Physics, PhD (Boston)

The Department of Physics offers a Doctor of Philosophy in Physics with specializations in different subfields that reflect the forefront research activities of the department including biological physics, condensed matter physics, elementary particle physics, astrophysics, nanomedicine, and network science. The program for the PhD degree consists of the required coursework, the proficiency exams, a preliminary research seminar, the completion of a dissertation based upon original research performed by the student, and a dissertation defense upon completion of the dissertation. Based on these measures, students are expected to obtain a graduate-level understanding of basic physics concepts and demonstrate the ability to formulate a research plan, communicate orally, and do research.

Entrance with a Bachelor's Degree

COURSEWORK

The required courses are grouped into two sets, Part 1 and Part 2, having a total of 42 semester hours as a minimum. Part 1 courses (first-year courses) are taken prior to the proficiency exam. Students without a master's degree must complete all Part 1 courses in the first year to remain in good academic standing in the graduate program. Part 2 courses (second-year courses) may be taken before or after passing the proficiency exam. See Core Course Requirements and Program of Study for course details. Students with a master's degree should see Advanced Entry Program Requirements.

GRADE REQUIREMENTS

The minimum grade required for the successful completion of the Part 1 courses is a B (3.000) average. Students will only be allowed to take the proficiency exam if they fulfill this requirement. The minimum grade required for the successful completion of Part 2 (excluding advanced research) is at least a B (3.000) average for the Part 2 courses. The Part 2 courses, including any makeup of grade-point-average deficiencies (see following), must be completed within two calendar years of passing the proficiency exam. The department expects students to complete the bulk of these courses in the first year after the proficiency exam. The cumulative average will be calculated each semester. No more than two courses or 8 semester hours of credit, whichever is greater, may be repeated in order to satisfy the requirement for the PhD degree. A student who does not maintain a 3.000 cumulative average for two consecutive semesters, or is otherwise not making satisfactory progress toward the PhD degree requirements, may be recommended for termination at the discretion of the graduate committee. Within the above limitations, a required course for which a grade of F is received must be repeated with a grade of C or better and may be repeated only once. In calculating the overall cumulative average, all graduate-level coursework completed at the time of clearance for graduation will be counted.

PROFICIENCY EXAM REQUIREMENT

A student who fails to achieve the required B average for the Part 1 courses must petition the graduate committee in order to remain in the graduate program and be eligible to take the proficiency exam. All students registered in the PhD program are required to pass a written proficiency exam, unless they are granted an exemption (see below).

The proficiency exam consists of four parts, which are based on the first-year courses. An exemption for each part is granted if a B, or higher, is earned in the corresponding course (listed below in parentheses). Exam exemptions are only granted based on courses taken at Northeastern University.

- Classical Mechanics and Mathematical Methods (Classical Mechanics/Math Methods (PHYS 7301))
- Electricity and Magnetism (Electromagnetic Theory (PHYS 7302))
- Statistical Mechanics (Statistical Physics (PHYS 7305))
- Quantum Mechanics (Quantum Theory 2 (PHYS 7316))

The proficiency exam is given twice yearly: once prior to the start of the fall semester and again within the first two weeks of the start of the spring semester. Each part consists of a three-hour written exam, and no student will be required to take multiple parts on the same day.

All students enrolled in the PhD program must take the fall proficiency exam after completing their first-year course of study with the required GPA unless they are granted a waiver. Unless exempted, students taking the exam for the first time must take all parts. A student who does not pass the exam on their first attempt must pass the exam the next time it is given in order to continue in the PhD program. Any part passed on the first attempt does not need to be repeated.

PHD CANDIDACY

Degree candidacy is established when the student has passed (or exempted) the proficiency examination and completed both the Part 1 and Part 2 course requirements. PhD candidacy may be achieved before completion of the advanced elective if the elective in the student's specialization is not offered in a given year. The elective must be taken at the next opportunity. PhD degree candidacy is certified by the college. A maximum of five years after the establishment of doctoral degree candidacy is allowed for the completion of degree requirements.

PhD Dissertation Requirement

All PhD students are required to complete a dissertation based upon new and original research in one of the three following options:

- In one of the current theoretical or experimental research programs in the department, under direct supervision of an advisor from the Department of Physics. A dissertation committee will be formed consisting of the advisor; two full-time members of the department; and an additional member, either from within the department or from an outside department or institution.

- In a recognized interdisciplinary field involving another research area of the university, under the direct supervision of a faculty member in that field. In this case, an interdisciplinary committee is formed under the approval of the graduate committee, consisting of the direct supervisor, a departmental advisor, one other member of the department, and an additional member of either the department or the external department.
- In an area of applied research in one of the industrial or high-technology laboratories associated with the department's industrial PhD program. The direct supervisor is associated with the institution where the research is performed. In this case, a dissertation advisory committee is established by the graduate committee, consisting of the direct supervisor, the departmental advisor, and two other members of the department.

PhD students must select their departmental advisor no later than the end of the spring semester of their second year or their second semester after having passed the proficiency examination, whichever comes first. This process should start as soon as the student has identified a field of research or has passed the proficiency exam.

PHD DISSERTATION COMMITTEE, PRELIMINARY THESIS PROPOSAL, AND PRELIMINARY RESEARCH SEMINAR

By the end of the spring semester of the third year or the second semester in which the student is enrolled for PhD dissertation, whichever comes first, each PhD student must have an approved dissertation committee and thesis proposal.

The student (with the aid and approval of their thesis advisor) will submit a PhD thesis proposal to the graduate committee clearly outlining a plan to carry out new and original research in the context of previously published research in the scientific literature and also describe the methodologies to be employed. The thesis proposal is limited to 15 pages or less, including references. A proposed makeup of the dissertation committee will be submitted at the same time.

The graduate committee will evaluate the merit of the proposal and make recommendations for improvements when necessary, including any changes to the composition of the dissertation committee. No more than two submissions for a particular proposal may be made. In the case where a revised proposal does not meet a minimum academic standard that provides a basis for making such improvements, the graduate committee may instruct the student to select a different thesis topic or advisor.

After approval by the graduate committee, the proposal is circulated to the general faculty for comments. If the graduate coordinator receives any objections, the proposal will be referred back to the graduate committee for final resolution.

After the proposal and dissertation committee have been approved, the student will make a public presentation of the material in the preliminary research seminar before the dissertation committee in a format open to the full department and advertised one week in advance. The dissertation committee will then meet in closed session to evaluate the seminar. The preliminary research seminar must take place no later than the semester after the thesis proposal is approved and, normally, in the same semester.

In the event that the dissertation advisor is changed, a new committee must be formed, with the approval of the graduate committee, and a new preliminary research seminar given.

PHD DISSERTATION DEFENSE

The dissertation defense consists of a public presentation, followed by a question period conducted by the dissertation committee and limited to them and the department faculty. The date of the dissertation presentation must be publicized and a copy of the thesis deposited with the graduate program coordinator at least one week prior to the defense. If during this posting period or in the two business days following the defense a written objection to the thesis is lodged with the department chair by a member of the faculty, the chair may appoint an ad hoc postdefense review committee to provide advice on the scientific issues raised by the objection. Students should note that they must be registered for Dissertation or Dissertation Continuation during the semester in which they defend their dissertation and that they should schedule their defenses well in advance of the end of the semester in order to accommodate the review/waiting period and the time required to deposit the thesis.

The final dissertation defense is held in accordance with the College of Science regulations.

PhD Specialization Options

Students choose a specialization in biological physics; particle physics; condensed matter physics; or, with preapproval of a faculty member, in the following areas: nanomedicine or network science.

Multiple specializations are allowed if the individual requirements for each specialization are met.

Note that the specialization will not appear on the degree diploma or on the official transcript but can be listed as the field of study on CVs and grant proposals.

Transfer Credit

Students must petition in writing through the graduate committee to the director of graduate student services for all transfer credit. A copy of an official transcript must be attached to the Request for Transfer Credit form. A maximum of 9 semester hours of credit obtained at another institution may be accepted toward the PhD degree provided that the credits transferred consist of a grade of B or better, are graduate-level courses, have been earned at an accredited institution, and have not been used toward any other degree. Grades are not transferred.

Course Waivers

Course waivers may be accepted toward the PhD degree course requirements, though they will not change the number of credits required for the program. The student must have received a B grade or better in equivalent graduate-level core courses that have been earned at an accredited

institution. Students must petition in writing to the graduate committee for all course waivers and provide documentation in the form of official transcripts to support their petition.

Residence Requirement

The residence requirement is satisfied by at least one year of full-time graduate work (i.e., enrollment in PhD Dissertation, for two consecutive semesters). Students must be continually enrolled throughout the pursuit of the dissertation.

Internship Option

A PhD candidate may spend one year in a participating high-technology, industrial, or government laboratory immediately after passing the PhD proficiency examination. In this program, the student is expected to remain in touch with the university by taking one course per semester at the university and by frequent contact with a faculty advisor. After the one-year paid internship, the student returns to the university to do the dissertation. Eligibility for this program is contingent on acceptance both by the department and by the external laboratory.

Program Requirements

Complete all courses and requirements listed below unless otherwise indicated.

Milestones

Coursework
Proficiency examinations (completed or exempted)
Annual review
Candidacy
Preliminary research seminar proposal with proposed dissertation committee
Preliminary research seminar talk
Dissertation defense

Core Course Requirements [1]

Code	Title	Hours
PHYS 5318	Principles of Experimental Physics	4
PHYS 7210	Introduction to Research in Physics (Take this repeatable course twice)	0
PHYS 7301	Classical Mechanics/Math Methods	4
PHYS 7302	Electromagnetic Theory	4
PHYS 7305	Statistical Physics	4
PHYS 7315	Quantum Theory 1	4
PHYS 7316	Quantum Theory 2	4
PHYS 7321	Computational Physics	4
PHYS 9984	Advanced Research	1-8

Electives

Code	Title	Hours
Introductory Electives		
If preapproved to specialize in nanomedicine or network science, consult program director.		
Complete 8 semester hours from the following:		8
PHYS 7322	Nonequilibrium Physics	
PHYS 7323	Elementary Particle Physics	
PHYS 7324	Condensed Matter Physics	
PHYS 7325	Quantum Field Theory 1	
PHYS 7731	Physics of Biological Processes and Living Systems 1	
Advanced Elective		
Complete 4 semester hours from the following:		4
PHYS 7733	Topics: Elementary Particle Physics and Cosmology	
PHYS 7734	Topics: Condensed Matter Physics	
PHYS 7741	Physics of Biological Processes and Living Systems 2	

PhD Specialization Options

- A specialization is required.[2]
- Courses completed in fulfillment of a specialization may also fulfill the elective requirements above.
- A specialization in nanomedicine or network science requires prior approval.

Code	Title	Hours
Biological Physics [3]		
PHYS 7731	Physics of Biological Processes and Living Systems 1	4
PHYS 7741	Physics of Biological Processes and Living Systems 2	4
Particle Physics [4]		
PHYS 7323	Elementary Particle Physics	4
PHYS 7733	Topics: Elementary Particle Physics and Cosmology	4
Condensed Matter Physics		
PHYS 7324	Condensed Matter Physics	4
PHYS 7734	Topics: Condensed Matter Physics	4
Nanomedicine		
NNMD 5270	Foundations in Nanomedicine: Therapeutics	3
NNMD 5370	Nanomedicine Research Techniques	4
Network Science		
PHYS 5116	Network Science 1	4
PHYS 7335	Dynamical Processes in Complex Networks	4

Dissertation

Code	Title	Hours
Taken third year and beyond.		
PHYS 9990	Dissertation Term 1	
PHYS 9991	Dissertation Term 2	
Complete the following (repeatable) course until graduation:		
PHYS 9996	Dissertation Continuation	

Program Credit/GPA Requirements

42 total semester hours required
Minimum 3.000 GPA required

1 Methods for Teaching in the Introductory Physics Laboratory 1 (PHYS 7220) and Methods for Teaching Introductory Physics Laboratory 2 (PHYS 7230) are required for students awarded a Teaching Assistantship.

2 Note that the specialization will not appear on the degree diploma or on the official transcript but can be listed as the field of study on CVs and grant proposals. The two courses under specialization include one of the electives previously listed above.

3 By approval of the graduate committee, biological physics students may substitute graduate courses in biology, physics, or chemistry from the following list instead of Physics of Biological Processes and Living Systems 2 (PHYS 7741):

- Biochemistry (BIOL 6300)
- Molecular Cell Biology (BIOL 6301)
- Molecular Modeling (CHEM 5638)
- Additional appropriate courses may also be substituted by approval of the physics graduate committee.

4 Elementary Particle Physics (PHYS 7323) is required for a specialization in particle physics. The advanced elective may be Topics: Elementary Particle Physics and Cosmology (PHYS 7733).

Plan of Study

Sample Plan of Study

FALL TERM ENTRANCE [1]

Year 1

Fall	Hours	Spring	Hours
PHYS 7210	0	PHYS 5318	4
PHYS 7301	4	PHYS 7210	0
PHYS 7302	4	PHYS 7305	4
PHYS 7315	4	PHYS 7316	4
	12		**12**

Year 2

Fall	Hours	Spring	Hours
PHYS 7321	4	PHYS 9984	2-8

Electives	8	Advanced elective	4
	12		**6-12**

Year 3

Fall	Hours	Spring	Hours
PHYS 9990	0	PHYS 9991	0
	0		**0**

Total Hours: 42-48

1 Program completed with successful submission and defense of dissertation.