Northwestern | McCORMICK SCHOOL OF ENGINEERING

Electrical Engineering Graduate Study Manual

2025-2026

Department of Electrical & Computer Engineering
McCormick School of Engineering, Northwestern University
Technological Institute
2145 Sheridan Road, Room L359
Evanston, IL 60208

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Welcome

Dear Students,

As Director of Graduate Studies for the Electrical Engineering (EE) graduate program at Northwestern University, I am delighted to welcome you to our department and community.

Electrical Engineering at Northwestern, housed within the Department of Electrical and Computer Engineering (ECE) in the McCormick School of Engineering, offers MS and Ph.D. programs that prepare students for advanced research, innovation, and leadership in a wide range of areas.

The EE program explores foundational and cutting-edge topics across systems, devices, and intelligence. Whether your interests lie in signal processing, photonics, quantum computing, or artificial intelligence, you'll find a rich academic environment and the freedom to chart your own intellectual path.

Our faculty are internationally recognized leaders advancing the frontiers of knowledge across engineering and computing. Their collaborations span Northwestern's engineering and science departments, the Feinberg School of Medicine, national laboratories like Argonne and Sandia, and leading companies across the globe.

As a graduate student, you'll benefit from a rigorous academic environment, personalized mentorship, and opportunities to engage in world-class research that shapes the technologies of tomorrow.

We look forward to working with you and supporting your journey in the Electrical Engineering program. Welcome to Northwestern!

Sincerely,

Professor Randy Freeman
Director of Graduate Studies, Electrical Engineering
Department of Electrical & Computer Engineering
Email: freeman@northwestern.edu

Overview

This manual provides detailed information about the educational opportunities in the electrical engineering program. It includes descriptions of our curricula, milestones, processes, and information about our faculty, facilities, services, and student activities. The handbook is in full compliance with the guidelines provided by The Graduate School (TGS) and often refers to sources available at their website.

Graduate Studies in Electrical Engineering

Northwestern University's Electrical Engineering (EE) program, housed within the Department of Electrical and Computer Engineering (ECE), offers programs leading to the MS and Ph.D. degrees. Electrical Engineering at Northwestern encompasses a diverse set of research areas that reflect both foundational depth and technological innovation. These include, but are not limited to, signals and systems, communications, control, photonics, solid-state electronics, quantum technologies, and advanced device and circuit design. Our faculty are actively engaged in research across signal acquisition and interpretation, information transmission, dynamic system control, and the development of novel solid-state, photonic, and quantum systems.

The broad interdisciplinary interests of our faculty foster strong collaborative research across Northwestern's engineering and science departments, the Feinberg School of Medicine, and external partners including national laboratories such as Argonne, Fermi, Sandia, and Oak Ridge, as well as industry. This collaborative and cross-disciplinary environment enhances the academic and research experience of our graduate students, empowering them to engage in impactful work that extends far beyond the classroom.

Core Electrical Engineering Faculty

The Core Electrical Engineering Faculty is comprised of Profs. Koray Aydin, Randall Berry, Arthur Butz, Oliver Cossairt, Randy Freeman, Matthew Grayson, Dongning Guo, Seng-Tiong Ho, Michael Honig, Mahdi Hosseini, Igor Kadota, Aggelos Katsaggelos, Pedram Khalili, Prem Kumar, Chung-Chieh Lee, Ilya Mikhelson, Hooman Mohseni, Thrasyvoulos (Thrasos) Pappas, Martin Plonus, Manijeh Razeghi, Alan Sahakian, Selim Shahriar, Ermin Wei, Ying Wu, and Horace Yuen.

The complete faculty list and profiles can be found on the ECE website at:
https://www.mccormick.northwestern.edu/electrical-computer/people/faculty.html

Affiliated Electrical Engineering Faculty

In addition to the Core Electrical Engineering faculty, the EE program maintains strong connections and interactions with other affiliated faculty that are world-renowned experts in their respective fields. The Affiliated Electrical Engineering Faculty can be found on the

ECE website at: https://www.mccormick.northwestern.edu/electrical-computer/people/affiliated.html

Electrical Engineering MS/Ph.D. Program Mission Statement

The MS and Ph.D. programs in Electrical Engineering provide education, technical expertise, skills, mentoring and opportunities to develop graduate students into independent and productive scholars, practitioners, and thought leaders in their chosen area of specialization. The program offers a firm technical background to prepare graduate students for lifetime careers in academia and industry, guides them in the pursuit of original research and emerging fields, fosters intellectual curiosity, and prepares students for life-long learning to adapt in response to the needs of a rapidly changing world. The program also aims to develop the students' ethos as researchers and scholars, and promotes the effective oral and written communication of scientific concepts.

Learning Objectives and Assessment Strategies

To provide clarity and transparency around program curricular goals and criteria, per TGS' Assessment Initiative guidelines, the table below enumerates the EE graduate programs' learning objectives, aligns them to program-specific milestones/requirements, and outlines assessment criteria and strategies.

Learning objective(s) *Students should be able to…*	Milestone/ Requirement/ Capacity	Assessment Strategies and Criteria* *How do we know this objective has been achieved? What criteria do we have to measure success?*
Demonstrate technical expertise and skills in Electrical Engineering.	Courses / Literacies (mathematical, scientific, engineering, programming, design, digital)	Assessment Strategy: Advisor, faculty committee, and class instructors evaluate course performance. Discussed at EE-wide annual student performance evaluation. Criteria: Satisfies Core EE coursework; Satisfies Track EE coursework; Meets coursework milestones within specified time limits; Meets minimum GPA requirements.
Contribute original research to scholarly community.	MS Thesis; PhD Prospectus; Dissertation; Publication of research papers / Research	Assessment Strategy: Advisor and faculty committee assess research papers, MS Thesis or PhD Prospectus and Dissertation, demonstrating levels of achievement. Advisor and faculty committee (together with peers from the scientific community through program committee service) assess research papers. Discussed at EE-wide annual student performance evaluation. Criteria: Offers original work; Presents novel ideas; Advances the field; Defines and uses appropriate methodology; Adheres

		to scientific method; Delineates sources.
Design and execute accurate experiments; Quantitatively evaluate research artifacts and	Methodology and experimental sections in MS	Assessment Strategy: Advisor and faculty committee assess successful design, analysis and evaluation of research experiments and artifacts in
experimental results.	Thesis, MS Project Report, PhD Prospectus, Dissertation, and published research papers / Research	MS Thesis or Project, or PhD Prospectus and Dissertation, and (together with peers from the scientific community through program committee service) in research papers. Discussed at EE-wide annual student performance evaluation. Criteria: Defines and uses appropriate methodology; Utilizes appropriate measurement tools; Configures and uses appropriate experimental environment; Sound & complete evaluation and analysis of artifacts and experimental results.
Enact ethical research methodologies and practices.	Responsible Conduct of Research Training (RCR) / Research	Assessment Strategy: Successful completion of RCR training. Discussed at EE-wide annual student performance evaluation. Criteria: Fosters ethical problem-solving skills; Increases the ability to recognize ethical issues in design and conduct of research; Identify and understand ethics regulations, policies, and resources.
Articulate scientific research, scientific results and their impact to the field and to society in writing.	MS Thesis; MS Project Report; PhD Prospectus; Dissertation; Publication of research papers / Communication (scientific writing)	Assessment Strategy: Advisor and faculty committee (together with peers from the scientific community through program committee service) assess writing skills prioritizing specific criteria that demonstrate levels of achievement. Discussed at EE-wide annual student performance evaluation. Criteria: Document organization; Construction of argument flow; Clarity of explanation; Clarity of visual aids; Conciseness; Completeness; Successful publication of research paper.

Articulate scientific research, scientific results and their impact to the field and to society in oral presentation and speaking.	MS Thesis oral defense; PhD Prospectus oral exam; PhD Thesis oral defense; Presentations in seminars and conferences / Communication (presentation, public speaking)	Assessment Strategy: Advisor, faculty committee, and peers assess speaking and oral presentation skills, using specific criteria that demonstrate levels of achievement. Discussed at EE-wide annual student performance evaluation. Criteria: Presentation organization; Construction of argument flow; Clarity of oral arguments and explanations; Clarity of visual aids; Information pruning; Audience engagement; Ability to answer questions; Ability to provide rationale for research or aspects of the research; Ability to articulate broader impact.
Develop effective teaching strategies and methods; Develop course materials; Evaluate student learning; Lead recitation sessions.	Teaching Assistantship (TA) / Teaching	Assessment Strategy: Teaching assistant collaborates with professor and fellow TAs during course development and teaching. Instructor, peer TAs and students (through CTECs) evaluate TA's performance. Discussed at EE-wide annual student performance evaluation. Criteria: Quality and usefulness of developed course materials; Ability to clearly explain concepts; Ability to incorporate examples to foster learning; Student engagement during recitations and office hours; Ability to answer student questions clearly (online, in class, office hours); Ability to evaluate written and lab work fairly; CTEC evaluations
Effectively manage infrastructure building and development tasks; Effectively manage research project and publication timelines; Effectively manage lab sub-groups and collaborate with peers.	Organization and Management/ Leadership and Collaboration	Assessment Strategy: Research projects typically require substantial infrastructure building and development, and effective management of complex timelines to achieve publication. Research projects often require multi-person teams, typically led by a graduate student. Student leads may also participate in other sub-groups as collaborators. The quality and completeness of the infrastructure, the efficacy in managing research and publication timelines, task prioritization, and leadership and collaboration ability are assessed informally by the advisor and faculty committee. Discussed at EE-wide annual student performance evaluation. Criteria: Infrastructure quality; Infrastructure completeness; Efficacy or task prioritization; Demonstrated effectiveness of time management; Effectively coordinates development and experimental efforts; Team meets internal deadlines.

Create and communicate professional development plan.	Annual Meeting/ Career Development	Student develops and shares career plan annually with advisor, Director of Graduate Studies in EE and faculty committee at annual evaluation meeting; Student seeks appropriate resources in response to professional development plan, such as identifying career paths of program alumni.

Personnel

Graduate students are expected to discuss all academic issues with their advisors first, in an open and constructive manner. Help with administrative aspects is provided by the ECE Graduate Affairs Coordinator (Tech Institute Room L359, ecegrad@northwestern.edu) The Graduate Affairs Coordinator can advise students on the best course of action, and promptly take the measures needed toward the successful completion of the student's graduate degree.

In addition, graduate students in the Electrical Engineering program may discuss questions regarding academic matters, degree requirements or disputes with advisors or committee members. Ph.D. students can speak with the Director of Graduate Studies (DGS) in Electrical Engineering, Prof. Randy Freeman (freeman@northwestern.edu). MS students can speak with the Director of the MS Program, Prof. David Zaretsky (david.zaretsky@northwestern.edu).

Finally, sometimes (albeit, infrequently) complex situations arise in academic life that may require the consultation and direct involvement of The Graduate School (TGS; https://www.tgs.northwestern.edu/). Additional information on TGS appears in the next section of the handbook.

Program Resources

The program, the ECE department, the McCormick School of Engineering and Applied Science, and the University offer a wealth of resources to assist graduate students in their academic life.

Graduate Student Tracking System (GSTS)

The Graduate Student Tracking System (GSTS; https://gsts.northwestern.edu/) is the online portal used to record and manage the student's progress through the graduate program. GSTS lists the major program milestones and their respective deadlines (students should always consult this handbook for additional milestones and deadlines), completed coursework and unofficial transcripts, course plans, advisor, committee members, annual evaluation reviews, etc. GSTS can also be used by the student to formally invite faculty members to serve in the student's committee, provide concise descriptions of the student's research, complete the annual self-evaluation, submit

milestone forms, request admission to Ph.D. candidacy, degree completion, etc. It is strongly recommended that GSTS is used in all cases that it is applicable, e.g., for all formal communications with the student's advisor, committee members, program administration, and program-related form submissions and petitions.

Course Planning Resources

Graduate students should regularly check the ECE and CS courses webpages when planning the courses to be taken in the subsequent quarters, discuss their course plan with their academic advisor, and populate the data in GSTS. The schedule and descriptions for ECE courses can be found online at https://www.mccormick.northwestern.edu/electrical-computer/courses/, and the schedule and descriptions for CS courses at https://www.mccormick.northwestern.edu/computer-science/courses/. Course names with prefixes COMP_ENG, COMP_SCI and ELEC_ENG denote CE, CS and EE courses, respectively.

Students can register for courses using CAESAR (https://www.caesar.northwestern.edu/). Courses approved for credit by The Graduate School are courses with a Career Course of "The Graduate School", as designated in CAESAR.

The Graduate School (TGS)

Every graduate student is assigned a counselor at TGS. The counselor monitors overall academic progress from the standpoint of TGS-based milestones, along with a satisfactory GPA, etc. Please be advised that most of the forms that concern completion of milestones are subject to a final approval by TGS in addition to being approved by the student's academic advisor and the EE program. TGS is located at 633 Clark Street in Evanston, and its webpage (https://www.tgs.northwestern.edu/) contains a wealth of information pertaining to various aspects of students' life.

Northwestern University Graduate Faculty

The faculty of The Graduate School is drawn from the faculties of colleges or schools of the University which have placed the administration of part (or all of the graduate work) under the control of The Graduate School. Information on membership to the Northwestern University Graduate Faculty can be found at https://www.tgs.northwestern.edu/about/for-faculty/.

Other Resources

Other useful information (e.g., forms, job postings, announcements of visits by companies/recruiters, seminars, etc.) is posted at https://www.mccormick.northwestern.edu/electrical-computer/resources/.

Services

In addition to the world-class educational opportunities to work with top faculty while accessing a wealth of facilities, research labs, and libraries for intellectual growth, Northwestern University offers a variety of services which can assist different aspects of student life.

Wildcard

The Wildcard is your photo identification card and can be used in almost every place that needs an identity verification on campus (library, recreational facilities, Norris University Center, campus, intercampus bus transit, etc.). It is issued by the Wildcard office in Norris University Center, underground level, Evanston campus, and at the University Services (support services) office in Abbott Hall, Room 100, Chicago campus. Lost or stolen ID cards are replaced for a $15 fee. Broken or damaged cards will be replaced at no charge (providing the damaged card is returned). For more information, visit https://www.northwestern.edu/wildcard/.

Transportation

There are three basic types of services available:

- Shuttle: there are several shuttle buses that operate in each of the Chicago and Evanston campuses (and between the two) upon presentation of a valid Wildcard. Detailed information is available at https://www.northwestern.edu/uservices/transportation/shuttles/.
- Route 201: the Route 201 CTA bus (https://www.transitchicago.com/bus/201/) offers free service to Ryan field and to the Old Orchard mall in Skokie upon presentation of a valid Wildcard.
- U-Pass: this is a collaboration between Northwestern and Chicago Transit Authority (CTA) based on Ventra (https://www.tgs.northwestern.edu/services-support/transportation/upass-faq.html) a contactless payment fare card and system that serves as a U-Pass. The card is issued at the beginning of every academic year, and can be used 365 days a year on all CTA buses and trains.

Health Services

Northwestern University provides a basic outpatient care and other primary-care services, and there are facilities in both Evanston and Chicago campuses. The Evanston location is at 633 Emerson Street (Searle Building). Per TGS regulations, every graduate student is legally required to have health insurance coverage. While it is provided for Ph.D. students and a partial coverage is available for MS students, one may opt out of this coverage, as

long as there is a proof of sufficient alternate coverage for the entire duration of graduate studies. In case of life-threatening or severe emergencies call 911 to summon paramedics, or go to the nearest hospital emergency room. If in need of urgent after-hours medical care, call 847-491-8100. More information can be found at the Health Services website at https://www.northwestern.edu/healthservice-evanston/.

Counseling and Psychological Services (CAPS)

CAPS provides a set of core mental health services on campus, including clinical services, educational workshops, and consultation with faculty and staff as needed. Services are free for all students and available on both the Evanston (633 Emerson St) and Chicago campuses (710 N. Lake Shore Drive, Abbott Hall, 5th Floor, Suite 500; 847-491-2151 https://www.northwestern.edu/counseling/).

Personal Safety

Students should always be aware of their surroundings and avoid areas that have indication of being a potentially non-safe environment (e.g., poorly lit walkways and alleys at night). The University Police is on duty 24/7 and they are located at 1200 Davis St. in Evanston. In the case of emergency, always dial 911. Note that there are blue-light poles distributed across the University, which can also be used to contact the University police. The non-emergency contact number is 847-491-3456.

Office of International Student and Scholar Services (OISS)

The OISS is available to all the international students and its primary two roles are: (a) to provide guidance and advise for maintaining proper immigration status consistent with the laws of the United States; (b) to ensure compliance with those laws and help the students with various forms, such as OPT (Optional Practical Training) and CPT (Curriculum Practical Training). The OISS is located at 630 Dartmouth Place. More information is available at https://www.northwestern.edu/international/. OISS staff can be contacted via phone at 847-491-5613 or via email to intoff@northwestern.edu. Your OISS advisor is assigned by your last/family/surname, please visit the staff page to find yours: https://www.northwestern.edu/international/about/our-staff/index.html.

AccessibleNU

Northwestern University and the Electrical Engineering program are committed to providing an accessible, supportive and challenging environment for all undergraduate, graduate, professional school, and professional studies students with disabilities who attend the University. AccessibleNU works with our faculty to provide students with disabilities a learning and community environment that affords them full participation, equal access, and reasonable accommodation.

Any student requesting accommodations related to a disability or other condition is required to register with AccessibleNU (accessiblenu@northwestern.edu; 847-467-5530) and provide professors with an accommodation notification from AccessibleNU, preferably within the first two weeks of class. More information on AccessibleNU can be found at https://www.northwestern.edu/accessiblenu/.

Postal Services

Mailboxes maintained by the staff are provided for all graduate students for university-related postal- mail and packages only (not for personal use) and are located in the ECE Main Office. Each student is expected to show their WildCard upon pickup, and may only pick up their own mail, not that of another student. It should be made a matter of a habit to check for such mail at least once a month. Our mailing address is:

Department of Electrical and Computer Engineering
McCormick School of Engineering
2145 Sheridan Road, Rm L359
Evanston, IL 60208, USA

The Graduate School (TGS) Resources

The Graduate School (TGS) offers a wide range of resources to support graduate students' academic, professional, and personal success. These include professional development programs, health and wellness services, academic support, legal assistance, international student services, and family resources such as parental leave and childcare grants. TGS also provides guidance on housing, transportation, and opportunities to engage in the vibrant campus and community life in Evanston and Chicago. Visit www.tgs.northwestern.edu for details on these and other resources.

ECE Departmental Resources

Graduate students are expected to discuss all academic issues with their advisers first, in an open and constructive manner. Further help with academic issues is provided by the ECE Graduate Student Affairs Coordinator (Tech, Rm L359; ecegrad@northwestern.edu). The staff in the Graduate Office is experienced and can advise you on the course of action and promptly take the measures needed towards successful completion of your degree. Mailboxes maintained by the staff are provided for all graduate students for university-related postal mail and packages only (not for personal use) and are located in the ECE Main Office (L359). Each student is expected to show their Wildcard upon pickup, and may only pick up their own mail, not that of another student. It should be made a matter of a habit to check for such mail at least once a month.

The information about our courses is available at: https://www.mccormick.northwestern.edu/electrical-computer/courses/

Graduate students should make it a habit of checking the above webpage when planning the courses to be taken in the subsequent quarters, and then proceed with a discussion with the respective academic advisers, and populating the data in the Graduate Student Tracking System (GSTS).

Other useful information (e.g., forms, job posting, announcements of visits by companies/recruiters, etc.) can be found at: https://www.mccormick.northwestern.edu/electrical-computer/

ECE organizes various social events throughout the Academic Year for which announcements via email are made regularly.

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 The Office of Civil Rights and Title IX Compliance, 1800 Sherman Avenue, Suite 4-500, Evanston, Illinois 60208, 847-467-6165, TitleIXCoordinator@northwestern.edu.

Questions specific to sex discrimination (including sexual misconduct and sexual harassment) should be directed to Northwestern's Title IX Coordinator in the 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 calling 800-421-3481 or visiting https://www2.ed.gov/about/offices/list/ocr/complaintintro.html. 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.

General Admission Requirements

The primary objective of the admission process in the ECE Department is to determine an applicant's qualifications and judge the applicant's prospects for success in their desired program of study. To maintain a proper balance between department resources and the size of the graduate student population, we must limit offers of admission to the most qualified applicants. Thus, our admission process is highly selective and competitive in nature.

The deadline for **Ph.D.** applications is **December 15** of the respective year for the applicants who wish to be admitted to the program starting in the Fall Quarter of the subsequent academic year. The deadline for **MS** applications is typically the **last week of February** of the year during which an applicant plans to start in the Fall Quarter.[1]

Requests for admission and financial aid for doctoral students are reviewed in the weeks following the application deadline. It is the policy of the department that students begin their programs in Fall Quarter. Under special circumstances, students are allowed to begin in the Winter or Spring Quarter. A typical applicant is expected to have a B.S. in electrical engineering, computer engineering, or a related discipline from a recognized institution. Highly qualified candidates with other academic backgrounds may also be considered. The specific undergraduate preparation required for graduate study depends on the program and the area of specialization. An applicant with insufficient undergraduate preparation in any particular area but well qualified in every other respect may be required to take certain undergraduate courses as soon as possible after enrolling at Northwestern. A student would be informed of such a requirement at the time of admission, along with grade expectations.

The Graduate School (TGS) website https://www.tgs.northwestern.edu/admission/index.html provides a means to navigate through the application process for graduate study at Northwestern University.

[1] NOTE: MS applicants are only admitted for a Fall Quarter start date. This is to avoid any problems with the course sequence.

Financial Aid

Ph.D. Students

The policy of the McCormick School is to admit only those students for whom financial support can be provided in the form of Northwestern Fellowships (e.g., Cabell, Murphy), research assistantships, and teaching assistantships. Students who have financial support from outside institutions or government grants will also be considered for admission. However, if such internal (McCormick, CS or ECE Department) or external (company, institutional, governmental) financial support is not provided, then the EE program will not recommend admission of the student to The Graduate School.

All students receiving financial aid in the form of fellowships, research assistantships, or teaching assistantships must register as full-time students. The normal full-time program of graduate study is 3- 4 units per academic quarter. The maximum permitted is 4 units.

MS Students

The ECE Department encourages MS students, especially from industry, to apply. However, the Department does not provide financial support to MS students. Such students can be supported by a company, government, or an external fellowship, or be self-supported. **MS students are not eligible for teaching assistantships or research assistantships**.

Student Responsibilities and Academic Misconduct

It is the responsibility of each graduate student to ensure that all the requirements of The Graduate School (TGS) and the ECE Department are met, given the program he or she selects; that necessary examinations are properly scheduled; and that deadlines dependent on current Northwestern University calendars are observed. The current procedures and degree requirements of the ECE Graduate Programs are detailed in this Manual.

Students should always consult with the ECE Graduate Student Affairs Coordinator (Tech, L359, ecegrad@northwestern.edu) first to execute procedures, confirm requirements, and obtain paperwork for exams and various other procedures. In addition, students are strongly urged to consult regularly with their faculty advisers.

Official notices about degree program progress, financial aid and other important notices are sent to each student's official email and mailboxes.

Students are responsible for checking their official Northwestern email account (@u.northwestern.edu) on a regular basis, no less than once a week.

Students are responsible for checking their official department mailbox on a regular basis, no less than once per month.

All students at Northwestern University are responsible for knowing the University's policies on academic integrity. The principles and possible consequences of academic misconduct are documented at: https://www.northwestern.edu/provost/policies/academic-integrity/principles.html

Students found guilty of academic misconduct, such as cheating on coursework or plagiarizing research, by definition are failing to make satisfactory academic progress, and are hence subject to be placed on academic probation.

https://www.tgs.northwestern.edu/academic-policies-procedures/policies/satisfactory-academic-progress.html

Students must be particularly vigilant in programming courses. Unless the instructor for the course has explicitly documented otherwise in the course syllabus:

- Code you submit must be your own.
- Copying and adapting someone else's code is not allowed.
- Studying someone else's solution for a specific assigned problem is not allowed.
- This includes code from a friend, an online article, or online code repository.
- Letting another student study your solution is not allowed.

If an instructor concludes that cheating has occurred, he or she will submit the evidence to your dean for adjudication. Penalties for cheating will depend on the specifics of the case. They can range from loss of points on the assignment in question, a reduction in letter grade for the course, or even failure in extreme circumstances.

Part-time Graduate Studies

U.S. citizens and permanent residents may pursue their graduate studies in EE on a part-time basis, subject to approval by the EE program. Part-time graduate studies are not available to international applicants because the U.S. government does not give student visas for part-time enrollment. Please discuss the details of the part-time graduate program with the EE academic advisors, the Director of Graduate Studies in EE, and the Graduate Affairs Coordinator of your home department.

Graduate Internships & Post-Graduation Employment

With the permission of their advisor, a graduate student wishing to combine research work with industrial experience may elect to participate in the Crown Family Graduate Internship Program. This experience permits the student to gain a broader understanding of some problems that eventually could serve as the background for a thesis or project. For more information on the Crown Family Graduate Internship Program, see Internships During Graduate Study.

International students who seek employment in the US upon graduating, who are on an F-1 visa, are in good academic standing, and have a valid I-20 should be aware that the visa status required for legal employment in the US after graduation is called OPT, and it **MUST BE APPLIED FOR 3-4 MONTHS BEFORE GRADUATION**. Without submitting this application in advance, you will not be able to transition smoothly from the F-1 student status to the OPT visa status, and any such interruption may delay or prohibit your employment with a US employer. The Office of International Student and Scholar Services (OISS) assists students with collection and submission of the required documents. In addition to consulting with your adviser, you should also schedule a meeting at least one month in advance of the OPT submission deadline to ensure you have enough time to collect the needed documentation.

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.

MS Program

This section discusses the details of the academic aspects of obtaining an MS degree with the ECE department. Unless otherwise specified, all the items pertain to both EE and CE majors.

Advising and Course Requirements

Advising

Each MS student is assigned an academic advisor upon admission, Director of MS Studies, Prof. David Zaretsky. However, the student's preferences and interests may change, especially if they elect to follow the project or thesis degree plan, which typically entails the completion of one or more 590 research units. This may require the student's transition to a new research advisor, who will likely also advise on courses to take. Such a transition involves the following steps:

1. The student first obtains the formal agreement of a Core or Affiliated Electrical Engineering faculty to serve as the student's MS Thesis or Project advisor;
2. The student notifies the current assigned advisor and the ECE Graduate Affairs Coordinator;
3. The ECE Graduate Affairs Coordinator records the advisor change in the Graduate Student Tracking System (GSTS).

Each MS student should consult with their advisor before registering online for courses on CAESAR. Failure to do so could result in poor course selection that would delay completion of the student's MS degree, or even result in academic probation due to poor grades. All courses should be listed and updated quarterly in GSTS..

Course Requirements

To obtain an MS Degree in EE, the student must successfully complete a total of **12 course units**, with the following requirements met (common for all MS options). The choice of courses must represent a coherent program of study that prepares the student for advanced work in a specific field. The ECE Specializations provide recommended courses to take that focus on specific industry fields, but students may choose to customize their study plan with guidance from their graduate advisor.

General Requirements
• The student must complete a total of 12 course units made up of 6 Core and 6 Electives. • Only 300-level or higher courses are counted towards the degree (excluding 399 and undergraduate courses). • At least 9 courses must be eligible for TGS credit. • At least 3 units at the 400-level or above (excluding 499 Independent Projects and 590 Research) • Except for 590 Research, all courses must be taken for a quality letter grade (i.e., ABC, not P/N). • Any course taken for P/N credit is not included in calculating the grade-point average (GPA). • All coursework must be completed with a composite grade-point average of B (GPA 3.0) or higher. • Courses may not be repeated for credit, except 499, 590, and Special Topics courses with different sections (e.g. ECE 395/495, CS 396/496, CS 397/497, etc.) • Courses completed for undergraduate credit cannot be repeated or counted for graduate credit. • The course study plan must be approved by the student's advisor prior to registration.
Core Courses (6 units)
• 6 Units of ECE courses (ELEC_ENG or COMP_ENG). • At least 3 units of EE courses must be completed. • 499 Projects and 590 Research are not included.
Elective Courses (6 units)
• 6 Units of elective courses. • At least 3 units of ECE or CS courses must be completed (ELEC_ENG, COMP_ENG or COMP_SCI). • At most 3 units of courses outside of ECE and CS, with approval by the Director of Master's Program. • At most 3 units of 499 Projects. • At most 2 units of 590 Research for an MS Project Plan, or 3 units of 590 Research for an MS Thesis Plan.

ECE Specializations

The master's program offers great flexibility in shaping your education based on your academic and career objectives. You can choose to focus your studies on a particular specialization from twelve (12) tracks listed below, or you can create a custom program to gain exposure in any number of areas of interest.

- Artificial Intelligence & Machine Learning
- Computer Vision & Image Processing
- Cybersecurity
- Embedded Systems
- High-Performance Computing
- Internet of Things & Edge Computing
- Network & Communication Systems
- Photonics & Optoelectronics

- Quantum Computing, Sensing & Communications
- Robotics & Autonomous Systems
- Semiconductors
- Sustainable Energy & Low-Power Design

Each specialization provides a list of recommended core and elective courses from which to build your education and career path. However, it is important to note that you do not need to follow these recommended courses specifically, so long as you complete the program requirements as outlined above.

Graduate Minor Programs

Students enrolled in the full-time master's programs have the option of earning a certificate in a minor to complement their Master's in Electrical Engineering and enhance their credentials and marketability. Generally, each minor program requires 3 units, which are applied towards your 6 elective requirements for the master's program. Since these units are outside of the ECE Department, they require approval of the Director of the Master's Program. You can learn more about the Minor programs on the McCormick Graduate Study website.

- **Minor in Engineering Management:** One particularly popular combination is a major in any engineering field with a three-course minor in engineering management, or EM Minor, offered through the Master of Engineering Management (MEM) Program within the Department of Industrial Engineering and Management Sciences.
- **Minor in Entrepreneurship:** The Farley Center for Entrepreneurship and Innovation offers the graduate minor in entrepreneurship, designed to provide the requisite skill sets to students who plan to create or participate in a start-up endeavor during their careers. It can also provide knowledge to assist researchers when traditional funding sources no longer exist, and commercialization is the next logical step. Applications are accepted annually for students planning to commence coursework in the fall quarter.
- **Minor in Cybersecurity:** The Master of Science in Information Technology program offers a three- unit cybersecurity minor to all students enrolled in professional Master's programs at McCormick. Applications are accepted each year starting September 1.
- **Minor in Scientific Computing:** The minor in scientific computing offers a substantive programming and algorithmic knowledge base to science students. It certifies that a student has the programming and algorithmic skills to develop codes to solve modern engineering problems.

Transfer of Credit

To transfer a course, a student must submit a petition to the Director of Master's Program in Electrical Engineering along with supporting evidence. The supporting evidence should include documentation of the course content (e.g., syllabus, slide decks, assignments, projects) and an official transcript that shows the grade received for the course. The student should identify which Northwestern University course they petition for a waiver. The coordinator of the corresponding course at Northwestern University will review the petition and make a recommendation. The transfer of credit is ultimately subject to the approval of the student's advisor (MS Thesis Research advisor, MS Project advisor, or academic advisor, for MS degree options A, B, C, respectively) and the Director of Master's Program in EE. The following requirements also apply:

- At most three (3) of the required 12 units may be waived, based on graduate-level courses taken previously elsewhere.
- Only coursework that has not been applied to a completed degree will be considered for transfer credit for an MS degree.
- For a course to be transferred, it must substantially match a course at Northwestern University that counts toward the 12-unit requirement.

The student must consult with their advisor before registering for courses. Failure to do so could result in poor course selection that would delay completion of the student's MS degree, or even result in academic probation due to poor grades or missed coursework completion deadlines.

ECE course credit waivers

An MS student may petition to have **at most three** course credits waived, based on the student's graduate level courses taken previously elsewhere. Only coursework that has **not** been applied to a completed degree will be considered for transfer credit for a MS degree. A petition for such a waiver must include complete documentation (e.g., syllabus, assignments, projects, etc.) of the content of a graduate level course from the student's previous institution that most closely matches the ECE Department course credit to be waived. The student must also provide an official transcript, sent directly to the department, that shows the grade received for each course used for transfer credit.

The coordinator of this ECE Department course will review the petition and make a recommendation. All such waivers are ultimately subject to the approval of the advisor, the ECE Research Group, and the ECE Director of Master's Program.

Enrollment Options to Maintain Resident Student Status

There are several non-classroom courses that may, at times, be used to maintain residency and student status. Below is a brief guide to these courses. Before enrolling in any non-classroom course, especially a special registration course listed below, be sure to consult with your academic advisor and the ECE graduate student services staff.

Special Registration Courses: These courses are used to maintain student status in cases where registering for research or classroom courses is not appropriate.

- **TGS 512 - Continuous Registration**: This course does not apply to the 12 units that must be completed for any ECE MS degree. It may, however, be a way to save money if a student has already completed the required letter-graded units and needs to maintain student status while completing a project or thesis. Tuition for TGS 512 is $100 and students do not need to pay the activity fee. Students may enroll in TGS 512 only if they have completed all their quality letter-graded (ABC) courses. The only credits that may be taken after TGS 512 are 590 Research. When enrolled in TGS 512, the student cannot enroll in additional classes.
- **TGS 588 - Resident Master's Study**: Available to master's degree students who are primarily doing research related to a master's thesis or project. It provides full-time status but allows no accumulation of credit or residency toward the master's degree. This registration requires The Graduate School's permission.

TGS Degree Requirements

All MS students must satisfy The Graduate School's requirements for obtaining the Master of Science degree, outlined at https://www.tgs.northwestern.edu/about/policies/masters-degree-requirements.html. This handbook presents **program-specific** requirements that are in addition to, or further elaborate upon, the requirements established by TGS, and **may go beyond TGS minimums**. A complete description of TGS' requirements, academic policies and procedures for graduate study at Northwestern University, can be found at https://catalogs.northwestern.edu/tgs/academic-policies-procedures/.

MS Degree Study Plans

Each student pursuing an MS degree in Electrical Engineering must declare their intention to follow one of the degree plans (A, B, or C) summarized below. Students declare their intention to follow one of the degree plans no later than **May 1st of the 3rd academic quarter** (typically the Spring Quarter of the first year of study). The student's declaration is subject to approval by their advisor. The student's declaration to pursue a Thesis or Project MS degree is contingent upon first securing an MS Thesis or Project advisor. Upon approval of the student's MS degree declaration, the student must satisfy the declared MS option's additional requirements.

Every MS option establishes certain time limits during which the MS student must complete all MS degree requirements. An MS student who does not meet the plan's completion deadline, and who does not successfully petition the EE Program for an extension of that deadline, will be placed on academic probation for a maximum of two academic quarters. At that point, the EE MS Program retains the option to dismiss the student in question.

Students who are interested in following a Thesis or Project MS degree are strongly encouraged to consult with a faculty research advisor and enroll in a 590 Research course beginning in the Winter or Spring quarter of their 1st year of study.

Plan A: MS Thesis

In this plan, a student declares their intent to earn the MS degree by completing a formal thesis that reports substantial original research results.

MS Thesis Research Advisor

To participate in this study plan, the student **must first obtain the formal agreement with a faculty researcher to serve as the student's MS Thesis Research Advisor**. Ideally, this agreement would be in writing (e.g., via email exchange between the student and the prospective faculty advisor). The primary MS Thesis Research Advisor should be a member of the Northwestern University Graduate Faculty and have an appointment in the ECE department. However, if the student is pursuing research outside of the ECE department, they should first seek permission from the director of the MS program, and they should have at least one ECE faculty member on their research committee, such as their academic advisor or the director of the MS program.

Declaring a Thesis MS Degree Plan

The process to declare a Thesis MS degree plan is as follows:

- The student obtains the formal agreement of a faculty member to serve as the student's MS Thesis advisor, as explained in the paragraph above.
- The student selects the "*Thesis-based MS*" specialization in GSTS.
- The student invites the prospective advisor faculty from (a) to serve as the "*Principal Research Advisor*" through GSTS. The faculty must formally accept the invitation through GSTS.

MS Thesis Committee

A successful thesis has two components: a written document and an oral defense of the research. These are judged by a committee, called the MS Thesis Committee. The student

must invite faculty to serve on their MS Thesis Committee, in consultation with their MS Thesis Research Advisor. The MS Thesis Committee must comprise at least two faculty members of the Northwestern University Graduate Faculty. At least one of the MS Thesis Committee members must be an ECE faculty member. The MS Thesis Research Advisor serves as the chair of the MS Thesis Committee.

The MS Thesis Committee must be formed no later than one week before the MS Thesis oral defense. It is strongly advised to form the MS Thesis Committee much earlier than that, to allow sufficient time for the committee members to schedule the oral defense at a mutually agreeable time, and to examine the MS Thesis written document. Late invitations to serve in an MS Thesis Committee may result in faculty declining to serve due to schedule constraints and time commitment to other responsibilities. Failure to secure an MS Thesis Committee may result in the student missing program milestones and completion deadlines and may result in the student being placed on academic probation.

Written and Oral Thesis Requirements

A **written thesis** must show evidence of original research and must be approved by the MS Thesis Committee. The format of the written thesis must conform to the dissertation formatting guidelines specified by TGS (https://www.tgs.northwestern.edu/academic-policies-procedures/dissertation-publication/dissertation-formatting-requirements/). There is no specific length for a thesis. Historically, they tend to be roughly 30 pages in the double-spaced graduate school thesis format. This is not a required length. The MS Thesis Committee may specify additional thesis format requirements or a minimum thesis length.

An **oral defense** of the thesis research is highly encouraged. The oral defense is attended (either physically, or via phone or video conferencing) and evaluated by the MS Thesis Committee. The oral defense talk should take between 30 minutes and 1 hour, followed by a Q&A session that may last up to one hour. It is recommended that the student and the MS Thesis Committee schedule at least two hours for an MS Thesis oral defense.

One week prior to the oral defense, the student must provide a complete draft of the thesis to the committee. Upon a successful oral defense, the MS Thesis Committee may request modifications to the written thesis document. The student must complete the necessary work to implement all requested modifications and submit the final written thesis document to the MS Thesis Committee for approval.

Common MS Requirements

The student must satisfactorily complete all Common MS Degree Requirements in the Course Requirements section.

Research Credits

Under the MS Thesis study plan, a maximum of 3 units of 590 Research can be counted toward the 6-unit elective requirement for the MS degree.

Time Limits

All requirements for the Thesis MS Degree, including coursework and approval of the thesis by the student's MS Thesis Committee, must be successfully completed before the end of the **7th academic** quarter (typically the Spring quarter of the 2nd year of study).

IMPORTANT: In the Spring term, The Graduate School requires that **all thesis defenses be completed ONE MONTH before the end of the quarter**, if the student is to graduate in the Spring term. Deadlines in other quarters are not as early. Consult the Office of the Registrar's academic calendar for thesis defense deadlines for each quarter.

Plan B: MS Project

In this plan, a student declares their intent to earn the MS degree by completing a project and writing a project report that contains results based on existing theory and techniques or experimental verifications.

MS Project Advisor

To participate in this study plan, the student **must first obtain the formal agreement with a faculty researcher to serve as the student's MS Project Advisor**. Ideally, this agreement would be in writing (e.g., via email exchange between the student and the prospective faculty advisor). The primary MS Project Advisor should be a member of the Northwestern University Graduate Faculty and either an ECE Faculty or affiliated with the ECE department. However, if the student is pursuing a project outside of the ECE department, they should first seek permission from the director of the MS program, and they should have at least one ECE faculty member on their advisory committee, such as their academic advisor or the director of the MS program.

Declaring a Project MS Degree Plan

The process to declare a Project MS degree plan is as follows:

- The student obtains the formal agreement of a faculty member to serve as the student's MS Project advisor, as explained in the paragraph above.
- The student selects the "*Project-based MS*" specialization in GSTS.
- The student invites the prospective advisor faculty from (a) to serve as the "*Principal Research Advisor*" through GSTS. The faculty must formally accept the invitation through GSTS.

MS Project Committee

The Project MS Degree option requires a written project report, which is judged by a committee called the MS Project Committee. The student must invite faculty to serve on their MS Project Committee, in consultation with their MS Project Advisor. The MS Project Committee must comprise of at least two faculty members that are a part of the Northwestern University Graduate Faculty. At least one of the MS Project Committee members must be an ECE faculty member. The MS Project Advisor serves as the chair of the MS Project Committee.

The MS Project Committee must be formed no later than one week before the MS Project examination date. It is strongly advised to form the MS Project Committee much earlier than that, to allow sufficient time for the committee members to schedule the oral presentation at a mutually agreeable time, and to examine the MS Project report. Late invitations to serve in an MS Project Committee may result in faculty declining to serve due to schedule constraints and time commitment to other responsibilities. Failure to secure an MS Project Committee may result in the student missing program milestones and completion deadlines, and may result in the student being placed on academic probation.

Project Requirements

A Project MS Degree requires a **written technical report**, which must be approved by the MS Project Committee. The format of the written project report is specified by the MS Project Committee. Unless the MS Project Committee or the MS Project Advisor specify otherwise, it is recommended that the project report conforms to the formatting guidelines of a doctoral thesis, as specified by TGS (https://www.tgs.northwestern.edu/academic-policies-procedures/dissertation-publication/dissertation-formatting-requirements/). There is no specific length for a project report. The length must be negotiated with the MS Project Committee.

The student must submit a complete draft of the written project report to the MS Project Committee at least one week prior to the formal examination date. The MS Project Committee may request modifications to the report. The student must complete the necessary work to implement all requested modifications and submit the final written project report to the MS Project Committee for approval.

Common MS Requirements

The student must satisfactorily complete all Common MS Degree Requirements in the Course Requirements section.

Research Credits

Under the MS Project study plan, a maximum of 2 units of 590 Research can be counted toward the 6-unit elective requirement for the MS degree.

Time Limits

All requirements for the Project MS Degree, including coursework and approval of the project report by the student's MS Project Committee, as well as any additional requirements established by the MS Project Advisor, must be successfully completed before the end of the **6th academic quarter** (typically the Winter quarter of the 2nd year of study).

Plan C: MS Courses Only

In this plan, the student must satisfactorily complete a set of courses that represent a coherent program of study and prepare the student for advanced work in a specific field. All students begin their Master's Degree as course-based, unless they otherwise elect another study plan.

Common MS Requirements

The student must satisfactorily complete all Common MS Degree Requirements in the Course Requirements section.

Research Credits

Under the Course-based MS Degree plan, 590 Research credits **do not count** toward the 12-unit requirement for the MS degree, as these credits are reserved for MS Project and Thesis degrees. If a student switches from the MS Project or Thesis plan to the Courses plan, any 590 units previously taken will not apply towards their degree requirements.

Time Limits

All requirements for the Course-based MS Degree must be satisfactorily completed before the end of the **5th academic quarter** (typically the Fall quarter of the 2nd year of study).

An MS student who does not meet the plan's completion deadline, and who does not successfully petition the ECE Department for an extension of that deadline, will be placed on academic probation for a maximum of two academic quarters. At that point, the Department retains the option to dismiss the student in question.

Changing the MS Study Plan

Declaring an MS Study Plan can be implemented at any point on GSTS. However, changing the MS Study plan after one has been selected requires that the student notify by email the Graduate Affairs Coordinator, in which the student and the faculty research advisor explain the requested MS Plan change. If approved, the time limit for completing the work will reflect the new study plan with no further extensions.

Degree Completion

To complete the MS degree, students must complete the following steps:

- Complete the allocation of courses in GSTS. The Director of MS Studies will validate the program and course requirements are fulfilled.
- Complete the Application for Degree (AFD) in GSTS
- Complete the Master's Degree Completion (MDC) form in GSTS
- Complete the Exit Interview, which will be sent by the Graduate Affairs Coordinator via email.
- Due dates for the aforementioned forms can be found on the university's Academic Calendar
- **For Coursework students:** in the section for Committee Members, students should enter the name of the Director of Master's Program, Prof. David Zaretsky, as the Chair. In either the Co-Chair or Member box, students should enter the name of the Director of Graduate Studies for Electrical Engineering, Prof. Randy Freeman.
- **For Project and Thesis students:** students should enter the names of their committee members, and then enter the name of the MS Director Prof. David Zaretsky. The student's file will be checked for any missing documents, grades, etc. The file will be given to the committee chair prior to the defense, and signed off upon receipt of the thesis and completion of the work.

BS/MS Option for Northwestern University Students

The combined BS/MS degree program allows you to work on a master's degree at the same time you are completing your bachelor's degree. Northwestern University undergraduate students that wish to pursue an MS in EE must have successfully completed any 3 from the list of ECE courses below, or their equivalent. All other requirements for an MS degree in EE apply.

- ELEC_ENG 221: Fundamentals of Circuits
- ELEC_ENG 222: Fundamentals of Signals and Systems
- ELEC_ENG 223: Fundamentals of Solid State Engineering
- ELEC_ENG 224: Fundamentals of Electromagnetics and Photonics
- ELEC_ENG 225: Fundamentals of Electronics
- ELEC_ENG 302: Probabilistic Systems

If you are uncertain that you have the requirements, please reach out to the Director of Master's Program to discuss your background.

More information on the BS/MS program in the ECE department can be found here: https://www.mccormick.northwestern.edu/electrical-computer/academics/undergraduate/combined-bs-ms.html

Transfer to a different MS program

Whether it is Computer Engineering or Electrical Engineering, students admitted to an MS program in ECE are expected to complete the program of study to which they applied and were admitted. During the applications process, our admissions committee carefully reviews all the materials submitted, and students are admitted with a belief that they would succeed in the program they were admitted to. Only in very rare cases are MS students allowed to transfer to a different program.

Our MS programs have limited capacity, and we only accept a small percentage of applicants. We cannot accept all those who wish to transfer to them from other programs at Northwestern. Only in very rare cases are transfers from an MS in another Northwestern department allowed.

All requests to transfer programs must be approved by both the Director of Master's Program for the student's current degree program and the Director of Master's Program for the desired program. The current advisor will also be consulted during the evaluation of the request. **Transfer is not guaranteed**. If approved, **transfers may require one or more additional quarters of study**, since curriculum progress towards the original program is one of the prerequisites of a transfer request.

Transfer requests are accepted for review after the student has demonstrated success as evidenced by **at least one quarter of graded work** in the current degree program and, at the earliest, transfer requests may be placed in the 2nd (typically Winter) quarter - to be effective starting in the 3rd (typically Spring) quarter of their first year.

A student should request a program transfer no later than the date by which the students declare their degree plan**: May 1 of the academic year of their admission, at the latest**. In exceptional cases, requests for transfers will be considered after this date, however, they will be subject to extra review by the student's advisor, the Graduate Committee, and the Director of Master's Program.

Students who do not take any courses in the program to which they were admitted will not be considered for transfer until after they complete at least one quarter of graded work in the original program.

As a prerequisite, **a faculty member with primary affiliation in the desired program must express written consent to advise the student.** For Master's students who have selected the Thesis or Project option, this letter must explicitly state the advisor's

willingness to advise the student on a multi-quarter research project. Furthermore, students must provide a valid justification for wanting to transfer their program of study that must also be validated by the new advisor.

Requests for program transfer should be signed by the students' academic advisor and submitted to the ECE Graduate Affairs Coordinator and will be forwarded to the appropriate Graduate Chair(s) for evaluation. They will evaluate the transfer request by taking various factors into account. These factors include, but are not limited to:

- Success in the original program of study to which the student was admitted.
- The expected ability of the student to successfully complete graduate work in the desired program of study. Relevant evidence includes transcripts and work experience.
- The justification provided by the student for requesting a transfer. This justification must be based on something more substantial than a simple desire to change the title of the degree.
- The strength of the support expressed by a faculty member who has agreed to advise the student in the desired program.

Part-time Graduate Program

Graduate students who are US citizens or permanent residents may pursue their MS studies in the ECE Department on a part-time basis. The United States government does not give student visas to those enrolled part time.

Students should discuss any details with their academic advisor and email the ECE Graduate Affairs Coordinator for further information.

Pursuing a Ph.D. After Being Admitted to the MS Program

MS students must apply to any Northwestern Ph.D. program as a new student application through CollegeNet. There is no guarantee for admission into the Ph.D. program for students who are currently in the terminal MS program.

Ph.D. Program

This section describes the process and requirements for ECE doctorate (Ph.D.) students that wish to obtain a Ph.D. degree in Electrical Engineering, In addition to the requirements outlined below, each Research Interest Group's Program of Study (PS) has additional requirements. See Doctoral Programs of Study (PS) of this manual for details.

TGS Requirements

All Ph.D. students must satisfy The Graduate School's requirements for obtaining the Ph.D. degree, as outlined at https://www.tgs.northwestern.edu/about/policies/phd-degree-requirements.html, and maintain Satisfactory Academic Progress throughout their Ph.D. studies, as defined by The Graduate School at https://www.tgs.northwestern.edu/academic-policies-procedures/policies/satisfactory-academic-progress.html.

This handbook presents program-specific requirements that are in addition to, or further elaborate upon, the requirements established by TGS, and may go beyond TGS minimums. A complete description of TGS' requirements, academic policies and procedures for graduate study at Northwestern University can be found at https://catalogs.northwestern.edu/tgs/academic-policies-procedures/.

Milestones

Ph.D. students in EE must meet a set of milestones to remain in good academic standing. Any student who does not complete milestones in the timeline allotted will be considered in poor standing and therefore will be ineligible for fellowships, traineeships, teaching or research assistantships, and scholarships. Students who do not meet published requirements of satisfactory academic progress may be excluded from The Graduate School (TGS). Students who have taken time off for family or other approved leave will have appropriate accommodations made to adjust their milestones.

For additional information, students may use the following resources:

- https://www.tgs.northwestern.edu/about/policies/phd-degree-requirements.html
- https://www.tgs.northwestern.edu/academic-policies-procedures/policies/satisfactory-academic-progress.html

Selection of a Ph.D. Advisor

Ph.D. students are required to have a permanent advisor by the end of their third quarter (typically spring quarter). To continue in the ECE doctoral program beyond the third quarter of study, every Ph.D. student must have an academic advisor that is willing to serve as their advisor and who has an approved plan for funding. **The advisor must have an academic appointment in ECE.** This includes faculty with a courtesy appointment in ECE. When a student has chosen an advisor, they should inform the Graduate Affairs Coordinator by email and include the advisor on that correspondence.

For Ph.D. students, an initial faculty advocate is assigned to each student at the time of admission to assist with planning the first academic quarter of study. This advocate is most likely the faculty member who advocated for the student's admission to the program

and therefore a strong candidate for serving as the student's eventual faculty adviser. The student is not required to select the faculty advocate as their adviser.

The student's adviser will serve as the primary contact with the ECE Department and should be chosen to match the student's academic program of study and research interests (see Doctoral Programs of Study (PS)).

If a Ph.D. student decides to change advisers at any point during their studies, their previous adviser and the Director of Graduate Studies (DGS) must be consulted, and the DGS must approve.

In each quarter, the study plan should be approved by the student's adviser prior to registration. A typical full-time program of graduate study is three units per academic quarter. The maximum permitted is four units. All students receiving financial aid in the form of fellowships, research assistantships, or teaching assistantships must register as full-time students.

Admission to Ph.D. Candidacy

Ph.D. students must be admitted to candidacy by the end of **the 3rd year of study**, which falls on the last date of the 12th academic quarter.

A student failing to meet this milestone will not be considered in good academic standing, and therefore will be placed on academic probation, as per TGS Satisfactory Academic Progress webpage noted above.

Admission to candidacy requires meeting the academic requirements of the Program of Study of one of the three ECE Department Research Interest Groups and passing the Qualifying Exam of that Research Interest Group (see Doctoral Programs of Study (PS)).

Qualifying Examination

When a student is ready to take a Research Interest Group's Qualifying Exam, they should submit the Ph.D. Qualifying Exam Form in GSTS, under the "TGS Forms" tab. Note that the content of qualifying exams varies across different Programs of Study within the department. Doctoral Programs of Study (PS) specifies the requirements for each program of study.

The student should verify the availability of the proposed faculty committee on the date chosen for the exam and obtain all required signatures. Return the completed form to the ECE Graduate Student Affairs Coordinator (Tech L359). The Student Affairs Coordinator will submit the necessary information to TGS.

Prospectus (Dissertation Proposal)

Students must have a prospectus (dissertation proposal) approved by a faculty committee no later than the end of the **4th year of study**, which falls on the last date of the 16th academic quarter. A student failing to meet this milestone will not be considered in good academic standing and therefore will be placed on academic probation, per TGS Satisfactory Academic Progress Guidelines (see TGS Requirements).

A minimum of three individuals must serve on this committee. At least two members of this committee, including the committee chair, must be members of the Northwestern University Graduate Faculty (see https://www.tgs.northwestern.edu/about/for-faculty/). At least two members, including the committee chair, must be faculty in the ECE Department. See Doctoral Programs of Study (PS) for any additional Research Interest Group requirements for the committee. Upon formation of the prospectus committee, the student should submit the Ph.D. prospectus form through TGS Forms in GSTS and fill in the **ECE Examination Request Form** available online at https://www.mccormick.northwestern.edu/electrical-computer/resources/students/forms-documents.html. Instructions for scheduling an exam time and reserving a room are on this form.

Every Ph.D. candidate is required to prepare a dissertation indicating evidence of original and significant research. Read "Dissertation Formatting Guidelines" that can be downloaded from TGS at this link: https://www.tgs.northwestern.edu/academic-policies-procedures/dissertation-publication/dissertation-formatting-requirements/.

For the Final Exam, a student follows the same procedure as for the Ph.D. Qualifier Exam and Ph.D. Prospectus, although now the student clicks the "Ph.D. Final Exam" form in GSTS.

Four weeks prior to the Ph.D. Final Exam date, the student submits the ECE Examination Request form. The student must make sure that they have met all the degree requirements of the ECE Department as detailed in this manual and all requirements of The Graduate School, as specified on their website at the link provided in the TGS Requirements section.

An announcement of the student's Final Exam is then posted in the ECE Department. The student's file is checked for any missing documents, grades, etc. that need to be completed for the Final Exam and awarding of the Ph.D. degree. This file is given to the student's adviser prior to the Final Exam and must be in the examination room for reference. Upon conclusion of the Final Exam, all the committee members must submit their approval through GSTS.

Once the Ph.D. dissertation has been approved by the committee, and all subsequent edits and revisions are completed by the student, the student must submit the dissertation online via the ProQuest website. At this point, a TGS Student Services representative reviews the formatting and confirms via email that the dissertation is acceptable or notifies the student if changes need to be made.

Teaching Requirement

In February 2014, the McCormick School of Engineering approved the following Ph.D. teaching requirement effective with the Ph.D. class matriculating in Fall 2014:

- All students earning a Ph.D. degree from a McCormick program must meet one of the following requirements:
    - Serve as an instructor of an undergraduate course, or
    - Serve as a full-time teaching assistant (20 hours a week) in an undergraduate course for at least one quarter, or
    - Serve as a part-time teaching assistant (6-8 hours a week) in an undergraduate course for at least three quarters, or
    - Meet a Departmental teaching requirement that has been approved by The Graduate School.
- Teaching assistant positions must involve some face-to-face contact with students (office hours, lab or problem session, lecturing) in addition to grading.

In addition to options listed above, Ph.D. students in the ECE Department can choose to satisfy the teaching requirement by registering for two quarters of *Teacher Trainee* (TT) duties. Each TT quarter's work assignment involves a half-time teaching assistantship with some additional class involvement beyond grading homework or staffing a help desk. Typically, during the academic quarter, the TT prepares and presents one class lecture or designs one new homework assignment.

First-time TT students should register for GEN ENG 545 (Teaching Experience) to receive credit for their effort. Second-time TT students should register for GEN ENG 546, which is zero credit but does place on their transcript recognition of their contribution.

Note that a Ph.D. student cannot be both a teaching assistant and a TT in the same academic quarter. Also, registrations in GEN ENG 545 and GEN ENG 546 are only for TT students.

Also note that a student **will not be able to graduate until one of the teaching requirements listed above is fulfilled**. When a student files their thesis proposal, the student must also file a form listing what part of the teaching requirement has been fulfilled at that point and what, if any, teaching requirement has yet to be fulfilled.

Registration and Course Requirements

The Graduate School Requirements

Full-time registration is three units (courses) per quarter. Typically, students take three courses per academic quarter and may not take more than four courses per quarter.

The Graduate School (TGS) requires Ph.D. students to register full time in order to be eligible to receive funding. This includes summer quarters.

TGS requires a minimum of 9 graded graduate level courses (**note: ECE requires a minimum of 15 graded graduate level courses)**. The cumulative grade point average over these graded courses must be a B average (3.0 GPA) or higher.

See TGS' General Registration Policies webpage for more detail: https://www.tgs.northwestern.edu/about/policies/general-registration-policies.html

Doctoral students who are primarily doing research and are receiving funding should register for TGS 500. This provides full-time status. Students may register for TGS 500-0 Advanced Doctoral Study via CAESAR when they have completed coursework requirements or during summer quarters.

Students who have completed the program coursework and are continuing in their degree program (writing a thesis or dissertation and/or performing research required for the degree), but not receiving funding should register for TGS 512. TGS 512-0 Continuous Registration is a full-time registration intended for students who are continuing to work in a full-time capacity toward degree completion.

Any alterations in the degree progress timeline can be managed through Leave of Absence requests. Per TGS Continuous Registration Policy (see TGS General Registration Policies webpage link on in the preceding paragraph), all Ph.D. students must be registered at Northwestern University in each of the Fall, Winter and Spring terms until all degree requirements have been completed, including dissertation submission to The Graduate School.

Students receiving financial support (assistantships or fellowships) must be registered as full-time students, including summer quarters. Such students must also maintain satisfactory academic progress, as per TGS Satisfactory Academic Progress Guidelines (see TGS Requirements).

Common ECE Course Requirements

The ECE Department requires 15 graded units of graduate coursework for the Ph.D. Coursework includes ECE 499, but not ELEC_ENG 590 Research. At least 6 units should be at the 400 or 500 levels, not counting TT credits.

The Graduate School requires full-time registration while completing coursework (typically during the first two years). This translates to 24 credits of coursework, including the 15 credits of graded coursework. ELEC_ENG 590 research units make up the remainder of the units required.

A Ph.D. student's adviser or ECE Research Interest Group may require more than the minimum number of courses. In such cases, the number of ELEC_ENG 590 research units will be reduced correspondingly.

ELEC_ENG 499 is reserved for projects that are not directly related to the research required for the Ph.D. thesis or for readings in specific subjects for which the ECE Department has no regular courses.

Electrical engineering students are limited to two units of ELEC_ENG 499.

GEN_ENG 519: The National Science Foundation (NSF) requires everyone being paid on NSF grant money to complete Responsible Conduct of Research (RCR) training. For doctoral students, this requirement is satisfied by enrolling in GEN_ENG 519. All Ph.D. students are required to complete this training in their first year.

Maintaining Student Status and Continuous Registration

Ph.D. students must register for enough units to maintain their full-time or part-time student status and meet the continuous registration requirement as defined by TGS in The Graduate School Policy Guide (https://catalogs.northwestern.edu/tgs/academic-policies-procedures/general-registration/#continuousregistration). Units required to meet the continuous registration requirement and maintain student status beyond the coursework units required by the EE program may be fulfilled by registering for ELEC_ENG 590 Research units, or additional coursework, or the appropriate TGS General Registration courses.

Ph.D. students that are receiving funding should register for TGS 500 Advanced Doctoral Study instead of ELEC_ENG 590 Research after they have completed all coursework requirements and are doing primarily research. TGS 500 Advanced Doctoral Study is also available during the summer quarter to Ph.D. students that are receiving funding and are doing primarily research during that quarter.

Responsible Conduct of Research (RCR) Training

Conducting research responsibly and ethically is critical in any discipline, particularly science and engineering. Responsible Conduct of Research (RCR) training is a framework for imparting these standards and a critical component of scholarly work and career development. The training includes **two** components: web-based CITI training and instructor-led training (GEN_ENG 519). The McCormick School of Engineering requires that all Ph.D. students, regardless of funding, complete both the web-based CITI training and the instructor-led RCR training **within their first year of Ph.D. studies**.

Ph.D. students should complete the CITI course titled "*RCR course for graduate students and post docs*", and complete the zero-credit *GEN_ENG 519-0 Responsible Conduct for Research (RCR) Training* during the first year. Failure to meet this milestone will result in the student being ineligible to receive funding from National Science Foundation (NSF) and National Institutes of Health (NIH) grants. For more information, please see the McCormick School of Engineering webpages on RCR training at https://www.mccormick.northwestern.edu/faculty-staff-resources/research-conduct/.

Petitioning for Course Credit or Substitution

A Ph.D. student may petition to have at most six (6) ECE Department course credits waived based on graduate level courses taken previously at Northwestern or elsewhere that were not counted towards the completion of another degree. This petition must include complete documentation (e.g., syllabus, assignments/projects, etc.) of the content of the course from the student's previous institution that most closely matches the ECE Department course credit to be waived. The student must provide an official transcript, sent directly to the department, that shows the grade received for each course used for transfer credit.

Note, that for every course waived, the student must enroll in one credit of ELEC_ENG 590 Research in its place. This is because waiving the course does not lessen the registration requirement imposed by The Graduate School.

The coordinator of the equivalent ECE Department course will review the petition and make a recommendation. All such waivers are ultimately subject to the approval of the adviser and the ECE Director of Graduate Studies.

Programs of Study

Each student must complete a Program of Study that specifies additional course requirements beyond the common requirements for all ECE doctoral students. Doctoral Programs of Study (PS) specifies the requirements for each program of study.

Doctoral Programs of Study (PS)

In addition to the common requirements, every EE doctoral student must select a degree area in which they complete a Program of Study (PS) under a faculty member that specializes in that area. Each program has specific requirements for the coursework, qualification exam, and dissertation prospectus. The Electrical Engineering Ph.D. offer the following Programs of Study. Each subsection that follows describes one program of study.

- Solid-State, Photonic and Quantum Technologies
- Signals & Systems

Solid-State, Photonic and Quantum Technologies

Research Area Description:

Solid-state engineering focuses primarily on the science and technology of semiconductors for quantum structures and devices operating from the ultraviolet up to far infrared. Quantum devices are fabricated using the most advanced semiconductor synthesis technologies (MOCVD, MBE, gas source MBE, etc.), as well as microfabrication techniques (high-precision photolithography, e-beam evaporation, RTA, reactive-ion etching, etc.). The quantum devices are fully tested at each step in the fabrication process using advanced characterization techniques (diffraction, SEM, TEM, photoluminescence, Hall, etc.) Most of the research is performed within the Center for Quantum Devices (CQD), in a clean-room environment similar to what is found in industry. These quantum devices are in high demand by today's applications. Ultraviolet lasers and photodetectors are needed for astronomy, space communications and the monitoring of engines and heat sources. Red, green and blue (RGB) solid-state lasers are needed for high-brightness full-color displays and optical data storage (CD, DVD). High-power 0.808 μm, 0.98 μm, 1.3 μm, and 1.5 μm lasers and VCSELs are needed for medical applications and fiber optical communications. Infrared lasers (e.g. quantum cascade lasers), photodetectors (e.g. QWIPs), and focal plane arrays (FPAs) are needed for chemical analysis and night vision.

Optical systems and technology focuses on microcavity lasers, nanostructures, quantum and nonlinear optics, integrated optics, fiber optics and infrared waveguide devices, fiber-optic communications, and imaging through turbulence. Special emphases include: applications of novel quantum amplifiers in optical communications, imaging, and cryptography; devices for terabit per second WDM and TDM optical networks; and applications of computational techniques in integrated and nonlinear optics.

Ph.D. Coursework

The courses in this area are divided into Core Courses and Area-Specific Courses as follows:

Core Courses (Group A)

Each student is required to take **five** of the following ten core courses:

- ELEC_ENG 382 Photonic Information Processing
- ELEC_ENG 383 Fiber-Optic Communication
- ELEC_ENG 388 Microelectronic Technology
- ELEC_ENG 401 Fundamentals of Electronic Devices

- ELEC_ENG 402 Advanced Electronic Devices
- ELEC_ENG 403 Quantum Semiconductors
- ELEC_ENG 404 Quantum Electronics
- ELEC_ENG 405 Advanced Photonics
- ELEC_ENG 406 Nonlinear Optics
- ELEC_ENG 411 Fundamentals and Applications of Special Relativity

Area-Specific Courses (Group B)

Elective courses in Solid-State, Photonic and Quantum Technologies include:

- ELEC_ENG 333 Introduction to Communication Networks
- ELEC_ENG 381 Electronic Properties of Materials
- ELEC_ENG 384 Solid-state Electronic Devices
- ELEC_ENG 385 Optoelectronics
- ELEC_ENG 386 Computational Electromagnetics and Photonics
- ELEC_ENG 389 Superconductivity and its Applications
- ELEC_ENG 407 Quantum Optics
- ELEC_ENG 409 Semiconductor Lasers
- ELEC_ENG 422 Random Processes in Communications and Control I
- ELEC_ENG 423 Random Processes in Communications and Control II
- ELEC_ENG 425 Intro to Nanoscale Lasers, Quantum Noise, Photons & Measurement
- ELEC_ENG 427 Optical Communications
- ELEC_ENG 428 Information Theory
- ELEC_ENG 429 Selected Topics in Quantum Information Science and Technology
- ELEC_ENG 454 Advanced Communications Networks
- ES_APPM 411 Differential Equations of Mathematical Physics

With approval of their advisers, students can also take advanced courses (400-level) in Applied Mathematics, Physics and Astronomy, and Materials Science and Engineering, to fulfill the requirements of the Area-Specific Courses.

Ph.D. Qualifying Examination

Photonics Option: For Ph.D. students in the Photonics subgroup Program of Study (PS), the PS evaluation will be made by the Solid-State, Photonic and Quantum Technologies PS Committee, appointed by the group director, on the basis of the following criteria:

- the student's performance in coursework;
- the student's performance in research, and
- an oral exam.

The oral examination requirement can be bypassed if so deemed by the student's adviser.

The oral examination is conducted by a team selected by the PS committee and consists of at least three faculty members with expertise in the examination area. Some of the committee members can be faculty members from outside the ECE Department. The exam is offered once each year, and students must sign up for the exam with the director of the PS committee. A student is given two attempts to pass the PS evaluation. However, each student must get the PS evaluation done by the end of the student's second year in order to continue in the Ph.D. program. Extension of this deadline for up to one year may be granted by the EE Co Director of Graduate Studies if requested by the student's adviser.

SSE Option: For Ph.D. students in the Solid-State Engineering (SSE) subgroup, the PS evaluation, the student's adviser approves the exam and selects the qualifying exam committee members from experts in the field. At least three committee members must be from the ECE Department. The committee evaluation is based on the student's performance in coursework, an oral presentation, and a written proposal detailing the student's future research plans. The qualifying exam must be approved no later than just before the beginning of the fourth year of study (or end of third year).

Ph.D. Prospectus

In addition to the PS evaluation, a student must get a thesis prospectus approved by the end of the fourth year. The procedure for this approval is as follows. The student selects three faculty members, one of which must be their adviser, for the thesis committee. The student produces a written proposal and makes a presentation to this committee. Following an evaluation of the written proposal and the performance of the student during the presentation, the committee decides on approving the prospectus. A student is given two attempts to receive this approval.

Ph.D. Dissertation

Dissertations must be formatted according to TGS' standards: https://www.tgs.northwestern.edu/academic-policies-procedures/dissertation-publication/dissertation-formatting-requirements/

Dissertations not conforming to these instructions will not be accepted: https://www.tgs.northwestern.edu/about/policies/Ph.D.-degree-requirements.html#dissertation

Signals & Systems (Electrical Engineering)

Research Area Description:

Communications, Networks, and Control focuses on communications, telecommunications and communication networks, and control theory. Specific areas of study include: mobile wireless multi- user communication, estimation and detection, wireless networks, resource allocation in communication networks, data network protocol design, network performance modeling and analysis, nonlinear and robust control, and stochastic hybrid systems.

Signal Processing focuses on the digital representation and algorithmic manipulation of speech, audio, image and video signals. Specific topics within this general area include: image and video processing, recovery and compression, multimedia signal processing, filter design and rank-order operators, image and video transmission, medical and biomedical signal processing, medical imaging, machine and deep learning for signal processing, and algorithms for medical instrumentation.

Coursework Requirements

Each student must complete a sequence of courses in an area of specialization according to the recommendation of the adviser. These courses may be in Signals & Systems and other areas. Courses in Signals & Systems may include:

- ELEC_ENG 307 Communications Systems
- ELEC_ENG 328 Information Theory
- ELEC_ENG 332 Introduction to Computer Vision
- ELEC_ENG 333 Introduction to Communication Networks
- ELEC_ENG 359 Digital Signal Processing
- ELEC_ENG 360 Introduction to Feedback Systems
- ELEC_ENG 363 Digital Filtering

- ELEC_ENG 373 Deep Reinforcement Learning from Scratch
- ELEC_ENG 374 Introduction to Digital Control
- ELEC_ENG 375 Machine Learning: Foundations, Applications, and Algorithms
- ELEC_ENG 378 Digital Communications
- ELEC_ENG 380 Wireless Communication
- ELEC_ENG 410 System Theory
- ELEC_ENG 422 Random Processes in Communication and Control I
- ELEC_ENG 418 Advanced Digital Signal Processing
- ELEC_ENG 420 Digital Image Processing
- ELEC_ENG 421 Multimedia Signal Processing
- ELEC_ENG 423 Random Processes in Communications and Control II
- ELEC_ENG 426 Signal Detection and Estimation
- ELEC_ENG 427 Optical Communications
- ELEC_ENG 428 Information Theory
- ELEC_ENG 431 Human Perception and Electronic Media
- ELEC_ENG 432 Advanced Computer Vision
- ELEC_ENG 435 Deep Learning Foundations from Scratch
- ELEC_ENG 454 Advanced Communication Networks
- ELEC_ENG 463 Adaptive Signal Processing and Learning
- ELEC_ENG 473 Deep Reinforcement Learning from Scratch
- ELEC_ENG 475 Machine Learning: Foundations, Applications, and Algorithms
- ELEC_ENG 478 Advanced Digital Communications
- BMD_ENG 383 Cardiovascular Instrumentation
- BMD_ENG 384 Biomedical Computing
- BMD_ENG 401 Systems Physiology

- BMD_ENG 402 Advanced Systems Physiology

Ph.D. Qualifying Exam

To become a Ph.D. candidate, each student must pass the Ph.D. qualifying exam. The following exam format, content, and schedule applies to all students who enter the program after Fall 2019.

Format

Each student will be examined by a panel of at least three faculty including the student's advisor. The committee members must belong to the Graduate Faculty and have an appointment in the Signals & Systems division of the ECE department. If the student is co-advised by multiple faculty, the committee can be expanded to include the advisors, where the advisors are allocated a single vote towards

the outcome of the exam. Questions and answers will be presented orally, and the panel will be selected by the division director in consultation with other faculty. The length of the exam is expected to last one hour, including an oral presentation and Q&A. The examination will be open only to faculty within the division.

Content

The student will be asked to give a 1/2 hour presentation summarizing the contents of at least one research paper. The committee will choose the paper(s) with input from the student. The presentation should have sufficient technical depth to enable the committee to evaluate the student's understanding of the main results along with associated background and course material. The panel may ask questions to probe this understanding both during and following the presentation.

Breadth and Depth Requirement

The student will be asked to specify four 400-level classes, which will form the basis for background Q&A. Three of these must be selected from each of the following categories:

- 1 graduate class on probability and random processes (422 or equivalent)
- 1 class on signal processing and control, chosen from 410, 420, 421, 463/395 (Adaptive Signal Processing), 431, 432, 470
- 1 class on optimization and machine learning, chosen from 424, 435, 473, 475, IEMS 450-2, Kellogg graduate optimization class

The fourth class can be any 400-level class approved by the committee. It is strongly encouraged that it be selected from classes within the Signals and Systems area, namely, the preceding classes in addition to 426, 428, 454, 495 (Cardiovascular Instrumentation).

Schedule

For students directly admitted into the Ph.D. program, the exam must be taken by the end of the fall quarter in their second year. An MS student who switches to the Ph.D. program follows the same rule where the year they switch is counted as the first year. Any exception to these rules must be approved by the division director. Each student must submit a request to take the exam to the Signals & Systems director. Ideally, the request should be submitted ten weeks before the intended exam date. The paper(s) for the oral presentation will be given to the student six weeks before the exam date.

The possible outcomes are pass, fail, and retake. The committee chair will send the committee's recommendation to the division following the exam, and will make accessible the supporting documents for review. A decision must then be made within a week. If there are no objections to the committee's recommendation, then the committee's recommendation applies. Otherwise, if there is disagreement, the group will vote on the case. The division director will then send a letter to the candidate stating the decision. If the outcome is fail, then the student will not have an opportunity to retake

the exam. If the outcome is retake, then the format and date of the retake will be decided by the committee, and the retake must be completed by the end of spring quarter in the second year. The outcome of the retake is pass or fail.

Ph.D. Prospectus

In the Signals & Systems Group, the prospectus is the student's proposal defense. The proposal is a written document describing the student's Ph.D. research topic, with background and prior work and

proposed work. The proposal defense is an event during which the student presents the proposal to their Ph.D. committee who then decide whether or not to pass the student either conditionally or unconditionally. Upon passing the prospectus the student then completes the research and writes and eventually defends the Ph.D. thesis.

Ph.D. Dissertation

Dissertations must be formatted according to TGS' standards: https://www.tgs.northwestern.edu/academic-policies-procedures/dissertation-publication/dissertation-formatting-requirements/

Dissertations not conforming to these instructions will not be accepted: https://www.tgs.northwestern.edu/about/policies/Ph.D.-degree-requirements.html#dissertation

Special Policies and Procedures

Internships During Graduate Study

A graduate student wishing to combine graduate study with work experience in industry or national labs may, with the permission of their advisor, elect to participate in an internship opportunity. This experience provides networking and potentially future career opportunities for the student, and permits the student to gain a broader understanding of contemporary problems that eventually could serve as the background for a thesis or project.

Ph.D. students (domestic and international) who wish to take advantage of an internship opportunity are encouraged to enroll in Career Development CRDV 510 Crown Family Graduate Internship, a non- credit, non-tuition-bearing course. A prerequisite for this course is a written approval of the Ph.D. advisor. Enrolling in CRDV 510 while participating in an internship allows the student to maintain full-time status. Additional details, requirements and procedures regarding CRDV 510 can be found at McCormick's website at https://www.mccormick.northwestern.edu/students/graduate/fellowships-internships/crown-family.html

Similarly, MS students (domestic and international) who wish to participate in an internship opportunity are encouraged to enroll in Career Development CRDV 411-1 Professional Engineering Internship.

International students who chose to do an internship must also apply for Curricular Practical Training (CPT) authorization for any off-campus internships. "Off-campus" is defined as any internship that takes place outside of Northwestern University. For more information on applying for CPT, please visit the Office of International Student and Scholar Services' website: https://www.northwestern.edu/international/living-working/student-employment/curricular-practical-training.html

Post-Graduation Employment

International MS and Ph.D. students who seek to complement their education with practical training though temporary employment in the U.S. upon graduation must apply for Optional Practical Training (OPT) authorization. **OPT MUST BE APPLIED FOR AT LEAST FOUR (4) MONTHS BEFORE**

GRADUATION. It is strongly recommended that international students interested in employment opportunities in the U.S. schedule an appointment with the Office of International Student and Scholar Services (OISS) at least one month in advance of the OPT submission deadline to obtain assistance and ensure sufficient time for the collection and submission of the required documents. Without submitting this application in advance, students may not be able to transition smoothly to OPT visa status, and any such

interruption may delay or prohibit their employment with a U.S. employer. For more information visit https://www.northwestern.edu/international/living-working/student-employment/index.html.

Student Status and Continuous Registration – Special Courses

Graduate students must register for enough units to maintain their full-time or part-time student status and meet the continuous registration requirement as defined by TGS in The Graduate School Policy Guide (https://catalogs.northwestern.edu/tgs/academic-policies-procedures).

There are a number of non-classroom courses that may be used to maintain continuous registration and student status at the university in cases where registering for research or classroom courses is not appropriate. Below is a brief guide to these courses. Before enrolling in these special registration courses, students must consult with their advisor, the Director of Graduate Studies in EE, and the Graduate Affairs Coordinator of their home department. Additional information, policies and procedures can be found at TGS' website at https://catalogs.northwestern.edu/tgs/academic-policies-procedures/general-registration/.

- **TGS 512-0: Continuous Registration** is appropriate for cases when a graduate student is not receiving funding and needs to maintain student status and meet the continuous registration requirement while completing an MS project or an MS or Ph.D. thesis. Students may enroll in this course only if they have completed the required units of coursework. When enrolled in TGS 512-0 Continuous Registration the student cannot enroll in additional classes. Enrolling in TGS 512-0 requires the permission of the student's advisor and the ECE Graduate Affairs Coordinator.

- **TGS 588-0: Resident Masters Study** is available to students pursuing an MS degree that receive financial support administered by the University. It is particularly useful to MS students who need to maintain full-time status, but who would have reached the required units of coursework for the MS program without full time registration in a quarter. This course allows additional enrollments and can be repeated for multiple quarters, but allows no accumulation of credit or residency toward the master's degree and it is not graded. Enrolling in TGS 588-0 Resident Masters Study requires the permission of the student's advisor, the ECE Graduate Affairs Coordinator, and TGS.

Leaves of Absence

Any alterations in the residency timeline may be managed through Leave of Absence requests. Students who have taken time off for an approved Leave of Absence will have appropriate accommodations made to adjust their milestones and program timelines. A

complete description of TGS' requirements, policies and procedures can be found at https://catalogs.northwestern.edu/tgs/academic-policies-procedures/.

Student Responsibilities and Academic Misconduct

It is the responsibility of each graduate student to ensure that all the requirements of The Graduate School (TGS) and the EE Program are met, that necessary examinations are properly scheduled, and that deadlines dependent on current Northwestern University, McCormick, home department and EE Program calendars are observed. The current procedures and degree requirements of the EE Graduate Program are detailed in this manual.

Students should always consult with the Graduate Affairs Coordinator of their home department first to execute procedures, confirm requirements, and obtain paperwork for exams and various other procedures (e.g., visa related issues). In addition, students are strongly urged to consult regularly with their faculty advisors.

Official notices about degree program progress, financial aid and other important notices are sent to each student's official email and mail boxes. Students are responsible for checking their official Northwestern email accounts (@u.northwetern.edu) on a regular basis, **at least once a week**, and their official department mailbox **at least once per month**.

All EE students must observe the policies on academic integrity set forth by Northwestern University, The Graduate School and the McCormick School of Engineering and Applied Science. The principles of academic integrity and possible consequences of academic misconduct are documented at:

- https://www.northwestern.edu/provost/policies/academic-integrity/principles.html (University)
- https://www.tgs.northwestern.edu/academic-policies-procedures/policies/academic-integrity.html (The Graduate School)
- https://www.mccormick.northwestern.edu/students/academic-integrity.html (McCormick)

Students found guilty of academic misconduct (e.g., cheating on coursework, plagiarizing research) by definition are failing to make satisfactory academic progress, and are subject to be placed on academic probation (https://www.tgs.northwestern.edu/academic-policies-procedures/policies/satisfactory-academic-progress.html#programprobation).

Students must be particularly vigilant in programming courses. Unless the instructor for the course has explicitly documented otherwise in the course syllabus:

- Code you submit must be your own. Copying and adapting someone else's code is not allowed.
- Studying someone else's solution (including an online article or code repository) is not allowed.
- Letting another student study your solution is not allowed.

If an instructor concludes that cheating has occurred, he or she will submit the evidence to the dean for adjudication. Penalties for cheating will depend on the specifics of the case. They can range from loss of points on the assignment in question, a reduction in letter grade for the course, obtaining a failing grade for the course, or even exclusion from the program in extreme circumstances.

Probation, Exclusion, and Appeal Process

If a student fails to remain in good academic standing at any point in the EE program, they will be placed on probation. This may result from violations of academic integrity standards (e.g., cheating on coursework, plagiarizing research) or from failure to meet any of the EE program's or The Graduate School's (TGS) requirements for the graduate degree. Such failures include, but are not limited to, not making satisfactory progress in thesis research or not having a permanent research advisor at any point during the program.

Students who are not making satisfactory academic progress in a given quarter will be placed on probation by TGS for the following quarter. Once on probation, the EE program reserves the right to review the student's case and impose additional requirements or penalties beyond those mandated by TGS. These may include, but are not limited to, loss of funding or program-specific sanctions.

During the probationary quarter, the student must fulfill all conditions set by both the EE program and TGS. This includes addressing the cause of unsatisfactory progress, whether by improving academic performance, seeking an alternate advisor, or working with their current advisor to restore satisfactory standing. At the end of the probationary quarter, the student must demonstrate satisfactory progress through a report from a permanent advisor. If the student fails to secure an advisor who can confirm satisfactory progress, the program reserves the right to discontinue funding from departmental or advisor sources and may recommend the student's exclusion (dismissal) from The Graduate School.

In cases where a student misses a milestone deadline (e.g., qualifying exams, proposal submission), they may petition TGS for an extension by providing a compelling reason and sufficient supporting evidence. If the petition is approved, the student will receive an extended milestone due date and a list of required actions to be completed by that date. Failure to meet these revised requirements may result in exclusion from both The Graduate School and the EE graduate program.

Violations that may lead to probation include failure to meet academic integrity standards (e.g., cheating on coursework), failure to maintain satisfactory academic progress (e.g., a cumulative GPA below 3.0), failure to respond to the Director of Graduate Studies or other ECE personnel, or failure to meet milestones related to research or project work (e.g., not submitting a project plan within the approved timeframe).

Once placed on probation, the ECE department reserves the right to review the student's academic standing and apply additional consequences. These may include, but are not limited to, loss of departmental or advisor funding, stricter deadlines, or exclusion from the graduate program.

More information on TGS policies regarding probation, academic progress, and appeals can be found here: https://www.tgs.northwestern.edu/academic-policies-procedures/policies/satisfactory-academic-progress.html