

# MECHANICAL ENGINEERING (ME)

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## ME F302 Dynamics of Machinery

4 Credits

Offered Fall

Kinematics and dynamics of mechanisms. Analysis of displacements, velocities, accelerations, and forces in linkages, cams and gear systems by analytical, experimental and computer methods. Design applications.

**Prerequisites:** ES F301 (may be taken concurrently); ES F210.

**Lecture + Lab + Other:** 3 + 3 + 0

## ME F308 Instrumentation and Measurement

3 Credits

Offered Spring

Principles of measurement, instrumentation, Laplace transform, Fourier series, transfer function, steady-state response, calibration, and errors.

Signal filtering and amplification, data acquisition, recording, and processing. Methods and devices for measuring strain, force, torque, displacement, velocity, acceleration, pressure, fluid flow properties, and temperature. Mechatronics, sensors, actuators, and controls.

**Prerequisites:** ES F331.

**Lecture + Lab + Other:** 2 + 3 + 0

## ME F313 Mechanical Engineering Thermodynamics

3 Credits

Offered Spring

Investigation and design of power and refrigeration cycles (Rankine, Brayton, Otto, and Diesel), compressible flow (isentropic, shock waves, and flow in ducts with friction), and combustion and gas vapor mixtures.

**Prerequisites:** ES F346.

**Lecture + Lab + Other:** 3 + 0 + 0

## ME F321 Industrial Processes

3 Credits

Offered Fall

Manufacturing processes used in modern industry. Primary and secondary manufacturing processes, casting, hot and cold forming, machining, welding and mass and efficient product design.

**Prerequisites:** Mechanical Engineering major.

**Lecture + Lab + Other:** 2 + 3 + 0

## ME F334 Elements of Material Science/Engineering

3 Credits

Offered Spring

Properties of engineering materials. Crystal structure, defect structure, structure and properties, aspects of metal processing, heat treatment, joining, testing and failure analysis for engineering applications and design.

**Prerequisites:** CHEM F105X and PHYS F212X.

**Lecture + Lab + Other:** 2 + 3 + 0

## ME F402 Advanced Mechanical System Design

3 Credits

Offered As Demand Warrants

Advanced analysis of two- and three-dimensional multi-body mechanical systems. Rigid body system formulation and deformable body system formulation. Application of CAE software for rigid body and large deformable body systems.

**Prerequisites:** ME F302; ME F408.

**Stacked with** ME F602.

**Lecture + Lab + Other:** 3 + 0 + 0

## ME F403 Machine Design

3 Credits

Offered Spring

Design and analysis of machines by analytical, experimental and computer methods. Identification of requirements and conceptual design of mechanical systems, detailed design of components, strength, life, reliability, and cost analysis.

**Prerequisites:** ES F331.

**Lecture + Lab + Other:** 3 + 0 + 0

## ME F405 Computer Aided Design

3 Credits

Offered Every Other Fall

Introduction to principles of computer aided design and engineering.

Applications of software and hardware in solid modeling, design analysis, motion analysis, rapid prototyping, and interface between computer aided design and computer aided manufacturing.

**Prerequisites:** Senior standing.

**Lecture + Lab + Other:** 1.5 + 4.5 + 0

## ME F406 Computer Aided Manufacturing

3 Credits

Offered Every Other Spring

Introduction to computer aided manufacturing (CAM). This includes the principles of computer aided process planning (CAPP) and an introduction to computer numerical control (CNC) tools used in manufacturing. Emphasis will be on methodology with hands-on applications of computer software and specific machine tools.

**Prerequisites:** ME F321; senior standing.

**Lecture + Lab + Other:** 1.5 + 4.5 + 0

## ME F408 Mechanical Vibrations

3 Credits

Offered Fall

Modeling of vibratory mechanical systems with single and multiple degrees of freedom. Study of free and forced vibrations with or without damping by lumped-parameter methods and finite element analysis.

Vibrations of rotor systems and vibration stability.

**Prerequisites:** ES F210, ES F301.

**Lecture + Lab + Other:** 3 + 0 + 0

## ME F409 Controls

3 Credits

Offered As Demand Warrants

Analysis and design of control systems. Block diagrams, transfer functions and frequency analysis. Closed loop systems and system stability. Industrial controllers and system compensation.

**Prerequisites:** ES F301.

**Lecture + Lab + Other:** 3 + 0 + 0

## ME F414 HVAC Systems Optimization (a)

3 Credits

Offered As Demand Warrants

Design of thermal and heating, ventilation, and air-conditioning (HVAC) systems with emphasis on economic considerations and optimization. Concepts of thermodynamics, fluid mechanics and heat transfer will be integrated under a design framework. A semester long project is conducted to design a thermal system, perform system simulations, and to optimize the design based on economic and technical considerations.

**Prerequisites:** ES F341; ES F346.

**Lecture + Lab + Other:** 3 + 0 + 0

**ME F415 Thermal Systems Laboratory (W)**

3 Credits

Offered Spring

Testing and evaluation of components and energy systems such as pumps, fans, engines, heat exchangers, refrigerators and heating/power plants.

**Prerequisites:** ME F308 (may be taken concurrently); WRTG F111X; ES F341; ME F313; ME F441.

**Lecture + Lab + Other:** 1.5 + 4.5 + 0

**ME F416 Design of Mechanical Equipment for the Petroleum Industry (a)**

3 Credits

Offered Fall

Design, selection and operation of equipment used in production and processing of crude oil and gas. Instrumentation and control systems used with mechanical equipment.

**Prerequisites:** ES F341; ES F346.

**Lecture + Lab + Other:** 3 + 0 + 0

**ME F440 Introduction to Microfluidics**

3 Credits

Offered Spring Odd-numbered Years

Overview of basic concepts and principles of fluids at the micron scale; introduction to the design and fabrication of microfluidic devices.

**Prerequisites:** ES F341 (may be taken concurrently); PHYS F103X (for Math and non-Physics science major); PHYS F211X (for Engineering, Math and Physics major); junior standing.

**Stacked with** ME F640.

**Lecture + Lab + Other:** 3 + 0 + 0

**ME F441 Heat and Mass Transfer**

3 Credits

Offered Fall

Application of heat and mass transfer concepts to engineering problems including steady state and transient conduction, numerical analysis of heat transfer problems, laminar and turbulent free and forced convection, and black body and real surface radiation.

**Prerequisites:** ES F301; ES F341; ES F346.

**Lecture + Lab + Other:** 3 + 0 + 0

**ME F443 Fluid Mechanics and Heat Transfer Characteristics of Nanofluids**

3 Credits

Offered As Demand Warrants

Description of nanofluids, nanostructured materials and dispersion in base fluids. Thermophysical properties: density, viscosity, thermal conductivity and specific heat. Theoretical equations and empirical correlations for properties. Principles of measurements of properties. Fluid dynamic losses and pumping power required for nanofluid flow in heat transfer systems. Experimental methods of determining the convective heat transfer coefficient of nanofluids. Practical application to heat exchangers in industries. Nanofluids flows in mini- and microchannels.

**Prerequisites:** ES F341; ME F441; senior standing.

**Stacked with** ME F643.

**Lecture + Lab + Other:** 3 + 0 + 0

**ME F450 Theory of Flight**

3 Credits

Offered Fall Even-numbered Years

Airfoil theory in subsonic flow. Performance, stability and control of aircraft. Aircraft design.

**Prerequisites:** ES F341 (may be taken concurrently); ES F346.

**Lecture + Lab + Other:** 3 + 0 + 0

**ME F451 Aerodynamics**

3 Credits

Offered Spring Odd-numbered Years

Aerodynamics of non-lifting and lifting airfoils in incompressible irrotational flow, wings of finite span, the Navier-Stokes equations, boundary layers, numerical methods, supersonic and transonic flow past airfoils, rocket aerodynamics, rocket drag.

**Prerequisites:** ES F341 (may be taken concurrently); ES F301; ES F346.

**Lecture + Lab + Other:** 3 + 0 + 0

**ME F452 Introduction to Astrodynamics**

3 Credits

Offered Fall Odd-numbered Years

Geometry of the solar system, detailed analysis of two-body dynamics and introduction to artificial satellite orbits; Hohmann transfer and patched conics for lunar and interplanetary trajectories. Elements of orbit determination.

**Prerequisites:** ES F208 or ES F210.

**Corequisites:** ES F301.

**Lecture + Lab + Other:** 3 + 0 + 0

**ME F453 Propulsion Systems**

3 Credits

Offered Spring Even-numbered Years

Basic principles of propulsion: turbojet, turboprop and rocket engines. Fluid mechanics and thermodynamics of flow in nozzles, compressors, combustors and turbines. Liquid and solid propellant rockets. Heat transfer in rocket motors and nozzles. Design and testing methods for components of propulsion systems.

**Prerequisites:** ME F313 (may be taken concurrently); ES F341.

**Lecture + Lab + Other:** 3 + 0 + 0

**ME F458 Energy and the Environment**

3 Credits

Offered Fall Odd-Numbered Years

Overview of basic concepts of energy supply, demand, production of heat and power impacts of energy use on the environment. Extensive discussion of mitigation technologies and strategies for meeting energy needs while preserving environmental quality.

**Prerequisites:** CHEM F106X; ES F346; MATH F252X; PHYS F211X.

**Cross-listed with** ENVE F458.

**Stacked with** ME F658; ENVE F658.

**Lecture + Lab + Other:** 3 + 0 + 0

**ME F464 Corrosion Engineering**

3 Credits

Offered Spring

Principles and forms of corrosion and factors that affect it. Methods of testing and measurement, control and prevention are examined.

**Prerequisites:** ME F334.

**Lecture + Lab + Other:** 3 + 0 + 0

**ME F486 Senior Design**

1 Credit

Offered Fall

The course is focused on pursuing the design of a real or simulated project which is selected jointly by students, project advisors and/or the instructor. Emphasis will be on the design of practical engineering systems and or components which integrate engineering knowledge and skills that students have acquired. The principles of design process will be introduced in lecture. Each design team is to generate design concepts, select the best concept and work towards completing a design.

**Prerequisites:** ME F441 (may be taken concurrently); COJO F131X or COJO F141X; WRTG F211X, WRTG F212X, WRTG F213X or WRTG F214X; senior standing.

**Lecture + Lab + Other:** 1 + 0 + 0

**ME F487 Design Project (O, W)**

3 Credits

Offered Spring

A real or simulated engineering design project selected jointly by student and instructor. Emphasis on design of practical mechanical engineering systems and/or components which integrate students' engineering knowledge and skills.

**Prerequisites:** ME F486.

**Lecture + Lab + Other:** 3 + 0 + 0

**ME F601 Finite Element Analysis in Engineering**

3 Credits

Offered Every Third Semester

Formulation of the finite element method. Applications to problems of engineering in solid mechanics, fluid mechanics and heat transfer. Use and development of codes for computer solution of problems.

**Prerequisites:** Graduate standing in engineering; ES F201; MATH F302.

**Lecture + Lab + Other:** 3 + 0 + 0

**ME F602 Advanced Mechanical System Design**

3 Credits

Offered As Demand Warrants

Advanced analysis of two- and three-dimensional multi-body mechanical systems. Rigid body system formulation and deformable body system formulation. Application of CAE software for rigid body and large deformable body systems.

**Prerequisites:** ME F302; ME F408.

**Stacked with** ME F402.

**Lecture + Lab + Other:** 3 + 0 + 0

**ME F608 Advanced Dynamics**

3 Credits

Offered Every Third Semester

Kinematics and kinetics of rigid bodies, introduction to analytical mechanics, Lagrange's equations and Hamiltonian mechanics. Applications to engineering problems.

**Prerequisites:** ES F210; MATH F302; graduate standing in engineering.

**Lecture + Lab + Other:** 3 + 0 + 0

**ME F609 Advanced Vibrations**

3 Credits

Offered Every Third Semester

Analysis of discrete and continuous vibrations via energy methods, free and forced response of linear systems, stability criteria, and introduction to random and nonlinear vibration. Applications to engineering problems.

**Prerequisites:** MATH F302; ME F408; graduate standing in engineering.

**Lecture + Lab + Other:** 3 + 0 + 0

**ME F617 Power Analysis**

3 Credits

Offered As Demand Warrants

Fundamentals of power generation including piping, pumps, fuels and combustion, steam generators, condensers, deaerators, evaporators, feedwater treatment and heating, regeneration, fuel handling, heat balance, equipment, economics, and plant layout.

**Prerequisites:** ME F313.

**Lecture + Lab + Other:** 3 + 0 + 0

**ME F631 Advanced Mechanics of Materials**

3 Credits

Offered Every Third Semester

Theories of elasticity and plasticity for small and large deformations.

Applications to engineering problems.

**Prerequisites:** ES F331; graduate standing in engineering.

**Lecture + Lab + Other:** 3 + 0 + 0

**ME F634 Advanced Materials Engineering**

3 Credits

Offered Every Third Semester

Atomic bonding, crystal structure, crystal imperfections, phases and interfaces, microstructures, phase diagrams, phase transformation, transport and diffusion, metal deformation, fracture of materials, deterioration of materials, electronic and physical properties of materials.

**Prerequisites:** ME F334; MATH F302; graduate standing in engineering.

**Lecture + Lab + Other:** 3 + 0 + 0

**ME F640 Introduction to Microfluidics**

3 Credits

Offered Spring Odd-numbered Years

Overview of basic concepts and principles of fluids at the micron scale; introduction to the design and fabrication of microfluidic devices.

**Prerequisites:** ES F341 (may be taken concurrently); PHYS F103X (for Math and non-Physics science major); PHYS F211X (for Engineering, Math and Physics major); junior standing.

**Stacked with** ME F440.

**Lecture + Lab + Other:** 3 + 0 + 0

**ME F641 Advanced Fluid Mechanics**

3 Credits

Offered Every Third Semester

Introduction to viscous flows, laminar boundary layers, turbulent boundary layers, turbulent jets and wakes, applications to heat transfer and drag.

**Prerequisites:** ES F341; graduate standing in engineering.

**Lecture + Lab + Other:** 3 + 0 + 0

**ME F642 Advanced Heat Transfer**

3 Credits

Offered Every Third Semester

Heat conduction in two and three dimensions under steady and transient conditions. Free and forced convection in internal and external flows.

Radiation from black and gray surfaces and gas-filled enclosures. Both analytical and numerical methods are covered.

**Prerequisites:** ME F441; graduate standing in engineering.

**Lecture + Lab + Other:** 3 + 0 + 0

**ME F643 Fluid Mechanics and Heat Transfer Characteristics of Nanofluids**

3 Credits

Offered As Demand Warrants

Description of nanofluids, nanostructured materials and dispersion in base fluids. Thermophysical properties: density, viscosity, thermal conductivity and specific heat. Theoretical equations and empirical correlations for properties. Principles of measurements of properties. Fluid dynamic losses and pumping power required for nanofluid flow in heat transfer systems. Experimental methods of determining the convective heat transfer coefficient of nanofluids. Practical application to heat exchangers in industries. Nanofluids flows in mini- and microchannels.

**Prerequisites:** ES F341; ME F441; graduate standing.**Stacked with** ME F443.**Lecture + Lab + Other:** 3 + 0 + 0**ME F656 Aerospace Systems Engineering**

3 Credits

Offered Fall Odd-numbered Years

A multidisciplinary team of students will perform a preliminary design study of a major aerospace system. Design considerations will include requirements for project management, aerospace vehicle design, power, attitude control, thermal control, communications, computer control and data handling. The students will present their final design in a written report and a public seminar.

**Prerequisites:** Graduate standing.**Cross-listed with** EE F656.**Lecture + Lab + Other:** 3 + 0 + 0**ME F658 Energy and the Environment**

3 Credits

Offered Fall Odd-numbered Years

Basic concepts of energy supply, demand, production of heat and power impacts of energy use on the environment. Extensive discussion of mitigation technologies and strategies for meeting energy needs while preserving environmental quality.

**Recommended:** CHEM F106X; ES F346; MATH F252X; PHYS F211X; graduate standing.**Cross-listed with** ENVE F658.**Stacked with** ME F458; ENVE F458.**Lecture + Lab + Other:** 3 + 0 + 0**ME F685 Arctic Heat and Mass Transfer (a)**

3 Credits

Offered As Demand Warrants

An introduction to the principles of heat and mass transfer with special emphasis on application to problems encountered in the Arctic such as ice and frost formation, permafrost, condensation and heat loss in structures.

**Prerequisites:** graduate standing.**Lecture + Lab + Other:** 3 + 0 + 0**ME F687 Arctic Materials Engineering (a)**

3 Credits

Offered As Demand Warrants

A study of engineering material performance at low temperatures.

**Prerequisites:** Graduate standing.**Lecture + Lab + Other:** 3 + 0 + 0**ME F698 Non-thesis Research/Project**

1-9 Credits

**Lecture + Lab + Other:** 0 + 0 + 0**ME F699 Thesis**

1-9 Credits

**Lecture + Lab + Other:** 0 + 0 + 0