

# ELECTRICAL ENGINEERING PHD

## Degree Requirements

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (<https://catalogs.northwestern.edu/tgs/academic-policies-procedures/>).

The PhD program in Electrical Engineering is divided into two Programs of Study:

- Solid-State, Photonic, and Quantum Technologies
- Signals and Systems

There are requirements common to both Programs as well as additional requirements specific to each Program.

## Common Requirements

### Course Requirements

- EE requires a minimum of **15 graded courses** that count for graduate (TGS) credit, not including ELEC\_ENG 590-0. The cumulative grade point average over these graded courses must be a B (3.0 GPA) or higher. Courses that provide zero units of credit do not count toward these 15 units.
- **At least 6** of these 15 units must be 400- or 500-level courses.
- **At most 2** of these 15 units can be ELEC\_ENG 499-0. This course is reserved for projects that are not directly related to the research required for the PhD thesis or for readings in specific subjects for which the ECE Department has no regular courses. ELEC\_ENG 499-0 is not intended to replace or augment the required units of ELEC\_ENG 590-0.
- All PhD students are required to complete the zero-credit Responsible Conduct for Research Training (GEN\_ENG 519-0) during their first year.
- A student's adviser may require more than the minimum number of courses. In such cases, the number of required ELEC\_ENG 590-0 units will be reduced accordingly.

### Other PhD Requirements

- Teaching Requirement
- Qualifying Examination
- Prospectus
- Dissertation
- Final Exam (dissertation defense)

[Additional requirements and processes are detailed in the Electrical Engineering Graduate Study Guide.](#)

## Solid-State, Photonic, and Quantum Technologies

### Course Requirements

**Total Units Required: 15**

| Course   | Title                           |
|--|---------------------------------|
| <b>Core courses in Solid-State, Photonic, and Quantum Technologies</b> |                                 |
| <i>Each student must take 5 of the following courses:</i>              |                                 |
| ELEC_ENG 382-0   | Photonic Information Processing |
| ELEC_ENG 383-0   | Fiber-Optic Communications      |
| ELEC_ENG 388-0   | Nanotechnology                  |

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|--|---|
| ELEC_ENG 401-0   | Fundamentals of Electronic Devices  |
| ELEC_ENG 402-0   | Advanced Electronic Devices   |
| ELEC_ENG 403-0   | Quantum Semiconductors  |
| ELEC_ENG 404-0   | Quantum Electronics   |
| ELEC_ENG 405-0   | Advanced Photonics  |
| ELEC_ENG 406-0   | Nonlinear Optics  |
| ELEC_ENG 411-0   | Fundamentals and Applications of Special Relativity                       |
| <b>Area-specific courses in Solid-State, Photonic, and Quantum Technologies</b>                    |   |
| <i>Electives must be approved by the student's adviser, and may include the following courses:</i> |   |
| ELEC_ENG 333-0   | Introduction to Communication Networks                                    |
| ELEC_ENG 381-0   | Electronic Properties of Materials  |
| ELEC_ENG 384-0   | Solid State Electronic Devices  |
| ELEC_ENG 385-0   | Optoelectronics   |
| ELEC_ENG 389-0   | Superconductivity and Its Applications                                    |
| ELEC_ENG 407-0   | Quantum Optics  |
| ELEC_ENG 408-2   | Computational Electrodynamics   |
| ELEC_ENG 409-0   | Semiconductor Lasers  |
| ELEC_ENG 422-0   | Random Processes in Communications and Control 1                          |
| ELEC_ENG 423-0   | Random Processes in Communications and Control 2                          |
| ELEC_ENG 424-0   | Distributed Optimization  |
| ELEC_ENG 425-0   | Introduction to Nanoscale Lasers, Quantum Noise, Photons, and Measurement |
| ELEC_ENG 427-0   | Optical Communications  |
| ELEC_ENG 428-0   | Information Theory and Learning   |
| ELEC_ENG 429-0   | Selected Topics in Quantum Information Science and Technology             |
| ELEC_ENG 454-0   | Advanced Communication Networks   |
| ES_APPM 414-0  | Differential Equations of Mathematical Physics                            |

## Signals and Systems

### Course Requirements

**Total Units Required: 15**

| Course  | Title   |
|---|---|
| <b>Courses in Signals and Systems</b>   |   |
| <i>Each student must complete a sequence of courses in an area of specialization according to the recommendation of the adviser. These courses may be in Signals and Systems and other areas. Courses in Signals and Systems may include:</i> |   |
| ELEC_ENG 307-0  | Communications Systems  |
| ELEC_ENG 332-0  | Introduction to Computer Vision   |
| ELEC_ENG 333-0  | Introduction to Communication Networks                                    |
| ELEC_ENG 359-0  | Digital Signal Processing   |
| ELEC_ENG 360-0  | Introduction to Feedback Systems  |
| ELEC_ENG 363-0  | Digital Filtering   |
| ELEC_ENG 374-0  | Introduction to Digital Control   |
| ELEC_ENG 378-0  | Digital Communications  |
| ELEC_ENG 380-0  | Wireless Communications   |
| ELEC_ENG 395-0  | Special Topics in Electrical Engineering (Cardiovascular Instrumentation) |
| ELEC_ENG 410-0  | System Theory   |
| ELEC_ENG 418-0  | Advanced Digital Signal Processing  |
| ELEC_ENG 420-0  | Digital Image Processing  |
| ELEC_ENG 421-0  | Multimedia Signal Processing  |
| ELEC_ENG 422-0  | Random Processes in Communications and Control 1                          |
| ELEC_ENG 423-0  | Random Processes in Communications and Control 2                          |
| ELEC_ENG 424-0  | Distributed Optimization  |
| ELEC_ENG 426-0  | Signal Detection and Estimation   |

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| ELEC_ENG 427-0 | Optical Communications   |
| ELEC_ENG 428-0 | Information Theory and Learning  |
| ELEC_ENG 431-0 | Human Perception and Electronic Media  |
| ELEC_ENG 432-0 | Advanced Computer Vision   |
| ELEC_ENG 433-0 | Statistical Pattern Recognition  |
| ELEC_ENG 435-0 | Deep Learning: Foundations, Applications, and Algorithms                     |
| ELEC_ENG 454-0 | Advanced Communication Networks  |
| ELEC_ENG 463-0 | Adaptive Filters   |
| ELEC_ENG 470-0 | Introduction to Nonlinear Control Theory                                     |
| ELEC_ENG 473-0 | Deep Reinforcement Learning  |
| ELEC_ENG 475-0 | Machine Learning: Foundations, Applications, and Algorithms                  |
| ELEC_ENG 478-0 | Advanced Digital Communications  |
| ELEC_ENG 495-0 | Special Topics in Electrical Engineering<br>(Cardiovascular Instrumentation) |