ENGINEERING MECHANICS: RESEARCH, M.S.

This is a named option within the Engineering Mechanics M.S. (http://guide.wisc.edu/graduate/engineering-physics/engineering-mechanics-m/s/)

This 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, image processing and analysis systems, surface and thin film characterization facilities, and x-ray diffraction facilities.

For more information on this specific degree plan, please see the EP website (https://www.engr.wisc.edu/department/engineering-physics/).

ADMISSIONS

Please consult the table below for key information about this degree program’s admissions 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/) of the Graduate School as well as the program(s).

Once you have researched the graduate program(s) you are interested in, apply online (https://grad.wisc.edu/apply/).

<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>
</tbody>
</table>

Summer Deadline | December 15
GRE (Graduate Record Examinations) | Required.*
English Proficiency Test | 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 (https://grad.wisc.edu/apply/requirements/#english-proficiency).
Other Test(s) (e.g., GMAT, MCAT) | n/a
Letters of Recommendation Required | 3

* 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 restrictions related to funding.

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.

NAMED OPTION 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

<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](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/](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

#### General

The program requires 30 credits of technical coursework approved by the student’s advisor. All courses must be at the 500-level or above. At least 15 credits must be 600-level and above OR from the following list:

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

**Mathematics Requirements**

3

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>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 SCI 714</td>
<td>Methods of Computational Mathematics I</td>
</tr>
<tr>
<td>MATH/ COMP SCI 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**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>E M A 506</td>
<td>Advanced Mechanics of Materials I *</td>
</tr>
<tr>
<td>E M A/CIV ENGR/ M E 508</td>
<td>Composite Materials</td>
</tr>
<tr>
<td>E M A 519</td>
<td>Fracture Mechanics *</td>
</tr>
<tr>
<td>E M A/M S &amp; E 541</td>
<td>Heterogeneous and Multiphase Materials *</td>
</tr>
<tr>
<td>E M A/M 570</td>
<td>Experimental Mechanics</td>
</tr>
<tr>
<td>E M A 605</td>
<td>Introduction to Finite Elements *</td>
</tr>
<tr>
<td>E M A 611</td>
<td>Advanced Mechanical Testing of Materials *</td>
</tr>
</tbody>
</table>
EM A/E P 615 Micro- and Nanoscale Mechanics \* 3
EM A 622 Mechanics of Continua \* 3
EM A 630 Viscoelastic Solids \* 3
EM A 700 Theory of Elasticity \* 3
EM A/M E 703 Plasticity Theory and Physics 3
EM A 705 Advanced Topics in Finite Elements \* 3
EM A/M E 706 Plates, Shells and Pressure Vessels 3
EM A/M E 708 Advanced Composite Materials 3
EM A/M E 722 Introduction to Polymer Rheology 3
M E/B M E 603 Topics in Bio-Medical Engineering (Topic: FE for Biomechanics) 1-3
M E 753 Friction, Lubrication and Wear 3
Fluid Mechanics
EM A 521 Aerodynamics \* 3
EM A 524 Rocket Propulsion \* 3
EM A 622 Mechanics of Continua \* 3
M E 563 Intermediate Fluid Dynamics \* 3
M E 572 Intermediate Gas Dynamics \* 3
M E 573 Computational Fluid Dynamics \* 3
M E 769 Combustion Processes 3
M E 770 Advanced Experimental Instrumentation 3
M E 774 Chem Kinetics of Combust Systems 3
M E 775 Turbulent Heat and Momentum Transfer 3
MATH 705 Mathematical Fluid Dynamics 3
Dynamics
EM A 523 Flight Dynamics and Control \* 3
EM A/M E 540 Experimental Vibration and Dynamic System Analysis \* 3
EM A 542 Advanced Dynamics \* 3
EM A 545 Mechanical Vibrations \* 3
EM A/ASTRON 550 Astrodynamics 3
EM A 610 Structural Finite Element Model Validation \* 3
EM A 642 Satellite Dynamics \* 3
EM A 742 Theory and Applications in Advanced Dynamics \* 3
EM A 745 Advanced Methods in Structural Dynamics \* 3
EM A 747 Nonlinear and Random Mechanical Vibrations \* 3
M E/E C E 577 Automatic Controls Laboratory 4
M E 740 Advanced Vibrations 3
M E 747 Advanced Computer Control of Machines and Processes 3
M E 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 EM A course except EM A 790, EM A 890, or EM A 990.

E M A 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/G L E 730 Engineering Properties of Soils

CIV ENGR/G L E 735 Soil Dynamics

MATH 705 Mathematical Fluid Dynamics
M E 740 Advanced Vibrations
M E 746 Dynamics of Controlled Systems
M E 747 Advanced Computer Control of Machines and Processes
M E 748 Optimum Design of Mechanical Elements and Systems
M E 751 Advanced Computational Dynamics
M E 753 Friction, Lubrication and Wear
M E 769 Combustion Processes
M E 770 Advanced Experimental Instrumentation
M E 774 Chem Kinetics of Combust Systems
M E 775 Turbulent Heat and Momentum Transfer

Independent Study/Research Credits
All students must take a minimum of 3 credits of EM A 599. A maximum of 6 credits of EM A 599 may be used toward the 30-credit minimum. Students in the thesis track may use a maximum of 12 credits of EM A 599 and EM A 790, combined, toward the 30-credit minimum. Credit for EM 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.

Thesis track\(^1\): minimum of 3 credits of EM A 599 and a minimum of 6 credits of EM A 790

Independent study track\(^1\): minimum of 3 credits of EM A 599

\(^1\) These tracks are internal to the program and represent different pathways a student can follow to earn this degree. Track names do not appear in the Graduate School admissions application, and they will not appear on the transcript.

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

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.
NAMED OPTION-SPECIFIC POLICIES

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 an 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.

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 five or more years prior to admission to a master’s 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.

GRIEVANCES AND APPEALS
These resources may be helpful in addressing your concerns:

- Bias or Hate Reporting (https://doso.students.wisc.edu/bias-or-hate-reporting/)
- Graduate Assistantship Policies and Procedures (https://hr.wisc.edu/policies/gapp/#grievance-procedure)
- Hostile and Intimidating Behavior Policies and Procedures (https://hr.wisc.edu/hib/)
  - Office of the Provost for Faculty and Staff Affairs (https://facstaff.provost.wisc.edu/)
  - Dean of Students Office (https://doso.students.wisc.edu/) (for all students to seek grievance assistance and support)
- Employee Assistance (http://www.eao.wisc.edu/) (for personal counseling and workplace consultation around communication and conflict involving graduate assistants and other employees, post-doctoral students, faculty and staff)
- Employee Disability Resource Office (https://employeedisabilities.wisc.edu/) (for qualified employees or applicants with disabilities to have equal employment opportunities)
- Graduate School (https://grad.wisc.edu/) (for informal advice at any level of review and for official appeals of program/departmental or school/college grievance decisions)
- Office of Compliance (https://compliance.wisc.edu/) (for class harassment and discrimination, including sexual harassment and sexual violence)
- Office of Student Conduct and Community Standards (https://conduct.students.wisc.edu/) (for conflicts involving students)
- Ombuds Office for Faculty and Staff (http://www.ombuds.wisc.edu/) (for employed graduate students and post-docs, as well as faculty and staff)
- Title IX (https://compliance.wisc.edu/titleix/) (for concerns about discrimination)

EM Grievance Procedures
Students who feel that they have been treated unfairly have the right to a prompt hearing of their grievance. Such complaints may involve course grades, classroom treatment, advising, various forms of harassment, or other issues. Any student or potential student may use these procedures.

- The student should speak first with the person toward whom the grievance is directed. In most cases, grievances can be resolved at this level.
- Should a satisfactory resolution not be achieved, the student should contact the program’s Grievance Advisor to discuss the grievance. The Graduate Student Coordinator can provide students with the name of this faculty member, who facilitates problem resolution through informal channels. The Grievance Advisor is responsible for facilitating any complaints or issues of students. The Grievance Advisor first attempts to help students informally address the grievance prior to any formal complaint. Students are also encouraged to talk with their faculty advisors regarding concerns or difficulties if necessary. University resources for sexual harassment concerns can be found on the UW Office of Equity and Diversity website.
- If the issue is not resolved to the student’s satisfaction, the student can submit the grievance to the Grievance Advisor in writing, within 60 calendar days of the alleged unfair treatment.
On receipt of a written complaint, a faculty committee will be convened by the Grievance Advisor to manage the grievance. The program faculty committee will obtain a written response from the person toward whom the complaint is directed. The response will be shared with the person filing the grievance.

The faculty committee will determine a decision regarding the grievance. The Grievance Advisor will report on the action taken by the committee in writing to both the student and the party toward whom the complaint was directed within 15 working days from the date the complaint was received.

At this point, if either party (the student or the person toward whom the grievance is directed) is unsatisfied with the decision of the faculty committee, the party may file a written appeal. Either party has 10 working days to file a written appeal to the College of Engineering.

The Assistant Dean for Graduate Affairs (engr-dean-graduateaffairs@engr.wisc.edu) provides overall leadership for graduate education in the College of Engineering (CoE) and is a point of contact for graduate students who have concerns about education, mentoring, research, or other difficulties.

The Graduate School has procedures for students wishing to appeal a grievance decision made at the college level. These policies are described in the Academic Policies and Procedures at https://grad.wisc.edu/academic-policies/.

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.

PEOPLE

FACULTY

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

ASSOCIATE PROFESSORS
Allen, Witt

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

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

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