ELECTRICAL ENGINEERING
PhD Student Guide

Fall 2026 – Summer 2027

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Table of Contents

Introduction and Purpose **3**

Program Contacts **4**

Learning Outcomes **4**

Program-Specific Academic Requirements & Policies **5**

Program of Study (PS) 5
Coursework Requirements 5
Course Waiver Policy 6

Teaching Requirement **7**

Typical Electrical Engineering PhD Timeline **7**

Program-Specific Milestone Policies **8**

Adviser 8
Qualifying Exam / Candidacy 9
Committee 10
Prospectus (Dissertation Proposal) 11
Dissertation and Defense (Final Exam) 12

Addendum: Learning Outcomes Table **13**

Introduction and Purpose

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 PhD. 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!

Professor Randy Freeman
Director of Graduate Studies, Electrical Engineering
Department of Electrical & Computer Engineering
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Program Contacts

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

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

Department Chair: Prem Kumar, kumarp@northwestern.edu. The Department Chair is responsible for providing academic leadership, managing faculty affairs, overseeing curriculum and instruction, supporting student success along with the DGS, handling budgeting and resource allocation, coordinating departmental operations, and representing the department externally.

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

Financial Assistant / Coordinator: Joseph Mazanek, Financial Coordinator, joseph.mazanek@northwestern.edu. Adam Barnett, Financial Assistant, adam.barnett1@northwestern.edu. These staff members handle financial aspects such as stipends and tuition payments.

Learning Outcomes

The PhD program in Electrical Engineering provides 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 effective oral and written communication of scientific concepts.

Note: There is an addendum at the end of the handbook that includes a table of the learning outcomes. It is recommended that you review it.

Program-Specific Academic Requirements & Policies

Program of Study (PS)

In addition to the common requirements, all EE PhD students must select a degree area in which they complete a Program of Study (PS) under a faculty member that specializes in that area. Each PS has specific requirements for the coursework, qualifying exam, and dissertation prospectus, as outlined later in this handbook. The Electrical Engineering PhD offers the following Programs of Study:

- Solid-State, Photonic and Quantum Technologies (SSPQT), and
- Signals & Systems (S&S).

These Programs of Study have the same names as the two research divisions within Electrical Engineering.

Coursework Requirements

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

The ECE Department requires 15 units of quality-graded (ABC), TGS-listed coursework for the PhD. Coursework may include COMP_ENG 499, but not COMP_ENG 590 research or any units for TA service.

The Graduate School and McCormick require full-time registration for all PhD students making degree progress. During the first two years, PhD students achieve full-time status by taking classes and completing ELEC_ENG 590 research units. This translates to 24 credits of coursework, including the ECE minimum of 15 credits of letter-graded coursework. For EE PhD students, only two units of ELEC_ENG 499 can count towards the 15-course requirement. ELEC_ENG 590 research units can make up the remainder of the units required.

Students in SSPQT must take at least 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

Students in S&S must take enough core courses to prepare for the qualifying exam, the guidelines for which are as follows.

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, and
- 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).

Course Waiver Policy

A PhD student may petition to have at most six (6) courses from the ECE 15-course requirement waived based on graduate level courses taken previously at Northwestern or elsewhere that were not counted towards the completion of an undergraduate 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 a transcript that shows the grade received for each such course. 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 EE Director of Graduate Studies. Also, waived courses do not contribute to the registration requirement for students to maintain full-time status.

Teaching Requirement

All PhD students in Electrical Engineering are required to serve as a full-time teaching assistant (20 hours per week) for at least one academic quarter within their first five years. This could be for a non-ECE course, with DGS approval. Students must specify their plans for satisfying this requirement before the department will approve their PhD prospectus.

Students cannot sign up to serve as TAs themselves; instead, their advisers must request that they serve when the department solicits TA nominations from faculty before the beginning of each quarter.

Typical Electrical Engineering PhD Timeline

This timeline represents the average timeline for our doctoral students. For milestone deadlines, see the next section.

Year 1:
- take courses, select a PhD adviser, and begin research

Year 2:
- take courses, pass the qualifying exam, and continue research

Year 3:
- form a thesis committee, prepare a prospectus, and continue research

Year 4:
- have the prospectus approved, and begin preparing the dissertation

Year 5 (and beyond):
- finalize and defend the dissertation

Students achieve PhD candidacy upon passing the qualifying exam and meeting the academic requirements of the student's Program of Study.

Students can optionally earn an MS degree on the way to earning a PhD. Students wishing to pursue this option must contact TGS so that they can properly set up the relevant forms in GSP. The Master's in Primary PhD form in GSP will be under the TGS Forms tab. This form is specifically used to request a MS degree in the same program as the student's PhD program. Completing this form is a necessary step before submitting other required forms for degree conferral, such as the Application for Degree and Master's Degree Completion forms, also submitted via GSP.

Program-Specific Milestone Policies

Adviser

An initial faculty advocate is assigned to each PhD student at the time of admission to assist with planning the first academic quarter of study. The faculty advocate may become a student's advisor, but it is neither guaranteed nor required.

To remain in good academic standing, PhD students must have a permanent adviser by the end of their third quarter. The advisor must have an approved plan for funding the student and be a Core Computer Engineering Faculty or an Affiliated Computer Engineering Faculty with an academic appointment in ECE (noted on our department website). When a student has chosen

an adviser, they should inform the Graduate Affairs Coordinator by email and include the adviser on that correspondence. They should also enter their adviser selection in GSP.

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

If a PhD student requires a change in adviser at any point during their studies, their previous adviser and the Director of Graduate Studies (DGS) must be consulted, and the DGS must approve.

Qualifying Exam / Candidacy

PhD students must be admitted to candidacy by the end of the 12th academic quarter and will be placed on academic probation if this is not met. Admission to candidacy requires meeting the academic requirements of the student's Program of Study and passing the associated qualifying exam. The timing and format of the qualifying exam/evaluation is different for each Program of Study (and possibly for each program subgroup), as outlined below.

Students ready to take the qualifying exam should submit the PhD Qualifying Exam Form in GSP, under the "Forms" tab. Upon the successful completion of the exam, the ECE Graduate Student Affairs Coordinator (Tech L359) will approve the form and send it on to TGS for approval.

SSPQT, photonics option: For PhD students in the photonics subgroup of SSPQT, the qualifying evaluation will be made by a 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 exam requirement can be bypassed if so deemed by the student's adviser. The oral exam is conducted by a team selected by the photonics subgroup 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 photonics subgroup committee. A student is given two attempts to pass the qualifying evaluation. However, each student must get the evaluation done by the end of the student's second year in order to continue in the PhD program. Extension of this deadline for up to one year may be granted by the EE Director of Graduate Studies if requested by the student's adviser.

SSPQT, solid-state engineering (SSE) option: For PhD students in the SSE subgroup of SSPQT, the student's adviser selects 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 the end of the third year of study.

S&S: Each student will be examined by a panel of at least three faculty including the student's adviser. 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 advisers, where the advisers 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.

Schedule: For students directly admitted into the PhD program, the exam must be taken by the end of the fall quarter in their second year. An MS student who switches to the PhD 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 division 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.

Outcomes: 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.

Committee

A minimum of three individuals must serve on the student's PhD thesis committee. This committee will approve both the prospectus and the dissertation. Note that this is not the same as the quals 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/our-community/for-faculty/graduate-faculty-membership.html). At least two members, including the committee chair, must be faculty in the ECE Department, and one member must be the student's adviser. Other members may be from outside ECE or Northwestern, provided they are approved by the student's adviser and the DGS. Committee members may participate remotely in prospectus and dissertation defenses, if approved by the adviser.

Prospectus (Dissertation Proposal)

Students must have their prospectus (dissertation proposal) approved by their faculty thesis committee no later than the end of the 16th academic quarter. The prospectus evaluation consists of an oral defense of the written dissertation proposal in front of the thesis committee. A student failing to meet this milestone will be placed on academic probation.

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 PhD prospectus form through Forms in GSP and fill in the **ECE Examination Request Form** available online at https://www.mccormick.northwestern.edu/electrical-computer/students/forms-documents.html. Instructions for scheduling an exam time and reserving a room are on this form.

Dissertation and Defense (Final Exam)

Students must submit the PhD Final Exam form through Forms in GSP before the deadline for the quarter in which the student wishes to graduate. Moreover, four weeks prior to the date of the PhD final exam, the student should submit the **ECE Examination Request Form** available online at https://www.mccormick.northwestern.edu/electrical-computer/students/forms-documents.html. Instructions for scheduling an exam time and reserving a room are on this form. The student must meet all other degree requirements of the ECE program and of TGS before submission of the form.

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 PhD 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 GSP.

Once the PhD 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.

Addendum – Learning Objectives Table

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.	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 experimental results.	Methodology and experimental sections in PhD Prospectus, Dissertation, and Published research papers / Research	Assessment Strategy: Advisor and faculty committee assess successful design, analysis and evaluation of research experiments and artifacts in 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.	PhD Prospectus; Dissertation; Publication of research papers / Communication (scientific writing)	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	Teaching Assistantship (TA) / Teaching	Assessment Strategy: Teaching assistant collaborates with professor and fellow TAs during course development and teaching. Instructor,

sessions.		peer TAs and students (through CTECs) evaluate TA's performance. 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.