MECHANICAL SCIENCE AND ENGINEERING

http://mechse.illinois.edu

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Major: Engineering
Degrees Offered: M.Eng.
Graduate Concentration: Computational Engineering

Major: Mechanical Engineering
Degrees Offered: M.Eng., M.S., Ph.D.

Major: Theoretical and Applied Mechanics
Degrees Offered: M.S., Ph.D.

Off-Campus Program: Mechanical Engineering
Degree offered: M.S.

Concentrations: Biomechanics, Computational Engineering (M.Eng.)

Graduate Degree Programs

Building upon the longstanding strengths of programs in mechanical engineering and in mechanics, the Department of Mechanical Science and Engineering (MechSE) at the University of Illinois at Urbana-Champaign is taking a bold, new approach to research and education that will enable it to address some of the most pressing problems facing the nation and the world. A new paradigm in research is being created in the department by integrating basic sciences such as biology, chemistry, applied mathematics, and applied physics with the traditional mechanical engineering and engineering mechanics disciplines of fluid mechanics-thermal science, solid mechanics-materials, and controls-dynamics. This integration is fostering new directions and discoveries in nanomechanics, nanomanufacturing, biomechanics and computational science and engineering.

The goal of all research in the department is to address critical societal problems in the areas of health, security-defense, energy-environment, manufacturing, and transportation. While the basic function of departmental research is generation of new knowledge, a growing number of projects are prompted by current needs of the State of Illinois and of the nation.

The department offers graduate programs leading to master's and doctoral degrees with exciting research opportunities as described in the Faculty Research Interests section below. Opportunity also exists for specializing in:

1. computational science and engineering via the Computational Science and Engineering (CSE) (http://www.cse.illinois.edu) transcriptable Concentration
2. energy and sustainability engineering via the Energy and Sustainability Engineering (EaSE) Option (http://ease.illinois.edu).

The M.Eng. is a professional master's degree program for students whose primary intent is a career in industry or government. This degree differs from the Master of Science degree in that it is a terminal degree and not a pathway to a doctoral program.

Admission

An applicant for admission to the Department of Mechanical Science and Engineering must:

1. be a graduate of an institution awarding a baccalaureate degree equivalent to that granted by the University of Illinois at Urbana-Champaign;
2. be adequately prepared for advanced study as demonstrated by his or her previous program of study and scholastic record; and
3. be recommended for admission by the Department of Mechanical Science and Engineering. A minimum grade point average of 3.25 (A = 4.00) for the last two years of undergraduate study is required and a 3.50 for any previous graduate work completed.

Scores on the Graduate Record Examination (GRE) (http://www.ets.org) general test are required of all applicants. Based upon the previous preparation of the student, prerequisite courses may be specified by the advisor, but the credit may not be applied toward a degree.

All applicants whose native language is not English must submit a minimum TOEFL (http://www.toefl.org) score of 103 (IBT), 257 (CBT), or 613 (PBT), or minimum International English Language Testing System (IELTS) (http://www.ielts.org) academic exam scores of 7.0 overall and 6.0 in all subsections. Applicants may be exempt from the TOEFL if certain criteria (http://grad.illinois.edu/admissions/instructions/04c) are met. Full admission status (http://grad.illinois.edu/admissions/instructions/04c) is granted for those meeting the minimum requirements and having taken the TOEFL or IELTS since the scores required for admission to MechSE are above the minimum scores demonstrating an acceptable level of English language proficiency.

Applicants to the M.Eng. must have a bachelor’s or master’s degree in engineering or a related field and will be considered for admission if they have a grade point average of at least 3.00 (A = 4.00) for the last two years of undergraduate study. Admission is possible for the spring term, but most admissions are for the fall term. The same requirements as listed above apply for all applicants whose native language is not English.

Students may apply to the Medical Scholars Program prior to beginning graduate school or while in the graduate program. Applicants to the Medical Scholars Program must meet the admissions standards for and be accepted into both Mechanical Science and Engineering and the College of Medicine. An application to the Medical Scholars Program will also serve as the application to the Mechanical Science and Engineering graduate programs. Further information on this program is available by contacting the Medical Scholars Program, (125 Medical Sciences Building, (217)-333-8146, msp@illinois.edu).

Students interested in the joint M.S.M.E.-M.B.A. degree program must apply initially to the M.B.A. program. In the term in which 60 hours of the M.B.A. course work prescribed for the joint-degree program is expected to be completed, they become eligible to petition to transfer to the M.S.M.E.

Information listed in this catalog is current as of 10/2018
degree program and with MechSE approval, may be admitted under the joint M.S.M.E.-M.B.A. program code.

**Off-Campus Programs**

The department offers the M.S. in Mechanical Engineering with both a thesis and a non-thesis option as described above.

**Graduate Teaching Experience**

Although teaching is not a general Graduate College requirement, experience in teaching is considered an important part of the graduate experience in both the ME and TAM Ph.D. programs. The TAM Ph.D. requires that one semester of teaching assistantship be completed during the program.

**Faculty Research Interests**

A new paradigm in research is being created in the department by integrating basic sciences such as biology, chemistry, applied mathematics, and applied physics with the traditional mechanical engineering and engineering mechanics disciplines of fluid mechanics/thermal science, solid mechanics/materials and controls/dynamics. This integration is fostering new directions and discoveries in nanomechanics, nanomanufacturing, biomechanics and computational science and engineering.

The goal of all research in the department is to address critical societal problems in the areas of health, security/defense, energy/environment, manufacturing, and transportation. While the basic function of departmental research is generation of new knowledge, a growing number of projects are prompted by current needs of the state of Illinois and of the nation.

Faculty research interests include the following:

- **Biomechanics** – cell adhesion and motility, biological machines, bio-fluid mechanics, orthopedic biomechanics, musculoskeletal biomechanics, rehabilitation engineering, bone mechanics, composite biological nanomaterials, single-cell mechanics, synthetic biomaterials, failure mechanics of biomaterials, cytoskeletal biomechanics, mechanotransduction, bio-imaging of cytoskeletal structures and stress distribution in living cells, human motion analysis, human-machine systems.

- **Nanomechanics/nanomanufacturing** – micro/nano-fluidics, NEMS and MEMS, photonic metamaterials and devices, 3D micro/nanofabrication, process planning, programmable machines, nanotubes, nano-materials, electronic and photonic materials, metal cutting, micro/meso-machining, agile fixturing, scanning probe microscopy, micro/nano heat and mass transfer, feature-based cost analysis, rapid prototyping, interface surface science and technology, tribology, magnetic storage, friction/vibration characterization, microscale transport, electrokinetic phenomena, nano-positioning, atomic force microscopy, nanoscale actuation and robotics.

- **Controls/dynamics** – autonomous networked vehicle control, nonlinear mechanical systems and phenomena, distributed-parameter systems, wavelet methods, stability theory, piecewise smooth dynamics, multi-body dynamics, control of multi-rate and asynchronous systems, equi-variant (symmetric) dynamical systems, control using methods of stochastic dynamics, experimental and analytical modal analysis, and control theory (non-linear, adaptive, robust, optimal, and distributed) with application to mechanical and electromechanical systems.

- **Fluid mechanics/thermal sciences** – bio-fluids, combustion, propulsion, energy systems and the environment, IC engines, gas turbines, laser diagnostics, energetic materials, combustion synthesis of materials, micro- and nano-scale heat transfer, kinetics of chemical processes, two-phase flow, liquid atomization and spray, air-conditioning and refrigeration systems, micro-fluidics, computational fluid dynamics, compressible flow, fluid-structure interactions, meshless methods, detonation, deflagration-to-detonation transition, shock propagation, reacting flows, internal ballistics of rockets and guns, continual eddies, turbulent boundary layers, turbulent wakes, stratified turbulence, turbulence simulation, instability modes, vortex dynamics, coating flows, flow separation, three-dimensional foams, direct numerical simulation, large-eddy simulation, and particle-image velocimetry.


**Centers, Programs, and Institutes**

The following research centers and programs are integral to the MechSE graduate program:

- Air Conditioning and Refrigeration Center (ACRC)
- Center for Intracellular Mechanics
- Center for Nanoscale Chemical-Electrical-Mechanical Manufacturing systems (Nano-CEMMS)
- Continuous Casting Consortium (CCC)
- Cooperative Networked Control of Dynamical Peer-to-Peer Vehicle Systems
- Fracture Control Program
- Manufacturing Research Center
- Midwest Structural Sciences Center
- The Center for Advanced Automotive Bio-Fuel Combustion Engines
- The Center for Process Simulation and Design
- The Center of Advanced Materials for Purification of Water with Systems (The WaterCAMPWS)
- The Global Enterprise for Micro-Mechanics and Molecular Medicine (GEM4)

To learn more about the research centers and programs within the MechSE department, please visit the department’s research center Web site (http://mechanical.illinois.edu/research).
Facilities and Resources
Research facilities include laboratories for advanced automation, air conditioning and refrigeration, combustion, computer-integrated manufacturing, control systems, design for manufacturing, gas dynamics, heat transfer, high-temperature materials, human factors and simulation of human-machine interaction, human dynamics and controls, intracellular mechanics, cell and molecular mechanics, internal-combustion engines, laser diagnostics for combustion, opto-electronic materials, machining and machine tool systems, mechanical behavior of materials, metrology, micromachining, microtribodynamics, polymer and composite materials processing, propulsion, rapid prototyping, robotics, short-pulse laser-ablation technology, thermal processing of materials, thermal radiation, tribology, and vehicle dynamics. Special facilities include a micro-fabrication facility with its own clean room (Class 10 and 1000) for silicon and CMOS-based micro-fabrication, test facilities for refrigeration and air-conditioning systems and components, low- and high-speed wind tunnels, and laboratories for study of combustion, quantitative visualization, complete specimenscale mechanical testing equipment including an environmental testing chamber, thermomechanical and multiaxial loading capabilities. The department has a machine shop staffed with skilled instrument makers.

Financial Aid
Financial assistance is available to students who are admitted and includes fellowships, research and teaching assistantships, and/or waivers of tuition and fees. Assistantship stipends vary with one’s entry level into the program. All applicants, regardless of U.S. citizenship, whose native language is not English and who wish to be considered for teaching assistantships must demonstrate spoken English language proficiency (http://grad.illinois.edu/admissions/taengprof.htm) by achieving a minimum score of 24 on the speaking subjection of the TOEFL iBT or 8 on the speaking subsection of the IELTS. For students who are unable to take the iBT or IELTS, a minimum score of 4CP is required on the EPI test (http://cte.illinois.edu/testing/oral_eng/epi_overview.html), offered on campus. All new teaching assistants are required to participate in the Graduate Academy for College Teaching (http://cte.illinois.edu/programs/ta_train.html) conducted prior to the start of the semester.

Master’s Degree Programs offered:
• Mechanical Engineering, M.Eng. (http://catalog.illinois.edu/graduate/graduate-majors/mechse/me-mech-eng)
• Mechanical Engineering, M.S. (http://catalog.illinois.edu/graduate/graduate-majors/mechse/ms-mech-eng)
• Mechanical Engineering, M.S. - Online
• Theoretical and Applied Mechanics, M.S. (http://catalog.illinois.edu/graduate/graduate-majors/mechse/ms-theoretical-applied-mech)

Doctor of Philosophy programs offered:
• Mechanical Engineering, Ph.D. (http://catalog.illinois.edu/graduate/graduate-majors/mechse/dr-philo-mech-eng)
• Theoretical and Applied Mechanics, Ph.D. (http://catalog.illinois.edu/graduate/graduate-majors/mechse/dr-philo-theo-applied-mech)

Mechanical Engineering, M.S.
Online
The online MSME degree program offers both a thesis (32 credit hours) and non-thesis (36 credit hours) option. (http://catalog.illinois.edu/graduate/graduate-majors/mechse/ms-mech-eng) Online students have five years to complete the degree requirements. The degree awarded through our online program is the exact same degree (http://catalog.illinois.edu/graduate/graduate-majors/mechse/ms-mech-eng) awarded to on-campus MSME students. The application process is very similar to our other programs which is described at our Applying to MechSE (http://mechanical.illinois.edu/graduate/applying-mechse) page. Applications for the online program are not required to submit GRE scores; after the application is submitted, our administrators will waive the requirement of the GRE for students applying to the online program.

Thesis Option

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME 599</td>
<td>Thesis Research (min-max applied toward the degree)</td>
<td>4-8</td>
</tr>
<tr>
<td>MSE 492</td>
<td>Lab Safety Fundamentals (credit does not apply toward the degree)</td>
<td>0</td>
</tr>
<tr>
<td>ME 590</td>
<td>Seminar (registration for 1 hour every term while in residence; credit does not apply toward the degree)</td>
<td>0</td>
</tr>
</tbody>
</table>

Elective courses (formal graded coursework) – chosen in consultation with advisor (subject to Other Requirements and Conditions below) 24-28

Total Hours 32

Other Requirements and Conditions (may overlap) 1
A minimum of 8 ME or TAM credit hours with 4 at the 500 level.
A minimum of 12 500-level credit hours applied toward the degree.
For the thesis option, a maximum of 4 hours of ME 597 or TAM 597 (or other approved independent study) may be applied toward the elective course work requirement.
No ME 599 credit may be applied toward the elective course work requirement (599 is not formal graded coursework).

Minimum GPA: 3.0

1 For additional details and requirements refer to the department’s graduate program requirements (http://mechanical.illinois.edu/graduate/mechse-graduate-degrees) and the Graduate College Handbook (http://grad.illinois.edu/gradhandbook).

Non-Thesis Option

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSE 492</td>
<td>Lab Safety Fundamentals (credit does not apply toward the degree)</td>
<td>0</td>
</tr>
<tr>
<td>ME 590</td>
<td>Seminar (registration for 1 hour every term while in residence; credit does not apply toward the degree)</td>
<td>0</td>
</tr>
<tr>
<td>ME 597</td>
<td>Independent Study</td>
<td>4</td>
</tr>
<tr>
<td>or TAM 597 Advanced Independent Study</td>
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</tbody>
</table>

Elective courses – chosen in consultation with advisor (subject to Other Requirements and Conditions below) 32

Total Hours 36

Information listed in this catalog is current as of 10/2018
Other Requirements and Conditions (may overlap) ¹

A minimum of 8 ME or TAM credit hours with 4 at the 500 level.

A minimum of 12 500-level credit hours applied toward the degree.

Departmental approval is required to pursue the non-thesis option.

Minimum GPA: 3.0

¹ For additional details and requirements refer to the department's graduate program requirements (http://mechanical.illinois.edu/graduate/mechse-graduate-degrees) and the Graduate College Handbook (http://grad.illinois.edu/gradhandbook).

Mechanical Science and Engineering offers 2 graduate concentrations:

- Biomechanics Concentration – Graduate (http://catalog.illinois.edu/graduate/graduate-majors/bio-engin/conc-biomechanics)
- Computational Engineering Concentration – Graduate (http://catalog.illinois.edu/graduate/graduate-majors/mechse/computational-eng)

available for M.Eng. degree only