MECHANICAL ENGINEERING

OVERVIEW

The main asset of the UVM mechanical engineering graduate program is certainly the human factor, including our dedicated faculty and staff, and motivated students.

Curriculum

We continuously update our curriculum to address modern topics in mechanical engineering, and to offer a breadth of courses that makes studying in our program more flexible, whether the student intends to earn an M.S. as a continuing student from local industries, or directly obtain a doctorate right from the bachelor's degree. Most of our graduate students are full-time and actively engaged in research projects with one or two faculty mentors who are dedicated to their success. The size of the program also enables them to have close interactions with the rest of the faculty, and to regularly participate in the life of the program via weekly graduate student seminars and invited speaker presentations.

Graduate

Since its creation, 200 students from across the United States and various countries around the world have graduated from the UVM mechanical engineering graduate program. Also, we actively seek to admit a diverse group of students in mechanical engineering to address the contemporary challenges of our society. For example, more than 42% of our graduating Ph.D. students in the past five years are women. To date, our graduates have achieved successful careers in academia as distinguished professors, in industry as engineers and entrepreneurs, and in government positions as program directors for national funding agencies or scientists at national laboratories.

Faculty and Research

The success of our graduate program is built on a distinguished faculty whose research is recognized nationally and internationally through innovation, dissemination of knowledge in high-impact journals, and research awards. Recently, our faculty has won major awards from the Department of Defense, the Department of Energy, NASA, NIH and the National Science Foundation, including the recipients of one ARO Young Investigator Award, one DoE Early Career Award, and three NSF CAREER Awards. Clearly, our focus is to create a research environment that is highly interdisciplinary and collaborative from which our students can flourish.

DEGREES

- Mechanical Engineering AMP
- Mechanical Engineering M.S.
- Mechanical Engineering Ph.D.

FACULTY

Dubief, Yves C.; Associate Professor, School of Engineering; PHD, Institut National Polytechnique de Grenoble
Dunlop, Mary J.; Assistant Professor, School of Engineering; PHD, California Institute of Technology

Fletcher, Douglas G.; Professor, School of Engineering; PHD, University of Virginia
Hitt, Darren Lee; Professor, School of Engineering; PHD, Johns Hopkins University
Huston, Dryver R.; Professor, School of Engineering; PHD, Princeton University
Jenkins, Robert; Professor Emeritus, School of Engineering; PHD, University of Leeds
Lee, Patrick C.; Assistant Professor, School of Engineering; PHD, University of Toronto
Marshall, Jeffrey Scott; Professor, School of Engineering; PHD, University of California Berkeley
Oldinski, Rachael Ann; Assistant Professor, School of Engineering; PHD, Colorado State University
Sansoz, Frederic P.; Professor, School of Engineering; PHD, Ecole Des Mines de Paris

Courses

ME 201. Biomaterials Engineering. 3 Credits.
A materials science and engineering approach is used to explore the structure-function relationships of natural and bio-inspired materials for various engineering applications. The emphasis is on mechanical design and function. The medical applications of biomaterials will be discussed. Prerequisite: ME 101.

ME 203. Machinery Analysis & Synthesis. 3 Credits.
Kinematic and kinetic analysis of two- and three-dimensional machines; kinematic synthesis, electromechanical and servo mechanisms; application to robotic mechanisms. Prerequisite: Senior standing in ME.

ME 207. Bioengineering. 3 Credits.
Introduction to bioengineering including biomechanics, rehabilitation, instrumentation, imaging, biomaterials, and transport. Pre/co-requisites: Senior/Graduate standing in Engineering; Instructor permission.

ME 208. Biomechanics: Tissue Engr. 3 Credits.
Solid biomechanics including structure, function and mechanical properties of biological tissues. Tissue engineering involving cell mechanics, scaffold materials, and signaling. Current literature topics are covered. Pre/co-requisites: Senior/Graduate standing in Engineering; Instructor permission.

ME 209. Biomechanics: Transport Proc. 3 Credits.
Transport and kinetic processes to vascular biology, respiratory mechanics and medicine. Steady and unsteady laminar flow, pulse wave reflections, curved and collapsible tube flow, turbulence. Pre/ co-requisites: Senior/Graduate standing in Engineering; Instructor permission.

ME 210. Control Systems. 3 Credits.
Analysis and design of continuous and discrete-time control systems; stability, signal flow, performance criteria, classical and state variable methods, simulation design tools, computer-based realizations. Prerequisites: EE 171 or ME 111. Cross-listed with: EE 210.
ME 213. Systems & Synthetic Biology. 3 Credits.
Applying engineering tools to the design and analysis of biomolecular processes; gene regulatory networks; nonlinear dynamics in molecular biology; biological circuit design; biological signal processing. Prerequisite: Background required: Differential Equations, Linear Algebra, Programming. Cross-listed with: CSYS 213, EE 213.

ME 218. Numerical Methods for Engineer. 3 Credits.
Foundational concepts of numerical integration, numerical differentiation, and numerical approximation and solution of differential and partial differential equations of the type encountered in the analysis of engineering problems and data processing. Prerequisites: MATH 271, CS 020; MATH 122 or MATH 124. Cross-listed with: CE 218.

ME 230. Orbital Mechanics. 3 Credits.
Motion of spacecraft in a central gravitational field. Two and restricted three-body problems; Kepler's equation; orbital maneuvers and rendezvous; interplanetary and lunar trajectories. Prerequisite: ME 012. Co-requisites: ME 111 or Instructor permission.

ME 234. Mechanical Vibrations. 3 Credits.
Analysis, measurement, and control of mechanical vibrations; SDOF, MDOF, and rotating systems, forced, free, and random vibrations. Prerequisite: ME 111 or Senior/Graduate standing in engineering or physical sciences.

ME 235. Turbomach Vibration Anyl/Tstng. 2 Credits.
Vibration in rotating machines; vibration measurement techniques; machinery condition and degradation; condition monitoring and predictive maintenance; industrial vibration techniques including proximity probes, accelerometers, FFT analyzer. Prerequisite: ME 244.

ME 237. Turbulence. 3 Credits.
Description of turbulent flows; statistical and modeling of turbulent flows; Navier Stokes as a dynamical system; experimental and numerical approaches. Prerequisite: ME 143.

ME 238. Energy Systems Engineering. 3 Credits.
Engineering assessment of both potentially sustainable and unsustainable practical primary energy systems. Examination of options of meeting demand and impacts on the environment. Prerequisite: ME 042.

ME 239. Rocket Propulsion. 3 Credits.
Flight mechanics and propulsion requirements for atmospheric and space flight. Thermochemistry of fuels and propellants. Operating principles of chemical, electrical and nuclear propulsion systems. Pre/co-requisites: ME 143/ME 240 recommended or permission of the Instructor.

ME 240. Compressible Flow. 3 Credits.
Theory of compressible flow. Normal and oblique shocks; expansion waves; unsteady wave motion; method of characteristics; linearized external flows; conical and 3D flows. Prerequisite: ME 143 or equivalent.

ME 241. Combustion Processes. 3 Credits.
Combustion thermodynamics; chemical kinetics; laminar flames, premixed and diffusion; turbulent flames; ignition, explosion, and detonation; droplet combustion; flame spread; large scale fires; rocket combustion. Prerequisite: Senior/Graduate standing.

ME 242. Adv Engr Thermodynamics I. 3 Credits.
Foundations of statistical mechanics. Gases and crystals. Chemical equilibrium. Irreversible processes. Prerequisite: Senior/Graduate standing or permission.

ME 243. Incompressible Flow. 3 Credits.
Intermediate treatment of incompressible fluid flow; Navier-Stokes equations; two-dimensional potential flows; wing theory; vorticity and vortex structures; laminar and turbulent boundary layers. Prerequisites: ME 143 or equivalent.

ME 244. Intro to Turbomachinery Anyl. 2 Credits.
Fundamental turbomachinery principles of fluid mechanics, thermodynamics, and structural analysis; basic equations and computational techniques for analysis and design to model and evaluate turbomachinery. Prerequisite: ME 243, MATH 271.

ME 245. Advanced Heat Transfer I. 3 Credits.
Analytical methods for multidimensional steady and transient heat conduction; phase change and moving boundaries. Thermal radiation exchange in enclosures; view factors; emitting/absorbing gases. Prerequisites: ME 144 or equivalent, or by Instructor permission.

ME 246. Centrifugal Compressors. 2 Credits.
Centrifugal pump design principles and practice; performance limits; cavitation; design tools and pump design optimization. Prerequisite: ME 244.

ME 247. Centrifugal Pumps. 2 Credits.
Centrifugal pump design principles and practice; performance limits; cavitation; design tools and pump design optimization. Prerequisite: ME 244.

ME 248. Turbomachinery Special Topics. 1 or 2 Credit.
Content in axial fans/compressors; axial, radial, or steam turbines; CFD, dynamics/rotordynamics, or materials for turbo-machinery; power plant or refrigeration cycle developments; turbocharged and compound IC-engines. Prerequisite: ME 244.

ME 249. Computational Fluids Engr. 0 or 3 Credits.
Computational methods for solving the Navier-Stokes equations and combined thermo-fluid flows; finite- differences and finite-volume techniques; use of standard commercial CFD software. Prerequisite: ME 143 or equivalent.

ME 252. Mechanical Behavior Materials. 3 Credits.
Isotropic and anisotropic elasticity; theory of plasticity; deformation mechanisms in crystalline solids; dislocation theory; creep behavior; advanced fatigue and fracture mechanisms. Prerequisites: ME 101; Instructor permission.
ME 253. Corrosion of Materials. 3 Credits.

ME 255. Adv Engineering Materials. 3 Credits.
Advanced material processing; physical and mechanical principles of high-temperature alloys, light-weight materials, thin films, nanomaterials, and biomedical materials; elements of computational materials design. Prerequisites: Senior/Graduate standing; or Instructor permission.

ME 257. Composite Materials. 3 Credits.

ME 259. Computational Solid Mechanics. 3 Credits.
Computational methods using the finite element analysis (FEA) applied to linear elastic and non-linear problems in the mechanics of deformable solids and structures, contact mechanics, and fracture mechanics. Hands-on computational experience using a commercial FEA software. Prerequisites: ME 014, MATH 124, and MATH 271, or equivalent.

ME 265. Integrated Product Developmnt. 3 Credits.
Project- based course focusing on the entire product life cycle. Team dynamics, process and product design, quality, materials, management, and environmentally-conscious manufacturing. Prerequisite: Senior standing. Cross-listed with: BSAD 293.

ME 270. Structural Dynamics. 3 Credits.
Vibrations, matrices, earthquake engineering, stability and wave propagation. Prerequisites: Senior/Graduate standing in Engineering or physical sciences, or Instructor permission. Cross-listed with: CE 272.

ME 271. Micro and Nano Systems. 3 Credits.
Operating principles, fabrication and design of engineered systems with submillimeter dimensions. Prerequisites: Senior/Graduate standing in Engineering or physical sciences.

ME 281. Seminar. 1 Credit.
Presentation and discussion of advanced mechanical engineering problems and current developments. Prerequisite: Senior/Graduate engineering enrollment.

ME 282. Seminar. 1 Credit.
Presentation and discussion of advanced mechanical engineering problems and current developments. Prerequisite: Senior/Graduate engineering enrollment.

ME 283. Lab Techniques Turbomach Dev. 2 Credits.
Instruments and transducers for performance, flow, and structural measurements in turbo-machinery; the role of test data in design and development; experimental data acquisition and processing. Prerequisite: ME 244.

ME 285. Biomedical Engineering Seminar. 1 Credit.
Presentation and discussion of advanced biomedical engineering problems and current research developments. Prerequisite: Senior/Graduate engineering enrollment.

ME 295. Advanced Special Topics. 1-18 Credits.
Content is dictated by expanding professional interest in newly developing, or recently developed, technical areas in which there is particular need or opportunity. Prerequisite: Senior/Graduate standing.

ME 304. Adv Engineering Analysis I. 3 Credits.
Analytical methods for the solution of partial differential equations in engineering mechanics and physics, including: eigenfunction expansions; Fourier series; Sturm-Liouville theory and special functions. Prerequisites: Graduate standing in engineering, mathematics, or physical sciences or Instructor permission. Cross-listed with: CE 304.

ME 305. Adv Engineering Analysis II. 3 Credits.
Advanced analytical techniques for problems in engineering mechanics and physics, including: integral transform methods Green’s functions, perturbation methods, and variational calculus. Prerequisites: ME 304 or equivalent. Cross-listed with: CE 305.

ME 312. Adv Bioengineering Systems. 3 Credits.
Advanced bioengineering design and analysis for current biomedical problems spanning molecular, cell, tissue, organ, and whole body systems including their interactions and emergent behaviors. Cross-listed with: CSYS 312.

ME 320. Special Problems in Elasticity. 3 Credits.
Advanced topics in the theory of elasticity in which there is a particular student and staff interest.

ME 321. Special Problems in Fluid Mech. 3 Credits.
Advanced topics in fluid mechanics in which there is a particular student and staff interest.

ME 322. Special Problems in Dynamics. 3 Credits.
Advanced topics in dynamics in which there is a particular student and staff interest.

ME 323. Special Prob in Thermodynamics. 3 Credits.
Advanced topics in thermodynamics in which there is a particular student and staff interest.

ME 324. Spec Problems in Heat Transfer. 3 Credits.
Advanced topics in heat transfer in which there is a particular student and staff interest.

ME 325. Special Problems in Materials. 3 Credits.
Advanced topics in behavior of materials in which there is a particular student and staff interest.

ME 330. Matrix Meth in Struct Dynamics. 3 Credits.
Matrices, eigenvalue problems, forced vibration, wave propagation.

ME 332. Engineering Elasticity. 3 Credits.
Tensors, complex variables, variational methods.
ME 333. Stress Analysis. 3 Credits.
Theory and experimental method of measuring static and dynamic stress and strain.

ME 336. Continuum Mechanics. 3 Credits.
Tensors, conservation laws, field equations for solids and fluids.

ME 338. Advanced Dynamics. 3 Credits.

ME 342. Advanced Combustion. 3 Credits.
Equations of reacting mixtures; modeling of steady and unsteady combustion, homogeneous/heterogeneous systems; ignition, explosions, detonations; combustion aerodynamics: turbulence, swirl, and sprays. Prerequisite: ME 241 or equivalent.

ME 343. Advanced Fluid Dynamics. 3 Credits.
Stress in continuum; kinematics, dynamics; potential fields; Wing theory; Navier-Stokes equation; hydrodynamic stability; turbulence; laminar, turbulent boundary layer theory; transient flows; free laminar, turbulent flows; mixing.

ME 344. Adv Eng Thermodynamics II. 3 Credits.
Microscopic thermodynamics; Maxwell-Boltzmann, Bose-Einstein, Fermi-Dirac statistics; kinetic theory of gases; transport properties, compressed gases, liquids, solid states; chemical systems; irreversible processes; fluctuations.

ME 345. Advanced Heat Transfer II. 3 Credits.
Advanced treatment of forced and free convection; thermal boundary layers; analytical and approximate solution methods. Phase change heat transfer. Micro/nano-scale heat transfer. Prerequisite: ME 245 or equivalent.

ME 346. Advanced Gas Dynamics. 3 Credits.
Transonic flows; hypersonic flows and shock relations; boundary layer interactions; high-temperature gases and aerothermodynamics; rarefied flows; computational methods. Prerequisite: ME 240 or equivalent.

ME 350. Multiscale Modeling. 3 Credits.

ME 371. Adv Engr Des Anyl&Synthesis I. 4 Credits.
Application of fundamental concepts, principles of advanced mathematics, physics, mechanics, electricity, thermodynamics, fluid dynamics, heat transfer, and decision-making processes to design, analysis, synthesis of complex engineering systems.

ME 372. Systems Engineering. 3 Credits.
Advanced course in systems engineering; reliability, maintainability, safety, and human factors engineering. Case studies. Prerequisites: ME 371 or Instructor permission.

ME 373. Integr Mechanism Design Anyl. 3 Credits.
Application of system analysis, rigid body dynamics, finite elements, fatigue analysis and structural dynamics to an integrated approach to mechanisms design. Prerequisites: ME 371 or Instructor permission.

ME 391. Master's Thesis Research. 1-18 Credits.

ME 395. Advanced Special Topics. 1-18 Credits.
Advanced topics in recently developed technical areas. Prerequisites: three hours with Instructor permission.

ME 491. Doctoral Dissertation Research. 0-18 Credits.