Mechanical Engineering

M.Engr. in Mechanical Engineering (https://catalog.und.edu/graduateacademicinformation/departmentalcoursesprograms/engineering/mechanicalengineering/me-meng/)

M.S. in Mechanical Engineering (https://catalog.und.edu/graduateacademicinformation/departmentalcoursesprograms/engineering/mechanicalengineering/me-ms/)

Ph.D. in Mechanical Engineering (https://catalog.und.edu/graduateacademicinformation/departmentalcoursesprograms/engineering/mechanicalengineering/me-phd/)

M.Engr. in Systems Engineering (https://catalog.und.edu/graduateacademicinformation/departmentalcoursesprograms/engineering/mechanicalengineering/me-mengr-uase/)

M.S. in Systems Engineering (https://catalog.und.edu/graduateacademicinformation/departmentalcoursesprograms/engineering/mechanicalengineering/me-ms-uase/)

Graduate Certificate in Systems Engineering (https://catalog.und.edu/graduateacademicinformation/departmentalcoursesprograms/engineering/mechanicalengineering/me-cert-uase/)

ME 514. High Temperature Materials. 3 Credits.
Course Objectives: The objective of this course is to provide students with their first in-depth exposure to high temperature materials, with a primary focus on ceramics and ceramics matrix composites. This course covers the fundamentals of mechanics and microstructure of structural materials for different high-temperature applications. The main emphasis during this course will be ceramic based materials. In addition, other high temperature materials like superalloys, Carbon, and their composites will be also covered. During this course, fundamental topics like bonding, structure, defects, sintering and grain growth, oxidation, and phase equilibria will be covered in detail. In addition, students will also get exposure to the mechanisms of time-dependent deformation, failure mechanism at high temperature, and thermal properties. Finally, different materials used at high temperature (metals, ceramics and their composites) will be reviewed. The successful completion of this course will prepare students for interdisciplinary problem solving and development of high temperature materials from both industrial and research context. Prerequisite: ME 301. S, even years.

ME 515. Advanced Processing of Materials and Biomaterials. 3 Credits.
In this course, students will develop fundamental and applied understanding about biomaterials. More particularly, they will develop strong understanding about processing, mechanical and surface behavior, and degradation mechanisms of biomaterials at microscopic and macroscopic levels. In addition, students will do case studies on specialized topics like wound healing, cell interaction, and dental materials, among others. Prerequisite: ME 301 or consent of instructor. S, odd years.

ME 523. Advanced Machine Design. 3 Credits.
Advanced design and analysis of machine components; kinematic synthesis and analysis of mechanisms, force analysis, rotor dynamics, gyrodynamics, stresses in thick cylinders and flywheels, lubrication, statistical considerations, energy methods, curved beams. Prerequisite: ME 322 and ME 323.

ME 524. Deformation and Fracture. 3 Credits.
Aspects of elasticity theory, continuum mechanics and fracture mechanics. Fundamental relationships between material structure and engineering properties. Principles and properties of composite materials. Prerequisite: ME 301 or consent of instructor.

ME 525. Metal Fatigue in Engineering. 3 Credits.
Metal fatigue in engineering, involving design, development, and failure analysis of components, structures, machines, and vehicles subjected to repeated loading. Prerequisite: ENGR 203 and ME 301, or consent of instructor.

ME 526. Advanced Vibrations. 3 Credits.
Advanced vibration theory including the solutions of multi-degree of freedom coupled systems, continuous systems, energy methods, and non-linear vibrations. Prerequisite: ME 426.

ME 529. Advanced Finite Element Methods. 3 Credits.
Computer-aided techniques for finite element analysis of engineering systems. Topics include solution algorithm for nonlinear methods, large deflection, inelastic and contact analysis, and analysis of vibrating systems. Prerequisite: ME 429 or consent of instructor.

ME 530. UAS in Engineering Design and Applications. 3 Credits.
Students will be exposed to the emerging role UAS play in both engineering design and applications. Students will study the distinctive requirements when designing or developing components and/or specialized applications used by the UAS industry. Proper mission planning techniques that utilize the unique capabilities of UAS and appropriate regulatory and legal use of UAS will be covered. These objectives will be accomplished through in-class lectures and special guest presentations by leaders in the field, as well as teams of students demonstrating their competence in a capstone engineering design and/or application project. Prerequisite: Consent of Instructor. S, odd years.

ME 532. Advanced Dynamics. 3 Credits.
Kinematics and kinetics of plane and three-dimensional motion, vector mechanics, general methods of linear and angular momentum, generalized coordinates, and variational methods including Hamilton's and Lagrange's equations. Prerequisite: ENGR 202 and MATH 266.

ME 542. Thermodynamics of Materials. 3 Credits.
Foundations of materials behavior in terms of energy and statistics. Topics will include entropy, free energy, phase equilibrium, ideal versus real solutions and diffusion. Prerequisite: ME 301 and ME 341, or consent of instructor.

ME 545. Fluidized-Bed Combustion Engineering. 3 Credits.
Fluidized-bed hydrodynamics and heat transfer. Design of fluidized-bed coal combustors. Combustion models and their significance. Prerequisite: ME 306 and ME 474, or consent of instructor.

ME 562. Graduate Seminar in Mechanical Engineering. 1 Credit.
This course exposes students to research topics in mechanical engineering and related disciplines. Students will learn how to present their research in technical presentations and papers. Prerequisite: Consent of instructor. Repeatable to 3.00 credits. S/U grading. F,S.

ME 566. Introduction to Machine Vision. 3 Credits.
An introduction to machine vision providing students with a general understanding of the imaging process, feature extraction and matching, object detection and tracking, model fitting, and camera pose estimation. Prerequisite: ME 322, ENGR 200, and MATH 266. F, even years.

ME 574. Advanced Heat Transfer. 3 Credits.
Advanced conduction in isotropic media in two and three dimensions steady and unsteady problems. Advanced convection including solution of Prandtl Boundary layer equations. Numerical methods, Fourier series, Bessel functions, LaPlace transforms, and error functions. Radioactive heat transfer. Prerequisite: ME 474 or consent of instructor.

ME 575. Conduction and Radiation Heat Transfer. 3 Credits.
Advanced study of conduction and radiation heat transfer. Solution methodologies to classical heat conduction problems will be introduced. Topics include: multidimensional steady conduction via separation of variables and principle of superposition; transient conduction with time-dependent boundary conditions via method of complex temperatures; numerical solutions to heat conduction problems; spectral dependence of radiation; blackbody and gray surface radiation; radiation exchange between surfaces; radiation shield. Prerequisite: ME 474 or consent of instructor.

ME 576. Convective Heat Transfer. 3 Credits.
Advanced study of convective heat transfer, involving developing an understanding of boundary layers, flow in pipes, and convective heat transfer processes. Topics include the concepts of boundary layers, laminar and turbulent flow on surfaces and inside of pipes, and turbulence models. Analytical tools introduced are useful for estimating or bounding heat transfer rates when correlations are not available. Prerequisite: ME 474.

ME 580. Introduction to Autonomous Robotics. 3 Credits.
An introduction to autonomous mobile robots including hardware, modeling, sensors, and basic localization and mapping techniques. Prerequisite: ME 322, ENGR 200, and MATH 266. F, odd years.

ME 590. Special Topics. 1-6 Credits.
Investigation of special topics dictated by student and faculty interests. May be repeated up to a total of 6 credits. Prerequisite: Departmental approval. Repeatable to 6.00 credits.

ME 591. Research in Mechanical Engineering. 1-6 Credits.
Independent graduate research in Mechanical Engineering. Repeatable to 6 credits. Repeatable to 6.00 credits.

ME 595. Design Projects. 3-6 Credits.
A three to six credit course of engineering design experience involving individual effort and formal written report. Prerequisite: Restricted to Master of Engineering students and subject to approval by the student's advisor.

ME 597. Graduate Cooperative Education. 1-2 Credits.
A practical work experience with an employer closely associated with the student's academic area. Arranged by mutual agreement among student, department, and employer. A written report will be submitted by the student to their advisor at the completion of the course. Prerequisite: Approval of ME graduate director and student's graduate advisor; must be legally eligible to work at the site. Repeatable to 4.00 credits. S/U grading. On demand.

ME 599. Doctoral Research. 1-15 Credits.
Independent doctoral research work in mechanical engineering contributing to the student's doctoral dissertation. Prerequisite: Admission to the PhD in Mechanical Engineering program. Repeatable. F,S,SS.

ME 996. Continuing Enrollment. 1-12 Credits.
Repeatable. S/U grading.

ME 997. Independent Study. 2 Credits.
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ME 998. Thesis. 1-6 Credits.
Development and documentation of scholarly activity demonstrating proficiency in Mechanical Engineering at the master's level. Repeatable to 6.00 credits. F,S,SS.

ME 999. PhD Student Doctoral Dissertation. 1-18 Credits.
PhD student doctoral dissertation. Prerequisite: Admission to the PhD in Mechanical Engineering Program and consent of the instructor. Repeatable to 18.00 credits. S/U grading. F,S,SS.

Undergraduate Courses for Graduate Credit

ME 417. Friction, Wear and Lubrication. 3 Credits.
Tribology is the study of friction, wear and lubrication. This is an interdisciplinary discipline which requires knowledge on surface science, fundamental laws of physics, chemistry, materials science and manufacturing. Course topics include friction on different materials, wear mechanisms, lubrication regimes, surface metrology, gear and bearing failures, green tribology and tribological opportunities in additive manufacturing. Prerequisite: ME 301. On demand.

ME 420. Composite Materials. 3 Credits.
The course covers the mechanics of composite laminates and plates, composite manufacturing processes, and composite testing techniques. Prerequisite: ME 301. On demand.

ME 424. Systems Dynamics and Control. 3 Credits.
Theory, analysis, and design of linear closed-loop control systems containing electronic, hydraulic, and mechanical components. Differential equations. LaPlace transforms, Nyquist and Bode diagrams are covered. Prerequisite: MATH 266 and ME 322. On demand.

ME 425. Numerical Methods for Engineers Using Advanced MATLAB Programming Techniques. 3 Credits.
In this course, numerical methods for solving differential equations, advanced Matlab programming techniques and their applications to practical engineering problems will be presented. Topics covered include Matlab programming, solving systems of equations, linear algebra, function and data manipulation, and differential equations. For students who enroll for graduate credit, they will apply class concepts to solve an engineering problem related to their research problems as a course project. Prerequisite: ENGR 200 and MATH 266. S.

ME 426. Mechanical Vibrations. 3 Credits.
Vibration analysis and design as it applies to single and multi degree freedom mechanical systems, isolation and absorption of vibration, vibration of continuous systems, numerical methods of solution. Prerequisite: ENGR 202 with a grade of C or better and MATH 266. S.

ME 428. Advanced Manufacturing Processes. 3 Credits.
Individual projects involving the manufacturing economics and flow charts for selected products and basic technical principles of manufacturing processes. Includes laboratory. Prerequisite: ME 418. On demand.

ME 429. Introduction to Finite Element Analysis. 3 Credits.
Finite element analysis is introduced as a design tool. Emphasis is given to modeling techniques and element types. Matrix methods are used throughout the class. Prerequisite: ENGR 203 with a grade of C or better. On demand.

ME 439. Introduction to Robotics. 3 Credits.
A systems engineering approach to robotics. Presents an introduction to manipulators, sensors, actuators, and end effectors for automation. Topics covered include kinematics, dynamics, control, programming of manipulators, pattern recognition, and computer vision. Prerequisite: ENGR 200 with a grade of C or better and MATH 166 with a grade of C or better. On demand.

ME 446. Gas Turbines. 3 Credits.
General principles, thermodynamics, and performance of gas turbine engines. Design consideration of engine components. Prerequisite: ME 341 with a grade of C or better. On demand.

ME 449. Internal Combustion Engines. 3 Credits.
Fundamentals of spark ignition and compression ignition engines, related components and processes. Prerequisite: ME 341 with a grade of C or better. On demand.

ME 451. Heating and Air Conditioning. 3 Credits.
Psychometrics, heating and cooling loads and analysis of air conditioning systems. Prerequisite: ME 341 with a grade of C or better and ME 306. On demand.

ME 464. Computational Fluid Dynamics. 3 Credits.
Computational fluid dynamics (CFD) is an introductory course focused on the numerical solution of partial differential equations (PDEs) using finite difference and finite volume methods. The course topics include the governing equations in fluid dynamics, classification of PDEs, boundary and initial conditions of PDEs, numerical discretization methods, analysis of numerical methods, model equations for incompressible and compressible flows, numerical methods suitable for model equations, and numerical linear algebra. Advanced topics in grid generation and turbulence modeling, important to practical applications of CFD, will also be discussed. Prerequisite: ME 341 with a grade of C or better, ME 306, and MATH 266. On demand.

ME 466. Aerodynamics. 3 Credits.
This is a course on the fundamentals of aerodynamics for engineers. The course will cover a review of fluid mechanics including inviscid, incompressible, and compressible flows. The course topics include parameters for airfoils and wings, incompressible flow over airfoils and wings of infinite and finite span, shock and expansion waves, quasi-one-dimensional compressible flow through nozzle, subsonic compressible flow over airfoils, supersonic flow over thin airfoils, introduction to viscous flow, and laminar and turbulent boundary layers. Prerequisite: ME 341 with a grade of C or better and ME 306. S.

ME 476. Intermediate Fluid Mechanics. 3 Credits.
Differential forms of conservation of mass, energy, and momentum for viscous fluid flow. Boundary layer theory and its applications. Principles of one-dimensional compressible flow. Prerequisite: ME 341 with a grade of C or better, ME 306, and MATH 266. On demand.

ME 477. Compressible Fluid Flow. 3 Credits.
Introduction to the theory and application of one-dimensional compressible flow. Course topics include isentropic flow in converging and converging/diverging nozzles, normal shock waves, oblique shock waves, Prandtl-Meyer flow, flow with friction and heat addition. Prerequisite: ME 341 with a grade of C or better and ME 306. On demand.

ME 484. Ground Vehicle Dynamics. 3 Credits.
ME 484 is a junior and senior level elective course. This course deals with the design of ground vehicle suspension and steering systems. Vehicle ride, handling and safety systems are covered along with passive and active suspension control. Prerequisite: ME 322. On demand.

ME 485. Multiphysics Modeling. 3 Credits.
Theory and techniques of modeling coupled thermal, fluid, mechanical, and/or electrical fields in components design. The focus is on the fundamental techniques used to simultaneously derive and solve coupled equations and the use of commercial multi physics finite element software. Prerequisite: ME 323. S.

ME 490. Special Laboratory Problems. 1-3 Credits.
Laboratory investigations of interest to students and faculty. Repeatable to maximum of 6 credits. Prerequisite: Consent of instructor. Repeatable to 6.00 credits. On demand.