010 with a C- or higher. Restriction: Restricted to majors in CEDC Mechanical Engineering. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: MECH 2033 or CVEN 3111 and MECH 3010 with a C- or higher

Restriction: Restricted to MECH majors within the College of Engineering, Design and Computing

**MECH 3147 - Bioengineering (3 Credits)**

Explores engineering principles that have application in biology, and principles discovered in biology which may have application in engineering. Some topics covered are: cell biology, molecular biology, viscoelasticity, physical theory of plant cell growth aerodynamics, fluid mechanics, biofluid dynamics and animal flight. Restriction: Restricted to MECH majors with junior standing within the College of Engineering, Design and Computing. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to MECH majors with junior standing within the College of Engineering, Design and Computing

**MECH 3208 - Special Topics (1-3 Credits)**

Subject matter to be selected from topics of current technological interest. Credit to be arranged. Restriction: Restricted to MECH majors within the College of Engineering, Design and Computing. Repeatable. Max Hours: 9 Credits.

Grading Basis: Letter Grade

Repeatable. Max Credits: 9.

Restriction: Restricted to MECH majors within the College of Engineering, Design and Computing

**MECH 3840 - Independent Study (1-3 Credits)**

This category is intended for upper-division level special topics which students may wish to pursue on their own initiative, with guidance from a professor who agrees to limited consultation on the work and to award credit when the project is completed. Restriction: Restricted to MECH majors within the College of Engineering, Design and Computing. Repeatable. Max Hours: 9 Credits.

Grading Basis: Letter Grade

Repeatable. Max Credits: 9.

Restriction: Restricted to MECH majors within the College of Engineering, Design and Computing

**MECH 3939 - Internship (1-3 Credits)**

Undergraduate internship course for credit. Must be approved by department and handled subject to experiential learning office rules. Max Hours: 3 Credits.

Grading Basis: Letter Grade

**MECH 4020 - Biomechanics (3 Credits)**

Static and dynamic biomechanical analysis, effects of mechanical loading on bone and cartilage, design considerations in orthopaedic devices, muscle function, biomechanics of human movement, cardiovascular biomechanics. Prereq: MECH 2023, 2033, MATH 3195 or 3200 with a C- or higher. Cross-listed with MECH 5020. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: MECH 2023, 2033, MATH 3195 or 3200 Restriction: Restricted to MECH majors within the College of Engineering, Design and Computing Typically Offered: Summer.

**MECH 4023 - System Dynamics II: Controls (3 Credits)**

Introduces the Laplace Transformation. Control system analysis using root locus and frequency response methods. Basic compensation techniques are to be covered. Prereq: MECH 3023 with a C- or higher. Restriction: Restricted to majors in CEDC Mechanical Engineering. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: MECH 3023 with a C- or higher Restriction: Restricted to MECH majors within the College of Engineering, Design and Computing

**MECH 4024 - Mechanical Behavior of Materials (3 Credits)**

Studies the response of materials to applied stresses. Emphasis is on the understanding of the relationships between structure and properties. Fracture mechanics and fatigue are introduced. Prereq: MECH 3024 with a C- or higher. Restriction: Restricted to majors in CEDC Mechanical Engineering. Cross-listed with MECH 5024. Max hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: MECH 3024 with a C- or higher Restriction: Restricted to MECH majors within the College of Engineering, Design and Computing

**MECH 4025 - Advanced Biomechanics (3 Credits)**

This course provides training in computational and experimental methods for biomechanical engineering analysis. Topics include finite element analysis of biological systems, orthopedic device design, medical imaging analysis, mechanical characterization of biological tissues, and biomechanics of human movement. Prereq: MECH 4020. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: MECH 4020

**MECH 4030 - Experimental and Computational Methods of Human Movement (3 Credits)**

The objective of this course is to provide an overview of the various experimental and computational tools to measure and study human movement. Using a motion capture laboratory and musculoskeletal modeling, these tools will be used to develop a thorough understanding of how engineering principles can be used to address the major challenges of human movement biomechanics, with a primary emphasis on experimental measurement methods and simulations of movement. These tools will be used to explore the interaction of musculoskeletal properties, including whole#body and joint level biomechanics, with the environment during dynamic motion. Course topics include neuromuscular mechanics, balance performance, inverse dynamics, simulation of dynamic muscle#tendon mechanics, and musculoskeletal model development. Cross-listed with MECH 5030. Term offered: fall, spring. Max hours: 3 Credits.  
Grading Basis: Letter Grade  
Typically Offered: Fall, Spring.

**MECH 4035 - Senior Design I (3 Credits)**

Group and individual projects to design engineering components and systems. Design methodology, product specs, creativity, design reviews, communication, presentations, and report writing are emphasized. MECH 4035 and MECH 4045 form a one year sequence and must be taken consecutively. Prereq: MECH 3035 with a grade C- or higher and 40 hours of MECH courses. Restriction: Restricted to majors in CEDC Mechanical Engineering. Max Hours: 3 Credits.  
Grading Basis: Letter Grade  
Prereq: MECH 3035 with a grade C- or higher and 40 hours of MECH courses. Restricted to majors in CEDC Mechanical Engineering.

**MECH 4045 - Senior Design II (3 Credits)**

Student teams manufacture and construct and/or redesign mechanical parts or assemblies that they designed in previous course (MECH 4035). A proposal, oral progress reports, and a final written report and demonstration are required. MECH 4035 and MECH 4045 form a one year sequence and must be taken consecutively. Prereq: MECH 4035 with a C- or higher. Restriction: Restricted to majors in CEDC Mechanical Engineering. Max Hours: 3 Credits.  
Grading Basis: Letter Grade  
Prereq: MECH 4035 with a grade of C- or higher Restriction: Restricted to MECH majors within the College of Engineering, Design and Computing

**MECH 4110 - Numerical Methods for Engineers (3 Credits)**

Introduces numerical analysis. Solution of linear and nonlinear equation systems. Numerical methods for ordinary and partial differential equations. Engineering applications. Prereq: MATH 3195 or (3191 and 3200) with a C- or higher. Restriction: Restricted to majors in CEDC Mechanical Engineering. Max Hours: 3 Credits.  
Grading Basis: Letter Grade  
Prereq: MATH 3195 OR (MATH 3191 and 3200) with a C- or higher Restriction: Restricted to MECH majors within the College of Engineering, Design and Computing.

**MECH 4112 - Internal Combustion Engines (3 Credits)**

Students obtain a sufficient understanding of internal combustion engines that will allow them to perform analysis of combustion thermodynamics and actual cycles, including heat addition, heat loss, air/fuel flow, and engine design and performance. Prereq: MECH 3012 with a C- or higher. Restriction: Restricted to majors in CEDC Mechanical Engineering. Cross-listed with MECH 5112. Max Hours: 3 Credits.  
Grading Basis: Letter Grade  
Prereq: MECH 3012 with a C- or higher Restriction: Restricted to MECH majors within the College of Engineering, Design and Computing

**MECH 4114 - Designing with Composites (3 Credits)**

Analysis and design of polymers and polymer-based composites. Failure criteria include static strength, stiffness, creep, fatigue, impact and fracture toughness. Design criteria include strength-to-weight ratio and cost-to-strength ratio. Prereq: MECH 3043 or CVEN 3121 with a C- or higher. Restriction: Restricted to majors in CEDC Mechanical Engineering. Cross-listed with MECH 5114. Max Hours: 3 Credits.  
Grading Basis: Letter Grade  
Prereq: MECH 3043 or CVEN 3121 with a C- or higher Restriction: Restricted to MECH majors within the College of Engineering, Design and Computing

**MECH 4115 - Applied Plasticity and Creep (3 Credits)**

Plastic deformation of materials applied to bulk and sheet metal manufacturing processes such as extrusion, rolling and sheet metal. Linear and nonlinear viscoelastic creep with applications to plates and shells. Prereq: MECH 3043 with a C- or higher. Restriction: Restricted to majors in CEDC Mechanical Engineering. Cross-listed with MECH 5115. Max Hours: 3 Credits.  
Grading Basis: Letter Grade  
Prereq: MECH 3043 with a C- or higher Restriction: Restricted to MECH majors within the College of Engineering, Design and Computing

**MECH 4116 - Robotics (3 Credits)**

Introduces kinematics, dynamics, and control of robot manipulators. Emphasis is placed on computer use in control of actual robots and in computer simulation of mathematical models of robots. Students must turn in a project report based on the computer simulation. Prereq: MECH 3065 with a C- or higher. Restriction: Restricted to majors in CEDC Mechanical Engineering. Max Hours: 3 Credits.  
Grading Basis: Letter Grade  
Prereq: MECH 3065 with a C- or higher Restriction: Restricted to MECH majors within the College of Engineering, Design and Computing

**MECH 4120 - Methods of Engineering Analysis (3 Credits)**

Selected topics from real analyses with applications to engineering analyses. Topics include vector calculus, ordinary differential equations, partial differential equations, and calculus of variations. Prereq: MATH 3195 or (MATH 3191 and MATH 3200) with a C- or higher. Restriction: Restricted to majors in CEDC Mechanical Engineering. Cross-listed with MECH 5120. Max Hours: 3 Credits.  
Grading Basis: Letter Grade  
Prereq: MATH 3195 OR (MATH 3191 and 3200) with a C- or higher Restriction: Restricted to MECH majors within the College of Engineering, Design and Computing.

**MECH 4132 - Power Plant Systems Design (3 Credits)**

Detailed engineering analysis and design of a thermal power plant, including heat balance, selection of equipment (boiler, turbines, heat exchangers, pumps, cooling tower), performance evaluation, economic evaluation and feasibility studies. Prereq: MECH 3022 with a C- or higher. Restriction: Restricted to majors in CEDC Mechanical Engineering. Max Hours: 3 Credits.  
Grading Basis: Letter Grade  
Prereq: MECH 3022 with a C- or higher Restriction: Restricted to MECH majors within the College of Engineering, Design and Computing

**MECH 4135 - Mechanical Systems Design (3 Credits)**

Detailed engineering design of mechanical systems. Students work in teams on a project selected for entire class. Projects are similar to typical ones from industry. Course stresses creativity, synthesis, design judgment, and analysis of real-world problems. Oral and written presentations are required. Prereq: MECH 3035 with a C- or higher. Restriction: Restricted to majors in CEDC Mechanical Engineering. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: MECH 3035 with a grade of C- or higher Restriction: Restricted to MECH majors within the College of Engineering, Design and Computing

**MECH 4136 - Control Systems Design (3 Credits)**

Detailed engineering design of control systems. Students work in teams on a project selected for entire class. Projects are similar to typical ones from industry. Course stresses creativity, synthesis, design judgment, and analysis of real-world problems. Oral and written presentations are required. Prereq: MECH 4023 with a grade of C- or higher. Restriction: Restricted to majors in CEDC Mechanical Engineering. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: MECH 4023 with a C- or higher Restriction: Restricted to MECH majors within the College of Engineering, Design and Computing

**MECH 4141 - Fluid Mechanics (3 Credits)**

Viscous incompressible fluid flows. Topics include derivation of equations governing viscous compressible fluid motion; specializations to simple flows; boundary-layer theory; similarity solutions; introduction to turbulence and Reynolds stresses. Prereq: MECH 3021 with a grade of C- or higher. Restriction: Restricted to majors in CEDC Mechanical Engineering. Cross-listed with MECH 5141. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: MECH 3021 with a C- or higher Restriction: Restricted to MECH majors within the College of Engineering, Design and Computing

**MECH 4142 - Thermal Systems Design (3 Credits)**

Detailed engineering design of thermal/fluids systems. Students work in teams on a project selected for entire class. Projects are similar to typical ones from industry. Course stresses creativity, synthesis, design judgment, and analysis of real-world problems. Oral and written presentations are required. Prereq: MECH 3010, MECH 3021, and MECH 3042 with a grade of C- or higher. Restriction: Restricted to majors in CEDC Mechanical Engineering. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: MECH 3010, MECH 3021 and MECH 3042 with a grade of C- or higher. Restricted to majors in CEDC Mechanical Engineering.

**MECH 4147 - Engineering Economy (3 Credits)**

Applies economic and financial principles to evaluation of engineering alternatives. Calculation of annual costs, present worth, and prospective rates of return on investment. Review of systems analysis techniques, including simulation, linear programming, and project scheduling. Restriction: Restricted to MECH majors at the junior or higher level standing within the College of Engineering, Design and Computing. Cross-listed with CVEN 4077. Max Hours: 3 Credits. Semester Hours: 3 to 3

Grading Basis: Letter Grade

Restriction: Restricted to MECH majors at the junior or higher level standing within the College of Engineering, Design and Computing

**MECH 4155 - Air Conditioning Design (3 Credits)**

Basic principles of heating and ventilating systems. Determination of heating and cooling loads. Design and layout of heating, ventilating, and air conditioning systems. Includes design project. Prereq: MECH 3022 and MECH 3042 with a grade of C- or higher. Restriction: Restricted to majors in CEDC Mechanical Engineering. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: MECH 3022 and 3042 with a grade of C- or higher Restriction: Restricted to MECH majors within the College of Engineering, Design and Computing

**MECH 4160 - Introduction to Operations Research (3 Credits)**

Introduces operations research, including mathematical programming models, models for decision alternatives, for procurement and inventory, and for queuing operations. Prereq: MATH 3195 or (MATH 3191 and MATH 3200) with a grade of C- or higher. Restriction: Restricted to majors in CEDC Mechanical Engineering. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: MATH 3195 OR (MATH 3191 and 3200) with a C- or higher Restriction: Restricted to MECH majors within the College of Engineering, Design and Computing.

**MECH 4163 - Rigid-Body Dynamics (3 Credits)**

Review of Newtonian dynamics, Lagrange's equations for particles, systems, and rigid bodies. Conservative and non-conservative systems, moments of inertia, principal axes, angular momentum and Euler equations. Illustrations from spinning bodies, including tops, gyro-compass and rotating machinery. Prereq: MECH 2033 or CVEN 3111, MATH 3195 or (MATH 3191 and MATH 3200) with a grade of C- or higher. Restriction: Restricted to majors in CEDC Mechanical Engineering. Cross-listed with MECH 5163. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: MECH 2033 or CVEN 3111 and (MATH 3195 or MATH 3191 and MATH 3200) with a grade of C- or higher. Restriction: Restricted to MECH majors within the College of Engineering, Design and Computing

**MECH 4166 - Computerized Numerical Control (CNC) Manufacturing (3 Credits)**

Modern manufacturing engineering concepts using computerized numerical control (CNC). The students learn state-of-the-art CNC methodologies, including digitizing, drawing, generating codes, and manufacturing, using modern CNC machines. Restriction: Restricted to MECH majors with junior standing within the College of Engineering, Design and Computing. Cross-listed with MECH 5166. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to MECH majors with junior standing within the College of Engineering, Design and Computing

**MECH 4175 - Finite Element Analysis in Machine Design (3 Credits)**

Students learn basic theory of finite element analysis (FEA) as it applies to stress analysis and design of mechanical components. Commercial package will be used giving students practical experience in the use of FEA. Prereq: MECH 3035 with a grade of C- or higher. Restriction: Restricted to majors in CEDC Mechanical Engineering. Cross-listed with MECH 5175. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: MECH 3035 with a grade of C- or higher Restriction: Restricted to MECH majors within the College of Engineering, Design and Computing

**MECH 4176 - Introduction to Sports Engineering (3 Credits)**

Sports Engineering requires working both with the principles of biomechanics and the principles of engineering design and analysis. Using biomechanics is necessary in understanding the forces on the interface between the human athlete and his/her equipment. Recommended Prereq: MECH 2033, 3012 and 3021. Cross-listed with MECH 5176. Max Hours: 3 Credits.  
Grading Basis: Letter Grade

**MECH 4177 - Energy Conversion (3 Credits)**

This introductory Energy Conversion course introduces the basic background, terminology, and fundamentals of various forms of energy conversion. The topics covered will include: fuel cells, batteries, photovoltaic systems, solar thermal, and wind energy. Recommended Prereq: MECH 3012. Cross-listed with MECH 5177. Max Hours: 3 Credits.  
Grading Basis: Letter Grade

**MECH 4178 - Solar Engineering (3 Credits)**

This course provides the student with the basic ideas and calculation procedures on how solar processes work and how their performance can be predicted. Recommended Prereq: MECH 3012. Cross-listed with MECH 5178. Max Hours: 3 Credits.  
Grading Basis: Letter Grade

**MECH 4179 - Introduction to Turbomachinery (3 Credits)**

This introductory Turbomachinery course introduces the basic background, terminology, and fundamentals of various forms of turbomachines. The analysis of the various turbomachines will be focused on the performance of the turbomachine. Recommended Prereq: MECH 3012. Cross-listed with MECH 5179. Max hours: 3 Credits.  
Grading Basis: Letter Grade

**MECH 4195 - Solid Modeling (3 Credits)**

This is a basic course in solid modeling using Solid Works computer software. Topics include feature-based modeling, parametric part design, parent/child relationships, use of datums, patterning, relations, sweeps, blends, assembly, tolerancing, rapid prototyping, CNC manufacturing, CMM inspection, and Step standards. Restriction: Restricted to major in CEDC Mechanical Engineering with junior standing. Max Hours: 3 Credits.  
Grading Basis: Letter Grade  
Restriction: Restricted to MECH majors with junior standing within the College of Engineering, Design and Computing

**MECH 4208 - Special Topics (1-3 Credits)**

Subject matter to be selected from topics of current technological interest. Credit to be arranged. Restriction: Restricted to majors in CEDC Mechanical Engineering. Cross-listed with MECH 5208. Repeatable. Max hours: 9 Credits.  
Grading Basis: Letter Grade  
Repeatable. Max Credits: 9.  
Restriction: Restricted to MECH majors within the College of Engineering, Design and Computing

**MECH 4228 - Special Topics (1-3 Credits)**

Prereq: MECH 3032 (Electric Systems-Circuits Lab). Repeatable. Max hours: 9 Credits.  
Grading Basis: Letter Grade  
Repeatable. Max Credits: 9.  
Prereq: MECH 3032.

**MECH 4238 - Special Topics (1-3 Credits)**

Restricted to majors in CEDC Mechanical Engineering. Repeatable. Max Hours: 9 Credits.  
Grading Basis: Letter Grade  
Repeatable. Max Credits: 9.  
Restriction: Restricted to MECH majors within the College of Engineering, Design and Computing

**MECH 4840 - Independent Study (1-3 Credits)**

This category is intended for upper division level special topics which students may wish to pursue on their own initiative, with guidance from a professor who agrees to limited consultation on the work and to award credit when the project is completed. Restriction: Restricted to majors in CEDC Mechanical Engineering. Repeatable. Max Hours: 9 Credits.  
Grading Basis: Letter Grade  
Repeatable. Max Credits: 9.  
Restriction: Restricted to MECH majors within the College of Engineering, Design and Computing