ENGINEERING MECHANICS, M.S.

The master of science and doctor of philosophy degrees in engineering mechanics are offered within a graduate program covering contemporary areas in both theoretical and applied mechanics. With the guidance of a major professor, a program can be designed to meet an individual student’s needs and interests.

The Engineering Mechanics M.S. program is appropriate for students with an undergraduate background in mechanics. Prospective M.S. students with an undergraduate background in science, who would like to transition into engineering, are encouraged to consider the Engineering Mechanics: Fundamentals of Applied Mechanics (http://guide.wisc.edu/graduate/engineering-physics/engineering-mechanics-ms/engineering-mechanics-fundamentals-applied-mechanics-ms) named option.

The program is broadly structured into several main areas of instruction and research interests in mechanics of materials and astronautics: continuum mechanics, computational mechanics, dynamics and vibration, fluid mechanics, nanomechanics, solid mechanics, and biomechanics. Related fields in which minor work may be done include civil and environmental engineering, chemical and biological engineering, electrical and computer engineering, materials science, mechanical engineering, nuclear engineering and engineering physics, physics, geological engineering and geology, mathematics, statistics, and computer science.

Current faculty research interests include adhesive-bonded joints; composites; failure criteria; analytical and computational solid mechanics; analytical and computational dynamics; multibody dynamics; analytical and computational active and passive space-structure control systems; dynamic stability; nonlinear fracture mechanics of traditional and advanced materials; continuum mechanics; modal analysis; nanomechanics and nanotribology; fluid-structure interaction; non-Newtonian fluid flow; structural mechanics; viscoelasticity; viscoplasticity; cell mechanics; and biomechanics.

Laboratories are well equipped for experimental testing and research; these include holography, Moire, atomic force microscopy, vibration testing, and other optical methods for experimental mechanics research. The department has access to college-wide facilities. The Wisconsin Laboratory for Structures and Materials Testing has facilities for testing large structures, fatigue and vibration labs, and complements the department’s laboratories. The Materials Science Center provides state-of-the-art instrumentation, support facilities, and expert technical assistance for research and education in materials. Its facilities include scanning and transmission electron microscopes, image processing and analysis systems, surface and thin film characterization facilities, and x-ray diffraction facilities.

Please consult the table below for key information about this degree program’s requirements. The program may have more detailed admissions requirements, which can be found below the table or on the program’s website.

Graduate admissions is a two-step process between academic programs and the Graduate School. Applicants must meet the minimum requirements (https://grad.wisc.edu/apply/requirements/#english-proficiency) of the Graduate School as well as the program(s).

ADMISSIONS

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall Deadline</td>
<td>December 15</td>
</tr>
<tr>
<td>Spring Deadline</td>
<td>October 1</td>
</tr>
<tr>
<td>Summer Deadline</td>
<td>December 15</td>
</tr>
<tr>
<td>GRE (Graduate Record Examinations)</td>
<td>Required.*</td>
</tr>
<tr>
<td>English Proficiency Test</td>
<td>Every applicant whose native language is not English or whose undergraduate instruction was not in English must provide an English proficiency test score and meet the Graduate School minimum requirements (<a href="https://grad.wisc.edu/apply/requirements/#english-proficiency">https://grad.wisc.edu/apply/requirements/#english-proficiency</a>).</td>
</tr>
<tr>
<td>Other Test(s) (e.g., GMAT, MCAT)</td>
<td>n/a</td>
</tr>
<tr>
<td>Letters of Recommendation</td>
<td>3</td>
</tr>
<tr>
<td>Required</td>
<td></td>
</tr>
</tbody>
</table>

* Except for current UW-Madison NE/EP/EMA undergraduate students.

The Graduate School sets minimum requirements for admissions (https://grad.wisc.edu/admissions/requirements). Academic program admission requirements are often more rigorous than those set by the Graduate School. Please check the program website (https://www.engr.wisc.edu/department/engineering-physics/academics/ms-engineering-mechanics) for details and admissions deadlines.

FUNDING

GRADUATE SCHOOL RESOURCES

Resources to help you afford graduate study might include assistantships, fellowships, traineeships, and financial aid. Further funding information (https://grad.wisc.edu/funding) is available from the Graduate School. Be sure to check with your program for individual policies and processes related to funding.

PROGRAM RESOURCES

Admission and funding are separate decisions. Not all admitted students are offered support. International applicants must secure a research assistantship, teaching assistantship, fellowship, or independent funding before admission is final. A portion of the top domestic applicants is invited to visit Madison in March. The funding for RAs comes from faculty research grants. Each professor decides on his or her own RA offers. Funded students are expected to maintain full-time enrollment. See the program website (https://www.engr.wisc.edu/department/engineering-physics/academics/ms-engineering-mechanics) for additional information.
REQUIREMENTS

MINIMUM GRADUATE SCHOOL REQUIREMENTS

Review the Graduate School minimum academic progress and degree requirements (http://guide.wisc.edu/graduate/policiesandrequirementstext), in addition to the program requirements listed below.

MAJOR REQUIREMENTS

MODE OF INSTRUCTION

<table>
<thead>
<tr>
<th>Mode of Instruction</th>
<th>Face to Face</th>
<th>Evening/Weekend</th>
<th>Online</th>
<th>Hybrid</th>
<th>Accelerated</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

Mode of Instruction Definitions

**Evening/Weekend:** These programs are offered in an evening and/or weekend format to accommodate working schedules. Enjoy the advantages of on-campus courses and personal connections, while keeping your day job. For more information about the meeting schedule of a specific program, contact the program.

**Online:** These programs are offered primarily online. Many available online programs can be completed almost entirely online with all online programs offering at least 50 percent or more of the program work online. Some online programs have an on-campus component that is often designed to accommodate working schedules. Take advantage of the convenience of online learning while participating in a rich, interactive learning environment. For more information about the online nature of a specific program, contact the program.

**Hybrid:** These programs have innovative curricula that combine on-campus and online formats. Most hybrid programs are completed on-campus with a partial or completely online semester. For more information about the hybrid schedule of a specific program, contact the program.

**Accelerated:** These on-campus programs are offered in an accelerated format that allows you to complete your program in a condensed time-frame. Enjoy the advantages of on-campus courses with minimal disruption to your career. For more information about the accelerated nature of a specific program, contact the program.

CURRICULAR REQUIREMENTS

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Credit Requirement</td>
<td>30 credits</td>
</tr>
<tr>
<td>Minimum Residence Credit Requirement</td>
<td>16 credits</td>
</tr>
<tr>
<td>Minimum Graduate Coursework Requirement</td>
<td>15 of the required 30 credits must be in graduate-level coursework; courses with the Graduate Level Coursework attribute are identified and searchable in the university's Course Guide (<a href="https://registrar.wisc.edu/course-guide/">https://registrar.wisc.edu/course-guide/</a>).</td>
</tr>
<tr>
<td>Overall Graduate GPA Requirement</td>
<td>3.00 GPA required</td>
</tr>
</tbody>
</table>

Other Grade Requirements

Courses in which grades of BC, C, or below are received cannot be counted toward the degree except as follows:

1) Credits of C will be allowed provided they are balanced by twice as many credits of A or by four times as many credits of AB, 2) Credits of BC will be allowed provided they are balanced by twice as many credits of AB or by an equal number of credits of A.

Assessments and Examinations

A thesis is not required for a Master’s degree in Engineering Mechanics. Credit for Master’s research (E M A 790) will be granted toward meeting the M.S. requirements only when a formal M.S. thesis is submitted and approved by the thesis committee. If submitting a M.S. thesis, a thesis Oral Defense is required. Candidates must pass an oral exam administered by a three-member committee, selected by the student's advisor. At least two of the committee members must be members of the UW-Madison Graduate Faculty. (For more information, see https://grad.wisc.edu/documents/committees/.) Typically, the student presents an overview of their thesis/research, and then the examiners ask questions in closed session. See the Graduate School’s information https://grad.wisc.edu/current-students/masters-guide/ and note the requirement for an advisor approval page; the form that appears in Appendix C of the Handbook may be used.

Language Requirements

No language requirements.

REQUIRED COURSES

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>E M A/CIV ENGR/ M E 508</td>
<td>Composite Materials</td>
<td>3</td>
</tr>
<tr>
<td>E M A 519</td>
<td>Fracture Mechanics</td>
<td></td>
</tr>
<tr>
<td>E M A 522</td>
<td>Aerodynamics Lab</td>
<td></td>
</tr>
<tr>
<td>E M A 523</td>
<td>Flight Dynamics and Control</td>
<td></td>
</tr>
<tr>
<td>E M A/M E 540</td>
<td>Experimental Vibration and Dynamic System Analysis</td>
<td></td>
</tr>
<tr>
<td>E M A/ M S &amp; E 541</td>
<td>Heterogeneous and Multiphase Materials</td>
<td></td>
</tr>
<tr>
<td>E M A/E P 547</td>
<td>Engineering Analysis I</td>
<td></td>
</tr>
<tr>
<td>E M A/E P 548</td>
<td>Engineering Analysis II</td>
<td></td>
</tr>
<tr>
<td>E M A/M E 570</td>
<td>Experimental Mechanics</td>
<td></td>
</tr>
</tbody>
</table>

Mathematics Requirements

Students must take at least 3 credits (1 course) from the following list:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>E M A/E P 547</td>
<td>Engineering Analysis I</td>
</tr>
<tr>
<td>E M A/E P 548</td>
<td>Engineering Analysis II</td>
</tr>
<tr>
<td>MATH 519</td>
<td>Ordinary Differential Equations</td>
</tr>
<tr>
<td>MATH 521</td>
<td>Analysis I</td>
</tr>
<tr>
<td>MATH 522</td>
<td>Analysis II</td>
</tr>
<tr>
<td>MATH 540</td>
<td>Linear Algebra II</td>
</tr>
<tr>
<td>Course Code</td>
<td>Course Title</td>
</tr>
<tr>
<td>-------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>MATH 619</td>
<td>Analysis of Partial Differential Equations</td>
</tr>
<tr>
<td>MATH 623</td>
<td>Complex Analysis</td>
</tr>
<tr>
<td>MATH 703</td>
<td>Methods of Applied Mathematics 1</td>
</tr>
<tr>
<td>MATH 704</td>
<td>Methods of Applied Mathematics-2</td>
</tr>
<tr>
<td>MATH/COMP SC 714</td>
<td>Methods of Computational Mathematics I</td>
</tr>
<tr>
<td>MATH/COMP SC 715</td>
<td>Methods of Computational Mathematics II</td>
</tr>
</tbody>
</table>

**Breadth Requirement**

Students must take at least 5 courses from the list below. At least 3 must be identified by a *. The courses must span at least 2 of the 3 areas defined below. For each of the 2 areas, the student must take at least 2 courses.

**Solid Mechanics**

- EMA 506 Advanced Mechanics of Materials I * 3
- EMA/CIV ENGR/ME 508 Composite Materials 3
- EMA 519 Fracture Mechanics * 3
- EMA/M S & E 541 Heterogeneous and Multiphase Materials * 3
- EMA/EMA 570 Experimental Mechanics 3
- EMA 605 Introduction to Finite Elements * 3
- EMA 611 Advanced Mechanical Testing of Materials * 3
- EMA/EPE 615 Micro- and Nanoscale Mechanics * 3
- EMA 622 Mechanics of Continua * 3
- EMA 630 Viscoelastic Solids * 3
- EMA 700 Theory of Elasticity * 3
- EMA/E/EMA 703 Plasticity Theory and Physics 3
- EMA 705 Advanced Topics in Finite Elements * 3
- EMA/EMA 706 Plates, Shells and Pressure Vessels 3
- EMA/EMA 708 Advanced Composite Materials 3
- EMA/EMA 722 Introduction to Polymer Rheology 3
- M/E/B/E ME 603 Topics in Bio-Medical Engineering (Topic: FE for Biomechanics) 1-3
- ME 753 Friction, Lubrication and Wear 3

**Fluid Mechanics**

- EMA 521 Aerodynamics * 3
- EMA 622 Mechanics of Continua * 3
- ME 563 Intermediate Fluid Dynamics * 3
- ME 572 Intermediate Gas Dynamics * 3
- ME 573 Computational Fluid Dynamics * 3
- ME 769 Combustion Processes 3
- ME 770 Advanced Experimental Instrumentation 3
- ME 774 Chem Kinetics of Combust Systems 3
- ME 775 Turbulent Heat and Momentum Transfer 3

**Dynamics**

- EMA 523 Flight Dynamics and Control * 3
- EMA/ME 540 Experimental Vibration and Dynamic System Analysis * 3
- EMA 542 Advanced Dynamics * 3
- EMA 545 Mechanical Vibrations * 3
- EMA/ASTRON 550 Astrodynamics 3
- EMA 610 Structural Finite Element Model Validation * 3
- EMA 642 Satellite Dynamics * 3
- EMA 742 Theory and Applications in Advanced Dynamics * 3
- EMA 745 Advanced Methods in Structural Dynamics * 3
- EMA 747 Nonlinear and Random Mechanical Vibrations * 3
- M/E/C/E 577 Automatic Controls Laboratory 4
- ME 740 Advanced Vibrations 3
- ME 747 Advanced Computer Control of Machines and Processes 3
- ME 748 Optimum Design of Mechanical Elements and Systems 3

**Depth Requirement**

At least 2 courses (6 credits) must be 700-level or above in mechanics, from the following list:

- Any EMA course except EMA 790, EMA 890, or EMA 990.
- EMA 601 Special Topics courses may only be counted as 700-level if designated as such by the instructor.
- CBE 720 Microhydrodynamics, Brownian Motion, and Complex Fluids
- CIV ENGR/GLE 730 Engineering Properties of Soils
- CIV ENGR/GLE 735 Soil Dynamics
- MATH 705 Mathematical Fluid Dynamics
- ME 740 Advanced Vibrations
- ME 746 Dynamics of Controlled Systems
- ME 747 Advanced Computer Control of Machines and Processes
- ME 748 Optimum Design of Mechanical Elements and Systems
- ME 751 Matrix Methods in the Design and Analysis of Mechanisms
- ME 753 Friction, Lubrication and Wear
- ME 769 Combustion Processes
- ME 770 Advanced Experimental Instrumentation
- ME 774 Chem Kinetics of Combust Systems
- ME 775 Turbulent Heat and Momentum Transfer

**Optional Independent Study/Research Credits**
A maximum of 6 credits of EMA 599 may be used toward the 30-credit minimum. A maximum of 12 credits of EMA 790 may be used toward the 30-credit minimum. If using credits from both EMA 599 and EMA 790 toward the 30-credit minimum, a maximum combined total of 12 credits is allowed. Credit for EMA 790 will be granted toward meeting the M.S. requirements only when a formal M.S. thesis is submitted and approved by the thesis committee.

Optional Seminar Credits
Up to 3 credits of Mechanics Seminar may be used to count toward the 30-credit minimum.

NAMED OPTIONS (SUB-MAJORS)
A named option is a formally documented sub-major within an academic major program. Named options appear on the transcript with degree conferral.

View as list

- ENGINEERING MECHANICS: FUNDAMENTALS OF APPLIED MECHANICS, M.S. (HTTP://GUIDE.WISC.EDU/GRADUATE/ENGINEERING-PHYSICS/ENGINEERING-MECHANICS-MS/ENGINEERING-MECHANICS-FUNDAMENTALS-APPLIED-MECHANICS-MS)

POLICIES

GRADUATE SCHOOL POLICIES
The Graduate School's Academic Policies and Procedures (https://grad.wisc.edu/acadpolicy) provide essential information regarding general university policies. Program authority to set degree policies beyond the minimum required by the Graduate School lies with the degree program faculty. Policies set by the academic degree program can be found below.

MAJOR-SPECIFIC POLICIES

GRADUATE PROGRAM HANDBOOK
The Graduate Program Handbook (https://www.engr.wisc.edu/department/engineering-physics/academics/ms-engineering-mechanics) is the repository for all of the program's policies and requirements.

PRIOR COURSEWORK

Graduate Work from Other Institutions
With permission from their faculty adviser and the department chair, students may use up to 6 credits of graduate course work taken at another institution if they meet departmental M.S. requirements. Coursework earned five or more years prior to admission to a master's degree is not allowed to satisfy requirements.

UW-Madison Undergraduate
With faculty approval, students who have received their undergraduate degree from UW-Madison may apply up to 7 credits numbered 400 or above toward the minimum graduate degree credit requirement. This work would not be allowed to count toward the 50% graduate coursework minimum unless taken at the 700 level or above. No credits can be counted toward the minimum graduate residence credit requirement. Coursework earned five or more years prior to admission to a master's degree is not allowed to satisfy requirements.

With faculty approval, students who have received a ABET-accredited undergraduate degree (not including UW-Madison) may be eligible to apply up to 7 credits of their undergraduate coursework toward the Minimum Graduate Degree Credit Requirement. No credits can be counted toward the Minimum Graduate Residence Credit Requirement, nor the Minimum Graduate Coursework (50%) Requirement. Coursework earned five or more years prior to admission to a master's degree is not allowed to satisfy requirements.

PROBATION
A semester GPA below 3.0 will result in the student being placed on academic probation. If a semester GPA of 3.0 is not attained during the subsequent semester of full time enrollment (or 12 credits of enrollment if enrolled part-time) the student may be dismissed from the program or allowed to continue for one additional semester based on advisor appeal to the Graduate School.

ADVISOR / COMMITTEE
Each student is required to meet with his or her advisor prior to registration every semester.

CREDITS PER TERM ALLOWED
15 credits

TIME CONSTRAINTS
Students with a Bachelor of Science in Engineering Mechanics or equivalent are typically expected to complete the Master of Science in 3 semesters. Students with non-EM backgrounds will typically be permitted 4 semesters to complete their Master's if more than 27 credits are required.

OTHER
n/a

PROFESSIONAL DEVELOPMENT

GRADUATE SCHOOL RESOURCES
Take advantage of the Graduate School's professional development resources (https://grad.wisc.edu/pd) to build skills, thrive academically, and launch your career.
LEARNING OUTCOMES

1. Demonstrate a strong understanding of mathematical, scientific, and engineering principles in the field.
2. Demonstrate an ability to formulate, analyze, and independently solve advanced engineering problems.
3. Apply the relevant scientific and technological advancements, techniques, and engineering tools to address these problems.
4. Recognize and apply principles of ethical and professional conduct.

PEOPLE

FACULTY

PROFESSORS
Blanchard, Bonazza, Bronkhorst, Crone, Hegna, Henderson, Lakes, Schmitz, Smith, Sovinec, Waleffe, Wilson (chair)

ASSOCIATE PROFESSORS
Allen, Witt

ASSISTANT PROFESSORS
Choy, Couet, Geiger, Franck, Notbohm, Thevamaran

AFFILIATE PROFESSORS
Bednarz, Bier, Engle, Graham, Kolkowitz, Ludois, Ma, Miller, Morgan, Nellis, Pfotenhauer, Porter, Prabhakar, Robertson, Szlufarska, Thomadsen, Trujillo, Vanderby

EMERITUS PROFESSORS
Abdel-Khalik, Bisognano, Callen, Carbon, Conrad, Cook, Corradini, DeLuca, Drugan, Emmert, Fonck, Hershkowitz, Kammer, Kulcinski, Mackie, Malkus, Moses, Plesha, Sandor, Schlack, Vogelsang