

Theoretical and Applied Mechanics

PhD Student Guide

Effective: Fall 2026 – Summer 2027

Table of Contents

Introduction and Purpose	2
Program Contacts	2
Learning Outcomes	2
Program-Specific Academic Requirements & Policies	4
Coursework Requirements.....	4
Minimum Grade [& GPA] Requirements.....	5
Course Waiver Policy.....	5
Teaching Requirement	6
TA Assignment Process.....	6
Other Coursework and Activities	7
Required Events/Activities	7
Professional Skills Development.....	8
Typical TAM PhD Timeline	9
Program Specific Milestone Policies	10
Advisor.....	10
Annual Advisor Reviews	11
Committee	11
Qualifying Exam / Thesis Proposal Exam/ Candidacy.....	12
Dissertation/Thesis/Defense	13
Other Milestones.....	14
Program Resources/Support	14

Introduction and Purpose

Theoretical and Applied Mechanics (TAM) is an interdisciplinary, interdepartmental graduate degree program. Adaptable to the specific needs and abilities of its students, TAM allows qualified students of engineering, mathematics, physics, or an allied science to pursue their MSc and PhD in mechanics.

Some specific research areas for TAM PhD students include:

- Machine learning in mechanics
- Computational mechanics
- Mechanics in biology and fluids
- Micro/nanomechanics
- Multifunctional and metamaterials
- Geomechanics
- Structural reliability and nondestructive characterization

Program Contacts

This section provides a general description of who has responsibility for curricular, admission, financial, and other matters in the program. The most up-to-date list of personnel can be found on the Theoretical and Applied Mechanics website.

Director of Graduate Studies (DGS): Horacio D. Espinosa (espinosa@northwestern.edu). The DGS oversees the graduate program, advising students on academic matters and assisting with advisor selection and changes. The DGS also monitors academic progress and participates in decisions concerning academic probation and exclusion.

Graduate Program Assistant / Coordinator: Pat Dyess, Program Assistant (j-dyess@northwestern.edu). This staff member aids with administrative aspects of the program, including procedures, paperwork for milestones, registration issues, and other day-to-day operations.

Financial Assistant / Coordinator: Joey Riley-Sabaj, Financial Coordinator (joey.riley-sabaj@northwestern.edu). This staff member handles financial aspects such as stipends and tuition payments.

Learning Outcomes

Programs

Qualified students of engineering, materials sciences, physics, applied mathematics, or an

allied science may pursue graduate studies in solid mechanics or fluid mechanics through the program, which is administered by an executive committee of professors.

Programs of study in solid mechanics are available in computational, analytical, or experimental mechanics; biomechanics, fracture and damage mechanics; micromechanics and nanomechanics; composite, nanocomposite and hybrid materials including processing, characterization, and modeling; geomechanics, time and environment dependent, fatigue, and dynamic response of materials; and nondestructive evaluation.

Programs of study in fluid mechanics are available for both theoretical and experimental research in energy; computational fluid dynamics; aerodynamics and hydrodynamics; non-Newtonian fluids and gas-liquid and liquid-solid interface problems; and bioengineering applications.

PhD Program Learning Objectives, Milestones, and Assessment

Learning objective(s) <i>Students should be able to...</i>	Milestone/ Requirement/Capacity	Assessment Strategies and Criteria* <i>How do we know this objective has been achieved? What criteria do we have to measure success?</i>
Make original research contributions to science, engineering and technology.	Thesis Proposal Defense/ Dissertation/ Publications/ Patents	Assessment Strategy: Committee evaluates thesis defense, provides feedback for improvement. Criteria: Formulate a research plan with proper methodology, write an original thesis, publish research progress in journals or file patents/IP.
Communicate technical material and gain teaching experience	TA fulfilled / other teaching experience	Assessment Strategy: Course instructor evaluates outcomes, students provide formative assessment (e.g. CTECs, surveys). Designed classwork or homework serves as a summative assessment that measures students' success in acquiring the new skills and knowledge.
Establish a career plan	Annual Meeting	Student shares plan annually with advisor at annual progress review and individual meetings; student and advisor craft a plan for appropriate training and identify necessary resources for post-graduate success.
Enact ethical research methodologies and practices.	RCR Training/ Research	Criteria: Fosters ethical problem-solving skills; increase the ability to recognize ethical issues in design and conduct of research; identify and understand research ethics and applicable regulations, policies, and professional standards.

Program-Specific Academic Requirements & Policies

Coursework Requirements

The Graduate School requires PhD students to successfully complete at least nine quality letter-graded course units (ABC, not P/NP or S/U) authorized for graduate credit. Students must maintain at least a 3.0 cumulative GPA. You can view the full policy here:

<https://www.tgs.northwestern.edu/academic-policies-procedures/policies/phd-degree-requirements.html>

Course Requirements:

- **Number of courses taken at NU:** At least 9 graded courses must be taken at NU.
- **Number of post-BS courses:** A total of fifteen (15) course units is required towards the PhD. Nine (9) course units within these 15 course units must satisfy the MS course requirements. Students pursuing a **terminal MS** are required to complete 12 courses or 9 courses plus a project.
- **Level:** Students are *encouraged* to take at least one half (1/2) of the credited course units satisfying the post- MS requirement at the 400-level or above courses.
- **Seminar:** Regular attendance at the non-credit TAM Seminar Series **is required** when the student is in residence.
- **Professional Essentials:** Students may register for the non-credit ME 513 Seminar for one quarter within the first two years. It is strongly recommended that if the student decides to take this seminar course, it be taken before PhD candidacy.
- **Approval:** In consultation with the advisor, students should choose courses that accommodate individual needs, talents, and interests while satisfying the basic degree requirements.
- **Timeline.** The course requirements for the PhD program shall be fulfilled within the first 12 and 8 quarters of full-time registration for students matriculating with BS and MS, respectively.
- **Full-time registration:** Funded PhD students may register for TGS 500 or MECH_ENG 590 Research during summers in their first and second year, or whenever they are not taking a full-time load of courses to maintain full-time registration.

Core Courses:

There are no core course requirements, but TAM students typically take Mechanics of Continua, Advanced Finite Elements, Methods in Applied Mathematics, Differential Equations of Mathematical Physics, Introduction to Statistical Mechanics, Experimental Solid Mechanics, Cohesive Fracture and Scaling, Experiments in Micro/Nano Science and Engineering. This list is illustrative and does not constitute a core curriculum.

Elective Courses:

Students typically select advanced courses in their area of specialization from Engineering and Sciences.

Minimum Grade [& GPA] Requirements

For all graded courses, students must obtain at least a B– for the course to count towards the curriculum requirements.

A GPA of 3.5 or better is required for waiver of the qualifying examination.

Course Waiver Policy

MS from another school: Students admitted with a MS degree from elsewhere may submit a petition for a waiver of up to a maximum of six (6) course units towards the 15-course requirement, based on post-bachelor's degree study. An MS course waiver form (using the Petition section of the [PhD Requirements Form](#)) must be completed by the student and the advisor and be approved by the TAM Program Director. Students should submit this form as early as possible; see the Graduate Program Assistant, Pat Dyess, for details.

Teaching Requirement

All PhD students must complete an approved teaching experience by satisfying one of the following: (1) serving as instructor for an undergraduate course; (2) serving as a full-time teaching assistant, normally approximately 20 hours per week, for at least one quarter; or (3) serving as a part-time teaching assistant, normally approximately 6–8 hours per week, for at least three quarters. The teaching requirement is intended to provide students with experience communicating technical material, supporting student learning, and contributing to the instructional mission of the University.

Teaching-assistant responsibilities depend on the course and may include leading laboratory or discussion sections, preparing or demonstrating instructional material, holding office hours, grading assignments and examinations, assisting with course administration, and providing feedback to students. TA performance is evaluated by the course instructor and may also be informed by student course evaluations or other feedback.

Students completing a full teaching-assistant assignment must register for **GEN_ENG 546-0, Teaching Experience**, a zero-unit course, during the quarter in which the teaching assignment is performed. Students satisfying the requirement through three quarters of part-time TA service must register for GEN_ENG 545-0 during the applicable quarters.

TA Assignment Process:

Teaching assignments are coordinated by the departments that administer the relevant courses, typically Mechanical Engineering, Civil and Environmental Engineering, or Engineering Sciences and Applied Mathematics.

Students should discuss the timing of the teaching requirement with their research advisor. Advisors nominate students for available TA positions, after which the administering department determines assignments based on instructional needs, the student's expertise and preparation, funding arrangements, and the availability of positions. Advisor nomination does not guarantee a particular course or quarter.

Students should plan sufficiently far in advance to complete the teaching requirement without interfering with major research milestones. International students must satisfy the applicable University English-language proficiency requirement before they may be assigned instructional responsibilities.

Other Coursework and Activities

Formal coursework provides the disciplinary foundation for doctoral study, but participation in seminars, research-group activities, professional meetings, and skill-development programs is also an important part of graduate education. These activities expose students to current research, broaden their perspectives beyond their dissertation topic, and develop the communication and professional skills needed for careers in academia, industry, government, and research laboratories.

Required Events/Activities:

TAM Seminar Series

Regular attendance at the non-credit TAM Seminar Series is required during all quarters in which seminars are offered and the student is in residence. The seminar series brings faculty, visiting scholars, researchers, and practitioners to present current developments across theoretical, computational, and experimental mechanics.

- Students are expected to attend seminars consistently, arrive on time, remain for the full presentation, and participate professionally in the discussion when appropriate. If a student has a recurring course, teaching, or research conflict, the student should discuss it with the advisor and TAM Director.

Research-group activities

Students must participate actively in the scholarly activities of their research groups. Depending on the practices of the advisor and research group, these activities may include:

- Weekly or periodic research-group meetings.
- Presentations of research progress.
- Discussions of relevant journal articles.
- Journal clubs or literature-review meetings.
- Practice presentations before conferences and the dissertation defense.
- Training in laboratory procedures, computational tools, research reproducibility, and data management.
- Mentoring and collaborative activities involving other graduate students or undergraduate researchers.

Specific research-group expectations are established by the faculty advisor. Students should clarify these expectations when joining a research group and revisit them during annual progress discussions.

Conferences and broader scholarly participation

Students are strongly encouraged to present their research at conferences, workshops, and other appropriate scholarly venues. Presenting research provides valuable experience in technical communication and allows students to obtain feedback, build professional networks, and learn about developments outside their immediate research area.

Students should discuss conference participation and available travel support with their advisor. Eligible students may also seek conference travel funding through TAM, the administering department, McCormick, The Graduate School, professional societies, or external sponsors.

Proposal-writing experience

PhD students who do not already hold a major external fellowship are required to obtain proposal-writing experience during the first two years of doctoral study. Normally, this requirement is satisfied by applying for at least one appropriate major external fellowship.

If the student is not eligible for an appropriate major fellowship, the requirement may be satisfied, with the advisor's approval, by applying for another research award or fellowship or by making a substantive contribution to the preparation of a research proposal. Students should discuss suitable opportunities with their advisors early in the program.

Professional Skills Development:

TAM students are encouraged to participate in professional-development programs offered by The Graduate School, McCormick, the Searle Center for Advancing Learning and Teaching, Northwestern Career Advancement, and other University units. Relevant activities may include:

- Scientific and technical writing.
- Public speaking and research presentations.
- Grant and fellowship proposal writing.
- College teaching and course design.
- Mentoring and research-group leadership.
- Career planning and job-search preparation.
- Preparation of academic CVs, résumés, research statements, and teaching statements.
- Interviewing and professional networking.
- Research ethics, responsible conduct of research, and authorship.
- Research-data management, reproducibility, and open-science practices.
- Entrepreneurship, intellectual property, and technology commercialization.
- Team science, project management, and interdisciplinary collaboration.

Students may also register for the non-credit **MECH_ENG 513 Professional Essentials Seminar** for one quarter during the first two years of PhD study. If taken, the seminar is strongly recommended before admission to candidacy.

Students should identify professional-development goals in consultation with their advisor and revisit those goals as part of the annual review process. Participation in optional professional-development activities should be planned so that it complements, rather than delays, coursework, research, and required program milestones.

Typical Theoretical and Applied Mechanics PhD Timeline

Milestone/ Requirement	TAM Deadline	TGS Deadline	Notes
Choose advisor	Y1Q2		• Advisor must have appointment or courtesy appointment in TAM
Complete Responsible Conduct of Research (RCR) training (CITI & GEN_ENG 519)	Y1Q4 (McCormick deadline)		• Sections fill quickly; recommend taking early
External fellowship application	Y2Q4		• See graduate handbook for details
Complete course requirements	Y2Q4 (entering w/ MS)		• Must maintain 3.0 cumulative GPA. • Must have a 3.5 cumulative GPA for waiver on qualifying exam.
Thesis proposal examination	Y2Q4 (entering w/ MS) Y3Q4 (entering with a BS)	Y4Q4	• Written proposal and oral exam • Submit PhD Requirements Form • Proposal submitted to committee 1 week in advance • 3+ person committee • 2+ members of NU graduate faculty
Teaching requirement	Y5Q4	Y5Q4 (for TA)	• One quarter TA or 3 quarters part-time TA • Register for GEN_ENG 546 (full TA) or GEN_ENG 545 (part-time TA)
Dissertation and defense	Typical Y5Q4 w/MS; Y6Q4 w/o MS	Y9Q4	• Same committee requirements as proposal exam • Dissertation submitted to committee 2 weeks in advance

You achieve PhD candidacy upon passing a thesis proposal exam.

Students who fail to obtain an advisor, can graduate with a terminal MS, either with 12 courses or 9 courses and a project.

Program Specific Milestone Policies

Advisor

Students are recommended to seek out a research advisor to work with on his/her graduate research. Students are expected to identify a research advisor no later than the end of the second quarter of graduate study. The research advisor directs the student's research by providing research guidance, background information, computer resources, laboratory facilities, and often, research assistantship support. The advisor is on the student's examination committee and is usually the chair of the committee. The advisor also closely reviews the research report, thesis, or dissertation and may be a co-author on publications when the advisor's contributions satisfy applicable authorship criteria.

Students should contact TAM faculty, in their area of interest, to learn about their research projects and the availability of openings. The TAM director will provide guidance and facilitate communication between students and faculty. The exam and dissertation committees are arranged by the student in consultation with the advisor.

Annual Advisor Reviews:

Each PhD student must be evaluated annually before the end of the summer quarter. The annual evaluation includes:

1. Submission by the student of an annual progress report using the required format in the online Graduate Student Tracking System (GSTS).
2. An evaluation completed by the faculty advisor. A face-to-face meeting between the student and advisor is recommended before the advisor finalizes the evaluation.
3. If the student disagrees with the advisor's evaluation, the student may contact the TAM Director to request reconsideration. If the TAM Director is the student's advisor, the student may contact the McCormick Associate Dean for Graduate Education.

In addition to the annual evaluation, students are expected to meet regularly with members of their advisory committee, individually and collectively. Quarterly or twice-yearly meetings are recommended. Students should consult the full committee approximately two to three months before scheduling the thesis proposal examination or dissertation defense so that committee advice can be incorporated into the research and written document.

Students with a low GPA or unsatisfactory research progress may be placed on probation. Such cases are reviewed individually by the appropriate faculty evaluation committee. Depending on the student's subsequent progress, the student may be permitted to continue in the PhD program, advised to pursue a terminal MS degree, or advised to leave the program.

Committee:

The PhD advisory committee provides both research guidance and examination. The committee normally conducts the thesis proposal examination and subsequently serves as the final dissertation examination committee.

The advisory committee should be formed as soon as the general direction of the student's research has been established, ideally no later than the end of the second quarter following entry with an MS degree or the end of the second year following entry with a BS degree.

The committee must have at least three members and satisfy all McCormick and Graduate School requirements. Committees larger than the minimum of three members are permitted. The committee chair must be a member of the Graduate Faculty and is generally the student's research advisor. If the chair is not a TAM faculty member, a TAM faculty member must serve as co-chair.

The student and advisor jointly identify prospective committee members. The student is responsible for contacting and inviting the members to serve. The committee is subject to approval by both the TAM program and The Graduate School.

Electronic participation should follow the applicable McCormick and Graduate School policies. Any planned remote participation should be confirmed with the TAM Program Assistant sufficiently in advance of the examination.

Qualifying Exam/ Thesis Proposal Exam/ Candidacy

TAM does not administer a separate general qualifying examination for PhD students with a GPA of 3.5 or higher. **Admission to candidacy is achieved by passing the Thesis Proposal Examination.** The examination committee, previously specified, will assess the scope and innovation of the research proposal, a literature review, proposed methodology, preliminary results, outcomes and milestones.

One week prior to the exam, students must submit a **written proposal**, normally be fewer than 30 pages in total length and double-spaced. It should clearly present:

- The research problem and its significance.
- The relevant background and literature.
- The specific research objectives, questions, or hypotheses.
- The theoretical, computational, or experimental approach.
- Preliminary results or evidence of feasibility, when available.
- The anticipated contributions of the research.
- A plan for completing the proposed work.

Oral presentation and examination

The student presents the motivation, objectives, methods, preliminary findings, proposed work, and anticipated contributions of the dissertation. The presentation is followed by questions from the committee concerning the proposal, the student's research progress, the proposed methodology, and the student's knowledge of the relevant areas of theoretical and applied mechanics.

The student should determine the expected presentation length in consultation with the advisor and committee chair when scheduling the examination.

Evaluation: the committee considers:

- The significance and originality of the proposed research.
- The clarity and feasibility of the research plan.
- The appropriateness of the theoretical, computational, or experimental methods.
- The student's command of the relevant literature and foundational knowledge.

- The quality of the written proposal and oral presentation.
- The student's readiness to conduct independent doctoral research.

Before the examination, the student must complete and submit the TAM PhD Requirements Form to the TAM Program Assistant. The student schedules the examination in consultation with the advisor and committee members and provides all required program and Graduate School notifications and forms.

Following the presentation and questioning, the committee deliberates without the student present and determines the examination outcome. A student who fails may, upon recommendation of the committee, retake the examination within one quarter. A student who does not pass the second examination may not continue in the PhD program and may be considered for a terminal MS degree.

Students entering with an MS degree must pass the thesis proposal examination by the end of the second year of full-time PhD study. Students entering with a BS degree must pass it by the end of the third year of full-time PhD study. Students are eligible to take the thesis proposal examination when no more than three courses required for the PhD remain to be completed and all applicable Responsible Conduct of Research training requirements have been satisfied.

Students with a **GPA lower than 3.5** must arrange with the advisor and TAM program Director a course-based **qualifying examination**. A committee of two or more faculty members, excluding the advisor, will define the subjects and format, administer the exam and provide a grading rubric two months prior to the exam. Based on the student's research area, the committee determines the subjects to be tested. Students that pass the qualifying exam can subsequently take the thesis proposal exam (candidacy). A student who fails the qualifying exam, may, upon recommendation of the committee, retake the examination within one quarter. Failure of both attempts means the student cannot continue in the PhD program.

Dissertation/Thesis/Defense

The students must prepare a written dissertation describing the doctoral research. The dissertation must be satisfactory to the faculty advisor and examination committee and must comply with The Graduate School's dissertation formatting and submission requirements.

The final examination is an oral dissertation defense conducted by the student's examination committee and including the student's advisor. The examination addresses the dissertation research and may also assess the student's broader understanding of the field.

Students should consult all advisory committee members approximately two to three months before scheduling the defense. This consultation provides time for committee recommendations to be incorporated into the dissertation.

The completed dissertation must be distributed to every committee member at least two weeks before the scheduled defense.

Students must satisfy all current McCormick and Graduate School pre-defense, examination-request, formatting, and final-submission requirements. The expected presentation length and any public-presentation arrangements should be established with the advisor and committee chair when the defense is scheduled.

Other Milestones

In addition to course, candidacy, and dissertation requirements, TAM PhD students must complete the following program milestones:

- **Advisor selection:** Students are expected to identify a research advisor during the second quarter of graduate study.
- **Coursework:** Students must complete the TAM PhD course requirements and maintain the required academic standing.
- **Teaching experience:** Each PhD student must satisfy one of the following:
 1. Serve as instructor for an undergraduate course.
 2. Serve as a full-time teaching assistant, approximately 20 hours per week, for at least one quarter.
 3. Serve as a part-time teaching assistant, approximately 6–8 hours per week, for at least three quarters.

Students must register for the appropriate zero-unit teaching-experience course.

- **Proposal-writing experience:** A student who does not already hold a major external fellowship must apply for at least one major external fellowship during the first two years of PhD study. If no suitable fellowship is available, the student may, with advisor approval, apply for another research award or fellowship or make a substantive contribution to a research proposal.
- **English proficiency:** International students whose primary language is not English must satisfy the applicable McCormick/TGS English-proficiency requirement before serving as a teaching assistant.
- **Research presentations:** Students are strongly encouraged to present their research at conferences and other appropriate venues and to practice the final dissertation presentation before a broader audience.

Program Resources/Support

TAM students have access to the research laboratories and specialized facilities maintained by TAM faculty. The research advisor typically provides access to the laboratory facilities, computing resources, software, research guidance, and other resources needed for the student's dissertation research. Additional program-specific resources include:

- McCormick prototyping facilities, including machine tools and equipment for constructing experimental apparatus and prototypes.

- Departmental engineering computing facilities, including the PC/workstation laboratory in Tech AG21.
- TAM and Mechanical Engineering administrative support for graduate-program requirements, payroll, purchasing, travel reimbursement, and research administration.
- Research assistantships supported by faculty research grants.
- A limited number of teaching assistantships arranged through the department with the endorsement of the faculty advisor.
- Competitive Northwestern fellowships, including first-year and terminal-year fellowship opportunities.
- Guidance from TAM faculty and advisory committees representing multiple areas of theoretical, computational, and experimental mechanics.

Because staff assignments, room numbers, and contact information can change, students should consult with Pat Dyess (j-dyess@northwestern.edu).