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/)

View the University's Academic Rules for PhD Programs (http://catalog.upenn.edu/pennbook/academic-rules-phd/).

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 9990 Thesis/Dissertation Research) and may include up to two Independent Study (ESE 8990 Independent Study for PhD credit) units .

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.

- **Depth Requirement:** At least five graduate-level courses in areas supporting the research of the Ph.D. student.
- **Breadth Requirement:** At least two graduate-level courses which are distinct from the major research area. The courses may be thematically linked in a 500-600 sequence or may represent two 5000 level courses both distinct from the major research area. Independent Studies cannot be used in this category.
- **Critical Thinking Requirement:** At least two graduate-level courses satisfying formal analytical reasoning. Courses that satisfy this requirement include graduate courses in Mathematics, Engineering Mathematics, Statistics, or Discrete Mathematics and the following Physics courses:

Code	Title	Course Units
PHYS 5516	Electromagnetic Phenomena	1
PHYS 5518	Introduction to Condensed Matter Physics	1
PHYS 5529 & PHYS 5530	Modern Optics and Modern Optical Physics and Spectroscopy	2
PHYS 5531	Quantum Mechanics I	1
PHYS 5532	Quantum Mechanics II	1
PHYS 6611	Statistical Mechanics	1
PHYS 6612	Advanced Statistical Mechanics	1
PHYS 6661	Solid State Theory I	1
PHYS 6662	Solid State Theory II	1

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

- **Electives:** Any remaining courses approved by your faculty advisor may fulfill this category.
- **10 CUs of Research**: Students may use up to two Independent Study units (ESE 8990) to fulfill this requirement. Independent Study units are not required. Additional Research Units (9990) 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 of Research Units per semester to maintain full time status.

The degree and major requirements displayed are intended as a guide for students entering in the Fall of 2023 and later. Students should consult with their academic program regarding final certifications and requirements for graduation.