WELCOME TO U-M ME
A Top-Class Graduate Program!

Mechanical Engineering (ME) at the University of Michigan (U-M) is consistently ranked among the very top programs in the nation. Recently, based on data analyzed and published by the prestigious National Research Council (NRC), our PhD program received an overall #1-2 ranking by the independent website PhDs.org, with its default weightings of the NRC data for large institutions. Our multidisciplinary approach to research and learning combines trendsetting research with challenging coursework and leadership opportunities. The international reputation of the University of Michigan ensures access to world-class professors and the most up-to-date facilities, and the beautiful town of Ann Arbor is a great place to live and work.

This document will give you a quick overview of our top-notch research and graduate program, the University of Michigan, and lovely Ann Arbor. Some profiles of our alumni are included as well. For more detailed information, please check our website at http://me.engin.umich.edu/. Enjoy your reading!
AN EDUCATION PROGRAM FOR RESEARCH
Research from Beginning to End

Not all graduate programs are created equal with respect to research opportunities and early engagement in research. Roughly 50% of master’s students in U-M Mechanical Engineering are involved with an independent research project or a thesis. The Master’s program allows students conducting research to tailor their course structure so as to learn the analytical and experimental techniques that allow them to contribute quickly to cutting edge research. At the PhD level the qualification examination process involves graduate coursework in support of the individualized research topic under investigation by the student. In other words, the qualification and candidacy exams are uniquely determined for each individual student in a way that coursework and research are synergistic. U-M Mechanical Engineering also features a unique Research Process course which is taken by first year PhD students and master’s students to accelerate the development of research thinking, critical analysis skills, and high impact research hypotheses. Due to the synergy of coursework, examinations, mentoring opportunities, and a strong graduate student peer community, almost all students become candidates by the fourth semester in the program. This quick start is a hallmark of a program that is known for putting students on the leading edge of making scholarly contributions and impact in the real world, while graduating students with a plethora of job opportunities.
Program Overview

Over the years, more than 16,000 graduate students have chosen the Michigan program because of its consistent record of pushing the field’s frontier and the department’s exceptional rapport with students. As an ME graduate student, you’ll become part of a vibrant community that includes student-run organizations such as the ME Graduate Council, the Graduate Society of Women Engineers, and the National Society of Black Engineers, just to name a few. These organizations enable students to leverage professional networks and gain access to a social community that provides support for the rigorous pace of graduate engineering studies.

The Michigan graduate program in Mechanical Engineering offers two degrees: a Master of Science in Engineering (MSE), and a Doctor of Philosophy (PhD). You can also pursue dual degrees— for example, in the Engineering Sustainable Systems program with the School of Natural Resources & Environment, or with other programs within the Rackham graduate program. In addition, qualified undergraduates in the College of Engineering can pursue a combined graduate/undergraduate degree in the Sequential Graduate/Undergraduate Studies (SGUS) program.
MASTER’S DEGREE (MSE)

Students choose to pursue a master’s degree because of the opportunity to develop a personalized academic program to strengthen their knowledge of ME fundamentals in a specific area. There are three separate MSE degree program options: coursework only, coursework plus an individual research project, and coursework plus an MSE thesis.

DOCTOR OF PHILOSOPHY (PHD)

The goal of the PhD program is to create a culture of scholarship and high-impact research that produces articulate researchers who are called upon first to hold leadership positions in society and academia.

The PhD is the highest degree awarded by the ME Department and is recommended for students who are interested in leadership careers in academia (e.g. as a faculty member of a university), industry, or government. PhD graduates are trained to be the leaders and best in their fields and have doors open to a wide selection of career tracks. PhD students begin research immediately and have access to courses and networks that support research progress. ME is also a partner with the Rackham graduate school which offers workshops, training sessions, forums, and talks relevant to graduate students.
Research Areas

BIOSYSTEMS AND BIOMECHANICS: FROM CELLS TO PEOPLE

Biosystems and biomechanics research offers an interdisciplinary study of diverse biological phenomena across many size scales, from single DNA/protein molecules to cells and tissues and to human organs and body. Students apply engineering and physical principles to study molecular, cellular, and tissue biomechanics, construct miniaturized fluidic systems for biomedical diagnostic applications, and develop medical devices for rehabilitation. The close proximity of the world-renowned U-M Medical School enables seamless collaboration between engineering students and clinical and biomedical research professionals. Students interested in studying DNA and proteins can choose to work on DNA dynamics and coiling or protein dynamics and motors. Or, they can focus on engineering stem cell microenvironments and lab-on-chip technology, or develop solutions to healthcare challenges in resource-limited settings or wearable biomedical monitoring devices. Students benefit from the multidisciplinarity of U-M and channel their education towards creating revolutions in bioengineering and medical practice.
Computational Science & Engineering: Enhancing Phenomenological Predictions

Computational Science & Engineering applies high-performance computational techniques to a wide range of research, from combustion and biomedical engineering to turbomachinery and energy. Students have focused on nanoparticle interactions with biological systems, self-assembled nanostructures, energy storage materials, the design of biofuel molecules, and the tailored design of molecular structures for combustion performance. Students can also study computational biophysics, which addresses problems such as DNA mechanics and dynamics, or large-scale computation for cell motility and tumor growth, or concentrate on computational fluid dynamics, physics, or combustion and phononic design.
CONTROLS: CLOSING THE LOOP

Controls research at U-M ME encompasses everything from haptic and prosthetic devices, multi-scale robotics, fuel cells and biofuel energy conversion, manufacturing automation, to vehicle safety and next generation transportations. Research topics include position tracking of pedestrians or vehicles without GPS; technologies to aid people with disabilities including navigation aids for the blind and those with limited mobility; haptic interface systems that exploit the sense of touch for rehabilitation or education; micro-mechatronic systems for use in bio-medical devices or in computers; vehicle safety and handling; powertrain controls; diesel technology and braking methods for heavy vehicles; fuel cell and hybrid vehicles; autonomous ground robots; and reconfigurable manufacturing systems.
Alumni Profile

Charles Vest (MSME ’64, PhD ’67)

Charles Vest, president of the National Academy of Engineering and president emeritus of Massachusetts Institute of Technology, was hardly unfamiliar with U-M when he chose to pursue graduate work in mechanical engineering. His undergraduate mentor at West Virginia University urged him to apply; some of his undergraduate textbooks had been written by U-M faculty; and his father, Lewis Vest, had earned a doctorate in mathematics at the University.

While at U-M, Vest’s research interests and academic work focused on heat transfer and fluid mechanics. The most important part of his graduate education, he says, was the opportunity to study with and be mentored and advised by excellent faculty, who taught Vest how to formulate and solve problems.

“The most important part of my graduate education was the opportunity to study with excellent faculty. I learned how to solve problems, and this carried over into my career as an academic administrator. All of my opportunities started with my graduate education in U-M’s Mechanical Engineering department.”
Design: From Engineering Analysis to Better Living

Design is the transformation of fundamental understanding and creativity into the technological change that drives markets and meets societal needs. At U-M design takes on an analysis driven flavor, using engineering tools and multidisciplinary connections to understand how knowledge of engineering physics, chemistry, and biology can shape tomorrow’s solutions to global challenges. A key differentiator of the Michigan approach is that it takes a human-centered approach not just working within engineering, but also working with social scientists, architects, artists, policymakers, etc. across traditional academic boundaries to understand how technology can meet the needs of people. Students can focus on energy systems and technology design ranging from micro/nano devices to wind/solar energy transformation and storage, into technologies and systems that lead to advanced products, manufacturing processes, and services. Students also work on challenges for global health, environmental sustainability, smart/efficient mobility, and next generation infrastructures. Design students build on the elements of their engineering undergraduate education and apply the tools of optimization and innovation to meet global challenges.
DYNAMICS AND VIBRATIONS: SHAKING IT UP

Dynamics and Vibrations research studies the fundamentals of rigid and flexible body dynamics, vibrations, acoustics and controls. Through innovative research, students explore various topics, including nonlinear dynamics, structural dynamics, structural health monitoring, vibration controls, microrobotics, novel actuator and sensor systems, and adaptive structural systems. Human hearing and hearing biomimicry studies include the development of MEMS devices that mimic the function of the human inner ear. Sports training systems research include the use of MEMS inertial sensors for human motion analysis. In biomolecular dynamics research, students study the dynamics of biomolecular motors and DNA. Students also can concentrate efforts on fluid-structure interactions to better understand nonlinear structural and aeroelastic behaviors of systems such as turbine bladed disk assemblies. Students are well-positioned for entrepreneurial ventures or to lead research programs in academia, industry or government.
“A U-M ME degree gives your résumé an extra boost and provides professional opportunities through the extensive alumni community. You gain clout in the business world, since the name of the school and the rigor of the program are well known. And tackling the degree gave me much more confidence in my own engineering skills and problem-solving abilities.”

Carla Bailo (MSME ’86)

Carla Bailo (MSME ’86), now president of Nissan Technical Center North America, chose U-M Mechanical Engineering for its reputation, top-notch facilities, and the high caliber of professors and research in her main area of interest: automotive engineering.

Bailo clearly remembers taking an influential course on materials during her graduate study. “In the course we studied the Space Shuttle Challenger explosion and O-ring issue. Actually to solve a real-life problem using theory was amazing—it made me realize the importance of diligence in design and how critical the engineering role is to any mission.”
ENERGY: MULTISCALE POWER

The desire for sustainable energy has created new demands for energy research, and ME graduate students play an integral role in exploring and creating next-generation technology and system solutions. This interdisciplinary area includes a wide variety of technology applications from stationary power to transportation. For instance, students can focus on macro, micro, and nano devices for energy conversion. Or they can concentrate their work on the design of solar, wind, and thermal energy converters, including advanced photovoltaic power generation. Students can choose to work on alternative fuels design and combustion, which includes new concepts in the development of carbon-neutral vehicles, or focus on energy storage materials and systems, including the development of new materials for hydrogen storage. Additional topics include the design and maintenance of energy systems and the evaluation of government policies that influence technological development.
FLUIDS: MOLECULES IN MOTION

Fluids research at U-M comprises both fundamental and applied fluid mechanics research in order to study problems and opportunities related to energy, the environment, biomedical engineering, naval engineering, automotive engineering, and turbomachinery. Students often take a multidisciplinary approach to their research and work closely with other U-M departments to solve fluid mechanics challenges through theoretical, experimental and numerical investigations. Students can concentrate their efforts on multiphase flows, turbulence, acoustics, biological fluid dynamics, fluid-structure interaction, and microfluidics. Through rigorous study and research, students working in Fluids make discoveries and find solutions that can be applied to myriad applications while also advancing state-of-the-art theoretical understanding.
Michael Leamy (MSME ’95, PhD ’98)

Michael Leamy, an associate professor at Georgia Institute of Technology, applied only to one graduate program: U-M Mechanical Engineering. At Michigan, Leamy studied under and learned from top researchers in Mechanical Engineering, particularly in vibrations engineering and computational mechanics. He also made great friends from diverse backgrounds. “We did a lot of things outside of the classroom: intramural softball, hiking, and a little road tripping.”

After a teaching assistantship his first year, Leamy knew he wanted to pursue an academic career. “Both teaching and research are done at a very high level at Michigan with a great deal of integrity; it’s hard not to get sucked in. Having a U-M degree also is highly respected in academic circles, and that helped me ultimately land a position at another great university.”

“I knew I wanted to go to a diverse school with students pursuing degrees in many other fields, such as medicine, law, and business. . . U-M was the obvious choice.”
MANUFACTURING: ACCELERATING COMPETITIVENESS

U-M Manufacturing researchers are advancing the frontiers of what can be made and what can be commercialized. Students work alongside faculty members to develop innovative manufacturing processes and systems that transform concepts into market solutions. The scope of study available to students ranges from the development of personalized consumer products using reconfigurable and laser-based manufacturing to nanotube and nanowire structures and devices. Research extends in scales from precision manufacturing, micro-machining and micro-forming to product assembly and large scale production of carbon nanotubes, factory-scale energy conservation, and the development of sustainable manufacturing systems. Students also work on emerging manufacturing systems including biological printing and the development of autonomous mechatronic systems.
MECHANICS AND MATERIALS: PROBING THE STRUCTURES BEHIND THE STRUCTURE

Research in Mechanics and Materials unveils relationships between material structures and their behavior. This highly interdisciplinary area offers many opportunities for collaboration and focuses on experimental, theoretical, and computational aspects at a wide range of length and time scales. Students can focus on modeling of micro/nano mechanics, fracture, failure, and elasticity. Or their research can center on biological, semiconductor, polymer, or nano and active materials, such as self-assembled nanostructures; MEMS devices and toughening mechanisms in polymer nanocomposites; computational mechanics and dynamics; electrical storage, conduction, and conversion in applications such as batteries, chemical sensors, structural composites, and energy-efficient actuators; or tissue engineering and mechanics of soft materials.
“My advisors were stellar; I’ve tried to model my own advising of graduate students after them. The U-M ME program helped me develop the confidence to ask and answer hard questions, not only about how the physical world works—and how we can make it better—but also about the development and education of engineers themselves.”

Sheri Sheppard (PhD ME ’85)

Now a professor of mechanical engineering at Stanford University and co-director of the Center for Design Research, Sheri Sheppard chose the U-M ME graduate program for the quality—of the faculty, facilities and reputation—and the breadth of course offerings, from theoretical to practical. Her advisors, who had high expectations and always found time to talk and answer questions, had a strong influence on her, both then as a graduate student and now as a professor herself.

In the past decade, Sheppard has led several national studies on engineering identity and engineering education.
Mechatronics at U-M is at the forefront of designing high-performance machines, structures, devices, and processes. The field provides a hands-on and synergistic integration of mechanical engineering disciplines, encompassing controls, electronics, and computers. Students connect engineering models and analysis with real-world implementation by focusing their studies in several areas: mobile robots and autonomous vehicles; haptic interfaces; nanomanipulation; nanomanufacturing; and wearable medical monitoring devices. Students also contribute to projects related to smart materials, structural health monitoring, balance prostheses, and energy recovery from human movement.
MICRO/NANOENGINEERING: FROM THE GROUND UP

The Micro/Nanoengineering research area offers students the opportunity to examine a broad spectrum of technological and scientific problems related to small-scale materials, devices, and systems. Collaboration across disciplines, departments, and programs is the norm, including top researchers affiliated with the Medical School and the Lurie Nanofabrication lab. Students may focus on atomic scale and quantum mechanical simulation, which involves modeling nanoscale effects on materials properties and designing new materials based on these findings, or work on single molecule biosensors, bioimaging, and bioMEMS, including the design and fabrication of healthcare-related diagnostic devices. Or they may choose to concentrate on MEMS, NEMS, and microrobotics. Students also may work on nano materials and structures, such as synthesis and assembly of carbon nanotubes, or on thermoelectric devices and optoelectronics, such as measuring the transport properties of individual molecules. The contributions of U-M Micro/Nanoengineering students impact everyday life in key arenas including energy, healthcare, communications, and more.
Alan McGaughey (PhD ME ’04)

An associate professor of mechanical engineering at Carnegie Mellon University, Alan McGaughey chose U-M Mechanical Engineering for its outstanding reputation and extensive resources, including top investigators and cutting-edge research projects in nanoscale heat transfer, his main area of interest.

At U-M, McGaughey interacted with graduate students and faculty from diverse backgrounds in coursework and research. Colleagues and mentors from within the department as well as from Materials Science and Engineering and Physics helped him shape his thesis research into a successful interdisciplinary project. The many seminars he attended on preparing for an academic career helped him get a solid start on finding a faculty position.

McGaughey enjoyed going to hockey and football games, among other on- and off-campus activities. “The spirit and sense of community at Michigan were unlike anything I’d experienced before,” said McGaughey, who also met his wife, an Ann Arbor native, while at U-M.

“The spirit and sense of community at Michigan were unlike anything I’d experienced before. Working with my faculty advisor opened up opportunities that I did not think possible. My training at U-M made it possible for me to secure a faculty position as I was defending my thesis and prepared me for the challenges of an academic career”
MOBILITY AND TRANSPORTATION: COLLABORATING FOR INNOVATION

Mobility and transportation research at U-M has a long history of leadership through close collaboration with the automotive industry. It encompasses the internationally renowned Automotive Research Center, a Department of Energy supported Clean Vehicle Consortium, as well as three collaborative industry-university research labs. Students acquire a breadth and depth of engineering knowledge and apply it in a multidisciplinary approach to automotive system research. Those interested in energy and the environment can focus on alternative power sources for sustainability, advanced powertrains for fuel economy, or vehicle system electrification. Or they may choose to work on high performance smart materials for vehicle applications, or vehicle dynamics and control for safety including human error modeling and active safety. U-M students drive modern and future vehicle system design, and their work has a marked impact on energy and environmental sustainability, manufacturing and transportation in the U.S. and abroad.
THERMAL SCIENCES:
ENERGETIC STUDIES

Thermal Science has applications in automotive engineering as well as many other industries, including biomedical, chemical, manufacturing, aerospace, and aeronautics. By studying heat transfer physics and molecular dynamics, students can focus on nanostructuring materials to reflect or filter heat. Combustion diagnostics focuses on internal combustion processes and systems, including molecular spectroscopy and laser techniques. Microscale heat transfer and photovoltaic energy conversion includes diesel engine combustion, hybrid propulsion technology, alternative fuels, and fuel cells. Students can study heat transfer in porous media, fire suppression, and combustion engines. They may also study reburn and co-firing technologies/pollution mitigation, which focuses on pollution formation, nanoparticle interactions, and biomolecular systems.
Doug Smith (BSE ’77, MSME ’80)

Doug Smith, chief operating officer at Roush Enterprises, earned his master’s degree in mechanical engineering through his participation in Chrysler’s Institute of Engineering. With its affiliation with U-M, the Institute enabled Smith to gain valuable work experience in a variety of job functions at Chrysler while earning his graduate degree.

Smith joined the company that is now Roush Enterprises in 1981 and has been with the company since, holding positions of increasing scope and responsibility.

“I’ve spent most of my career on the technical side of the business, and graduate study at U-M gave me confidence in my technical abilities. Going to school while working made the ME program very real for me—I could relate what I was learning in my classes to what I was doing at work at Chrysler. There were so many relevant applications.”
About Ann Arbor

A TOP RATED CITY

Rated the fourth most livable city in America by Forbes Magazine (4/29/10), Ann Arbor combines small-town charm with big-city attractions. Restaurants offer Thai, Japanese, Vietnamese, Italian, and more. There are coffee shops aplenty, great shopping, and the world-famous Zingerman’s Deli.

Lovers of the outdoors will enjoy the Huron River, the miles of bike trails and paths, and the scenic parkland of “Tree City USA,” including the U-M’s beautiful Arboretum. Aficionados of music, theater, and dance will be amazed at the world-class artists who come to Ann Arbor to perform. And sports fans will be able to experience a football game in “The Big House,” Michigan’s 109,901-seat stadium, or watch any of the other 26 Michigan intercollegiate sports teams.

A low cost of living, lots of things to do, and a lovely place to do them in: that’s our town.
About the University of Michigan

Founded in 1817, the University of Michigan is one of the preeminent research universities in the world. Research expenditures in 2009–10 were $1,139,000,000—one of the largest of any US university. Our 19 schools and colleges have produced leaders like President Gerald R. Ford; Tony Fadell, inventor of the iPod; Larry Page, co-founder of Google; playwright Arthur Miller; actors James Earl Jones, Selma Blair, and Lucy Liu; Antonia Novello, the first female US Surgeon-General; and athletes like Tom Brady, Jim Harbaugh, and Desmond Howard.

The university comprises four campuses: Central, North, Medical (including the Hospitals), and South (athletics campus). Scenic North Campus is the location for the College of Engineering and for the schools of Art & Design, Architecture, and Music, Theatre & Dance. Free commuter buses run throughout the day to make it easy to travel between campuses.
More Information

Michigan’s graduate program in Mechanical Engineering is one of the best in the country, and we’d like to tell you more about it. Our website has detailed information on program prerequisites, degrees offered, application guidelines, and much more. Or call us at 734-764-0863 or email me-aso@umich.edu.

http://me.engin.umich.edu/academics/gsh/