

The ME Graduate Handbook

All about the Graduate Program

in

Mechanical Engineering

in

**The McCormick School of Engineering and
Applied Science**

at

Northwestern University



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Disclaimer: Northwestern University reserves the right to change without notice any statement in this publication concerning, but not limited to, rules, policies, tuition, fees, curricula, and courses.

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The ME Graduate Handbook

Information about the Graduate Program in

Mechanical Engineering

McCormick School of Engineering and Applied Science

Northwestern University

MECHANICAL ENGINEERING AT NORTHWESTERN UNIVERSITY

Northwestern University's Department of Mechanical Engineering is a leader in fundamental research in several cutting-edge technologies that are relevant to today's society. Our programs provide a solid foundation for careers in academia, industry and research labs. Northwestern's tradition of interdisciplinary research provides students with exciting new opportunities in the core disciplines of:

- Design & Manufacturing
- Robotics & Biosystems
- Mechanics & Materials

with cross-cutting research areas in:

- Advanced Manufacturing
- AI and Design
- Biosystems and Health
- Computational Engineering
- Energy and Sustainability
- Micro/Nanoengineering
- Robotics and Autonomy

You will find updated information about the current research activities of the department on our website:

<http://www.mccormick.northwestern.edu/mechanical/>.

NONDISCRIMINATION STATEMENT

Northwestern University does not discriminate or permit discrimination by any member of its community against any individual on the basis of race, color, religion, national origin, sex, pregnancy, sexual orientation, gender identity, gender expression, parental status, marital status, age, disability, citizenship status, veteran status, genetic information, reproductive health decision making, or any other classification protected by law in matters of admissions, employment, housing, or services or in the educational programs or activities it operates. Harassment, whether verbal, physical, or visual, that is based on any of these characteristics is a form of discrimination. Further prohibited by law is discrimination against any employee and/or job applicant who chooses to inquire about, discuss, or disclose their own compensation or the compensation of another employee or applicant.

Northwestern University complies with federal and state laws that prohibit discrimination based on the protected categories listed above, including Title IX of the Education Amendments of 1972. Title IX requires educational institutions, such as Northwestern, to prohibit discrimination based on sex (including sexual harassment) in the University's educational programs and activities, including in matters of employment and admissions. In addition, Northwestern provides reasonable accommodations to qualified applicants, students, and employees with disabilities and to individuals who are pregnant.

Any alleged violations of this policy or questions with respect to nondiscrimination or reasonable accommodations should be directed to Northwestern's Office of Civil Rights and Title IX Compliance, 1800 Sherman Avenue, Suite 4-500, Evanston, Illinois 60208, 847-467-6165, equity@northwestern.edu.

Questions specific to sex discrimination (including sexual misconduct and sexual harassment) should be directed to Northwestern's Title IX Coordinator in the Office of Civil Rights and Title IX Compliance, 1800 Sherman Avenue, Suite 4-500, Evanston, Illinois 60208, 847-467-6165, TitleIXCoordinator@northwestern.edu.

A person may also file a complaint with the Department of Education's Office for Civil Rights regarding an alleged violation of Title IX by visiting www2.ed.gov/about/offices/list/ocr/complaintintro.html or calling 800-421-3481. Inquiries about the application of Title IX to Northwestern may be referred to Northwestern's Title IX Coordinator, the United States Department of Education's Assistant Secretary for Civil Rights, or both.

THE GRADUATE PROGRAM IN MECHANICAL ENGINEERING

The Department of Mechanical Engineering offers programs leading to the MS and PhD degrees. Outstanding students may be admitted for graduate study directly from the bachelor's to the doctoral degree.

Students arrange their study and research in association with individual faculty members and often with the various interdepartmental and special programs associated with the Center for Surface Engineering and Tribology, the Center for Smart Structures and Materials, the Center for Robotics and Biosystems, Northwestern Institute on Complex Systems, the Segal Design Institute, Northwestern Initiative for Manufacturing Science and Innovation (NIMSI), the Program in Theoretical and Applied Mechanics, and the Predictive Science & Engineering Design (PS&ED) Cluster.

Graduate students are not required to follow a rigid curriculum; each student may arrange a curriculum that accommodates individual needs, talents, and interests while satisfying the basic degree requirements. The basic degree requirements are designed to ensure that the students develop a rigorous appreciation of mathematics, and have a broad exposure to fields of engineering and science outside of their immediate area of interest.

Graduate Program Goals/Mission Statement:

The graduate program in mechanical engineering aims to discover new knowledge and technologies, and train mechanical engineers that will shape our future. We strive to transform students to outstanding scholars, teachers and engineering professionals who will become the future leaders in science and engineering. Our graduate curriculum aims to enable students to learn the fundamentals of mechanical engineering by focusing on core disciplines in mechanics, manufacturing, and systems, together with essential areas of mathematics and physical sciences. Teaching and research experiences promote personal and professional growth while developing technical aptitude, while gaining creative thinking and communication skills that are necessary for crafting a better future.

The learning objectives and assessment strategies followed by our department for our graduate programs are listed below:

MS 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?</i> <i>What criteria do we have to measure success?</i>
Make original research contributions to science, engineering and technology management fields.	Research Project Planning and Execution	Assessment Strategy: Advisor evaluates planned research project, provides feedback for improvement. Criteria: Formulate a research plan with proper methodology, write an original thesis or project report, and as feasible publish research progress in journals or file patents/IP.
Demonstrate command over basic knowledge in the field and effective scholarly communication skills.	MS Thesis Defense or MS Research Project Report	Assessment Strategy: Thesis committee (or the advisor for research project) review of student's basic knowledge in the field, research skills, and presentation skills. Criteria: A research presentation summarizing key accomplishments.
Establish a career plan	Semi-Annual Meeting for MS Thesis Candidates	Student shares plan semi-annually with advisor at semi-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 clinical ethics regulations, policies, and resources.

PhD Program Learning Objectives, Milestones, and Assessment

Learning objective(s) <i>Students should be able to...</i>	Milestone/ Requirement/Cap acity	Assessment Strategies and Criteria* <i>How do we know this objective has been achieved?</i> <i>What criteria do we have to measure success?</i>
Make original research contributions to science, engineering and technology management fields.	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.
Demonstrate command over basic knowledge in the field and effective scholarly communication skills.	Research Qualification Exam	Assessment Strategy: Committee review of student's basic knowledge in the field, research skills, presentation skills. Criteria: A research presentation summarizing key accomplishments from the first year and a half.
Design a classroom activity 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 clinical ethics regulations, policies, and resources.

MS PROGRAM INFORMATION

(The following pages, 9-11, are applicable for the MS degree)

MS DEGREE REQUIREMENTS:

TGS minimum course requirements: TGS policy requires, as a minimum for master's degrees: Nine quality letter-graded (ABC, not P/NP) courses approved for TGS credit (i.e., courses with a "career" designation of "The Graduate School" in CAESAR). Full-time registration requires enrollment in a combination of course units and ME 590 (research) units for a total of 3 or more units each quarter. **The ME graduate program has further course requirements for MS degrees as detailed below.**

1 Thesis option

Course Requirements:

- **Number of units:** Twelve McCormick course units are required, including three ME 590 Research units. All courses must be approved for TGS credit and offered through McCormick unless prior written permission is obtained from the MS Program Director.
- **General program breadth requirement:** General program students must take at least one course each from four of the eight subareas: (1) Solids, (2) Fluids/Thermodynamics/Energy, (3) Robotics/Dynamics/Controls, (4) Design/-Manufacturing/Tribology, (5) MEMS/Nanotechnology, (6) Biomedical/Biology, (7) Mathematics/Science/Data Science, and (8) Engineering Management. Suggested courses that may fulfill each subarea are listed on pages 18-20.

Specializations: The following *optional* specializations are currently available for MS:

Advanced Manufacturing
Aerospace Engineering
Energy and Sustainability
Simulation-Driven Engineering (SDE)
Robotics and Control
Nanotechnology
Biology and Bio-inspired Engineering

For specialization requirements visit,

<https://www.mccormick.northwestern.edu/mechanical/academics/graduate/student-resources/masters-curriculum.html>

- **Level:** A minimum of 5 credited course units (excluding research units) must be 400-level or above.
- **ME courses:** A minimum of 5 course units (excluding research units) must be MECH_ENG courses or qualifying courses marked in the list on pages 19-21.
- **Seminar:** Registration and regular attendance at the non-credit MECH_ENG 512 Seminar is required for all quarters. Only those doing MS with thesis option should register for ME 512.
- **Approval:** There are no advisor holds. Thus, the students are free to choose courses that accommodate individual needs, talents, and interests while satisfying the basic degree requirements. Students are encouraged to talk with the MS Program Director for any questions or consultation. Note that the same full-time tuition is charged for either 3 or 4 courses in any given quarter. However, when students enroll in 1 or 2 units, the student is charged per course.
- **Continuous Registration:** Occasionally when more time is needed to complete a thesis, a student may be permitted, in consultation with the research advisor, to register for TGS 512 Continuous Registration. TGS 512 is considered full-time and costs about \$100 for the quarter. The restrictions are that the student must have completed 12 units prior to TGS 512 registration and must not be taking any other courses.

Research: Three credit units of ME 590 are required in which a suitable thesis under the direction of a faculty advisor must be completed and defended. When registering for the very first time, only one unit of ME 590 is permitted.

GPA requirement: GPA is determined by all BS/MS qualifying courses or post BS courses taken at Northwestern towards satisfying the course requirements above. A minimum GPA of 3.0 is required by The Graduate School to earn a MS degree. Students whose GPA falls below 3.0 will be placed on probation by TGS, and will be given two quarters to recover a 3.0 GPA. Failure to meet the minimum GPA after two quarters on probation will result in removal from the program. If after fulfilling

the course requirements, a student's GPA is below the minimum it may be necessary to take additional classes to raise the GPA to the required minimum.

Master's Thesis and Examination: The Mechanical Engineering Department requires a written thesis to be approved at a final examination. The final examination shall include a presentation by the student of the thesis material and examination by the Examining Committee. The committee must satisfy the TGS requirements specified for Master's students: (<https://www.tgs.northwestern.edu/about/policies/masters-degree-requirements.html#degree>). Coursework and core courses must be filled out on the "ME MS Degree Requirements" form, signed by the advisor and the MS Program Director. This form must be presented prior to the final examination. Upon successful completion of the final examination, the Examining Committee signs the *Master's Degree Completion form*. The results of the exam are then submitted to the Graduate School via GSTS: TGS Forms.

MS Thesis: The thesis should be based on original research that is of publishable quality and should have a quantity of material equivalent to at least one journal paper. It should be prepared according to the Graduate School format for PhD dissertations (<https://www.tgs.northwestern.edu/academic-policies-procedures/dissertation-publication/dissertation-formatting-requirements/index.html>). An *Application for Degree* must be submitted to The Graduate School by the relevant published deadline for June, August, December or March graduation.

Transferring from MS to PhD:

Occasionally, an outstanding MSME student may want to continue their studies for a PhD. Completion of MS is not a requirement for being in the PhD program. Since our PhD program is fully supported, the student will need to work effectively with his or her MS research advisor who may sponsor the student for a PhD provided the funding is available. After you have identified a sponsoring professor, please contact the ME Director of Graduate Studies who will make the final admission decisions, which will be subject to approval by The Graduate School. Note that there is no separate application to fill out; only a one-page Program Transfer form should be submitted (to the Graduate Program Assistant for processing) at least six weeks before the PhD enrollment.

If you are awarded an external Doctoral Fellowship (for example, NSF) please contact the Director of Graduate Studies right away. If you are pursuing a McCormick Professional MS (for example MSR), the above procedure does not apply. You will need to complete the TGS application for a PhD admission by the December 15th deadline and await the evaluations.

2 Non-thesis option for terminal MS degree

Course Requirements:

- **Number of units:** Twelve McCormick course units are required, including one MECH_ENG 499 Project unit. All courses must be approved for TGS credit and offered through McCormick unless prior written permission is obtained from the MS Program Director.
- **General program breadth requirement:** General program students must take at least one course each from four of the eight subareas: (1) Solids, (2) Fluids/Thermodynamics/Energy, (3) Robotics/Dynamics/Controls, (4) Design/-Manufacturing/Tribology, (5) MEMS/Nanotechnology, (6) Biomedical/Biology, (7) Mathematics/Science/Data Science, and (8) Engineering Management. Suggested courses that may fulfill each subarea are listed on pages 18-20.

Specializations: The following *optional* specializations are currently available for MS:

Advanced Manufacturing

Aerospace Engineering

Energy and Sustainability

Simulation-Driven Engineering (SDE)

Robotics and Control

Nanotechnology

Biology and Bio-inspired Engineering

For specialization requirements visit,

<https://www.mccormick.northwestern.edu/mechanical/academics/graduate/student-resources/masters-curriculum.html>

- **Level:** A minimum of 5 credited course units (excluding the one required project unit) must be 400-level or above.
- **ME courses:** A minimum of 7 course units (excluding project units) must be MECH_ENG courses or qualifying courses marked in the list on pages 19-21.
- **Seminar:** Regular attendance at the non-credit MECH_ENG 512 Seminar is encouraged but students with MS non-thesis option should not register for it. MECH_ENG 512 seminar times and locations are advertised in emails from ME department staff.
- **Approval:** There are no advisor holds. Thus, the students are free to choose courses that accommodate individual needs, talents, and interests while satisfying the basic degree requirements. Students are encouraged to talk with the MS Program Director for any questions or consultation. Note that the same full-time tuition is charged for either 3 or 4 courses in any given quarter. However, when students enroll in 1 or 2 units, the student is charged per course.

Project: One credit unit of ME 499 or an approved project course is required in which a suitable research project under the direction of a ME faculty advisor must be completed. Students may also petition to complete an additional unit of ME 499 credit for a more involved project in lieu of one course credit, resulting in a total of 10 course and 2 research units (12 units total).

GPA requirement: GPA is determined by all BS/MS qualifying courses or post BS courses taken at Northwestern towards satisfying the course requirements above. A minimum GPA of 3.0 is required by The Graduate School to earn a MS degree. Students whose GPA falls below 3.0 will be placed on probation by TGS, and will be given two quarters to recover a 3.0 GPA. Failure to meet the minimum GPA after two quarters on probation will result in removal from the program. If after fulfilling the course requirements, a student's GPA is below the minimum it may be necessary to take additional classes to raise the GPA to the required minimum.

Master's Completion: Coursework and core courses must be filled out on the "ME MS Degree Requirements" form and signed by the MS Program Director. This form must be submitted to the ME graduate program assistant.

An *Application for Degree* must be submitted to The Graduate School by the relevant published deadline for June, August, December, or March graduation.

PHD PROGRAM INFORMATION

(The following pages, 13-16, are applicable only for the PhD degree)

PHD DEGREE REQUIREMENTS:

A summary of PhD requirements is given in Table 1 and described in the following pages.

Table 1: PhD student milestone summary

Milestone/ Requirement	ME Deadline	TGS Deadline	Notes
Choose advisor	Y1Q1		<ul style="list-style-type: none">• Advisor must have appointment or courtesy appointment in ME department
Complete Responsible Conduct of Research (RCR) training (CITI & GEN_ENG 519)	Y1Q4 (McCormick deadline)		<ul style="list-style-type: none">• Sections fill quickly; recommend taking early
Qualification exam	Y2Q1 (entering w/ MS) Y2Q3 (entering w/o MS)	Y3Q4	<ul style="list-style-type: none">• Oral exam: 30-minute presentation, 30-minutes Q&A• 2-page abstract, 1 week in advance• 3-person committee (at least 1 from outside subdiscipline)• Committee chair cannot be advisor• 3 units of ME 590 before exam
External fellowship application	Y2Q4		<ul style="list-style-type: none">• See graduate handbook for details
Complete course requirements	Y2Q4 (entering w/ MS) Y3Q4 (entering w/o MS)		<ul style="list-style-type: none">• Must maintain 3.0 cumulative GPA (TGS requirement)• Must finish with a 3.5 cumulative GPA (ME requirement)
Dissertation proposal exam	Y2Q4 (entering w/ MS) Y3Q4 (entering w/o MS)	Y4Q4	<ul style="list-style-type: none">• 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• 1+ member with primary appointment outside ME
Teaching requirement	Y5Q4	Y5Q4 (for TA)	<ul style="list-style-type: none">• 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	Y9Q4	Y9Q4	<ul style="list-style-type: none">• Same committee requirements as proposal exam• Dissertation submitted to committee 1 week in advance

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 (excluding project/research units) are required towards the PhD. Nine (9) course units within these 15 course units must satisfy the MS course requirements, including the breadth requirement, minimum number of MECH_ENG courses, and minimum number of 400-level courses. See the section “Course Requirements” under MS Degree Requirements on p. 9.
- **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 Director of Graduate Studies (Graduate Chair). Students should submit this form as early as possible; see the Graduate Program Assistant, Pat Dyess, for details. Students admitted with an MS degree in Mechanical Engineering may request to be exempt from the MS course requirements (such as the breadth requirement), subject to approval from the Director of Graduate Studies.
- **Level:** At least one half (1/2) of the credited course units satisfying the post-MS requirement must be 400-level or above courses.
- **Seminar:** Registration and regular attendance at the non-credit MECH_ENG 512 Seminar is required for all quarters.
- **Professional Essentials:** Registration for the non-credit MECH_ENG 513 Seminar is required for one quarter within the first two years. It is strongly recommended that this seminar course be taken before PhD candidacy.
- **Approval:** There are no advisor holds. Thus, students are free to choose courses that accommodate individual needs, talents, and interests while satisfying the basic degree requirements. Students are encouraged to talk with their advisor for any questions or consultation.
- **Research Credits:** PhD students should register for at least three quarters of MECH_ENG 590 Research credits with their advisor before taking the required Research Qualification Exam. PhD students should not take MECH_ENG 499 Project credits; these will not count toward the PhD course requirements. However, independent-study MECH_ENG 499 courses that take the place of an in-class course may be used toward the course requirements, with the approval of a student’s advisor and the Director of Graduate Studies.
- **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 research MECH_ENG 590 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. See p. 28 for more information.

GPA requirement:

GPA is determined by all post-BS courses taken at Northwestern towards satisfying the course requirements above, excluding research and seminar units. At most one MECH_ENG 499 credit (either research or independent study) can be used in the overall GPA calculation, even if more than one MECH_ENG 499 (independent study) credit is counted toward the degree requirements. Students whose GPA falls short of a 3.5 average shall be required to take a preparatory examination prior to the Dissertation Proposal Exam (see below). These examinations will be administered by a committee consisting of at least three faculty members. The committee can consist of the same members as the Research Qualification Exam. The exam can be either written or oral or a combination of these two. Based on the research contents, the committee decides what subject(s) will be tested and informs the student the form and the content of the exam at least two months in advance. The result of the examination will be decided by the committee. Students who fail the preparatory examination will be given another chance to be re-examined in two months following the same rule described above. Students who fail both attempts shall not continue in the PhD program.

A minimum GPA of 3.0 is required by The Graduate School. Students whose GPA falls below 3.0 at any point will be placed on probation by TGS, and will be given two quarters to recover a 3.0 GPA. Failure to meet the minimum GPA after two quarters on probation will result in removal from the program.

Teaching Experience

All PhD students must meet one of the following requirements: (1) serve as an instructor of an undergraduate course, (2) serve as a full-time teaching assistant (20 hours a week) in an undergraduate course for at least one quarter, and (3) serve as a part-time teaching assistant (6-8 hours a week) in an undergraduate course for at least three quarters. The student must register for

GEN_ENG 546-0 “Teaching Experience” (0 units) for activities that fall under (1) and (2); register for GEN_ENG 545-0 “Teaching Experience” (0 units) for activities that fall under (3). Consult your advisor for help in obtaining a teaching assistant position.

Proposal Writing Experience

All PhD students who do not already have a major external fellowship* are required to apply for at least one such fellowship sometime during the first two years of their PhD study. If a major fellowship opportunity cannot be identified for which the student is eligible, the student may instead apply for another research award or fellowship or contribute to a research proposal, as approved by his or her advisor.

* A major external fellowship is defined as one that provides tuition and a stipend for two or more years, such as the NSF Graduate Research Fellowship, NDSEG fellowship, DOE fellowships, Ford Foundation, NASA Research Fellowship, Hertz Foundation Fellowship, Microsoft PhD Fellowship, Microsoft Ada Lovelace Fellowship, etc.

English Requirement:

All international PhD students whose primary language is not English should fulfill the English proficiency requirement after arriving at Northwestern. International students must fulfill the English proficiency requirement before being eligible for a teaching assistantship. International students whose primary language is English may seek an exemption by making a request through TGS English Language Programs. Students can satisfy the English proficiency requirement by passing the Versant test (scoring 65 or higher out of a possible 80) or SPEAK test (scoring 50 or higher out of a possible 60). There are four additional ways students may fulfill this requirement: (1) A score of 26 or higher (out of a possible 30) on the Speaking Section of the TOEFL internet-based test; (2) A score of 8 or higher on the Speaking Section of the IELTS test; (3) Two Versant test scores of 63 or 64; or (4) Teaching demonstration in LING 480 (The Language of Teaching and Teachers). More details of the English proficiency requirement can be found at <https://www.tgs.northwestern.edu/funding/assistantships/graduate-and-teaching/requirements.html>. Low-scoring students will be assigned to participate in a mandatory supplemental English language curriculum offered by English Language Programs (<https://www.elp.northwestern.edu/index.html>).

Admission to Candidacy:

Admission to The Graduate School does not constitute or guarantee a student’s admission to candidacy for the PhD degree. Admission to candidacy is contingent upon the recommendation of the Mechanical Engineering program and upon approval of The Graduate School. Students are admitted to candidacy for the PhD degree by passing a research qualification exam (see below) before the end of the 5th quarter (if entering with an MS degree) or the 7th quarter (if entering with a BS degree) of full-time graduate study.

Research Qualification Exam:

All PhD students shall pass an oral research qualification exam that tests their research ability. Students who enter with an MS degree or BS degree shall take the exam before the end of the 5th or 7th quarter of full-time graduate study, respectively. Taking the exam sooner is encouraged. With the consensus of the advisor, a PhD student who enters with a BS degree may first obtain an MS degree and use the MS thesis exam as a substitute for the PhD research qualification exam. Any requests for changes to the regular deadline require prior approval of the Committee of Graduate Studies. Students should register for at least three units of ME 590 before the exam.

The examination committee will consist of at least three faculty members who are members of the graduate faculty. A student’s faculty advisor will serve on the committee but will not be its chair. At least one member of the committee should either have a primary appointment outside the ME department, or be from a [Core Discipline](#) outside the student’s area of specialization. The student is responsible for personally contacting members of the committee to invite them to serve. The composition of the examination committee is subject to the final approval by Graduate Studies Committee. The examination committee members need not be the same as for the later Dissertation Proposal and PhD Dissertation.

The exam consists of a 30-minute presentation by the student and 30 minutes of questions by the faculty committee. The purpose of the exam is to demonstrate the ability to define a research problem, explain its relevance in scientific terms, and articulate current research challenges and a methodology to address such challenges, as well as for the student to demonstrate an understanding of the underlying fundamental concepts related to the research topic. A two-page abstract should be provided to the committee a week before the exam.

A student who does not pass the exam on the first attempt may (1) continue with the same advisor and retake the exam the next quarter, if agreed to by the advisor; (2) switch advisors if needed, and retake the exam after two more quarters; or (3) leave the program. No more than two attempts of taking the exam may be made.

The examination committee’s recommendation to fail students will be voted on by the entire tenure-track ME faculty, whose decision will be final.

Dissertation Proposal Exam:

Students are required to pass the Dissertation Proposal Exam (or Prospectus) no later than the end of the 2nd year of full-time study if entering with an MS degree, or the end of the 3rd year of full-time study if entering with a BS degree. Students are eligible to take the dissertational proposal exam when no more than 3 of the courses required for the PhD remain to be taken. The oral dissertation proposal examination will be based on, but not restricted to, a written research proposal (recommended to be less than 30 pages in total length, double spaced) prepared by the student, a proposal presentation made by the student, and an oral examination administered by the examination committee. The dissertation proposal should be provided to the committee at least a week before the final exam.

Students should complete and submit the [PhD Requirements Form](#) to the ME Program Assistant (Pat Dyess) before the Proposal Exam. Contact Pat Dyess for more details.

The proposal examination committee is normally the advisory committee of a student until completion of the PhD degree, and also conducts the final examination for the PhD at a later date. The committee should satisfy the TGS requirements (<https://www.tgs.northwestern.edu/about/policies/phd-degree-requirements.html>). In addition to the TGS requirements, the ME program requires that one committee member must have a primary appointment outside of the department. The chairperson of the committee must be a graduate faculty member and is generally the student's advisor. If the chairperson is not an ME faculty member, an ME faculty member must be identified to serve as the co-chair of the committee. Any faculty member may request the privilege of serving on the committee for a particular student, by contacting the student and advisor. The student is responsible for personally contacting members of the committee to invite them to serve. Formation of an examination committee is subject to the approval of both the ME department and The Graduate School.

Students who fail the examination may, upon the recommendation of their committee, retake it within one quarter. Students who do not pass the re-examination shall not continue in the PhD program.

PhD Dissertation:

A written dissertation on the research project that is satisfactory to the student's faculty advisor and the advisory (examination) committee, and meets the University's requirements, is required. The dissertation should be prepared according to the Graduate School format for PhD dissertations (<https://www.tgs.northwestern.edu/academic-policies-procedures/dissertation-publication/dissertation-formatting-requirements/index.html>).

Final Examination / Dissertation Defense

An oral examination by the examination committee of faculty, including the student's advisor, addressing the research is required. The written dissertation must be given to the members of the student's examination committee at least one week before the date of the scheduled examination.

PHD STUDENT ASSESSMENT AND FEEDBACK

The objective of the annual PhD student evaluation is to provide early and ongoing feedback to students regarding their performance during their PhD studies, and to provide guidance and advice for their work and progress. Annual evaluation is required by the Graduate School.

- 1) Each PhD student should be evaluated annually before the end of the summer quarter of each year. This evaluation should consist of the following:
 - a. Each student will submit an annual progress report following the required format in the online Graduate Student Tracking System (<https://gsts.northwestern.edu/>).
 - b. A face-to-face meeting between the advisor and student is highly recommended before the faculty advisor finalizes the advisor evaluation.
 - c. If a student disagrees with the advisor's evaluation, the student should contact the Director of Graduate Studies to request a reevaluation.
- 2) Students with low GPA and/or unsatisfactory research progress will be put on probation. Such cases will be carefully discussed and handled individually with the evaluation committee. Depending on subsequent improvements, students may be advised to leave, pursue a terminal MS, or continue with the PhD program.

SUGGESTED COURSE LISTS

MS/PhD Breadth Requirement: Acceptable Courses

MS students in the general (non-specialization) program, and PhD students entering without an MS degree, must fulfill the breadth requirement by taking at least one course from four of the eight subareas: (1) Solids, (2) Fluids/Thermodynamics/-Energy, (3) Robotics/Dynamics/Controls, (4) Design/Manufacturing/Tribology, (5) MEMS/Nanotechnology, (6) Biomedical/-Biology, (7) Mathematics/Science/Data Science, and (8) Engineering Management.

Suggested courses for each category are listed below. Note that these lists are not meant to be exhaustive, especially for non-MECH_ENG courses. For questions about whether a certain course can count toward a given category, MS students should contact the MS Program Director (Prof. Manohar Kulkarni), while PhD students should contact the Director of Graduate Studies (Prof. Greg Wagner).

A course may be used for meeting only one breadth area, even if it is listed here under multiple areas. Some existing graduate-level MECH_ENG or McCormick courses do not fill any breadth requirement category.

Finally, note that not all courses listed here are offered every academic year.

Solids

MECH_ENG 327	Finite Elements for Stress Analysis
MECH_ENG 328	Computational Forensics and Failure Analysis
MECH_ENG 362	Stress Analysis
MECH_ENG 413	Experimental Solid Mechanics
MECH_ENG 414-1	Mechanics of Composite Materials I
MECH_ENG 414-2	Mechanics of Composite Materials II
MECH_ENG 415	Mechanics of Manufacturing Processes
MECH_ENG 417	Multi-Scale Modeling and Simulation in Solid Mechanics
MECH_ENG 419	Wave Propagation in Elastic Solids
MECH_ENG 426-1	Advanced Finite Elements I
MECH_ENG 426-2	Advanced Finite Elements II
MECH_ENG 456	Mechanics of Advanced Materials
MECH_ENG 466	Inelastic Constitutive Relations for Solids
MECH_ENG 495	Mechanics of Thin Films
MECH_ENG 495	Metamaterials
MECH_ENG 495	Fracture of Soft Materials
*CIV_ENV 413	Experimental Solid Mechanics
*CIV_ENV 415	Theory of Elasticity
*CIV_ENV 417-1	Mechanics of Continua I

Fluids/Thermo/Energy

MECH_ENG 322	Thermodynamics and Statistical Mechanics II
MECH_ENG 364	Introduction to Aerospace Engineering
MECH_ENG 367	Quantitative Methods in Life Cycle Analysis
MECH_ENG 373	Engineering Fluid Mechanics
MECH_ENG 377	Heat Transfer
MECH_ENG 378	Applied Computational Fluid Dynamics and Heat Transfer
MECH_ENG 380	Thermal Energy Systems Design
MECH_ENG 395/495	Propulsion
MECH_ENG 418	Multi-Scale Modeling and Simulation in Fluid Mechanics
MECH_ENG 420	Micro- and Nanoscale Fluid Dynamics
MECH_ENG 422	Statistical Mechanics for Applications
MECH_ENG 423	Intro to Computational Fluid Dynamics
MECH_ENG 424	Advanced Topics in Computational Fluid Dynamics
MECH_ENG 425	Fundamentals of Fluid Dynamics

* Course may be considered a MECH_ENG course toward the minimum of 5 required MECH_ENG courses

MECH_ENG 427	Viscous Fluid Dynamics
MECH_ENG 467	Industrial Energy Management and Utilization
MECH_ENG 470	High Performance Computing for Multiphysics Applications
MECH_ENG 495	Aerodynamics
MECH_ENG 495	Turbulence and Combustion
CIV_ENV 440	Environmental Transport Processes
ES_APPM 426	Theory of Flows With Small Inertia
ES_APPM 429	Hydrodynamic Stability Theory
BMD_ENG 478	Transport Fundamentals

Robotics/Dynamics/Control

MECH_ENG 314	Machine Dynamics
MECH_ENG 333	Introduction to Mechatronics
MECH_ENG 363	Mechanical Vibrations
MECH_ENG 390	Intro to Dynamic Systems
MECH_ENG 395	Vehicle Dynamics and Design
MECH_ENG 409	Swarms and Multi-Robot Systems
MECH_ENG 410	Autonomous Quadrotor Design and Control
MECH_ENG 433	Advanced Mechatronics
MECH_ENG 448	Flexible Automation and Robotics
MECH_ENG 449	Robotic Manipulation
MECH_ENG 454	Numerical Methods in Optimal Control of Nonlinear Systems
MECH_ENG 455	Active Learning in Robotics
MECH_ENG 469	Machine Learning and Artificial Intelligence for Robotics
MECH_ENG 495	Computational Nanodynamics
MECH_ENG 495	Embedded Systems in Robotics
MECH_ENG 495	Sensing Navigation and Machine Learning for Robotics
MECH_ENG 495	Soft Robotics
ELEC_ENG 360	Introduction to Feedback Systems
ELEC_ENG 374	Introduction to Digital Control
ELEC_ENG 495	Introduction to Nonlinear Control Theory

Design/Manufacturing/Tribology

MECH_ENG 316	Mechanical Systems Design
MECH_ENG 320	Micro- and Nanomechanical Properties of Surfaces
MECH_ENG 340-1	Computer Integrated Manufacturing: Manufacturing Processes
MECH_ENG 340-2	Computer Integrated Manufacturing: CAD/CAM
MECH_ENG 340-3	Computer Integrated Manufacturing: Automation
MECH_ENG 341	Computational Methods for Engineering Design
MECH_ENG 346	Introduction to Tribology
MECH_ENG 366	Finite Elements for Design & Optimization
MECH_ENG 395	Industry 4.0 Manufacturing
MECH_ENG 439	Computer Control in Manufacturing
MECH_ENG 415	Mechanics of Manufacturing Processes
MECH_ENG 441	Engineering Optimization for Product Design and Manufacturing
MECH_ENG 442	Metal Forming
MECH_ENG 443	Metal Cutting
MECH_ENG 445	Micromanufacturing
MECH_ENG 446	Advanced Tribology
MECH_ENG 451	Micromachining
MECH_ENG 495	Manufacturing Process Mechanics
MECH_ENG 495	Sustainable Manufacturing Systems
MECH_ENG 495	Computational Statistics for Design
MECH_ENG 495	Introduction to Additive Manufacturing
MECH_ENG 495	Metal and Ceramic Additive Manufacturing
MAT_SCI 318	Materials Selection

MEMS/Nanotechnology

MECH_ENG 381	Introduction to Micro-electro-mechanical Systems
MECH_ENG 382	Experiments in Micro- and Nano-Science and Engineering
MECH_ENG 385	Nanotechnology
MECH_ENG 416	Computational Nanodynamics
MECH_ENG 417	Multi-Scale Modeling and Simulation in Solid Mechanics
MECH_ENG 418	Multi-Scale Modeling and Simulation in Fluid Mechanics
MECH_ENG 420	Micro- and Nanoscale Fluid Dynamics
MECH_ENG 445	Micromanufacturing
MECH_ENG 451	Micromachining
MECH_ENG 495	Mechanics of the Cell and BioMEMS

Biomedical/Biology

MECH_ENG 395	Bio-Inspired Surface Engineering
MECH_ENG 495	Mechanics of the Cell and BioMEMS
MECH_ENG 495	Artificial Life
BMD_ENG 462	Sensory Acquisition
BMD_ENG 463	Advanced Signal Processing Methods in Neuropathophysiology
BMD_ENG 465	Biomechanical Modeling & Simulation of Human Movement
BMD_ENG 467	Biomedical Robotics
BMD_ENG 495	NUvention: Medical Innovation

Mathematics/Science/Data Science

COMP_SCI 349	Machine Learning
ES_APPM 311-0,1	Methods of Applied Mathematics
ES_APPM 322	Applied Dynamics Systems
ES_APPM 346	Modeling and Computation in Science & Engineering
ES_APPM 370	Introduction to Computational Neuroscience
ES_APPM 411-1,2,3	Differential Equations of Mathematical Physics
ES_APPM 412	Methods of Nonlinear Analysis
ES_APPM 420-1,2,3	Asymptotic and Perturbation Methods in Applied Mathematics
ES_APPM 421-1	Models in Applied Mathematics
ES_APPM 426	Theory of Flows With Small Inertia
ES_APPM 429	Hydrodynamic Stability Theory
ES_APPM 430	Wave Propagation
ES_APPM 440	Integral Equations & Applications
ES_APPM 442	Stochastic Differential Equations
ES_APPM 445	Iterative Methods for Elliptic Equations
ES_APPM 446-1,2	Numerical Solution of Partial Differential Equations
ES_APPM 451	Mathematical Models in Biology
MECH_ENG 432	The Calculus of Variations and Its Applications
ELEC_ENG 435	Deep Learning: Foundations, Applications, and Algorithms
ELEC_ENG 473	Deep Reinforcement Learning
ELEC_ENG 475	Machine Learning: Foundations, Applications, and Algorithms
IEMS 304	Statistical Learning for Data Analysis
IEMS 308	Data Science and Analytics
IEMS 455	Machine Learning

Engineering Management

MECH_ENG 467	Industrial Energy Management and Utilization
MECH_ENG 495	Tech Innovation
DSGN 450	Differentiation by Design
MEM 402	Engineering Management
MEM 407	Decision Tools for Managers
MEM 415	Computer Simulation for Risk and Operations Analysis
MEM 426	Project Management
ENTREP 325	Engineering Entrepreneurship

Cross-Cutting Research Areas: Suggested Courses

The ME department has identified 7 cross-cutting research areas that draw on the strengths and expertise of faculty members from all core disciplines in the department: Advanced Manufacturing, AI and Design, Biosystems and Health, Computational Engineering, Energy and Sustainability, Micro- and Nanoengineering, and Robotics and Autonomy. Students interested in or doing research in these areas may take related courses from the department or across McCormick. The tables below list suggested courses in each research area.

Note that these 7 research areas are distinct from the 8 breadth requirement categories listed in the previous section. Courses in these 7 lists are suggestions, and not requirements. More information about the 7 research areas, including a Research Areas Matrix listing department faculty associated with each area, can be found on the department web site:

<https://www.mccormick.northwestern.edu/mechanical/research/areas/>

Courses schedules for the current academic year in the ME, and links to schedules in other departments, can also be found on the department web site: <https://www.mccormick.northwestern.edu/mechanical/academics/courses/>

Not all courses listed will be offered in the coming academic year, but those that are not have been offered recently and may be offered again in the future. Some courses, as marked, are offered in alternating years.

Advanced Manufacturing

Course Number	Title	2023-24 Quarter
MECH_ENG 327	Finite Elements Methods in Mechanics	F
MECH_ENG 329	Mechanistic Data Science for Engineering	--
MECH_ENG 340-1,2	Computer Integrated Manufacturing I, II	F,W
MECH_ENG 363	Mechanical Vibrations	S
MECH_ENG 395	Industry 4.0 Manufacturing	--
MECH_ENG 415	Mechanics of Manufacturing Processes	S
MECH_ENG 416	Computational Nanodynamics	--
MECH_ENG 419	Wave Propagation in Elastic Solids	--
MECH_ENG 422	Statistical Mechanics and Applications	F
MECH_ENG 426-1	Advanced Finite Element Methods 1	W
MECH_ENG 433	Advanced Mechatronics	S
MECH_ENG 439	Computer Control in Manufacturing	--
MECH_ENG 441	Engineering Optimization for Product Design and Manufacturing	W
MECH_ENG 445	Micromanufacturing	--
MECH_ENG 446	Advanced Tribology	F
MECH_ENG 451	Micromachining	--
MECH_ENG 466	Inelastic Constitutive Relations for Solids	--
MECH_ENG 470	High Performance Computing for Multiphysics Applications	--*
MECH_ENG 495	Metamaterials	W
MECH_ENG 495	Introduction to Additive Manufacturing	F
MECH_ENG 495	Metal and Ceramic Additive Manufacturing	S

* Offered in alternating academic years

CHEM_ENG 451	Applied Molecular Modeling	S
CIV_ENV 415-0	Theory of Elasticity	F
CIV_ENV 417-1	Mechanics of Continua: 1	F
CIV_ENV 426-1	Advanced Finite Element Methods 1	W
CIV_ENV 426-2	Advanced Finite Element Methods 2	S
ES_APPM 411-1	Differential Equations of Mathematical Physics	F

AI and Design

Course Number	Title	2023-24 Quarter
MECH_ENG 329	Mechanistic Data Science for Engineering	--
MECH_ENG 395	Vehicle Design and Dynamics	W
MECH_ENG 410	Quadrotor Design and Control	S
MECH_ENG 433	Advanced Mechatronics	S
MECH_ENG 441	Engineering Optimization for Product Design and Manufacturing	W
MECH_ENG 455	Active Learning in Robotics	S
MECH_ENG 469	Machine Learning and Artificial Intelligence for Robotics	F
MECH_ENG 472-1	Robot Design Studio 1	W
MECH_ENG 472-2	Robot Design Studio 2	S
MECH_ENG 495	Embedded Systems in Robotics	F
COMP_SCI 330	Human Computer Interaction	F
COMP_SCI 337	Intro to Natural Language Processing	F
COMP_SCI 348	Intro to Artificial Intelligence	F,S
COMP_SCI 349	Machine Learning	F,W,S
COMP_SCI 368/468	Programming Massively Parallel Processors with CUDA	W
COMP_SCI 396	Natural & Artificial Vision	S
COMP_SCI 449	Deep Learning	F,W,S
COMP_SCI 496	Generative Deep Models	--
COMP_SCI 496	Computational Optics	--
COMP_SCI 497	Deep Learning for Natural Language Processing	S
ELEC_ENG 375/475	Machine Learning: Foundation, Algorithms, and Applications	F
ELEC_ENG 422	Random Processes in Communications and Control I	W
ES_APPM 448	Numerical Methods for Random Processes	W
IEMS 304	Statistical Learning for Data Analysis	F,W,S
IEMS 351	Optimization Methods in Data Science	F
IEMS 401	Applied Mathematical Statistics	F

Biosystems and Health

Course Number	Title	2023-24 Quarter
MECH_ENG 381	Introduction to MEMS	--
MECH_ENG 382	Micro/Nano Science and Engineering	S
MECH_ENG 395	Bio-Inspired Surface Engineering	W
MECH_ENG 495	Artificial Life	W
BMD_ENG 311	Computational Genomics	F
BMD_ENG 312	Biomedical Applications in Machine Learning	S
BMD_ENG 317	Biochemical Sensors	F
BMD_ENG 333	Modern Optical Microscopy and Imaging	F
BMD_ENG 407	Experimental Design and Measurement	F
BMD_ENG 429	Advanced Physical and Applied Optics	F
IBIS 410	Quantitative Biology	F
IBIS 432	Statistics for Life Sciences	S

Computational Engineering

Course Number	Title	2023-24 Quarter
MECH_ENG 327	Finite Elements Methods in Mechanics	F
MECH_ENG 328	Computational Forensics and Failure Analysis	--
MECH_ENG 329	Mechanistic Data Science for Engineering	--
MECH_ENG 362	Stress Analysis	S
MECH_ENG 378	Applied Computational Fluid Dynamics and Heat Transfer	W
MECH_ENG 395	Deep Learning Discrete Calculus for Engineering	S
MECH_ENG 416	Computational Nanodynamics	--
MECH_ENG 418	Multiscale Modeling and Simulation in Fluid Mechanics	--
MECH_ENG 423	Introduction to Computational Fluid Dynamics	--*
MECH_ENG 424	Advanced Computational Fluid Dynamics	S
MECH_ENG 426-1/ CIV_ENV 426-1	Advanced Finite Element Methods I	W
MECH_ENG 426-2/ CIV_ENV 426-2	Advanced Finite Element Methods 2	S
MECH_ENG 441	Engineering Optimization for Product Design and Manufacturing	W
MECH_ENG 470	High Performance Computing for Multiphysics Applications	--*
CHEM_ENG 451	Applied Molecular Modeling	S
CIV_ENV 320	Structural Analysis - Dynamics	W
CIV_ENV 417-1	Mechanics of Continua: 1	F
COMP_ENG 368/468	Programming Massively Parallel Processors with CUDA	W

* Offered in alternating academic years

ELEC_ENG 435	Deep Learning Foundations from Scratch	W
ELEC_ENG 473	Deep Reinforcement Learning from Scratch	S
ELEC_ENG 475	Machine Learning: Foundations, Applications, and Algorithms	F
ES_APPM 444	High Performance Scientific Computing	S
ES_APPM 446-1	Numerical Solution of Partial Differential Equations	F
MAT_SCI 458	Computational Materials Science	W

Energy and Sustainability

Course Number	Title	2023-24 Quarter
MECH_ENG 322	Thermodynamics & Statistical Mechanics II	S
MECH_ENG 367	Quantitative Methods in Life Cycle Analysis	S
MECH_ENG 373	Engineering Fluid Mechanics	W
MECH_ENG 377	Heat Transfer	W,S
MECH_ENG 378	Applied Computational Fluid Dynamics and Heat Transfer	W
MECH_ENG 380	Thermal Energy Systems Design	S
MECH_ENG 395	Bio-inspired Surface Engineering	W
MECH_ENG 425	Fundamentals of Fluid Dynamics	--*
MECH_ENG 467	Industrial Energy Management and Utilization	W
MECH_ENG 495	Nanoscale Thermal Transport	S
CHEM_ENG 365	Sustainability, Technology and Society	F
CIV_ENV 303	Environmental Law and Policy	F
CIV_ENV 346	Ecohydrology	W
CIV_ENV 364	Sustainable Water Systems	W
CIV_ENV 368	Sustainability: The City	F
CIV_ENV 440	Environmental Transport Processes	F
ES_APPM 311	Methods of Applied Mathematics	F
ISEN 410	Topics in Contemporary Energy and Climate Change	--
ISEN 420	NUvention Energy	--
MAT_SCI 381	Energy Materials	F
MAT_SCI 382	Electrochem Energy Materials and Devices	S
MAT_SCI 385	Electronic and Thermal Properties of Materials	--

Micro- and Nanoengineering

Course Number	Title	2023-24 Quarter
MECH_ENG 381	Introduction to MEMS	--
MECH_ENG 382	Micro/Nano-Science and Engineering	S
MECH_ENG 413	Modern Experimental Solid Mechanics	S

* Offered in alternating academic years

MECH_ENG 416	Computational Nanodynamics	--
MECH_ENG 426-1/ CIV_ENV 426-1	Advanced Finite Element Methods 1	W
MECH_ENG 426-2/ CIV_ENV 426-2	Advanced Finite Element Methods 2	S
MAT_SCI 401	Chemical and Statistical Thermodynamics of Materials	F
MAT_SCI 405	Physics of Solids	S
MAT_SCI 451	Physics of Materials	F
MAT_SCI 458	Computational Materials Science	W

Robotics and Autonomy

Course Number	Title	2023-24 Quarter
MECH_ENG 314	Theory of Machines: Dynamics	F,S
MECH_ENG 333	Intro to Mechatronics	W
MECH_ENG 390	Introduction to Dynamic Systems	F
MECH_ENG 409	Swarms and Multi-Robot Systems	F
MECH_ENG 410	Quadrotor Design and Control	W
MECH_ENG 433	Advanced Mechatronics	S
MECH_ENG 441	Engineering Optimization for Product Design and Manufacturing	W
MECH_ENG 449	Robotic Manipulation	F
MECH_ENG 455	Active Learning in Robotics	S
MECH_ENG 469	ML and AI for Robotics	F
MECH_ENG 472-1,2	Robot Design Studio	W,S
MECH_ENG 495	Embedded Systems in Robotics	F
MECH_ENG 495	Artificial Life	W
MECH_ENG 495	Sensing, Navigation and Machine Learning for Robotics	W
MECH_ENG 495	Soft Robotics	S
COMP_SCI 348	Intro to Artificial Intelligence	F,S
ELEC_ENG 326	Electronic System Design I	W
ELEC_ENG 360	Introduction to Feedback Systems	W

OTHER IMPORTANT GRADUATE STUDY INFORMATION

Course Levels

Courses are labeled with letter prefixes having the following meaning:

- 1 - Introductory (Freshman level)
- 2 - Intermediate (Sophomore level)
- 3 - Advanced (Junior, Senior, and Graduate level)
- 4, 5- Graduate level

Grades

Credit for the MS or PhD degree will be given only for courses in which a letter grade above C has been received. No P/N registration will be accepted. A student whose overall grade average is below B (3.0) is not meeting academic standards and will be placed on probation. Failure to remedy that situation may lead to dismissal by The Graduate School.

An incomplete grade (Y) for any course except Projects (499) must be removed within one year of the official ending of the course. Research (590) may be graded as incomplete (K) until the research is finished. All K grades must be changed by the time the application for degree is submitted to The Graduate School.

More information on grading policies can be found on the TGS web site:

<https://www.tgs.northwestern.edu/academic-policies-procedures/policies/general-registration-policies.html#grades>

Financial Aid, Fellowships, and Registration

Recipients of financial aid must be fully registered. Full registration, according to The Graduate School regulations, means 3-4 courses per quarter.

Students enrolled in the MS program are not eligible for financial aid and assistantships except for the GEM Fellowship for under-represented minority students.

Several types of financial aid are available for PhD students. The Walter P. Murphy Fellowship and Cabell Fellowships are endowed fellowships that enable outstanding students to pursue their first year of graduate study with no teaching obligations. Information on merit-based fellowships offered by the Graduate School at Northwestern University can be found at <http://www.tgs.northwestern.edu/funding/fellowships-and-grants/index.html>. Terminal Year Fellowships are available on a competitive basis for students completing their PhD studies to enable them to focus entirely on their dissertation during their final year. The Department of Mechanical Engineering offers the Martin Outstanding Doctoral Fellowship to mid-career PhD students. Examples of external fellowships that are suitable to ME PhD students include the NSF Graduate Research Fellowship, the National Defense Science & Engineering Graduate Fellowship, and the HHMI International Student Research Fellowship.

Fellowships generally provide a monthly stipend and tuition for full-time study and research. Fellowships for underrepresented minority group members are available for new and continuing students. General information on fellowship opportunities for encouraging diversity can be found at <http://www.tgs.northwestern.edu/diversity/funding-resources/index.html>.

Research assistantships involve participation in ongoing funded research projects and are awarded at the discretion of the faculty advisor. Some new students and most continuing students are supported through research assistantships. Research assistantships provide a monthly stipend and tuition for full-time study and research. A limited number of teaching assistantships are available. A teaching assistant has responsibility for running the laboratory portion of a course or for grading papers and holding office hours. Teaching assistantships cover tuition, provide a monthly stipend, and are arranged by the department with the endorsement from the faculty advisor. Students whose native language is not English must pass the English proficiency requirement (see p. 15) to be considered for a teaching assistantship. Fellowships, research assistantships, and teaching assistantships are subject to income tax.

The Leon M. Keer and Family Fellowship provides financial assistance of up to \$2,500 to PhD students, especially students with financial need due to family care. Calls for applications for the Keer Fellowship will be sent to all students twice a year. Students with urgent financial needs should contact the Director of Graduate Studies or the ME Department Chair.

Full-time graduate students in good academic standing are eligible to apply for low-cost student loans. More information is available at the Student Loan Office, 555 Clark Street, 3rd Floor.

PhD students who receive financial support in the form of NU fellowships, research, and teaching fellowships are strongly discouraged from terminating PhD study with an MS degree. When such a situation happens and with the approval of the faculty advisor, the student must take the thesis option for the MS degree (see section on “MS Degree Requirements”), including writing and defending an MS thesis document.

Registration as a Full-Time Student

All students using departmental facilities in any quarter must be registered or must be employees of the University. During the fall, winter or spring quarters, a full-time registration of 3-4 units of courses and research normally should be elected. For MS students this is achieved by registering for a combination of course units and MECH_ENG 499 Research Project or MECH_ENG 590 Thesis Research. Preferable registration is for a total of 4 units per quarter for three quarters to fulfill the 12 required units for the MS degree within three quarters. MS students who need to continue their research after having completed the required 12 units should register for TGS 512 Continuous Registration, described below.

PhD students who are receiving funding should maintain a full-time registration of 3-4 units of courses and ME-590 Research. Students who need to continue their research but have completed their course requirements (including at least 3 credits of MECH_ENG 590) may register for TGS-500 Advanced Doctoral Study, as described below. Courses related to the student's area of study may be taken in addition to TGS 500, up to a maximum of 4 course units.

Registration for the *summer quarter* is required for students who receive funding. Registration for a summer internship is optional (see section on "Summer Internship" in "Other Important Graduate Student Information"). Students are strongly encouraged to discuss summer registration with their advisor.

MS research/project registration is summarized below:

MECH_ENG 499 Projects – Available to MS-without-thesis students to pursue research for their MS project. One unit of ME-499 is required. A second unit of ME-499 may be used to fulfill the MS degree requirements by petition. MECH_ENG 499 units may not be used toward the requirements of a PhD.

MECH_ENG 590 Research – Available to MS-with-thesis students. Three units of MECH_ENG 590 are required. Typical registration is for 1 to 3 research units in addition to courses to achieve a total of 3-4 units for full-time registration.

TGS 512 Continuous Registration – Available to MS students who have completed all course requirements (including the required number of MECH_ENG 499 or MECH_ENG 590 units), and are continuing research, need to use university facilities, are receiving financial aid, or hold F-1 or J-1 visa status. Requests for more than one TGS 512 registration will be reviewed by The Graduate School. Provides full-time status, but allows no accumulation of credit toward the master's degree. No other may be taken simultaneous with TGS 512 registration. Only a registration fee is required rather than tuition for regular registration.

PhD research/project registration is summarized below:

MECH_ENG 590 Research – Available to PhD students to pursue research for their PhD prior to candidacy. Typical registration is for 1 to 4 research units in addition to courses to achieve a total of 3-4 units for full-time registration until course requirements are completed.

TGS 500 Advanced Doctoral Study – Available to doctoral students who have completed all course requirements, are primarily doing research, and are receiving funding. Also appropriate for students receiving financial aid or on F-1 and J-1 visas. TGS 500 provides full-time status.

PhD research registration summary:

	Credit	Course Requirements	Tuition Rate	Use
MECH_ENG 590	Yes	Pre	Full	In first few (1-3) years while satisfying course requirements. Minimum three units required before taking the research qualification exam.
TGS 500	No	Post	Reduced	As needed after course requirements are fulfilled to maintain full-time student status until dissertation is submitted

Continuous Registration Requirement

All PhD students in years one through nine and MS students in years one through five must be registered at Northwestern University in each of the Fall, Winter and Spring terms. Students receiving funding must be registered during Summer terms. Explanation of the policy is available at:

<http://www.tgs.northwestern.edu/about/policies/general-registration-policies.html>

Where and When to Register

Register on CAESAR www.caesar.northwestern.edu. Registration deadlines are listed on the University's Academic Calendar: <https://www.registrar.northwestern.edu/calendars/index.html>

Finding an Advisor

Students are recommended to seek out a research advisor to work with on his/her graduate research within the first quarter of beginning 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 for the Dissertation Proposal Exam and Dissertation Defense. The advisor also closely reviews the research report, thesis, or dissertation and is co-author on publications arising from the research project. Upon matching with an advisor, the student must notify the department by entering their advisor's name in the GSTS (<https://gsts.northwestern.edu>). PhD students that are unable to find an advisor by the end of their first quarter may be put on academic probation by the program and must contact the Director of Graduate Studies immediately. The Director of Graduate Studies will determine a deadline by which the student must identify an advisor to avoid exclusion from the program due to unsatisfactory academic progress.

Student Wellness, Conflict Resolution and Changing an Advisor

Students are encouraged to consult the Director of Graduate Studies (DGS) at any point regarding their academic progress, potential conflicts with their advisor or others in the program, or other concerns that relate to their well-being. In rare instances, a change of advisor may be necessary due to loss of funding, mismatch of research interests, or other reasons. If the student and/or primary research advisor believe at any point that the student would be better served by a different advisor, the student must immediately contact the DGS. Under these circumstances, the DGS will work with the faculty and student to determine a deadline by which the student must identify a new advisor to avoid exclusion from the program due to unsatisfactory academic progress. PhD students are encouraged to contact the DGS regarding concerns related to changing advisors, while MS students are encouraged to contact the Director of MS Program. If the DGS or Director of the MS Program are themselves the student's advisor, then the student is encouraged to contact the Department Chair.

PhD Advisory Committee Guidelines

The role of the PhD advisory committee is one of guidance as well as examination. Members of the advisory committee will help direct the PhD student's research efforts and will also serve as the examining committee for the thesis proposal exam and the thesis exam. Any faculty member who requests membership on this committee will be granted that privilege. In order to enhance the student's progress the following guidelines should be followed:

- The advisory committee for the student should be formed as soon as the general direction of research is identified, ideally soon after the student is admitted to candidacy (after the Qualification Exam).
- The student should meet individually and collectively with the members of the advisory committee on a regular basis: quarterly or bi-annually is suggested.
- In addition to the regular meetings, the student should meet with all the advisory committee members before the proposal exam and thesis exam are scheduled; consultation 2-3 months prior to the exam date will allow time for advice to be incorporated into research before the exam.
- It is strongly recommended that the student give presentations on their work at every opportunity. Conference presentations and the practice of a final thesis presentation to a larger audience are particularly advised.
- The thesis proposal and the thesis should be completed and distributed to the advisory committee at least one week prior to each scheduled exam date.

Academic and Research Integrity

Academic dishonesty (e.g., cheating or plagiarism) is a serious matter for graduate students committed to intellectual pursuits, and will be adjudicated in accordance with procedures approved by the Graduate Faculty. Sanctions may involve a letter of warning, suspension, or exclusion from the university. Detailed description can be found at <https://www.tgs.northwestern.edu/academic-policies-procedures/policies/academic-integrity.html>. All graduate students who participate in funded research will need to complete the Responsible Conduct of Research (RCR) compliance training (<https://www.mccormick.northwestern.edu/faculty-staff-resources/research-conduct/>).

Family Leave Policy

Family leave includes both parental leave and medical leave. TGS provides 12 weeks of parental accommodation for students of all gender identities and gender expressions who become new parents (whether by childbirth or adoption). Family medical

leave may be taken in addition to the parental accommodation. Details can be found at <https://www.tgs.northwestern.edu/funding/about-graduate-funding/paid-medical-leave-and-parental-accommodations.html>.

Summer Internship

Students may seek internships during the summer term to gain practical experience in industry or at national laboratories in areas closely related to their research. The summer term is suitable time for an internship since no courses are offered by the ME department in the summer. Students seeking a summer internship should contact the McCormick Career Development office and begin the process in the winter quarter, although they may also find an internship on their own. Students may choose to register their summer internship through the McCormick Career Development office as CRDV 411 for MS students or CRDV 510 for PhD students. CRDV courses are non-credit, non-tuition-bearing courses. The CRDV registration enables international students with F-1 visas to qualify for CPT work authorization, allows health benefits to be maintained (if the student desires them and pays the appropriate fees), permits loans to be deferred, and provides evidence of the internship on transcripts.

The **Crown Family Internship** program is open to all doctoral students in the McCormick School. International students may participate by using a part or all of their practical traineeship visa during the internship. However, the total term of work experience (pre-graduation internship plus post-graduation work) may not exceed one year. Participants in this program register for CRDV 510. Up to three registrations of CRDV 510 are allowed, but no more than two registrations may be consecutive. Details and the application process of the Crown Family Internship are provided at the website <http://www.mccormick.northwestern.edu/students/graduate/fellowships-internships/crown-family.html>.

Conference Travel Grant

The Conference Travel Grant (CTG) offered by The Graduate School provides funds to assist PhD and MFA students traveling to conferences and/or seminars to make presentations on behalf of the University. Students are eligible for a maximum of **two grants** up to \$600 over the entire course of their graduate career. Details can be found at: <https://www.tgs.northwestern.edu/funding/fellowships-and-grants/internal-fellowships-grants/conference-travel-grant.html>.

New Computer Initiative

The ME department subsidizes a new computer for any full-time PhD student within three months of passing their PhD dissertation proposal exam, provided the exam occurs within two years of full-time study after the MS degree or three years of full-time study after the BS degree. The department will cover a laptop (or desktop) purchase up to \$1,500 through IBuyNU. If the cost is more than \$1,500, the student will be responsible for the difference. Please contact Sujin Kim (sujin.kim@northwestern.edu) with any questions.

Academic Probation

A student who is not making satisfactory academic progress will be placed on academic probation by The Graduate School and/or the ME department. When a decision to place a student on probation is made, the student will be given at most two quarters (not including summer quarter) to resume satisfactory academic standing. Detailed guidelines can be found at: <https://www.tgs.northwestern.edu/academic-policies-procedures/policies/satisfactory-academic-progress.html>.

Exclusion (Dismissal) and Appeals Process

A student who fails to resume good academic standing after at most two quarters after the quarter of being notified of their placement on probation by either The Graduate School or the program will be excluded from The Graduate School. Program exclusion requires approval from both the Director of Graduate Studies and the Chair of the department.

Students wishing to appeal an exclusion decision should follow the procedure specified by The Graduate School under “Appeal Process.” Student should send a copy of appeal to his or her academic advisor and the Director of Graduate Studies when submitting the appeal to The Graduate School. Students wishing to appeal a program’s decision to exclude must first appeal directly to the program by contacting the Director of Graduate Studies. The program must inform both the student and TGS of the outcome of the student’s appeal(s) in writing. A student may subsequently appeal program decisions to TGS.

Visit the Graduate School Policy page (<https://www.tgs.northwestern.edu/academic-policies-procedures/policies>) for a complete description of graduate school policies at Northwestern University.

MECHANICAL ENGINEERING DEPARTMENT INFORMATION

1. Support Staff:

Dyess, Pat	Graduate Program Assistant	Tech M211	j-dyess@northwestern.edu
Kim, Sujin	Financial Assistant	Tech M211	sujin.kim@northwestern.edu
Kulanda, Sinta	Business Coordinator	Tech M211	s-kulanda@northwestern.edu
Martin, Mady	Program Coordinator	Tech M211	madison.martin1@northwestern.edu
Marzec, Rick	Senior User Support Specialist	Tech AG24	r-marzec@northwestern.edu
Sparks, Hillary	Business Administrator	Tech M212	h-sparks@northwestern.edu
Thompson, Kyle	Financial Assistant	Tech M211	kyle.thompson@northwestern.edu
Wells, Jeremy	Administrative Assistant	Tech M211	jeremywells@northwestern.edu
Yassi, Calvin	Research Administrator	1007 Church St	calvin.yassi@northwestern.edu

The above rooms are located in the Technological Institute unless otherwise indicated.

2. Graduate Program Administrative Faculty:

Chen, Wei	Department Chair	weichen@northwestern.edu
Wagner, Greg	Director of Graduate Studies	gregory.wagner@northwestern.edu
Kulkarni, Manohar	MS Program Director	manohar.kulkarni@northwestern.edu
Lindvall, Bruce	Assistant Dean for Graduate Studies	b-lindvall@northwestern.edu

- 3. Photocopier/Scanner:** In Room Tech L291 there is a photocopier/scanner machine that you may use.
- 4. Paychecks:** For those students on payroll (fellowships, teaching assistantships or research assistantships), paychecks will be directly deposited to your bank account on the last working day of the month.
- 5. Eligibility to Work in the U.S:** If you are on the payroll (including fellowships, teaching assistantships or research assistantships), and you have not been on any Northwestern payroll during the last six months, you are required by law to complete an I-9 form - Employment Eligibility Verification Form. You will not receive your September paycheck unless this form is completed.. After completing Section I here <https://northwestern.i9servicecenter.com/Login.aspx> , take your documentation to the Payroll Office, 720 University Place, 2nd Floor (Office hours 8:30am-5:00pm, Monday-Friday), to complete Section 2.

E-Verify FAQs Electronic I9 Access and Section 1 Questions and Electronic I9 Section 2 Processors
<http://www.northwestern.edu/hr/payroll/e-verify/index.html>

How does E-Verify work regarding the 3 days of hiring an employee?
<http://www.northwestern.edu/hr/payroll/payment/index.html>

- 6. Mailboxes:** Graduate student and faculty mailboxes are located in Tech L291. *The departmental mailboxes should not be used for receiving personal mail.* The proper mailing address to receive mail is:
 Your Name
 Department of Mechanical Engineering
 2145 Sheridan Road
 Northwestern University
 Evanston, IL 60208-3111

7. **Phones:** Telephones are available in most graduate laboratories or offices. The phones are equipped to handle only campus and local calls. Campus calls, including the medical school, require only the last 5 digits of the phone number. Calls in the 847 (Chicago north shore) require dialing 9-XXX-XXXX. Local calls in the Chicago area require 9-LACXXX-XXXX, where LAC is the local area code (312 or 773-Chicago, 708 or 630-suburbs).
8. **Emergency:** For emergencies such as fire or injury dial **456** from any campus phone to directly connect to campus police. For life-threatening events, call **911** from a campus phone or your mobile phone.
9. **Email:** Graduate students may obtain an email account that is accessible from any networked computer. Email accounts may be obtained at the Computing Center, 1800 Sherman Avenue. A valid NU identification card is needed to obtain an email account.
10. **Purchasing:** To purchase non IBuyNU items, fill out the form located on the Resources webpage of the department website.

You can also request the form from the ME Department Financial Assistant, Sujin Kim, sujin.kim@northwestern.edu. Fill in all information, with chart-string provided by your advisor and signed by him or her, and submit to Sujin. When the requested items arrive, you will receive an email to pick up the package from the ME Department Mail Room, Tech M212. When items arrive, the packing slip should be provided to Sujin to notify her that the items were received and payment should be made.
11. **Travel Reimbursement:** Before planning your business travel, review the university's travel reimbursement policy at <http://www.northwestern.edu/uservices/> and see Sujin Kim, the department Financial Assistant, to review the key points of the policy. Be sure to keep all your itemized and credit card receipts to prevent your reimbursement from being delayed. Travel reimbursement forms should be filled out online and approved by your advisor within 30 days of return; see the department Financial Assistant for details.

MECHANICAL ENGINEERING DEPARTMENT FACILITIES

The facilities of the mechanical engineering laboratories provide many opportunities for graduate students to conduct their research. A list of facilities is available at:

<https://www.mccormick.northwestern.edu/mechanical/research/facilities.html>

MECHANICAL ENGINEERING DEPARTMENT FACULTY

A list of Mechanical Engineering department faculty, along with contact info and links to individual web pages, is available online:

<https://www.mccormick.northwestern.edu/mechanical/people/faculty/>

Any faculty member listed as a Core Faculty member, including those with courtesy appointments, may serve as the primary advisor for ME PhD students.

MECHANICAL ENGINEERING GRADUATE STUDENT SOCIETY (MEGSS)

The Mechanical Engineering Graduate Student Society (MEGSS) provides a student voice on departmental issues like faculty selection and curriculum matters. In this way, the concerns of the graduate students help shape the way the ME graduate program is run. To facilitate this, members of MEGSS attend select faculty meetings and sit on the Graduate Studies Committee and the Faculty Search Committees. More information about MEGSS can be found online:

<https://www.mccormick.northwestern.edu/mechanical/academics/graduate/megss.html>

MEGSS maintains an "ME Department Survival Guide" with useful information for new and current students:

https://docs.google.com/document/d/1ofmkzuXq8c8H2S7jPhU0iig_QytZBGRFEGAHvtEPfIs/edit