ELECTRICAL, ELECTRONICS, AND COMPUTER ENGINEERING

The EECE Ph.D. program addresses the critical need for engineers who are proficient in emerging technologies, knowledgeable in the latest advancements in science and engineering and research that combines deep knowledge in both electrical and computer-related areas. The Ph.D. degree is aimed primarily at those who wish to have academic as well as research and development careers.

This Ph.D. program of the Rackham Graduate School of the University of Michigan-Ann Arbor is located, administered, and offered by UM-Dearborn. The program observes the standards for admissions, registration, degree requirements, awarding of degrees, and other administrative policies and regulations established by the Executive Board of the Rackham Graduate School.

The EECE Ph.D. degree requirements include a minimum of 36 credits of coursework and a minimum of 24 credit hours of dissertation credits for Ph.D. students entering the program without a prior M.S. degree. Students without a master's degree may work toward an M.S. in Electrical Engineering or M.S. in Computer Engineering as part of the candidacy requirements. Both M.S. EE and M.S. CE require 30 credits of graded coursework. To complete the Ph.D. program, students will typically complete a minimum of 6 additional credits hours in coursework in order to satisfy the specific course requirements.

Students with a prior M.S. degree must satisfy the same course requirements or the equivalent from other institutions, as approved by the ECE Graduate Committee. In addition, they must complete 18 credit hours of graded coursework or directed study and a minimum of 24 credit hours of dissertation coursework at the University of Michigan-Dearborn to satisfy the Rackham residency requirement. Waiver of this requirement will be considered for students who obtained their master's degree from a University of Michigan program in a similar area and whose coursework meets the Ph.D. program requirements.

The Doctoral Program proceeds in three stages:

1. Pre-Candidacy

- Coursework providing breadth in ECE
- Coursework providing depth in the chosen area
- Research-based directed study

2. Candidacy

- Successful completion of the qualifying examinations
- Completion of all requirements for Candidacy, including the 4-hour cognate requirement.

3. Dissertation

- Successful dissertation proposal examination
- Successful completion of written Dissertation and public defense presentation

Step 1. Pre-Candidacy

At the beginning of their enrollment in the ECE Ph.D. Program, students will typically take a series of courses to satisfy the depth, breadth, and advanced mathematics requirements. A study plan should be made by every student under consultation with the student's advisor, which will outline the courses and research activities for meeting the milestones of the ECE Ph.D. program. The student's study plan needs to be approved by the ECE Ph.D. Committee, and a copy of the study plan will be included in the student's file. Any change of the study plan must be approved by the ECE Ph.D. Committee.

Breadth Requirement

Students must select three courses from three different core areas. Equivalency is possible. Courses selected to fulfill the ECE Ph.D. Breadth requirement may not also be used to fulfill the ECE Ph.D. Depth requirement. All Ph.D. breadth courses must be completed with a grade of B+ or better within 3 full terms (1 1/2 years) for a student with a relevant Master's degree and 4 full terms (2 years) for all other students. Courses taken at another university that are equivalent in level and content may fulfill one or more of these requirements with appropriate approval.

Depth Requirement

The Depth coursework requirement is designed to ensure that students complete graduate-level coursework relevant to their chosen area of specialization and acquire the core research skills and knowledge of the current research and technologies relevant to this specialization. Here, students must select two courses from one core area, including at least one advanced course (indicated with an asterisk). The Depth courses must be completed with a grade of A- or better. These courses may not be completed via equivalency. These courses must be completed within 3 full terms (1 1/2 years) for a student with a relevant Master's degree and 4 full terms (2 years) for all other students.

Technical Electives

Students can take any courses in the four core areas listed below. The selected courses must be approved by the student's research advisor and the Ph.D. Program Committee and a signed Depth Course Approval form must be submitted when signing up for the Qualifying Examination.

Code	Title	Credit Hours
Computer Systems and Networks		
ECE 514	VLSI Design	
ECE 528	Cloud Computing	
ECE 535	Mob Dev & Ubiqys Comp Sys	
ECE 550	Communication Theory	
ECE 554	Embedded Systems	
ECE 570	Computer Networks	
ECE 5701	Intro to Wireless Comm	
ECE 5702	High-Speed and Adv Networks	
ECE 575	Computer Architecture	
ECE 5752	Reconfigurable Computing	
ECE 578	Advanced Operating Systems	
ECE 5542	Embedded Sig Proc and Control	
ECE 612	Wireless Sensor Networks	
ECE 614	Ctrl Networks for Embedded Sys	
ECE 670	Adv Comp Netwk&WL Comm	
ECE 675	Computer Architecture II	

Control Systems and Signal Processing	
ECE 512	Analog Filter Design
ECE 550	Communication Theory
ECE 555	Stochastic Processes
ECE 560	Modern Control Theory
ECE 565	Digital Control Systems
ECE 567	Nonlinear Control Systems
ECE 580	Digital Signal Processing
ECE 5802	Multirate Sig Proc w/Appl
ECE 581	Arch for Digital Signal Proc
ECE 582	Intro to Statistical DSP
ECE 584	Speech Processes
ECE 589	Multidimen Digital Signal Proc
ECE 661	Sys Ident and Adaptive Control
ECE 665	Optimal Control Systems
ECE 681	Adv Digital Sig Processing
Electronics, Optoelectronics, Power and Energy Systems	
ECE 519	Adv Topics in EMC
ECE 515	Vehicle Electronics II
ECE 517	Adv Pwr Electrncs&Motor Drvs
ECE 532	Auto Sensors and Actuators
ECE 533	Active Automotive Safety Sys
ECE 539	Production of Elec Prods
ECE 541	Sustainable Energy Systems
ECE 542	Intr to Pwr Mgmt & Reliability
ECE 5462	Elec Aspects of Hybrid Vehicle
ECE 566	Mechatronics
ECE 615	Advanced Power Electronics
ECE 646	Adv Elec Drive Transportation
Intelligent Systems and Robotics	
ECE 527	Multimedia Secur & Forensics
ECE 531	Intelligent Vehicle Systems
ECE 532	Auto Sensors and Actuators
ECE 535	Mob Dev & Ubiqys Comp Sys
ECE 536	All Weather Automotive Vision
ECE 537	Data Mining
or CIS 568	Data Mining
ECE 542	Intr to Pwr Mgmt & Reliability
ECE 543	Kinem, Dynam Control Robots
ECE 544	Mobile Robots
ECE 552	Fuzzy Systems
ECE 555	Stochastic Processes
ECE 576	Information Engineering
ECE 579	Intelligent Systems
ECE 5831	Pat Rec & Neural Netwks
ECE 587	Sel Top:Image Proc/Mach Vision
ECE 588	Robot Vision
ECE 643	Humanoids
ECE 644	Advanced Robotics
ECE 679	Adv Intelligent Sys

Advanced Mathematics

Student must take at least one advanced mathematics course. A list of approved advanced mathematics courses is presented below. It is acceptable to use advanced mathematics courses to meet the cognate course requirement.

Code	Title	Credit Hours
MATH 504	Dynamical Systems	3
MATH 5055	Integral Equations	3
MATH 512	Introduction to Modern Algebra	4
MATH 514	Finite Difference Methods for Differential Equations	3
MATH 515	B-Splines & Their Applications	3
MATH 516	Finite Element Methods for Differential Equations	3
MATH 520	Stochastic Processes	3
MATH 525	Statistical Inference	3
MATH 551	Advanced Calculus	4
MATH 552	Advanced Calculus II	3
MATH 554	Fourier Series and Boundary Value Problems	3
MATH 555	Functions of a Complex Variable with Applications	3
MATH 558	Introduction to Wavelets	3
MATH 562	Mathematical Modeling	3
MATH 583	Discrete Optimization	3
MATH 584	Applied&Algorithmic Graph Thy	3
MATH 592	Introduction to Topology	3

Directed Study

All students who aspire to receive a Ph.D. must demonstrate a potential for conducting original research. This is accomplished by completing either three or six credit hours of a research-oriented directed study prior to the Preliminary Exam. These must be taken while in residence on the UMD campus. Ph.D. students must complete all credits of ECE 691 within their first two semesters. At least 3 credit of ECE 691 must be completed in the concentration area of the degree and prior to taking the Qualifying Exam.

Ph.D. Research Seminar

All Ph.D. students will participate in ECE research seminars and colloquia, which will expose them to eminent researchers and current research topics in the broad areas of ECE.

Ph.D. Research Methodology Seminar: ENGR 700

This course provides doctoral students with the fundamental training for conducting high-level scholarly research used in the various fields of engineering. Topics include evaluation of information resources, intellectual property, writing for journals and dissertation, effective work with scientific literature, literature review, plagiarism, publication, bibliographic management, and library resources. Students also complete the Responsible Conduct of Research (RCR) and Scholarship Training workshops. Additionally, students appointed as GSIs are required to attend the approved GSI training workshop.

The course is required for all doctoral students in the first year of enrollment and prior to taking the qualifying exam. Students must register for two semesters of ENGR 700 (one Fall semester and one Winter semester). Passing is based on participation and attendance. The seminars will carry no credit hours.

Cognate Credits

The cognate requirement is intended to foster intellectual breadth in graduate studies. Students must undertake at least 4 credit hours of coursework in an area outside of their chosen field of specialization. The cognate requirement should be approved by the Ph.D. Program Committee, and will generally be satisfied in one of the following ways:

1. Completion of at least 4 credit hours of cognate coursework in one or more approved graduate-level courses listed with a grade of B or better. No more than 6 credit hours of cognate courses can be counted towards the degree requirement.
2. Completion of graduate coursework at another institution that meets the expectation of the cognate requirement. This coursework must be completed no more than 5 years before admission to the EECE Ph.D. program.

Qualifying Examination

The Ph.D. qualifying examination is intended to allow a Ph.D. student to demonstrate her/his potential for conducting original research.

A Ph.D. student must complete at least one directed study course of ECE 591/691 prior to the Qualifying Exam. The directed study course must be taken as a Rackham student at the ECE Department at UM-Dearborn. During their first year in the Ph.D. program, students are required to perform independent research in collaboration with an ECE faculty member. The intent of this research requirement is to provide adequate opportunity for students to work closely with a research advisor to prepare to take the qualifying exam before their qualification deadline. The first-year research requirement is a condition of continued departmental financial support guarantees and can be waived only by petition to the Ph.D. Program Committee with an explanation of special circumstances (e.g., a research-oriented internship directly relevant to the student's qualifying exam preparation) endorsed by the student's academic or research advisor. This requirement does not apply to students who transfer from a terminal MS to the Ph.D. program, who will be given more than one calendar year after entering the MS program.

The student's qualification is evaluated through a written report of a project done in a research-oriented directed study, followed by a 1-2 hour oral exam by a Ph.D. Qualifying Examination Committee, which consists of three faculty members not including the research advisor, two of which are ECE faculty and one is an affiliate faculty. The three faculty members on the Ph.D. qualifying committee are selected by the ECE Ph.D. Program Committee. The oral examination will cover the student's directed study project and knowledge directly related to the student's research area. This examination will be administered during the qualification examination period in every Fall and Winter semester. The director of the students' directed study project may not serve as one of the examiners. The student must submit four copies of the directed study written report to the ECE Ph.D. Program Coordinator at least two weeks before the qualifying examination. The examiners will be given the written report at least one week before the examination.

The faculty in the qualifying examination committee will grade students on a scale of 1-4, representing Poor, Fair, Good and Excellent, respectively. An average score across all faculty members on the examination committee will be at least 3.0 in order to pass the qualifying examination. A student is given two chances to take the qualifying examination within the first three years.

Step 2. Candidacy

Students are initially admitted to the program as pre-candidates. Candidacy will normally be achieved in the second or third year of study after completion of the Qualifying Examination and completion of at least three semesters of courses with a grade-point-average of at least 3.5 over a scale of 1-4. A student will be admitted to Ph.D. Candidacy only if she/he satisfies every requirement below.

Candidacy Requirements

1. Successful completion of the ECE Qualifying Examination, which is described below.
2. Fulfillment of all course requirement and all other candidacy requirements such as cognate coursework with a grade-point-average of at least 3.4 over a scale of 1 ~ 4. A student may satisfy the Ph.D. cognate requirement—four to six hours of graduate-level coursework — by taking the graduate course(s) associated with CECS programs (not his/her own), by taking the graduate course(s) outside the department, or by a mixture thereof. Courses taken from other programs cannot overlap in content with any ECE course-related material. Any course in question must have prior approval of the ECE Ph.D. Program Committee.
3. Soon after passing the Qualifying Examination, the candidate and the advisor will form a Dissertation Committee, which should be submitted to the ECE Ph.D. Program Committee for preliminary approval. Normally the advisor serves as chair or co-chair of this committee. It is the responsibility of the student and the advisor to find eligible faculty members willing to serve. A typical Ph.D. Dissertation Committee will consist of three regular ECE faculty, one industry expert with a Ph.D. degree, and one faculty member outside of the ECE department. The Dissertation Committee is responsible for reviewing the student's progress, including the dissertation proposal and the final dissertation. The dissertation committee must be approved by the ECE. Ph.D. Program Committee at least one month before the dissertation proposal examination date.
4. A student must apply for candidacy by submitting the appropriate forms to the ECE Ph.D. Program Committee. These forms must be submitted before the student plans to become a candidate. Candidacy is not awarded automatically; it must be applied for.

The achievement of candidacy is considered an important milestone in a Ph.D. student's progress, and all students are expected to apply for candidacy as soon as they are eligible. Full-time students with a relevant Master's degree must achieve candidacy in four terms (2 years). Students that have only a Bachelor's degree will be allowed six terms (3 years) to achieve candidacy. Part-time students with a relevant Master's degree must achieve candidacy in six terms (2.5 years). Part-time students that have only a Bachelor's degree will be allowed eight terms (4 years) to achieve candidacy.

Step 3. Dissertation

Dissertation Committee

The Dissertation Committee will consist of the chair and at least three other members. The student's dissertation advisor will serve as chair. Of the additional members, two must hold at least 50% appointment as tenured or tenure-track faculty of the Computer and Information Science Department, with at least one being a member of the graduate faculty. The third committee member must be from outside the department: a faculty from another department or another university or an expert from industry.

The composition of the Dissertation Committee has to be approved by the Ph.D. Program Committee.

Dissertation Proposal

A full-time (part-time) student entering with a Bachelor degree must successfully complete a dissertation proposal within 3.5 (4) years from the start of graduate study to maintain satisfactory progress. A student full-time (part-time) with a relevant Master's degree must complete the dissertation proposal examination within 2.5 (3) years. The dissertation proposal examination will be administered by the Dissertation Committee (see above). The student will submit a dissertation research proposal to the Dissertation Committee at least two weeks in advance of the date of an oral examination. In the written proposal, the student must precisely identify the intellectual area in which he or she intends to pursue research and must demonstrate an in-depth understanding of that area. The student must give a general description of the research problem to be addressed and an outline of the approach that will be taken. It is desirable that the research problem be specified in considerable detail and that some initial results be presented. During the oral presentation, the student will present the proposed dissertation research, including relevant background material and preliminary research results. During and after the presentation, the Dissertation Committee will explore the research area with the student to determine whether the student has completed this phase successfully. The Dissertation Committee will prepare a written evaluation report on the outcome of the proposal presentation, and a copy of the written proposal will be placed in the student's file. Students may receive one of the two possible outcomes, (1) the Dissertation Committee has approved the dissertation proposal, or (2) the student needs to revise the dissertation proposal and take the proposal examination one more time.

Dissertation and Final Defense

After the dissertation proposal has been approved, the candidate may proceed with the dissertation research and the writing of the dissertation. Upon completion of the dissertation, the student must receive a written evaluation of her/his dissertation from each member of the Dissertation Committee, and must defend her/his dissertation orally in an open examination (the Final Defense) before the Dissertation Committee, in accordance with Rackham rules. The dissertation defense may not be scheduled in the same academic term as the dissertation proposal examination.

Dissertation Proposal Examination and the dissertation oral defense should be at least 14 weeks.