Requirements for the Ph.D. Degree in Electrical & Systems Engineering

Doctoral students must complete a minimum of 20 graduate level course units (C.U.) with a minimum of 11 C.U. of approved courses (not including ESE 899 and 999) in order to be eligible for graduation. Beyond this, no more than 2 C.U. of independent study (899) or research credit (999) can be counted towards the 20 C.U. minimum. Up to 9 C.U. can be permitted as transfer credits, with a maximum of 5 C.U. able to count against courses that are not independent study (899) or research (999) courses. 11 C.U. must be completed at the University of Pennsylvania, of which at least 6 C.U. of must be non ESE 899, or 999 units.

RCR Requirement (Non-credit requirement)
Not required to complete RCR if you joined the program before fall 2010.

- EAS 900: Responsible Conduct in Research Engineering
- CITI Online module via Penn’s Knowledge Link

Depth Major Requirements (5 C.U.)
At least five graduate-level courses in areas supporting the research of the Ph.D. student.

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- ________________________________  ________________________________
- ________________________________

Breadth Major Requirements (2 C.U.)
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 500 level courses, both distinct from the major research area. Independent studies cannot be used in this category.

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Critical Thinking Requirements (2 C.U.)
At least two graduate level courses satisfying formal analytical reasoning, which includes graduate courses in Mathematics, Engineering Mathematics, Statistics, or Discrete Mathematics and certain designated courses in Physics (only PHYS 516, PHYS 518, PHYS 530, PHYS 531, PHYS 532, PHYS 611, PHYS 612, PHYS 661, PHYS 662). Independent studies cannot be used in this category.

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Electives (2 C.U. minimum)
Independent studies cannot be used in this category. Additional elective credits may be necessary, based on use of transfer credits and independent studies.

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Independent Studies/ESE 899 (0 C.U. required/up to 2 C.U. permitted)
Only Independent Studies (ESE 899) can be used in this category.

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Teaching Practicum Requirements (1 C.U.)
You may only register for this requirement beginning in your second year with the permission of the course instructor to serve. An English Proficiency Certificate is required for undergraduate teaching and recommended for instruction at the graduate level. Certificates can be awarded after a successful score on SPEAK or IPT exams or through a TOEFL Speaking score exemption. Please see Penn’s English Language Programs website for more details.

- ESE 895: TA Practicum (0.5 C.U.)  ESE 895: TA Practicum (0.5 C.U.)

University Requirements
- Qualifications Examinations (2 examinations required) – Pass (see reverse)
- Research/Dissertation Proposal – Pass
- Dissertation Defense – Pass
Electrical & Systems Engineering Doctoral Program – Qualifier Examinations

**Requirement:** The qualifying exam is a written examination. Students must pass TWO (2) qualifier exams by the end of the spring of the second academic year of their doctoral study.

**Selection:** There are three core research thrusts – Devices; Circuits & Computer Engineering; and Information Systems. There are two qualifier areas per research thrust.

Each doctoral student must pass two (2) qualifier exams from any of the six available options. The qualifier exam in each area is the final exam in the corresponding course.

<table>
<thead>
<tr>
<th>THRUSTS</th>
<th>Devices</th>
<th>Circuits &amp; Computer Engineering</th>
<th>Information Systems (Control &amp; Communications)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qualifier Areas</td>
<td>ESE 510: Electromagnetic &amp; Optical Theory (offered in FALL)</td>
<td>ESE 534: Computer Organization (offered in SPRING)</td>
<td>ESE 500: Linear Systems Theory (offered in FALL)</td>
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**Grading:** The department will appoint a two-member committee for each of the courses, with the instructor for the current year acting as the head of the committee. Each committee will finalize and publicly announce the course syllabus by the second week of the semester.

These syllabi will serve both as plans for the courses and as reading lists for the corresponding sections of the Qualifier. All Qualifier courses will have written in-class final exams, taking place during the usual university final examination period.

The qualifiers will be set and graded by the same two-member faculty committee that also set the syllabus. The committee will then determine precisely the minimum performance on each specific exam that would constitute a Qualifier pass.

Thresholds for qualifier pass/fail will generally be higher than the pass/fail for that course. The Qualifier results are separate from the grade in the course; i.e., the complete course load (e.g., homeworks, projects, midterms, quizzes). Thus the criteria for obtaining the grade in the course are set separately from the Qualifier passing criteria. The results will be announced to the students by the graduate chair/coordinator.