

APPLIED PHYSICS 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/>).

Master's

The Applied Physics Program does not offer a terminal master's program, and only students who intend to pursue the PhD are admitted. However, PhD students who satisfactorily complete the first year of classes and pass a comprehensive examination are eligible to receive a Master of Science degree.

PhD

The formal requirements for a PhD in Applied Physics are:

- The core courses
- The oral qualifying exam
- The teaching experience
- The prospectus or thesis proposal
- The thesis defense

Core Courses

Total Units Required: 10

| Course | Title |
|--|--|
| Core Courses | |
| MAT_SCI 401-0 or PHYSICS 416-0 | Chemical & Statistical Thermodynamics of Materials Introduction to Statistical Mechanics |
| PHYSICS 412-1 & PHYSICS 412-2 | Quantum Mech and Quantum Mechanics |
| PHYSICS 411-1 | Methods of Theoretical Physics |
| GEN_ENG 519-0 or CHEM 519-0 or PHYSICS 519-0 | Responsible Conduct for Research Training ^{required but not for credit} Responsible Conduct of Research Training Responsible Conduct of Research Training |
| PHYSICS 414-1 | Electrodynamics |
| MAT_SCI 405-0 or PHYSICS 422-1 | Physics of Solids Condensed-Matter Physics |
| Computational Methods of Applied Physics course ^{See list of course options below.} | |
| Experimental Methods of Applied Physics course ^{See list of course options below.} | |
| Elective 1 (Graduate level class) | |
| Elective 2 (Graduate level class) | |

List of course options for Computational Methods of Applied Physics

| Course | Title |
|----------------|--|
| CHEM 448-0 | Computational Chemistry |
| CHEM_ENG 451-0 | Applied Molecular Modeling |
| ES_APPM 446-2 | Numerical Solution of Partial Differential Equations |
| MAT_SCI 458-0 | Atomic Scale Computational Materials Science |
| MECH_ENG 417-0 | Multi-scale Modeling and Simulation in Solid Mechanics |
| MECH_ENG 418-0 | Multi-Scale Modeling and Simulation in Fluid Mechanics |
| MECH_ENG 423-0 | Intro to Computational Fluid Dynamics |
| MECH_ENG 426-1 | Advanced Finite Element Methods I |

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| MECH_ENG 426-2 | Advanced Finite Element Methods II |
| ELEC_ENG 435-0 | Deep Learning: Foundations, Applications, and Algorithms (Cross listed with DATA_SCI 423-0) |
| ELEC_ENG 463-0 | Adaptive Filters (Must complete computational project for approval) |
| ELEC_ENG 475-0 | Machine Learning: Foundations, Applications, and Algorithms (Cross-listed with DATA_SCI 423-0) |
| ELEC_ENG 495-0 | Special Topics in Electrical Engineering (Approval is for Optimization techniques for machine learning and deep learning and for Deep learning from scratch) |
| PHYSICS 430-0 | Nonlinear Dynamics & Chaos |
| PHYSICS 441-0 | Statistical Methods for Physicists and Astronomers |
| PHYSICS 465-0 | Advanced Topics in Nonlinear Dynamics |

List of course options for Experimental Methods of Applied Physics

| Course | Title |
|----------------|--|
| MECH_ENG 433-0 | Advanced Mechatronics |
| MAT_SCI 460-0 | Electron Microscopy |
| MAT_SCI 461-0 | Diffraction Methods in Material Science |
| MAT_SCI 465-0 | Advanced Electron Microscopy & Diffraction |
| MAT_SCI 466-0 | Analytical Electron Microscopy |

Oral Qualifying Exam

Students are required to pass a qualifying exam before advancing to the second year of the program. This exam takes the form of a short presentation made to an examining committee, followed by a closed question session before the committee. There is no written qualifier.

Teaching Experience

One quarter of teaching experience is required by the Graduate School. Since AP is a graduate-only program, our students gain this experience by serving as TAs in a variety of undergraduate departments.

Prospectus or Thesis Proposal and Defense

Students must submit and defend their thesis proposal before the end of the spring quarter of the third year.

This includes a written proposal and a 30 mins defense followed by questions from the faculty committee.

Thesis Defense

Each PhD candidate must pass a Thesis Defense based on the work presented in the candidate's dissertation. The faculty committee assembled previously for the thesis proposal and defense conducts the examination. The examination involves a mandatory open and publicized oral presentation and discussion during the first hour, followed by a closed examination with only the faculty committee.