

## MECHANICAL ENGINEERING

[https://www.uvm.edu/cems/me/graduate\\_program](https://www.uvm.edu/cems/me/graduate_program) ([https://www.uvm.edu/cems/me/graduate\\_program/](https://www.uvm.edu/cems/me/graduate_program/))

### 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 graduate student seminars and invited speaker presentations.

### Graduate

Since its creation, 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. 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. Our focus is to create a research environment that is often interdisciplinary and collaborative from which our students can flourish. Our faculty is actively engaged in applied and fundamental research to address timely scientific questions relevant to mechanical engineering, using experimental, computational and theoretical methods. The mechanical engineering faculty at UVM works closely with students in five research areas: 1- Computational Multiscale Simulations & Theory; 2- Thermo-fluid & Aerospace Engineering; 3- Medical Research; 4 - Dynamical Sensing, Monitoring and Control, and 5- Materials Science and Engineering.

### DEGREES

- Mechanical Engineering AMP (<http://catalogue.uvm.edu/graduate/mechanicalengineering/mechanicalengineeringamp/>)
- Mechanical Engineering M.S. (<http://catalogue.uvm.edu/graduate/mechanicalengineering/mechanicalengineeringms/>)

- Mechanical Engineering Ph.D. (<http://catalogue.uvm.edu/graduate/mechanicalengineering/mechanicalengineeringphd/>)

### FACULTY

**Dubief, Yves C.**; Associate Professor, Department of Mechanical Engineering; PHD, Institut National Polytechnique de Grenoble  
**Fiorentino, Niccolo M.**; Assistant Professor, Department of Mechanical Engineering; PHD, University of Virginia  
**Fletcher, Douglas G.**; Professor, Department of Mechanical Engineering; PHD, University of Virginia  
**Floreani, Rachael Ann**; Associate Professor, Department of Mechanical Engineering; PHD, Colorado State University  
**Garimella, Suresh**; President, University of Vermont, Professor, Department of Mechanical Engineering; PHD, University of California at Berkeley  
**Huston, Dryver R.**; Professor, Department of Mechanical Engineering; PHD, Princeton University  
**Louisos, William**; Senior Lecturer, Department of Mechanical Engineering; PHD, University of Vermont  
**Ma, Jihong**; Assistant Professor, Department of Mechanical Engineering, PHD, University of Minnesota, Twin Cities  
**Marshall, Jeffrey Scott**; Professor, Department of Mechanical Engineering; PHD, University of California Berkeley  
**Meyers, Jason**; Research Assistant Professor, Department of Mechanical Engineering; PHD, Univ. Libre de Bruxelles / von Kármán Institute  
**Sansoz, Frederic P.**; Professor, Department of Mechanical Engineering; PHD, Ecole des Mines de Paris  
**Schadler, Linda S.**; Dean, College of Engineering and Mathematical Sciences; Professor, Department of Mechanical Engineering; PHD, University of Pennsylvania

### 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 or BME 112. Cross-listed with: BME 201.

#### 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 204. Biothermodynamics. 3 Credits.

Inter-disciplinary; guides the student through the thermodynamics of living organisms, comprised of the study of energy transformation in the life sciences. Designed for students from the STEM disciplines. Covers Gibbs free energy, statistical thermodynamics, binding equilibria, and reaction kinetics. Prerequisites: ME 123, ME 124, or BME 112. Cross-listed with: BME 204.

**ME 206. Biomechanics of Human Motion. 3 Credits.**

Biomechanics of Human Motion will describe the typical processes—from small scale protein interactions to large scale joint torques—that result in human locomotion. Clinical problems and athletic performance will be discussed. Students will learn about musculoskeletal tissues related to force generation/transmission and will perform kinematic/kinetic analyses. Prerequisites: BME 011 or ME 012. Pre/Co-requisites: ME 101 or ME 111 or BME 111. Cross-listed with: BME 206.

**ME 207. Intro Biomedical Engineering. 3 Credits.**

Introduction to bioengineering science including biomechanics, biomaterials, biomedical imaging, rehabilitation engineering, biomedical computing, biomedical instrumentation, and transport phenomena. Prerequisite: Senior standing in all engineering majors other than Biomedical Engineering, Graduate Student standing with Instructor permission. Cross-listed with: EE 207.

**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. Prerequisites: ME 101 or BME 112. Cross-listed with: BME 208.

**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. Credit not given for more than one of the courses EE 110, ME 210. Prerequisites: EE 171 or ME 111. Cross-listed with: EE 210.

**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 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 236. Renewable Energy Harvesting. 3 Credits.**

Covers the engineering fundamentals of different renewable energy technologies, including wind power, tidal power, solar power, biomass, hydropower, etc. Focus placed on the mathematical derivation and application of small scale vibration energy harvesting technologies. Prerequisite: ME 143 or CE 160.

**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 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 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 249. Computational Fluids Engr. 0 or 3 Credits.**

Project-based. 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 250. Air Breathing Propulsion. 3 Credits.**

Presents a study on air-breathing propulsion systems. Initial focus will be on various types of engine systems, real and ideal parametric cycle analysis, and individual internal component performance. Will then move to contemporary propulsion topics and research that push aerospace systems to new flight envelopes. Prerequisites: ME 144, ME 240.

**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 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.**

Fibers, matrices. Unidirectional and short fiber composites. Experimental characterization. Prerequisite: ME 101.

**ME 259. Computational Solid Mechanics. 3 Credits.**

Project-based. 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. QR: Integrated Product Dev. 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 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.

**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.

**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.

**ME 336. Continuum Mechanics. 3 Credits.**

Tensors, conservation laws, field equations for solids and fluids.

**ME 338. Advanced Dynamics. 3 Credits.**

Application of Lagrange's equation, Hamilton's principle to mechanical systems. Systems with constraints. Matrix formulation of problems in kinematics, dynamics. Stability of linear, nonlinear systems.

**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 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.**

Computational modeling of the physics and dynamical behavior of matter composed of diverse length and time scales. Molecular simulation. Coarse-graining. Coupled atomistic/continuum methods.

**ME 390. Internship. 1-18 Credits.**

On-site supervised work experience combined with a structured academic learning plan directed by a faculty member or a faculty-staff team in which a faculty member is the instructor of record, for which academic credit is awarded. Offered at department discretion.

**ME 391. Master's Thesis Research. 1-18 Credits.****ME 392. Independent Study. 1-18 Credits.**

A course which is tailored to fit the interests of a specific student, which occurs outside the traditional classroom/laboratory setting under the supervision of a faculty member, for which credit is awarded. Offered at department discretion.

**ME 394. Independent Graduate Research. 1-18 Credits.**

Graduate student work on individual or small team research projects under the supervision of a faculty member, for which credit is awarded. Offered at department discretion.

**ME 395. Advanced Special Topics. 1-18 Credits.**

Advanced topics in recently developed technical areas. Prerequisites: three hours with Instructor permission.

**ME 490. Internship. 1-18 Credits.**

On-site supervised work experience combined with a structured academic learning plan directed by a faculty member or a faculty-staff team in which a faculty member is the instructor of record, for which academic credit is awarded. Offered at department discretion.

**ME 491. Doctoral Dissertation Research. 1-18 Credits.**

**ME 494. Independent Graduate Research. 1-18 Credits.**

Graduate student work on individual or small team research projects under the supervision of a faculty member, for which credit is awarded. Offered at department discretion.

**ME 496. Advanced Special Topics. 1-18 Credits.**

See Schedule of Courses for specific titles.