MECHANICAL ENGINEERING

The mechanical engineering program is accredited by the Engineering Accreditation Commission of ABET, abet.org (http://www.abet.org). This engineering discipline has a very broad spectrum of applications in all aspects of modern technology. Students undertake studies in statics and dynamics, CAD, materials science, strength of materials, machine design, thermodynamics, fluid mechanics, heat transfer, and system dynamics. A team-based senior design project completes the technical education.

The Program Educational Objectives (PEOs) are broad statements that describe what alumni do within a few years following graduation. The Mechanical Engineering Department is committed to graduating engineers who within a few years of their graduation are expected to:

1. Apply engineering science to analyze and design thermal and mechanical systems.
2. Pursue engineering careers or advanced studies in mechanical engineering or related technical fields.
3. Employ effective communication skills as team members or team leaders in an ethical and professional manner with a sense of social and global responsibility.
4. Engage in lifelong learning by contributing to their chosen field, actively participating in professional societies and broadening their professional knowledge with formal and/or informal continuing education.

The mechanical engineering curriculum is constructed to include abundant experiential learning. This is accomplished through the integration of synchronized laboratory experiences within the framework of the theoretical courses in the basic curriculum, and by making use of well-equipped laboratories and computing facilities.

Programs

- Mechanical Engineering Major (https://catalog.fairfield.edu/undergraduate/engineering/mechanical-engineering/bs-mechanical-engineering)
- Mechanical Engineering Five-Year Dual Degree Bachelor and Master of Science Program (https://catalog.fairfield.edu/undergraduate/engineering/mechanical-engineering/mechanical-engineering-five-year-dual-degree-bsms)

Courses

ME 0201 Engineering Statics **3 Credits**
Prerequisites: PS 0115, PS 0115L, MA 0146.
This introduction to rigid body mechanics using vector representation covers free body diagrams and static equilibrium in two- and three-dimensional space; solves problems in trusses, frames, and simple mechanisms; and develops methods in problem-solving techniques using computer-based approaches. Students perform lab experiments to support lecture theories and prepare professional-level reports.

ME 0203 Kinematics and Dynamics **3 Credits**
Prerequisites: ME 0201, MA 0245.
This course presents kinematics principles applied to particles and rigid body elements. Topics include analysis of forces and motion using Newton's second and third laws of motion; theory of kinetics of particles and rigid body elements under rectilinear and curvilinear motion, vector methods; principles of work, energy, and power; and momentum and impact.

ME 0203P Kinematics and Dynamics PLG **0 Credits**

ME 0206L Mechanics Lab **1 Credit**
Fee: $80 Engineering Lab Fee
Corequisite: ME 0201.
Students do mechanics experiments for two- and three-dimensional structures under static loading conditions. Concepts include vectors, equilibrium, moments, truss analysis, forces, and center of gravity of objects. This course includes topics in engineering materials, such as hardness, toughness, microscopic analysis, machinability and thermal properties. The course introduces strain gages, instrumentation and statistical data analysis. Students perform experiments and prepare laboratory reports.

ME 0207 Materials Science **3 Credits**
Attributes: EVME Environmental Studies Major Elective, EVNS Environmental Studies: Natural Science, EVPE Environmental Studies Elective
Prerequisites: CH 0111, CH 0111L.
This course covers chemical and physical properties of metals, polymers, and ceramics. Subjects include atomic structure, crystallography, strengthening mechanisms, microstructure, chemical composition, diffusion, binary phase diagrams, transformation diagrams, corrosion and materials science protection. Importance of the interrelationship between a material's processing, microstructure, and properties is discussed. The lab demo portion examines material science testing and microstructure analyses. Sample preparation and metallographic techniques are also learned.

ME 0241 Principles of Thermodynamics **3 Credits**
Prerequisites: PS 0115, PS 0115L.
This course on macroscopic thermodynamics with applications covers conservation of energy for open and closed systems; equations of state and pure substances; first and second law of thermodynamics, including the concepts of internal energy; and enthalpy and entropy as applied to aero-thermal components. Tables of thermodynamic properties, ideal gases and elements of cycle analysis, and applications of thermodynamic cycles, such as Carnot and Rankine, are discussed.

ME 0307L Dynamics Systems Lab **1 Credit**
Fee: $80 Engineering Lab Fee
Corequisites: ME 0203, ME 0308.
Students perform experiments covering the concepts of kinematics, dynamics, and mechanisms. Concepts included are: Newton's Laws, momentum, mechanical energy, impact, and friction. The course includes concepts in the area of strength of materials, such as: stress, strain, loading, modulus of elasticity, and fatigue. It also covers analysis of beams, photoelastic studies, and statistical data analysis. Students complete written lab reports.

ME 0308 Strength of Materials **3 Credits**
Corequisite: ME 0203.
Prerequisites: ME 0201, MA 0245.
This course examines concepts of two-dimensional stress and strain, factors of safety, thermal strain, static indeterminacy, stress concentration, bending including normal and shearing stresses, torsion, direct shear, principal stresses; Mohr's Circle; thin-walled pressure vessels; beam theory including shear and bending moment diagrams; deflection; elastic curves; indeterminate beams; energy methods; the use of superposition; and impact effects and column theory. Lab experiments reinforce these aspects of theory. This course includes a design project.

ME 0310L Product Manufacturing Lab **1 Credit**
This course is designed to be an introductory course in the Product Manufacturing field. The course provides theoretical concepts as well as the development of the knowledge and skills required in CNC programming, machine setup and operation, 3D printing, laser, manual machining and metrology. The laboratory portion emphasizes practical application of CNC machine tools, 3D printing, and manual machining, which involve set-ups and procedures for operation.

ME 0311 Machine Design **3 Credits**
Prerequisite: ME 0308.
This course applies the fundamentals of mechanical engineering design to analyze, design, and/or select components typically used in the design of complete mechanical systems. The course covers the design process and analysis of stress and deflection; material properties and loading (steady state and variable) as they relate to failure prevention; and the procedures for design and analysis of common machine elements such as columns, cylinders, fasteners and springs. In team reverse-engineering projects, students apply the course topics to real hardware. The course emphasizes computer techniques and responsible design (safety factors and ethics).

ME 0318 Finite Element Analysis **3 Credits**
Prerequisites: EG 0130, MA 0251, ME 0308.
An introduction to concepts in finite element analysis; this course covers one- and two- dimensional element formulation and structural analysis. This finite element analysis is extended to three dimensional problems in dynamic systems and control, design and manufacturing, mechanics and materials, and fluids and thermal systems. This course will provide an overview of the complimentary topic of computational fluid dynamics (CFD). Students solve problems both manually and with the use of modern computer finite element software, ANSYS and FLUENT.

ME 0319 Applications of Finite Element Analysis **3 Credits**
Prerequisite: ME 0318.
This course examines applications of finite element analysis in modern engineering including structural analysis, fluid flow and heat transfer. It is an introduction to the concepts of dynamics as applied to structure. Finite element formulations covering 1-, 2-, and 3-dimensional elements as well as energy methods are developed. Students develop techniques for application of finite element method in structural design, dynamic system response, fluid and thermal analyses. Application of methodology to fluid flow is presented. Students solve example and design problems manually and using modern finite element analysis software, ANSYS and FLUENT.

ME 0321 Theory and Applications of Robot Kinematics **3 Credits**
Prerequisite: ME 0203.
Topics in advanced kinematics include introduction to basic concepts and definitions related to kinematics, commonly used links and joints, kinematic analysis of mechanisms, introduction to robotic mechanisms, homogeneous transformations, Euler angles, Denavit-Hartenberg representation of forward kinematics of robots, inverse kinematics solution of robots, degeneracy and dexterity, and differential motion and velocity relations. Industrial application of kinematics will also be covered and the course will include a laboratory or project component.

ME 0322 Advanced Dynamics **3 Credits**
Prerequisite: ME 0203.
The topics in the area of dynamics include degrees of freedom, generalized coordinates, constraints, , physics of failure, flexures, and optmechanics. The course will focus on practical applications of advanced dynamics, including linkages, cams, and kinematic mechanisms, as well as computer applications and project design.

ME 0323 Thermal Management of Microdevices **3 Credits**
This course addresses the thermal design in electronic assemblies which includes thermal characteristics, heat transfer mechanisms and thermal failure modes. Thermal design of electronic devices enables engineers to prevent heat-related failures, increase the life expectancy of the system, and reduce emitted noise and energy consumption. This course provides the required knowledge of heat transfer for such analysis and various options available for thermal management of electronics. This course also presents advanced methods of removing heat from electronic circuits, including heat pipes, liquid immersion and forced convection.

ME 0324 Micro and Nano Manufacturing **3 Credits**
Prerequisites: CH 0111, ME 0207, PS 0116.
This course will introduce students to the latest advancements in micro and nano manufacturing. The course will enable students to become familiar with advanced manufacturing techniques in light of the global emphasis on micro and nano manufacturing. Topics to be covered include lithography, mechanical micromachining, laser fabrication, polymers and nanocomposites, and nano imprinting. The important topics of metrology and process control at the micro and nano scale will also be discussed. Students will conduct a class project integrating the different processes for an application in electromechanical or biomedical field. A lab component is also present where students get a hands-on experience with material processing and characterization tools. Open to seniors only.

ME 0325 Engineering Systems Dynamics **3 Credits**
Prerequisites: MA 0251, ME 0318.
The student will become familiar with the analysis of the dynamic response of structures, structural components to transient loads, and foundation excitation. Course includes single-degree-of-freedom and multiple-degree-of-freedom systems, frequency response concepts, and introduction to modal analysis. Basic concepts of vibration control and control theory will be introduced.

ME 0327 Fracture Mechanics **3 Credits**
Prerequisite: ME 0308.
This course covers fracture mechanics concepts for design, materials selection, and failure analysis. The fundamental principles of fracture parameters and criteria, stress field at the tip of a crack, fracture toughness, thickness effect, plastic zone concept, and crack growth under cyclic loading and aggressive environment will be presented. Emphasis will be placed on the practical applications of fracture mechanics by incorporation ofa failure investigation study where the students utilize the skills developed with the course to root cause a real world failure. Taking a holistic approach each student will have their own case study and learn to incorporate fracture mechanics, material science, mechanics of materials, computer simulation and manufacturing techniques and knowledge into their project.

ME 0330 Mechanics of Composite Materials **3 Credits**
Prerequisite: ME 0207.
While the use of man-made composites have existed for centuries for practical applications, engineered composite materials are finding increasing use in many high technology applications such as aerospace, electronics, sporting goods, and structural components for high stability systems. This course is designed to provide a comprehensive understanding of classification, processing, properties, selection and failure of polymer, metal and ceramic based composite materials.

ME 0342 Applications of Thermodynamics **3 Credits**
Prerequisite: ME 0241.
This course applies concepts learned in ME 0241. Topics include mixtures of ideal gases and vapors; psychrometry; combustion analysis of common power generating, refrigeration, and air conditioning cycles; figures of merit including thermal efficiency; continuity equation, basic energy relations for turbomachinery; fundamentals of compressor and turbine design; and application and synthesis of design using thermodynamic principles. This course includes a lab segment.

ME 0346 Energy Conversion **3 Credits**
Prerequisite: ME 0347.
This course covers the major topics in energy conversion, including fuels used in energy conversion; solar energy; gas turbine engines and applications; internal combustion engines; heat pumps; classic and novel power and refrigeration cycles; system analysis; system economics; and environmental considerations. The course includes computer simulation of power plant performance to optimize energy conversion efficiency. Students will be required to conduct a research on the environmental impacts of the major current energy conversion systems.

ME 0347 Fluid Mechanics **3 Credits**
Prerequisite: ME 0241.
Topics in this course include incompressible fluids at rest and in motion; Bernoulli's theorem and the principle of similarity flow through orifices, nozzles, and pipes; flow through open channels; energy relationships as applied to pipe lines, pumps, and turbines; acceleration of fluid masses; losses in fluid flow systems; fluid dynamics; the momentum theorem in turbomachinery; and introduction to compressible fluid flow. This course emphasizes design solutions using computer analysis and synthesis. The course includes a design project of a system that applies the principles of fluid flow.

ME 0348L Thermal and Fluids Lab **1 Credit**
Fee: $80 Engineering Lab Fee
Corequisites: ME 0342, ME 0347.
This laboratory learning experience provides the opportunity to explore various components, such as the compressor, condenser, and evaporator, in a series of experiments using refrigeration equipment. Students investigate lift and drag in a wind tunnel, pressure losses in duct flow, and the Bernoulli principle. Also, students determine the efficiency of a centrifugal pump, plot PV diagrams for the Otto Cycle, and study a Pelton Wheel Hydraulic Turbine. The course emphasizes statistical analysis, test planning, data evaluation, and report writing.

ME 0349 Heat Transfer **3 Credits**
Prerequisite: ME 0347.
This course covers one- and two-dimensional heat conduction, including solutions for finned surfaces and solutions for transient problems; convection heat transfer in laminar and turbulent flows; fundamental radiation concepts; laws of thermal radiation; radiation exchange geometrical factors and network methods;heat exchangers and electrical analogies. The course emphasizes design solutions using computer analysis and synthesis. In the lab, students investigate heat transfer in plane surfaces, enhanced heat transfer in extended surfaces, and heat exchanger effectiveness. This course includes a practical design project of a system that applies the principles of heat transfer.

ME 0350L Energy Transfer Lab **1 Credit**
Fee: $80 Engineering Lab Fee
Corequisites: ME 0325, ME 0349.
A laboratory experience for engineering students utilizing hands-on experiments to explore energy transfer methods related to transmitted forces in vibrating systems, as well as thermal transfer gradients in mechanical, electrical, and electronic systems. Students use simulation and modeling software for many experiments, including conduction and convection heat transfer processes. The course emphasizes statistical analysis, instrumentation, and report writing.

ME 0353 Computational Fluid Dynamics **3 Credits**
Prerequisites: EG 0145, ME 0347.
Introduction to computational methods used for the solution of advanced fluid dynamics problems.Emphasis on concepts in finite difference methods as applied to various ordinary and partial differential model equations in fluid mechanics, fundamentals of spatial discretization, numerical integration, and numerical linear algebra. A focus on the engineering and scientific computing environment. Other topics may include waves, advanced numerical methods (like spectral, finite element, finite volume), non-uniform grids, turbulence modeling, and methods complex boundary conditions.

ME 0354 Heat and Mass Transfer **3 Credits**
Prerequisite: ME 0349.
This course covers the concepts of conduction, convection, and radiation heat transfer as well as mass transfer. Boiling and condensation; design and performance of selected thermal systems (including heat exchangers); and laminar and turbulent flows as related to forced and free convection are all studied. Mathematical modeling of engineering systems using modern analytical and computational solution methods are also covered.

ME 0362 Turbomachinery **3 Credits**
Prerequisite: ME 0347.
The theoretical basis and the fundamentals of modern turbomachinery for aerospace (helicopter, aircraft) and power generation (marine, industrial) applications are studied. Brayton engine cycle analysis and performance improvement are reviewed. Applications of the principles of fluid mechanics and thermodynamics to the design of turbines and compressors are examined, as well as component analysis and velocity diagram for axial compressors, centrifugal compressors and axial turbines. Discussion of combustion and environmental emissions. This course carries a design/research project

ME 0372 Applications of Theory of Elasticity **3 Credits**
Prerequisite: ME 0308.
This course covers theory of elasticity (stress, strain, and generalized Hooke's law), strain energy methods (Castigliano's theorem), thin shells of revolution (equilibrium equations, pressure vessels), thin plates (rectangular and circular plates, moment-curvature relations), beams of elastic foundations and buckling.

ME 0382 Independent Study: Advanced Mechanical Project **1-3 Credits**
Prerequisite: Completion of non-elective mechanical engineering courses and at least one major elective.
During this design course emphasizing individual creativity, students (working with a faculty mentor) develop project objectives and performance specifications. At review meetings, students present progress on the project including analytic and experimental results to date. A final report and presentation demonstrates the accomplishments and significant conclusions. Faculty involvement creates a realistic engineering development environment. Students may take this course as independent study once the prerequisites have been met. Enrollment by departmental approval only.

Faculty

Professors

Etemad, *chair*
Zabinski

Assistant Professors

Srinivas Sundarram
Safari

Lecturers

Anekwe
Bauer
Carballo Boschetti
Cupic
Dornfeld
Estejab
Goldberg
Gunawardana
Judge
Lutian
McFadden
Schaer
Waugh
Wojna