MECHANICAL ENGINEERING (MECH_ENG)

MECH_ENG 222-0 Thermodynamics & Statistical Mechanics - I (1 Unit)
Basic thermodynamics, applications to energy efficiency and climate change, and introduction to statistical thermodynamics. Prerequisite: MATH 220-2 and GEN_ENG 205-3.

MECH_ENG 224-0 Scientific and Embedded Programming in Python (1 Unit)   Python is arguably now the world's foremost programming language. It is the go-to coding language for data scientists, machine learning researchers, design engineers, and anyone who needs to grab and process the vast amounts of data online, from networked sensors, or smart devices. Recently Python has become practical for coding in embedded systems, as well. Embedded microcontrollers are relevant for our annual robot design competition, NU engineering teams (Solar car, Baja), internships, and experimental apparatuses. Our approach to coding emphasizes algorithm creation, debugging, methodical creation and partitioning in a modern notebook framework, as well as hardware-level access for microcontroller applications. The course is taught in an active learning format. Prerequisite: GEN_ENG 205-1 or GEN_ENG 206-1.

MECH_ENG 233-0 Electronics Design (1 Unit)   Design and prototyping of analog and digital electronic circuits using semiconductor devices: diodes, transistors, op amps, logic chips, etc. Optical and other sensors, power electronics, filters, and feedback control. Extensive hands-on construction and debugging. Intended for engineers in all disciplines.

MECH_ENG 240-0 Intro to Mechanical Design and Manufactrng (1 Unit)
Introduction to strategy and methods of designing, manufacturing, and testing of mechanical products. Material properties and selection methodology, engineering drawing and CAD, and simple manufacturing processes. Prerequisites: MAT_SCI 201-0; CIV_ENV 216-0.

MECH_ENG 241-0 Fluid Mechanics I (1 Unit)   Fundamentals of fluid mechanics. Properties and statics of fluids. Kinematics and dynamics of fluid motion-continuity, momentum, and energy equations. Dimensional analysis, flow in closed conduits. Prerequisites: MATH 228-2 (may be taken concurrently) and GEN_ENG 205-4.

MECH_ENG 301-0 Introduction to Robotics Laboratory (1 Unit)   A laboratory-based introduction to robotics. Focus will be on both hardware (sensors and actuators) and software (sensor processing and behavior development). Topics will include: the basics in kinematics, dynamics, control and motion planning; and an introduction to Artificial Intelligence (AI) and Machine Learning (ML). Cross-listed as COMP_SCI 301-0.

MECH_ENG 314-0 Machine Dynamics (1 Unit)
This class covers the foundations of rigid multi-body mechanics. Topics include geometry of rigid bodies, rotating bodies, Lagrangian mechanics and variational principles, conservation of energy and momentum, symmetries, impact dynamics, and numerical methods that may be used to simulate mechanical systems. Students numerically simulate rigid body systems and use rigid body geometry to visualize simulations. Prerequisite: GEN_ENG 205-4.

MECH_ENG 315-0 Theory of Machines: Design of Elements (1 Unit)
Factors influencing the proportioning of machine elements-stresses, deformations, and failure criteria-as applied to shafts, springs, belts, bearings, gears. Lectures, laboratory. Prerequisite: MECH_ENG 240-0.

MECH_ENG 316-0 Mechanical Systems Design (1 Unit)
Design of mechanical systems such as cams, multi-bar linkages, and precision machines. Design principles and best practices. Case studies and team-based projects.

Prerequisite: MECH_ENG 315-0.

MECH_ENG 320-0 Micro- and Nanomechanical Properties of Surfaces (1 Unit)
Micro and nanomechanical interactions between surfaces, fractal nature of surfaces, interfacial forces, principles of micromechanics, characterization of surfaces using atomic force microscopy, optical interferometry, and nanoindentation.

MECH_ENG 322-0 Thermodynamics and Statistical Mechanics II (1 Unit)
Classical and statistical thermodynamics.
Prerequisite: MECH_ENG 222-0.

MECH_ENG 327-0 Finite Elements for Stress Analysis (1 Unit)
Development of finite elements from variational principles and application to static stress analysis. Introduction to techniques for transient and generalized field problems. Computer implementation of finite element techniques. Taught with CIV_ENV 327-0; may not receive credit for both courses.

MECH_ENG 328-0 Computational Failure Analysis (1 Unit)
The course will cover the use of the scientific method for accident investigation, hypothesis development, and the use of the finite element method to analyze the root cause of a failure. Practical application problems for both civil and mechanical structures will be analyzed using commercial finite element codes (Abaqus, Hypermesh, LS-Dyna).
Prerequisite: CIV_ENV 327-0 or MECH_ENG 327-0.

MECH_ENG 329-0 Mechanistic Data Science for Engineering (1 Unit)
Introduce mechanistic data science for engineering through the integration of mathematical scientific principles using six basic#data science concepts: multimodal data generation and collection, extraction of mechanistic features, knowledge-driven dimension reduction, reduced order surrogate models, regression and classification models, and system and design. These concepts will be implemented using Python and MATLAB for engineering applications.

MECH_ENG 333-0 Introduction to Mechatronics (1 Unit)
Introduction to microprocessor-controlled electromechanical systems. Interfacing sensors and actuators to computers, electrical and mechanical prototyping, dissection of a commercial product. Final team project.
Prerequisite: MECH_ENG 233-0 or ELEC_ENG 221-0 or BMD_ENG 308-0, or consent of instructor.

MECH_ENG 340-1 Computer Integrated Manufacturing: Manufacturing Processes (1 Unit)
Use of computers to improve productivity and reduce costs in the manufacture of discrete parts and assemblies. Manufacturing processes: Analysis and evaluation of process usage in the contemporary manufacturing environment.
Prerequisite: MECH_ENG 240-0 or consent of instructor.

MECH_ENG 340-2 Computer Integrated Manufacturing: CAD/CAM (1 Unit)
Use of computers to improve productivity and reduce costs in the manufacture of discrete parts and assemblies. CAD/ CAM: Geometric modeling, dimensioning systems, tolerances, design for manufacture, programming of machine tools.
Prerequisite: MECH_ENG 340-1 or consent of instructor.

MECH_ENG 340-3 Computer Integrated Manufacturing: Automation (1 Unit)
Use of computers to improve productivity and reduce costs in the manufacture of discrete parts and assemblies. Manufacturing automation: sensors, actuators, and computers for automation; principles

of computer control; programmable logic controllers; robotic devices; assembly automation.
Prerequisite: MECH_ENG 340-2 or consent of instructor.

MECH_ENG 341-0 Computational Methods for Engineering Design (1 Unit)
Introduction to a wide range of computational techniques for engineering design. Modeling, simulation, optimization, design software, examples, and projects with emphasis on computational techniques for design and manufacturing related applications.
Prerequisite: senior standing or consent of instructor.

MECH_ENG 346-0 Introduction to Tribology (1 Unit)
Fundamentals of surface contact: surface topography, asperity contact, interfacial phenomena. Friction theories and wear mechanisms. Temperatures in sliding contacts. Hydrodynamic, hydrostatic, elastohydrodynamic, and boundary lubrication.

MECH_ENG 359-0 Reliability Engineering (1 Unit)
Probability concepts and random variables. Failure rates and reliability testing. Wearin, wear-out, random failures. Probabilistic treatment of loads, capacity, safety factors. Reliability of redundant and maintained systems. Fault tree analysis.
Prerequisite: GEN_ENG 205-4.

MECH_ENG 360-0 Mechanics of Sports (1 Unit)   Applications of mechanics and mathematical modeling to sports, including baseball, basketball, golf, soccer, swimming, and running, among others. Introduction to the biomechanics of sports.

MECH_ENG 362-0 Stress Analysis (1 Unit)
Theory of elasticity: elastic stability, principle of minimum potential energy, Rayleigh-Ritz methods. Introduction to finite element methods of stress analysis: computer implementation and use of commercial codes. Structural analysis of rods, beams, columns, and plates.
Prerequisite: CIV_ENV 216-0.

MECH_ENG 363-0 Mechanical Vibrations (1 Unit)
Analysis of vibrations in single and multi-degree of freedom systems. Free and forced vibrations with various types of damping. Response to steady-state and transient excitations.
Prerequisite: MECH_ENG 314-0.

MECH_ENG 364-0 Introduction to Aerospace Engineering (1 Unit)
The purpose of the course is to learn the language of aerospace engineering and to explore emerging concepts in this field. This course will cover essential topics in areas relevant to aerospace engineering including Aerodynamics, Flight Dynamics, Propulsion, and Orbital Mechanics. Computational tools for structural analysis, fluid flow calculations, and flight dynamics modeling will be introduced.
Prerequisites: CIV_ENV 216-0, MECH_ENG 241-0 or equivalent.

MECH_ENG 366-0 Finite Elements for Design & Optimizatn (1 Unit)
Numerical methods for interaction and optimal CAD. Fully stressed design; design sensitivity analysis and descent methods; optimality criteria to automated design.
Prerequisites: senior standing; MECH_ENG 327-0 or consent of instructor.

MECH_ENG 367-0 Quantitative Methods in Life Cycle Analysis (1 Unit)
Lifecycle analysis (LCA) framework for environmental assessment of technology systems, focusing on modeling methods for systems mass and energy flows, process and input-output-based systems inventories, environmental impact analysis, and methods for robust engineering decisions. MECH_ENG 367-0 is taught with CHEM_ENG 367-0; may not receive credit for both courses.

MECH_ENG 371-0 Combustion Engines (1 Unit)

Theoretical and actual cycles, combustion, detonation, carburetion, fuels, performance characteristics, and fuel-cell power.

MECH_ENG 373-0 Engineering Fluid Mechanics (1 Unit)
Laminar and turbulent duct flows. Boundary layers and potential flows. Lift and drag forces. Thermodynamics and mechanics of compressible flow. Nozzle flows and choking. Wave motion and shock waves. Applications to fluid machinery.
Prerequisite: MECH_ENG 241-0.

MECH_ENG 377-0 Heat Transfer (1 Unit)
Fundamentals of heat transfer by conduction, convection, and radiation. Steady and transient heat conduction in solids. Forced and free convection in fluids. Properties of thermal radiation. Radiation heat transfer between solids. Solar radiation.
Prerequisite: MECH_ENG 241-0.

MECH_ENG 378-0 Applied Computational Fluid Dynamics and Heat Transfer (1 Unit)
This course provides an understanding of the theory and process of computational flow analysis by giving students the opportunity to use commercial simulation software (ANSYS/Fluent) to solve fluid flow problems. Topics covered include conservation of mass, momentum and energy; boundary conditions; turbulence modeling; mesh generation; solution procedures; and verification/validation. Topics will be presented through lectures, hands-on computer lab sessions, and team-based projects.

MECH_ENG 380-0 Thermal Energy Systems Design (1 Unit)
Applications of the principles of energy engineering analysis to the design of thermal systems. Consideration of such systems as air conditioning, oil piping, refrigeration, fluid distribution, and pneumatic control. Projects will be tailored to the class. Solution of open-ended design problems including introduction to EES (Engineering Equation Solver) software that has built-in thermophysical properties.
Prerequisite: Basic Thermodynamics or equivalent.

MECH_ENG 381-0 Introduction to Micro-electro-mechanical Systems (1 Unit)
Introduction to MEMS devices, with an emphasis on their manufacturing and mechanical behavior. Materials properties, microfabrication technology, mechanical behavior of microstructures, design, and packaging. Case studies on sensors, wireless communications, fluidic systems, microengines, and biological devices.
Prerequisite: CIV_ENV 216-0 or consent of instructor.

MECH_ENG 382-0 Experiments in Micro- and Nano Science and Engineering (1 Unit)
Interdisciplinary topics spanning the physical and biological sciences and engineering. Seven integrated labs in which students acquire hands-on experience in various aspects of micro-and nanoscience and engineering: cleanroom microfabrication, flow visualization in micro-channels, nanomechanics, AFM and dippen nanolithography, multiphysics computational tools, and experimental techniques to evaluate micro-and nanoscale devices.
Prerequisite: MECH_ENG 381-0 or consent of instructor.

MECH_ENG 390-0 Intro to Dynamic Systems (1 Unit)
Modeling the dynamic behavior of physical systems. Concepts of causality, dependent and independent storages, and state. Introduction to bond graphs. Generation of state equations; analytical and computer simulation of system behavior. Application to problems of engineering interest.
Prerequisites: MECH_ENG 241-0; CIV_ENV 216-0; GEN_ENG 205-4.

MECH_ENG 395-0 Special Topics in Mechanical Engineering (1 Unit)

Topics suggested by students or faculty members and approved by the department.

MECH_ENG 398-1 Engineering Design I (1 Unit) Experience in the creative process of design. Defining product specifications, developing and analyzing ideas, using CAD drawings, building physical prototypes, demonstrating feasibility, and achieving full alpha-level functionality. Prerequisite: senior standing or consent of department.

MECH_ENG 398-2 Engineering Design II (1 Unit) Experience in the creative process of design. Defining product specifications, developing and analyzing ideas, using CAD drawings, building physical prototypes, demonstrating feasibility, and achieving full alpha-level functionality. Prerequisite: senior standing or consent of department.

MECH_ENG 399-0 Projects (1-3 Units) Special studies to be done under faculty direction. Credit to be arranged.