

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 (BS, MS and MEng) and PhD programs in mechanical engineering for a diverse group of working students.

Program Educational Objectives

The programs offered by the Department of Mechanical Engineering of the University of Colorado Denver can generally 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 bachelor's, master's, and doctoral degrees, who within a few years of graduation are able to:

- be employed by a diverse group of industries, research laboratories, and educational institutions
- pursue careers in engineering, interdisciplinary areas, research and education, and
- pursue postgraduate education and advanced degrees

The focus areas in which a student may undertake studies at the Denver campus include fluid mechanics, solid mechanics, additive manufacturing, biomechanics, renewable energy, thermodynamics, composite materials, and outdoor recreational gear.

Graduate

The Department of Mechanical Engineering offers graduate courses, a master of science (MS) (<http://catalog.ucdenver.edu/cu-denver/graduate/schools-colleges-departments/college-engineering-design-computing/mechanical-engineering/mechanical-engineering-ms/>) degree program and a master of engineering (MEng) (<http://catalog.ucdenver.edu/cu-denver/graduate/schools-colleges-departments/college-engineering-design-computing/mechanical-engineering/mechanical-engineering-meng/>) program. In addition, the multidisciplinary engineering and applied science doctor of philosophy (<http://catalog.ucdenver.edu/cu-denver/graduate/schools-colleges-departments/college-engineering-design-computing/engineering-applied-science-phd/>) degree is available through the Department of Mechanical Engineering. The areas of research interest in which a student may undertake studies at the Denver campus include manufacturing processes, fluid mechanics, solid mechanics, bioengineering, energy thermodynamics, and composite materials.

As a student in the MS, MEng, or PhD program, you must meet with your graduate advisor before or during your first semester and design a sequence of elective courses that form a coherent program plan.

Concurrent Bachelor's/Master's Degrees

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 12 credit hours of 5000-level or above

courses applying to both degrees. The 5000-level courses must meet the degree requirements for the graduate degree 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 four 5000-level courses does not guarantee admission into the graduate program. Please see an advisor for restrictions and guidelines.

Engineering and Applied Science PhD Program

The engineering and applied science doctor of philosophy program consists of studies in engineering and engineering-related disciplines. It is a multidisciplinary program in keeping with the interdisciplinary nature of modern research. The degree is conferred by the College of Engineering Design and Computing. However, applicants to the degree program apply to and enter the program through one of four departments, called the host department, of the college. The applicant chooses their host department based on their intended primary concentration of study. The four departments of the college that serve as host departments are Civil Engineering, Computer Science and Engineering, Electrical Engineering, and Mechanical Engineering. Each host department offers several concentrations. The secondary concentration is chosen in consultation with your PhD advisor. The coursework in the primary and secondary areas must consist of ten courses (30 semester hours). In addition to other courses, a student must take at least five courses in his/her primary area of concentration and at least three courses in a secondary area of concentration. Other courses may be recommended by the student's advisor. Research that spans across two or more of the five college departments is strongly encouraged and is a major strength of the program.

Admissions to Mechanical Engineering

All applicants should apply online at: www.ucdenver.edu/academics/colleges/Graduate-School/prospective/Pages/apply.aspx (<http://www.ucdenver.edu/academics/colleges/Graduate-School/prospective/Pages/apply.aspx>)

Inquiries about graduate study in mechanical engineering should be addressed to:

CU Denver Department of Mechanical Engineering

Campus Box 112
P.O. Box 173364
Denver, CO 80217-3364

mechanical@ucdenver.edu

Applicants who are not citizens or permanent residents of the United States should make application through the

Office of International Admissions

Campus Box 185
P.O. Box 173364
Denver, CO 80217-3364

(See the International Students (<http://catalog.ucdenver.edu/cu-denver/graduate/international-admissions/>) section of the catalog.) All applicants for admission must submit complete credentials as outlined in the instructions that accompany the application materials.

Programs

- Engineering and Applied Science, PhD (<http://catalog.ucdenver.edu/cu-denver/graduate/schools-colleges-departments/college-engineering-design-computing/mechanical-engineering/engineering-applied-science-phd/>)
- Mechanical Engineering, MEng (<http://catalog.ucdenver.edu/cu-denver/graduate/schools-colleges-departments/college-engineering-design-computing/mechanical-engineering/mechanical-engineering-meng/>)
- Mechanical Engineering, MS (<http://catalog.ucdenver.edu/cu-denver/graduate/schools-colleges-departments/college-engineering-design-computing/mechanical-engineering/mechanical-engineering-ms/>)

Faculty

Full Professors:

Kristin Wood, PhD, California Institute of Technology

Associate Professors:

R. Dana Carpenter, PhD, Stanford University

Kannan N. Premnath, PhD, Purdue University

Kai Yu, PhD, Georgia Tech

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:

Brecca Gaffney, PhD, University of Denver

Guoying Dong, PhD, McGill University

Linyue Gao, PhD, Iowa State University

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

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, PE-Texas

J. Kenneth Ortega, PhD, University of Colorado Boulder

Mechanical Engineering (MECH) Courses

MECH 5020 - 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. Restriction: Restricted to CEDC graduate students. Cross-listed with MECH 4020. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to graduate standing majors in the College of Engineering, Design and Computing

Typically Offered: Summer.

MECH 5025 - 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 or MECH 5020. Restriction: Restricted to CEDC graduate students. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: MECH 4020 or MECH 5020. Restriction: Restricted to CEDC graduate students.

Typically Offered: Fall, Spring.

MECH 5030 - 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 4030. Term offered: fall, spring. Max hours: 3 Credits.

Grading Basis: Letter Grade

Typically Offered: Fall, Spring.

MECH 5110 - 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. Restriction: Restricted to CEDC graduate students. Cross-listed with MECH 4110. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to graduate students

Typically Offered: Fall, Spring.

MECH 5114 - 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. restriction: Restricted to CEDC graduate students. Cross-listed with MECH 4114. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to graduate standing majors in the College of Engineering, Design and Computing

MECH 5120 - 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: Graduate standing or permission of instructor required. Cross-listed with MECH 4120. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to graduate students

MECH 5121 - Introduction to Fluid Dynamics (3 Credits)

Physical properties of gases and liquids; kinematics of flow fields; equations describing viscous, heat-conducting Newtonian fluids. Exact solutions and rational approximations for low- and high-speed dissipative flows, surface and internal waves, acoustics, stability, and potential flows. Graduate standing or permission of instructor required. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to graduate students

MECH 5122 - Macroscopic Thermodynamics (3 Credits)

Axiomatic presentation of fundamentals of classical thermodynamics (first law); energy, work and heat. Equilibrium, reversible, and irreversible processes; entropy production and the second law. Applications to stability and phase equilibrium. Irreversible thermodynamics and the Onsager reciprocal relations. Restriction: Graduate standing or permission of instructor required. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to graduate students

MECH 5123 - Introduction to Continuum Mechanics (3 Credits)

Cartesian tensor notation. Deformation, strain, strain rate and compatibility. Definition of stress vector and tensor. Fundamental balance laws of mass, momentum and energy; entropy production inequality. Constitutive equations for elastic, viscoelastic and plastic materials; ideal, compressible, and viscous fluids. Beltrami-Mitchell and Navier-Stokes equations. Restriction: Graduate standing or permission of instructor required. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to graduate students

MECH 5124 - Yield-Limited Behavior of Materials (3 Credits)

Analysis of material behavior within the "elastic range," with emphasis on the phenomenon of yield and factors that influence it. Examination of the theory of dislocations; study of strengthening mechanisms in solids. Consideration of various time-dependent but reversible (inelastic) deformation phenomena. Presentation of appropriate engineering case studies to augment various topics. Graduate standing or permission of the instructor required. Prereq: MECH 5143 with a grade of B- or higher. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: MECH 5143 with a grade of B- or higher Restriction: Restricted to graduate standing or higher

MECH 5133 - Theory of Inelastic Materials (3 Credits)

Mathematical theory of linear viscoelasticity. Finite elements models. Solution of boundary-value problems in linear viscoelasticity. Non-Newtonian flow. Selected topics in nonlinear material behavior. Graduate standing or permission of the instructor required. Prereq: MECH 5143 with a B- or higher. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: MECH 5143 with a grade of B- or higher Restriction: Restricted to graduate standing or higher

MECH 5141 - Viscous Flow (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. Restriction: Restricted to CEDC graduate students. Cross-listed with MECH 4141. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to graduate standing majors in the College of Engineering, Design and Computing

MECH 5142 - Statistical Thermodynamics (3 Credits)

Introduces the molecular interpretation and calculation of thermodynamic properties of matter, thermodynamic probability, distribution functions, Schrodinger wave equations and solutions and ensemble theory. Applications to ideal and real gases, solids, liquids, radiation, conduction electrons, and chemical equilibrium. Restriction: Graduate standing or permission of instructor required. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to graduate students

MECH 5143 - Theory of Elasticity (3 Credits)

Review of the basic equations of linear theory of elasticity. St. Venant torsion and flexure. Plane strain, plane stress, and generalized plane stress. Application of conformal mapping and Fourier transform techniques. Restriction: Graduate standing or permission of instructor required. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to graduate students

MECH 5144 - Plasticity and Creep (3 Credits)

Inelastic deformation of materials such as metals, alloys, glasses, composites and polymers from the phenomenological and structural point of view. Case studies of plastic and creep deformations in engineering materials. Prereq: MECH 5143 with a grade of B- or higher and graduate standing or permission of the instructor required. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: MECH 5143 with a grade of B- or higher Restriction: Restricted to graduate standing or higher

MECH 5161 - Compressible Flow (3 Credits)

Energy, continuity, and momentum principles applied to compressible flow; one-, two-, and three-dimensional subsonic, supersonic and hypersonic flows. Normal and oblique shocks, and method of characteristics. Prereq: MECH 5141 with a grade of B- or higher and graduate standing or permission of the instructor required. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: MECH 5141 with a B- or higher Restriction: Restricted to graduate standing or higher

MECH 5162 - Heat Transfer I (3 Credits)

Review of equations governing transport of heat by conduction and radiation. Analytical and numerical solution of boundary value problems representative of heat conduction in solids. Radiation properties of solids, liquids and gases; transport of heat by radiation. Prereq: Graduate standing or permission of instructor required. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to graduate students

MECH 5163 - Dynamics (3 Credits)

Review of Newtonian dynamics, Lagrange's equation 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. Restriction: Restricted to CEDC graduate students. Cross-listed with MECH 4163. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to graduate standing majors in the College of Engineering, Design and Computing

Typically Offered: Fall, Spring.

MECH 5166 - 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. Prereq: Graduate standing or permission of instructor required. Cross-listed with MECH 4166. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to graduate students

MECH 5172 - Heat Transfer II (3 Credits)

Review of equations governing transport of heat in fluids in motion. Description of heat transfer in free and forced convection, including laminar and turbulent flow. Dimensional analysis and heat transfer correlations, numerical methods and combined heat transfer mechanisms. Graduate standing or permission of the instructor required. Prereq: MECH 5141 with a B- or higher. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: MECH 5141 with a B- or higher Restriction: Restricted to graduate standing or higher

MECH 5175 - Finite Element Stress Analysis (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. Graduate standing or permission of the instructor required. Prereq: MECH 5143 with a B- or higher. Cross-listed with MECH 4175. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: MECH 5143 with a grade of B- or higher Restriction: Restricted to graduate standing or higher

MECH 5177 - Renewable Energy (3 Credits)

This course bridges the introductory and intermediate levels for renewable energy and the intermediate levels for wind energy. It offers cutting-edge insights into renewable energy, with a focus on wind energy, covering topics such as renewable energy sources, wind resource assessment, wind turbine aerodynamics, wind turbine wake modeling, wind farm simulation, and wind farm layout optimization. Various state-of-the-art tools widely utilized in academia and industry will be introduced. Restriction: Restricted to graduate students in the College of Engineering, Design, and Computing. Cross-listed with MECH 4177. Term offered: Spring. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to graduate students

Typically Offered: Spring.

MECH 5178 - 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. Prereq: Graduate standing or permission of instructor required. Cross-listed with MECH 4178. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to graduate students

MECH 5180 - Advanced Heat Transfer (3 Credits)

This course provides fundamental concepts and applicable mathematical techniques for understanding the physics of various modes of heat transfer. Topics include heat conduction in finite and semi-infinite domains, phase change, microscale heat conduction, laminar forced and free convection, turbulence forced and free convection, and thermal radiation. Prereq: Graduate standing or permission of instructor required. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Graduate level students.

MECH 5182 - Microscale Transport Phenomena (3 Credits)

This course provides the foundations on the physics of microscale transport phenomena, where continuum effects break down, with applications in MEMS and NEMS. Topics include gas microflows, liquid microflows, surface tension-driven flows, electrokinetics transport, kinetic theory, simulation techniques, lattice Boltzmann methods. Restriction: Restricted to graduate students in the College of Engineering, Design and Computing. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to graduate standing majors in the College of Engineering, Design and Computing

MECH 5188 - Introduction to Turbulence (3 Credits)

This course provides an introduction to turbulence, which is ubiquitous in nature and having a wide range of applications in engineering. The chaotic phenomena in such a class of flows poses major challenges in their understanding and modeling. The topics covered in this course include the statistical 4 tools and spectral analysis for turbulence description, basic equations of motion and flow instability, Reynolds decomposition of flow, energy transport by mean and turbulence motions, turbulence scales, vortex motion, classical turbulent flow configurations, such as free shear flows (jets, wakes, mixing layers) and wall bounded flows (channels, boundary layers), Kolmogorov and other phenomenological theories, and turbulence modeling. Restriction: Restricted to students with graduate standing, or permission of instructor. Cross-listed with MECH 4188. Term offered: Fall, Spring. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to students with graduate standing.

Typically Offered: Fall, Spring.

MECH 5208 - Special Topics (3 Credits)

Subject matter to be selected from topics of current technological interest. Credit to be arranged. Restriction: Restricted to CEDC graduate students. Cross-listed with MECH 4208. Repeatable. Max hours: 9 Credits.

Grading Basis: Letter Grade

Repeatable. Max Credits: 9.

Restriction: Restricted to graduate standing majors in the College of Engineering, Design and Computing

Typically Offered: Fall, Spring.

MECH 5228 - Special Topics (3 Credits)

Restriction: Restricted to CEDC graduate students. Repeatable. Max hours: 9 Credits.

Grading Basis: Letter Grade

Repeatable. Max Credits: 9.

Restriction: Restricted to graduate standing majors in the College of Engineering, Design and Computing

Typically Offered: Fall, Spring, Summer.

MECH 5238 - Special Topics (1-3 Credits)

Restriction: Graduate standing or permission of the instructor required.

Repeatable. Max hours: 9 Credits.

Grading Basis: Letter Grade

Repeatable. Max Credits: 9.

Restriction: Restricted to graduate students

MECH 5840 - Independent Study (1-3 Credits)

Available only through approval of the graduate advisor. Subjects arranged to fit needs of the particular student. Restriction: Graduate standing or permission of the instructor required. Repeatable. Max hours: 6 Credits.

Grading Basis: Letter Grade with IP

Repeatable. Max Credits: 6.

Restriction: Restricted to graduate students

MECH 5939 - Internship (1-3 Credits)

Students gain engineering design experience involving application of specific technical concepts and skills in a supervised industrial environment. (Must have approval from MECH faculty.) Max hours: 3 Credits.

Grading Basis: Letter Grade

MECH 5950 - Master's Thesis (3 Credits)

Restriction: Graduate standing or permission of the instructor required.

Repeatable. Term offered: Fall, Spring, Summer. Max hours: 6 Credits.

Grading Basis: Letter Grade with IP

Repeatable. Max Credits: 6.

Restriction: Restricted to graduate students

Additional Information: Report as Full Time.

Typically Offered: Fall, Spring, Summer.

MECH 5960 - Master's Report (3 Credits)

Master of Science in Engineering report. Students seeking the Master of Science in Engineering, and who do not choose to do a thesis, must complete an individual project of an investigative and creative nature under the supervision of a member of the graduate faculty. Restriction: Graduate standing or permission of the instructor required. Repeatable. Max hours: 6 Credits.

Grading Basis: Letter Grade with IP

Repeatable. Max Credits: 6.

Restriction: Restricted to graduate students

Additional Information: Report as Full Time.

MECH 5970 - Graduate Problem Course (3 Credits)

The graduate problem course is for the solution of specific problems in MECH specialty areas. Each student is assigned a set of problems of some difficulty requiring the use of the literature of the various areas covered. Prereq: 15 hours of graduate level courses in MECH. Max Hours: 3 Credits.

Grading Basis: Letter Grade

MECH 6184 - Advanced Fluid Mechanics (3 Credits)

This course provides a description of the advanced concepts for understanding the physics of fluid motion under different regimes. Topics include kinematics, stresses, equation of motion, vorticity transport, low Reynolds number flow, irrotational flow, interfacial flow, acoustics&waves, hydrodynamic stability & transition, turbulent flow. Prereq: MECH 5141.

Restriction: Restricted to students with graduate standing, or permission of instructor. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: MECH 5141. Restriction: Restricted to students with graduate standing.

MECH 8990 - Doctoral Dissertation (1-10 Credits)

Restriction: Graduate standing or permission of the instructor required.

Repeatable. Max hours: 10 Credits.

Grading Basis: Letter Grade with IP

Repeatable. Max Credits: 10.

Restriction: Restricted to graduate students

Additional Information: Report as Full Time.

Typically Offered: Fall, Spring.