PHYSICS

Graduate Program Head	Mauricio Terrones
Program Code	PHYS
Campus(es)	University Park (Ph.D., M.S., M.Ed.)
Degrees Conferred	Doctor of Philosophy (Ph.D.) Master of Science (M.S.) Master of Education (M.Ed.)
The Graduate Faculty	View (https://secure.gradsch.psu.edu/gpms/?searchType=fac&prog=PHYS)

Graduate instruction and research opportunities are available in:

- atomic and molecular physics,
- laser physics,
- experimental and theoretical condensed matter and materials physics,
- surface physics,
- low-temperature physics,
- statistical physics,
- acoustics,
- nuclear physics,
- experimental and theoretical particle physics,
- quantum field theory,
- general relativity,
- cosmology and relativistic astrophysics, and
- quantum gravity.

Work in some areas is conducted in cooperation with the Materials Research Institute, the Applied Research Laboratory, and other interdisciplinary research facilities.

Admission Requirements

Applicants apply for admission to the program via the J. Jeffrey and Ann Marie Fox Graduate School application for admission (https://gradschool.psu.edu/admissions/how-to-apply/). Requirements listed here are in addition to Graduate Council policies listed under GCAC-300 Admissions Policies (https://gradschool.psu.edu/graduate-education-policies/).

Graduate Record Examination (GRE) scores are not required for admission. Submission is welcome if available.

The language of instruction at Penn State is English. English proficiency test scores (TOEFL/IELTS) may be required for international applicants. See GCAC-305 Admission Requirements for International Students (https://gradschool.psu.edu/graduate-education-policies/gcac/gcac-300/gcac-305-admission-requirements-international-students/) for more information.

A bachelor's degree in physics or an allied field is required for admission to the M.S., and Ph.D. programs. Students with a 2.50 or higher junior/senior grade-point average (on a 4.00 scale) in physics and mathematics will be considered, and the best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 GPA may be made for students with special backgrounds, abilities, and interests. Exceptions may also be made for applicants for doctoral programs who have completed master's degrees at other institutions.

Admission and study programs for the M.Ed. degree are handled on an individual basis.

Degree Requirements

Master of Education (M.Ed.)

Requirements listed here are in addition to Graduate Council policies listed under GCAC-700 Professional Degree Policies (https://gradschool.psu.edu/graduate-education-policies/).

A minimum of 30 credits at the 400, 500, or 800 level is required, with a minimum of 18 credits at the 500 or 800 level, and at least 6 credits at the 500 level.

At least 18 credits in physics are required. Six additional nonresearch science credits (which may be in physics) and a 6-credit minor in a field of professional education also must be included. A term paper must be submitted and accepted by the department.

Master of Science (M.S.)

Requirements listed here are in addition to Graduate Council policies listed under GCAC-600 Research Degree Policies. (https://gradschool.psu.edu/graduate-education-policies/)

A minimum of 30 credits at the 400, 500, 600, or 800 level is required. For the thesis option, at least 18 credits must be at the 500 and 600 level, combined. For the non-thesis option, at least 18 credits must be at the 500-level. 600 and 610 credits are for the thesis option only. Required courses include PHYS 559 (2 credits) and PHYS 590.

Code	Title	Credits
Required Courses		
PHYS 559	Graduate Laboratory	2
PHYS 590	Colloquium	1

There are two options.

- Thesis option: A research-based thesis must be written. The thesis must be based on at least 6 credits of PHYS 600 or PHYS 610 and must conform to Graduate School regulations. The thesis must be accepted by the advisers and/or committee members, the head of the graduate program, and the Graduate School.
- Nonthesis option: PHYS 530, PHYS 557, and either PHYS 561 or 410 are required. Students must complete at least 18 credits at the 500 level. This is an additional 6 to 10 credits beyond the required courses depending on whether the students take PHYS 561 or PHYS 410. A short paper must be submitted to, and accepted by, the department.

There is no degree examination for either option.

Doctor of Philosophy (Ph.D.)

Requirements listed here are in addition to Graduate Council policies listed under GCAC-600 Research Degree Policies. (https://gradschool.psu.edu/graduate-education-policies/)

Code	Title	Credits
Required Courses		
PHYS 517	Statistical Mechanics	3
PHYS 530	Theoretical Mechanics	3

PHYS 557	Electrodynamics	3
PHYS 559	Graduate Laboratory	2
PHYS 561	Quantum Mechanics I	3
First-Year Seminar Series		
Total Credits		**14**

Courses required beyond these depend on the Ph.D. research subfield. Students take at least four additional 3-credit, 500-level physics courses.

A qualifying examination is given at the end of the first year, a comprehensive examination approximately two years after the qualifying examination, and a final oral examination (the dissertation defense) takes place after the completion of the dissertation. The dissertation must be accepted by the Ph.D. committee, the head of the graduate program, and the Graduate School. There is no departmental foreign language requirement, although a reading knowledge of one foreign language may be needed in some areas of research.

Minor

A graduate minor is available in any approved graduate major or dual-title program. The default requirements for a graduate minor are stated in Graduate Council policy GCAC-218 Minors (https://gradschool.psu.edu/graduate-education-policies/gcac/gcac-200/gcac-218-minors/).

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the Tuition & Funding (https://gradschool.psu.edu/funding/) section of the J. Jeffrey and Ann Marie Fox Graduate School's website. Students on graduate assistantships must adhere to the course load limits (https://gradschool.psu.edu/graduate-education-policies/gsad/gsad-900/gsad-901-graduate-assistants/) set by the Fox Graduate School.

The following awards typically have been available to graduate students in this program:

Homer F. Braddock Graduate Fellowships

Available to exceptional Ph.D. candidates in several departments of the Eberly College of Science. They carry stipends of $3,500 to $7,500 per year for each of the first three years.

Wheeler P. Davey Memorial Fellowships

Carry stipend of variable amount and are available to a limited number of qualified graduate students in the Eberly College of Science.

David C. Duncan Graduate Fellowships

Available to first- and second-year graduate students in physics and carry a stipend of approximately $2,000 per year for each of the first two years.

Frymoyer Scholarship

W. Donald Miller Graduate Fellowship

David H. Rank Memorial Physics Award

The Nellie and Oscar L. Roberts Fellowships

Available to graduate students majoring in the physical sciences and in biochemistry and molecular biology. Each award is for $4,000 per year for one or two years.

Courses

Graduate courses carry numbers from 500 to 699 and 800 to 899. Advanced undergraduate courses numbered between 400 and 499 may be used to meet some graduate degree requirements when taken by graduate students. Courses below the 400 level may not. A graduate student may register for or audit these courses in order to make up deficiencies or to fill in gaps in previous education but not to meet requirements for an advanced degree.

Physics (PHYS) Course List (https://bulletins.psu.edu/university-course-descriptions/graduate/phys/)

Learning Outcomes

Master of Education (M.Ed.)

1. **KNOW:** Graduates will demonstrate mastery in physics core knowledge and research methodologies that underpin the practice of modern physics. Mastery is defined as the ability to define and explain principles, recognize their application in physical phenomena, and to choose and apply appropriate principles and mathematical tools to set up and solve physics problems. Graduates will be able to apply physics concepts and combine them with high-level mathematical methods to solve problems.
2. **PROFESSIONAL PRACTICE:** Graduates will (i) know and understand professional standards of ethics and conduct, (ii) be able to analyze situations to identify the standards that should apply and (iii) will be able to describe how they may be appropriately acted upon.
3. **COMMUNICATE:** Graduates will demonstrate the ability to communicate professionally, in written form, research work and conclusions to physics sub-field expert and non-expert audiences.
4. **THINK:** Graduates will be able to summarize modern methods in physics education and curricular development for physics education.
5. **APPLY/CREATE:** Graduates will be able to apply foundational knowledge and methods to a specific research problem, they will be able to summarize the primary literature directly connected to it and to analyze and judge new contributions to the primary literature in the same area.

Master of Science (M.S.)

1. **KNOW:** Graduates will demonstrate mastery in physics core knowledge and research methodologies that underpin the practice of modern physics. Mastery is defined as the ability to define and explain principles, recognize their application in physical phenomena, and to choose and apply appropriate principles and mathematical tools to set up and solve physics problems. Graduates will be able to apply physics concepts and combine them with high-level mathematical methods to solve problems.
2. **PROFESSIONAL PRACTICE:** Graduates will (i) know and understand professional standards of ethics and conduct, (ii) be able to analyze situations to identify the standards that should apply and (iii) will be able to describe how they may be appropriately acted upon.
3. **COMMUNICATE:** Graduates will demonstrate the ability to communicate professionally, in written form, research work and conclusions to physics sub-field expert and non-expert audiences.
4. **THINK:** Graduates will be able to summarize (i) several outstanding problems or questions in diverse subfields of physics, (ii) the experimental, observational, or theoretical origins of these problems, and (iii) the principal efforts proposed or underway to address them.
5. **APPLY/CREATE:** Graduates will be able to apply foundational knowledge and methods to a specific research problem, they will be

able to summarize the primary literature directly connected to it and to analyze and judge new contributions to the primary literature in the same area.

Doctor of Philosophy (Ph.D.)

1. **KNOW:** Graduates shall demonstrate advanced knowledge and understanding in physics core knowledge (statistical mechanics, theoretical mechanics, classical electrodynamics, and quantum physics) and experimental, observational, and theoretical methodologies, that underpin the practice of modern physics.
2. **THINK:** Graduates shall demonstrate, at a level appropriate to a departmental colloquium, (i) knowledge of several outstanding problems or questions in diverse sub-fields of physics, (ii) the experimental, observational, or theoretical origins of these problems, and (iii) the principle efforts proposed or underway to address them.
3. **COMMUNICATE:** Graduates shall demonstrate the ability to communicate professionally, in written and oral form, research work and conclusions to physics sub-field expert and non-expert audiences.
4. **PROFESSIONAL PRACTICE:** Graduates shall demonstrate (i) knowledge and understanding of professional standards of ethics and conduct, (ii) the ability to analyze situations to identify the standards that should apply and (iii) describe how they may be appropriately acted upon.
5. **APPLY/CREATE:** Graduates shall have a specialty area within the broad domain of physics, within which they shall demonstrate (i) advanced knowledge and understanding of the primary literature, (ii) the ability to analyze and judge new contributions to the primary literature, (iii) the ability to pose complex research problem(s) and identify the knowledge and methodologies required to address them, and (iv) the ability to apply that knowledge and those methodologies to create new knowledge and/or develop new experimental techniques that advance (or show the potential to advance) knowledge and understanding within the specialty area.

Contact

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