COMPUTER ENGINEERING
PhD Student Guide

Fall 2026 – Summer 2027

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Northwestern | McCORMICK SCHOOL OF ENGINEERING

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Introduction and Purpose

Dear Students,

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

Computer Engineering at Northwestern is a joint program between the Department of Electrical and Computer Engineering (ECE) and the Department of Computer Science (CS) within the McCormick School of Engineering. We offer programs leading to the MS and Ph.D. degrees, designed to prepare students for impactful careers in research, industry, and academia.

Computer Engineering covers a diverse set of research areas which our faculty are actively pursuing. These areas include computer architecture, computer systems, operating systems, compilers, parallel systems, distributed systems, high-performance and parallel computing, distributed computing, data mining, artificial intelligence, machine learning, big data science and applications, integrated circuits/VLSI, mixed-signal circuit design, design automation, formal methods, embedded and real-time systems, mobile and wearable computing, internet of things, cyber-physical systems, database systems, and reconfigurable systems.

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 will 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 Computer Engineering program. Welcome to Northwestern!

Sincerely,

Professor Jie Gu
Director of Graduate Studies, Computer Engineering
Department of Electrical & Computer Engineering
Email: jgu@northwestern.edu

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): Jie Gu, jgu@northwestern.edu. The DGS oversees the graduate program, advising students on academic matters and assisting with advisor selection and changes. The DGS also monitors academic progress and participates in decisions concerning academic probation and exclusion.

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. This staff member handles financial aspects such as stipends and tuition payments.

Learning Outcomes

Computing engineering spans across the full stack of computing. This includes VLSI circuit design, electronic design automation, computer architecture, embedded system, high performance computing, software system, etc. The PhD program of computer engineering provides highly specialized training to students in developing software and hardware system solutions. The program is designed to prepare graduate students for lifetime careers in academia and industry focusing on technology excellence, leadership and foresight vision for driving the development of future technology. Strong communication and presentation skills are also required for PhD students to complete their degree. Appendix 1 lists all expected learning outcomes.

Program-Specific Academic Requirements & Policies

This section describes the process and requirements for ECE doctorate (PhD) students that wish to obtain a PhD in Computer Engineering. Please note, CS doctoral students who wish to obtain a PhD in Computer Science through the Computer Engineering track are directed to that program's guide.

All PhD students must satisfy The Graduate School's (TGS) requirements, as outlined at https://www.tgs.northwestern.edu/about/policies/phd-degree-requirements.html, and maintain Satisfactory Academic Progress throughout their PhD studies, as defined by TGS 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 McCormick.

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. Additional constraints are as follows:

- The student must maintain a composite grade-point average of 3.0 or higher.
- Students are advised to discuss course selections with the student's advisor or initial faculty advocate prior to registration. Poor course selection could delay degree completion or even result in academic probation due to poor grades or missed milestones. Three to four graded courses per quarter are expected in the initial part of PhD studies.
- COMP_ENG 495 Life Skills Building must be taken during the first two years. We strongly suggest taking it in the first year.
- All students must take COMP_ENG 361 Computer Architecture I
- At least 6 courses must be 400-level or above.
- At most 6 units of COMP_ENG / COMP_SCI / ELEC_ENG 499 Projects can be counted toward the 15 units requirement. 499 is reserved for projects that are not directly related to research required for the PhD thesis or for readings in specific subjects for which the ECE Department has no regular courses.
- Students must register for COMP_ENG 590 for sufficient credits each term to reach a minimum of three credits. After passing their prospectus and completing all required courses, students may instead register for TGS 500, which enables full-time enrollment.
- Students must fulfill the "Track" requirements listed below.

Track Courses

Computer Engineering PhD students must satisfy the requirements of at least three of the six Computer Engineering tracks. A track is considered complete when a student successfully completes at least two courses within that track. Courses that appear in multiple tracks may only be counted toward one track requirement. Additional 300-level and above courses (e.g. courses with temporary numbers such as COMP_ENG 395/495, ELEC_ENG 395/495, COMP_SCI 396/496, or COMP_SCI 397/497) may be used to fulfill track requirements with the approval of the student's advisor and the Director of Graduate Studies in Computer Engineering. Courses with both 300- and 400-level numbers (e.g., COMP_ENG 368/468) may only be taken once.

Track A. Digital Design & VLSI

- COMP_ENG 303 Advanced Digital Design
- COMP_ENG 355 ASIC and FPGA Design
- COMP_ENG 357 Design Automation in VLSI
- COMP_ENG 391 CMOS VLSI Circuit Design
- COMP_ENG 393/493 Advanced Low-Power VLSI and Mixed-signal IC Design
- COMP_ENG 459 VLSI Algorithmics

Track B. Embedded and Cyber-Physical Systems

- COMP_ENG 346 Microcontroller System Design
- COMP_ENG 347-1 Microprocessor Systems Project I
- COMP_ENG 347-2 Microprocessor Systems Project II
- COMP_ENG 364/464 Cyber-Physical Systems Design and Application
- COMP_ENG 366/466 Embedded Systems
- COMP_ENG 395/495 Wearables and Physical Computing
- ELEC_ENG 326 Electronic System Design I
- ELEC_ENG 327 Electronic System Design II
- COMP_ENG 395/495 Internet of Things and Edge Computing
- COMP_ENG 395/495 Embedded Artificial Intelligence
- COMP_ENG 395/495 Mobile and Ubiquitous Computing

Track C. Computer Architecture

- COMP_ENG 361 Computer Architecture I
- COMP_ENG 368/468 Programming Massively Parallel Processors with CUDA
- COMP_ENG 452 Advanced Computer Architecture
- COMP_ENG 453 Parallel Architectures
- COMP_ENG 456 Modern Topics in Computer Architecture

Track D. Software Systems

- COMP_SCI 321 Programming Languages
- COMP_SCI 322 Compiler Construction
- COMP_SCI 323 Code Analysis and Transformation
- COMP_SCI 339 Introduction to Database Systems

- COMP_SCI 340 Introduction to Networking
- COMP_SCI 343 Operating Systems
- COMP_SCI 345 Distributed Systems
- COMP_SCI 351-1 Introduction to Computer Graphics
- COMP_SCI 354 Network Penetration & Security
- COMP_SCI 446 Kernel and Other Low-level Software Development

Track E. Parallel and Distributed Systems

- COMP_ENG 329 The Art of Multicore Concurrent Programming
- COMP_ENG 358 Introduction to Parallel Computing
- COMP_ENG 368/468 Programming Massively Parallel Processors with CUDA
- COMP_ENG 395 Special Topics in Computer Engineering: Blockchain and Cryptocurrency
- COMP_ENG 453 Parallel Architectures
- COMP_SCI 340 Introduction to Networking
- COMP_SCI 345 Distributed Systems
- ELEC_ENG 333 Introduction to Communication Networks
- COMP_ENG 395/495 AI for Science and Business

Track F. Algorithms

- COMP_ENG 356 Introduction to Formal Specification & Verification
- COMP_ENG 459 VLSI Algorithmics
- COMP_ENG 510 Seminar; only the following offering: Social Media Mining
- COMP_SCI 336 Design & Analysis of Algorithms
- ELEC_ENG 332 Introduction to Computer Vision
- ELEC_ENG 390 Introduction to Robotics
- IEMS 450-1 Mathematical Optimization I
- IEMS 450-2 Mathematical Optimization II
- IEMS 457 Integer Programming
- COMP_ENG 395/495 AI for Science and Business

Track G. Internet-of-Things

- COMP_ENG 365/465 Internet-of-things Sensors, Systems, And Applications
- COMP_ENG 395/495 Special Topics in CE: Wearables and Physical Computing
- COMP_SCI 433 Wireless Protocols for the Internet of Things
- COMP_SCI 409 Swarms and Multi-Robot Systems
- BME 353-0-01 Bioelectronics
- COMP_ENG 395/495 Internet of Things and Edge Computing
- COMP_ENG 395/495 Embedded Artificial Intelligence
- COMP_ENG 395/495 Mobile and Ubiquitous Computing

Course Waiver Policy

At most six (6) of the required 15 units may be waived, based on graduate-level courses taken previously, provided these courses were not used toward obtaining an undergraduate degree. For a course to be transferred, it must substantially match a course at Northwestern University that counts toward the 15 unit requirement.

To transfer a course, a student must submit a petition to the CE DGS 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 and the CE DGS. Computer Science students petitioning for a course waiver must also receive approval from the CS DGS.

Teaching Requirement

All PhD students in Computer 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 Computer 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 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.

PhD students must have a permanent adviser by the end of their third quarter to remain in good standing. The advisor must have an approved plan for funding the student, and the advisor must be a Core Computer Engineering Faculty or an Affiliated Computer Engineering Faculty with an academic appointment or a courtesy appointment in ECE. 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 academic program of study and research interests.

If a Ph.D. 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.

Annual Advisor Reviews

Students must maintain satisfactory academic progress. This is assessed through an Annual Academic Standing Review in which all Core Computer Engineering Faculty participate as voting members. The date of the Review will be announced each year. At least one week before the review, students should submit an annual progress report and self-evaluation in GSP. At least one week before the annual review conference, the advisor is also required to submit an evaluation of the student's research progress in GSP. A face-to-face meeting between the advisor and student is highly recommended before the faculty advisor finalizes the advisor evaluation in GSP. If a student disagrees with the advisor's evaluation, the student should contact the Director of Graduate Studies in CE before the Review.

Satisfactory progress is assessed at the Review by consideration of completion of required courses, meeting TGS and program milestones, publishing scholarly research at venues and with frequency appropriate for the specific field of study, participating in professional development activities with appropriate frequency, and the advisors assessment of progress in thesis research.

Failure to maintain good academic standing is grounds for placing the student on Probation, as detailed in the McCormick handbook.

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.

PhD students achieve Candidacy through either course completion or by passing an Oral Qualifier Exam. For the course completion route, students must complete 9 of the 15 required courses, including all the required CE Core Courses/CE Track Courses, with a cumulative GPA of 3.5 or higher on these courses.

Remaining course units should be fulfilled through graded coursework of other electives that comply with the 15-unit course requirements of the Ph.D. program in CE. While up to 6 previous graduate-level coursework completed at another institution can be transferred, up to 3 of these units can be used to contribute to the GPA calculation for admission to Ph.D. candidacy. This is subject to the approval of the advisor and the Director of Graduate Studies in CE. Students who have completed more than 9 units of graded coursework can select at their discretion 9 units toward satisfying the requirements for admission to Ph.D. candidacy.

To apply for Ph.D. candidacy, qualified students need to submit a Ph.D. Qualifying Exam petition form through TGS Forms in GSP. The DGS evaluates the petition and the student's file, and, if approved, forwards the necessary information to TGS.

If the student has not completed the required courses by the end of Q12, the student will be placed on probation and required to take an Oral Qualifier Examination in the next academic quarter. The outcome of this exam will determine whether the student can be admitted to PhD candidacy. The examination is proctored by a committee of at least 3 Core Computer Engineering Faculty that are members of the Northwestern University Graduate Faculty. This committee is formed by the student's advisor and approved by the DGS. The student is responsible for scheduling the Oral Qualifier Examination in consultation with their advisor. A student failing the Oral Qualifier Examination will be excluded from the PhD program. To take the Oral Qualifier Examination, a CE student needs to submit the Examination Request Form through GSP.

Prospectus (Dissertation Proposal)

Students must have a prospectus (dissertation proposal) approved by a faculty committee no later than the end the 16th academic quarter. A student failing to meet this milestone will be placed on probation for a maximum of two quarters.

A minimum of three individuals must serve on this committee. At least two members of this committee, including the committee chair, must be a Core Computer Engineering Faculty or an Affiliated Computer Engineering Faculty. The PhD Prospectus Committee Chair is typically the advisor and must be a Core or Affiliated Computer Engineering Faculty. With the approval of the Committee Chair and the DGS, the PhD Prospectus Committee may include one additional voting member from outside Northwestern University because they are an expert in the area of the student's research. The DGS may

request a resume or curriculum vitae from the prospective external committee member before approving the appointment. Others may be invited to attend the Ph.D. Prospectus Committee meetings as non-voting members.

Upon formation of the prospectus committee, the student should submit the Ph.D. 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. A proposal of the Ph.D. dissertation research topic must be presented orally and in writing by the student. Following an evaluation of the written prospectus document and the performance of the student during the oral presentation, the Ph.D. Prospectus Committee decides on approving the Ph.D. Prospectus.

Dissertation/Thesis/Defense

Students should submit a 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 CE 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.

Program Resources/Support

Professional Skills Development

The Ph.D. program in Computer Engineering aims not only to provide the education, expertise and technical skills that will develop the graduate students into independent and productive scholars in their chosen field of research, but also to provide mentoring in oral and written communication of scientific concepts that will allow the graduate students to effectively reach wider audiences. To that effect, the Computer Engineering program strongly encourages all Ph.D. students to engage in professional development activities in technical writing and public speaking, subject to their advisor's

approval.

Technical Writing

To enhance their technical writing skills beyond writing papers geared toward readers in their own highly-specialized scientific community, students are strongly encouraged to apply to a select subset of the external and internal fellowships they are eligible for. These fellowships can increase the student's stipend, open up new opportunities for flexibility in research, and can be quite prestigious. TGS and the CS and ECE departments maintain pages on available opportunities, but students should also seek advice from their advisor and/or the CE DGS. All Ph.D. students wishing to apply to fellowship opportunities should first consult with their advisor. In addition, students are encouraged to contribute to the writing of grant proposals and/or grant reports, in collaboration with their advisors.

The CE Ph.D. program expects that all Ph.D. students will engage in such activities at some point in their Ph.D. careers. Engagement in technical writing activities will be one of the criteria that students will be evaluated on at the Annual Academic Standing Review.

Public Speaking

Strong communication and public speaking skills are necessary to reach the highest professional levels in both academia and industry. Ph.D. students are expected to participate in public speaking activities by frequently attending seminars organized by the CS and ECE departments, and by volunteering to present their research in departmental seminars. Engagement in public speaking activities will be one of the criteria that students will be evaluated on at the Annual Academic Standing Review.

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 CE-wide annual student performance evaluation. Criteria: Satisfies Core CE coursework; Satisfies Track CE 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, 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 CE-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 PhD Prospectus and Dissertation, and (together with peers from the scientific community through program committee service) in research papers. Discussed at CE-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 CE- 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 CE-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.