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 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 collegewide 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, imaging processing and analysis systems, surface and thin film characterization facilities, and x-ray diffraction facilities.

**GRADUATE SCHOOL ADMISSIONS**

Graduate admissions is a two-step process between academic degree programs and the Graduate School. Applicants must meet requirements of both the program(s) and the Graduate School. Once you have researched the graduate program(s) you are interested in, apply online (https://grad.wisc.edu/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>
</tbody>
</table>

**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>Yes</td>
<td>No</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

Requirements Detail

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Credit</td>
<td>60 credits</td>
</tr>
<tr>
<td>Residence Credit</td>
<td>32 credits</td>
</tr>
<tr>
<td>Graduate Coursework</td>
<td>30 of the required 60 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="http://my.wisc.edu/CourseGuideRedirect/BrowseByTitle">http://my.wisc.edu/CourseGuideRedirect/BrowseByTitle</a>). In addition, at least 18 of the non-research credits must be in classes having the graduate-level designation.</td>
</tr>
<tr>
<td>Overall Graduate GPA</td>
<td>3.00 GPA required.</td>
</tr>
<tr>
<td>Other Grade Requirements</td>
<td>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.</td>
</tr>
</tbody>
</table>

Assessments and Examinations

Ph.D. qualifying examination is required of all students. After acceptance of the student’s doctoral plan of study, the student must take an oral preliminary examination. Final oral examination is required at the end of the thesis work.

Language Requirements

No language requirements.

Doctoral Minor/Breadth Requirements

There are two minor options available:

Minor Option A
Students minor in a single department and satisfy the minor requirements of that department.

Minor Option B (Distributed Minor)
This option requires a minimum of 9 credits in two or more departments outside the major, in related courses selected for their relevance to a particular area of concentration. The following rules apply:
1. Courses typically included on or within the scope of the E M A Qualifying Exam shall not be considered acceptable for the Ph.D. Minor Option B.
2. At least 6 credits must be taken in courses listed in the UW-Madison Guide as “Grad 50%” courses.

REQUIRED COURSES

At least 36 of the required 60 credits must be in classes satisfying the following general requirements and mathematics, breadth and depth requirements.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>All courses must be at the 500-level or above. At least 21 credits must be 600-level and above OR from the following list:</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>E M A/CIV ENGR/ME 508 Composite Materials</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E M A 519 Fracture Mechanics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E M A 522 Aerodynamics Lab</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E M A 523 Flight Dynamics and Control</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E M A/M E 540 Experimental Vibration and Dynamic System Analysis</td>
<td></td>
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<tr>
<td></td>
<td>E M A/M S &amp; E 541 Heterogeneous and Multiphase Materials</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E M A/E P 547 Engineering Analysis I</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E M A/E P 548 Engineering Analysis II</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E M A/M E 570 Experimental Mechanics</td>
<td></td>
</tr>
</tbody>
</table>

Mathematics Requirements

At least 6 credits (2 courses) must be in applied mathematics 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>MATH 619</td>
<td>Analysis of Partial Differential Equations</td>
</tr>
</tbody>
</table>
MATH 623  Complex Analysis
MATH 703  Methods of Applied Mathematics 1
MATH 704  Methods of Applied Mathematics-2
MATH/COMP SCI 714  Mathematics I
MATH/COMP SCI 715  Mathematics II

**Breadth Requirement**
As part of their M.S. or Ph.D., students must have taken courses from at least 2 of the 3 areas defined below. For each of the 2 areas, the student must have taken at least 2 courses. The courses must be at a similar level to those listed below.

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

**Fluid Mechanics**
- EMA 521  Aerodynamics  3
- EMA 622  Mechanics of Continua  3
- M 563  Intermediate Fluid Dynamics  3
- M 572  Intermediate Gas Dynamics  3
- M 573  Computational Fluid Dynamics  3
- M 769  Combustion Processes  3
- M 770  Advanced Experimental Instrumentation  3
- M 774  Chem Kinetics of Combust Systems  3
- M 775  Turbulent Heat and Momentum Transfer  3
- MATH 705  Mathematical Fluid Dynamics  3

**Dynamics**
- EMA 523  Flight Dynamics and Control  3
- EMA/M 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 577  Automatic Controls Laboratory  4
- M 740  Advanced Vibrations  3
- M 747  Advanced Computer Control of Machines and Processes  3
- M 748  Optimum Design of Mechanical Elements and Systems  3

**Depth Requirement**
At least 4 courses (12 credits) must be 700-level or above in mechanics, applied mathematics, or computer science. At least 2 of the courses (6 credits) must be from List 1 (below), and the remaining 2 courses (6 credits) may be from List 1 or List 2.

**List 1**
- 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
- M 740  Advanced Vibrations
- M 746  Dynamics of Controlled Systems
- M 747  Advanced Computer Control of Machines and Processes
- M 748  Optimum Design of Mechanical Elements and Systems
- M 751  Advanced Computational Dynamics
- M 753  Friction, Lubrication and Wear
- M 769  Combustion Processes
- M 770  Advanced Experimental Instrumentation
- M 774  Chem Kinetics of Combust Systems
- M 775  Turbulent Heat and Momentum Transfer

**List 2**
- COMP SCI/MATH 714  Methods of Computational Mathematics I
- COMP SCI/MATH 715  Methods of Computational Mathematics II
- COMP SCI 733  Computational Methods for Large Sparse Systems
It is acceptable for students who earned an M.S. degree in Engineering Mechanics at UW-Madison to use coursework completed while in the M.S. degree program to meet the requirements above.

**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 advisor and the department chair, students may use up to 6 credits of graduate work taken at another institution if they meet departmental MS requirements. Coursework earned ten or more years prior to admission to the PhD program is not allowed to satisfy requirements.

**Graduate Coursework from Previous MS**
With advisor and EP Graduate Studies Committee approval, students may use up to 15 credits of prior MS coursework toward the PhD, provided that all of the following are met: (1) The student has completed an MS degree in a relevant field. (2) The coursework proposed by the student is at the graduate level and was taken as part of the student's completed MS program. (3) The student’s faculty advisor agrees that the prior coursework proposed by the student satisfies the Engineering Mechanics PhD program requirements in terms of subject area and rigor. (4) A member of the EP Graduate Studies Committee who is familiar with the EM PhD program confirms the advisor's recommendation.

1 All credits earned toward the EM MS degree at the University of Wisconsin-Madison count toward the EM PhD program. This policy applies to students who have not completed a previous MS degree in a relevant field.

**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.

**UW–Madison University Special**
With program approval, students are allowed to count up to 15 credits of coursework numbered 400 or above taken as a UW–Madison Special student toward the minimum graduate residence credit requirement, and the minimum graduate degree credit requirement. UW–Madison coursework taken as a University Special student would not be allowed to count toward the 50% graduate coursework minimum unless taken at the 700 level or above. Coursework earned ten years or more prior to admission to a doctoral 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 their advisor prior to registration every semester.

CREDITS PER TERM ALLOWED

15 credits

TIME CONSTRAINTS

The Ph.D. qualifying examination should be first taken no later than completion of the M.S. requirements, or the beginning of the fifth semester of graduate study, whichever comes first. Students entering the program with a master’s degree in EMA, EP or NE from another institution, and taking the qualifying exam in that same major, must take the exam by the beginning of their third semester.

Students must submit the doctoral plan of study one month before the end of the semester following the one in which the qualifying exam is passed.

Candidates are expected to pass the Ph.D. preliminary examination no later than the end of the third year of graduate study, or by the end of the second regular semester following the one in which the Ph.D. qualifying examination was passed, whichever is later. A candidate who fails to take the preliminary examination within four years of passing the qualifying examination must retake the qualifying examination.

An oral examination on the findings of the Ph.D. research is required at the end of the thesis work. The candidate must apply for a warrant from the Graduate School through the student services office at least three weeks prior to the exam. The final oral examination must be taken within five years of passing the preliminary examination.

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 an extraordinary, deep 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.
5. Demonstrate an ability to synthesize knowledge from a subset of the biological, physical, and/or social sciences to help frame problems critical to the future of their discipline.
6. Demonstrate an ability to conduct original research and communicate it to their peers.

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