

ELECTRICAL AND SYSTEMS ENGINEERING, PHD

The ESE PhD program is designed to provide sufficient structure to help you build a strong foundation and to have sufficient flexibility to accommodate the direction of your creativity. You will collaborate closely with your faculty advisor on the direction of your research and develop skills needed to perform independent research and teaching in an exciting, intellectual environment. Current concentration areas are circuits and computer engineering, nanodevices and nanosystems, and information and decision systems. ESE research is focused on the development and application of systems theory to the design of physical, biological, and socio-technical artifacts that improve the human condition.

For more information: <http://www.ese.upenn.edu/current-students/doctoral/index.php> (<http://www.ese.upenn.edu/current-students/doctoral/>)

Course Requirements

ESE Doctoral students must complete a required series of 20 course units (CUs) of graduate-level courses and research units. A minimum of 10 CUs must be graduate level courses. The remaining 10 CUs are composed of Research Units (ESE 9999).

10 CUs of Coursework: these graduate level courses are organized by depth, breadth, critical thinking and elective categories.

The student must discuss with their advisor the courses that would best suit each of these categories for their specific PhD career at Penn. Course plans for ESE PhDs are very individualized and must be approved by their Faculty Advisor.

Code	Title	Course Units
EAS 9000	Responsible Conduct for Research (RCR), Engineering	0
Depth Requirement		5
At least five graduate-level courses in areas supporting the research of the Ph.D. student.		
Breadth Requirement		2
At least two graduate-level courses which are distinct from the major research area. ¹		
Critical Thinking Requirement		2
At least two graduate-level courses satisfying formal analytical reasoning. ²		
ENM 5000-9999		
MATH 5000-9999		
STAT 5000-9999		
PHYS 5516	Electromagnetic Phenomena	
PHYS 5518	Introduction to Condensed Matter Physics	
PHYS 5529 & PHYS 5530	Modern Optics and Modern Optical Physics and Spectroscopy	
PHYS 5531	Quantum Mechanics I	
PHYS 5532	Quantum Mechanics II	
PHYS 6611	Statistical Mechanics	

PHYS 6612	Advanced Statistical Mechanics	
PHYS 6661	Solid State Theory I	
PHYS 6662	Solid State Theory II	
ESE 5000	Linear Systems Theory	
ESE 5100	Electromagnetic and Optics	
ESE 5210	The Physics of Solid State Energy Devices	
ESE 5320	System-on-a-Chip Architecture	
ESE 5720	Analog Integrated Circuits	
ESE 5230	Quantum Engineering	
ESE 5300	Elements of Probability Theory	
CIS 6730	Computer-Aided Verification	
ENM 5120	Nonlinear Dynamics and Chaos	
ENM 5310	Data-driven Modeling and Probabilistic Scientific Computing	
ESE 5420	Statistics for Data Science	
AMCS 5100	Complex Analysis	
AMCS 5141	Advanced Linear Algebra	
BE 5180	Optical Microscopy	
CIS 5000	Software Foundations	
CIS 5020	Analysis of Algorithms	
Elective		1
Any remaining courses approved by your faculty advisor may fulfill this category.		
Research Courses³		10
ESE 9999	Independent Study Research	
Teaching Requirement		
ESE 8950	Teaching Practicum	
Dissertation		
ESE 9950	Dissertation	
Total Course Units		20

University PhD Benchmarks

In addition to Program requirements, the following milestones must be completed:

Code	Title	Course Units
	Qualifying Evaluation	
	Candidacy Examination	
	Dissertation Defense/Oral Exam	
	Dissertation Deposit	

For more information view the University's Academic Rules for PhD Programs (<http://catalog.upenn.edu/pennbook/academic-rules-phd/>).

¹ The courses may be thematically linked in a 5000-6000 sequence or may represent two 5000 level courses both distinct from the major research area. Independent Studies cannot be used in this category.

² Courses from other departments may be used provided they have a clear focus on mathematical reasoning and techniques and have been pre-approved. Independent study Research cannot be used in this category.

³ Additional Research Units (9999) may be taken in order to maintain a full-time status (see below). Students who have completed their course

work will register for 3 CUs 9999 per semester to maintain full time status until they register for 9950.

The degree and major requirements displayed are intended as a guide for students entering in the Fall of 2025 and later. Students should consult with their academic program regarding final certifications and requirements for graduation.
