

## Boston University Physics Requirements for the PhD degree

### 1. Satisfactory Academic Progress and PhD Milestones

The Graduate School of Arts and Sciences (GRS) and the Physics Department guarantee five full years (12 months) of financial support for students working toward the PhD, subject to maintaining *Satisfactory Academic Progress*. This support will be in the form of Teaching Fellowships, Research Assistantships, or Graduate Fellowships. Funding beyond five years is generally provided to students who are working productively toward the PhD degree. The time limit for completion of the PhD degree is seven years (exceptions require a petition to GRS). The following accomplishments are required for Satisfactory Academic Progress:

#### End of First Year

Completion of PY501, PY511, PY512, PY521, PY541, each with a grade B- or better. Students who completed the equivalent of these graduate level courses as part of a Master's degree elsewhere may apply for transfer of credit.

#### No Later than End of Second Year

High Pass grades on Part 1 and Part 2 of the *Written Comprehensive Exam*.

#### No Later than End of Third Year

- Completion or waiver of the *Advanced Lab* requirement (PY581).
- Passing grade on the *Preliminary Oral Exam*.

#### No Later than End of Fourth Year

- Selection of the *PhD Committee* by the end of the Fall semester.
- Interim Progress Report* submitted to the Director of Graduate Studies (DGS) by the end of the Spring semester, to be prepared in consultation with, and approved by the members of the PhD Committee.

#### Schedule Guidelines for Completion of PhD

- Dissertation Prospectus* submitted to the DGS and GRS approximately *seven months* before the Final Oral Exam. Year-specific deadlines are available from the GRS.
- Departmental Seminar*, a presentation of PhD research to the PhD committee and an audience of departmental students and faculty. It should be held no later than *six months* before the Final Oral Exam.
- Dissertation Abstract*, approved by the DGS and Physics chair, and submitted to GRS *three weeks* prior to Final Oral Exam.
- Properly formatted draft of thesis* submitted to readers and GRS *three weeks* before Final Oral Exam.
- Final Oral Exam.

### 2. Course requirements

Sixteen four-credit courses are required with grades of B- or higher. These include Quantum Mechanics I and II (PY 511-512), Electrodynamics I (PY 521), Mathematical Physics (PY 501),

Statistical Physics and Thermodynamics (PY 541), and Advanced Lab (PY 581). At least four additional lecture courses (numbered between 500 and 850) must be taken, with at least two *distribution courses* from outside the student's research specialty (see the appendix for details). Up to six non-lecture courses may be applied to the 16-course requirement, with no more than two directed study courses and no more than two seminar courses. PY 501, 511, 512, 521, 541 and an elective lecture course are normally taken during the first year of graduate study. A student who has either taken an advanced undergraduate lab course or has had significant experimental research experience may petition to the faculty member in charge of PY 581 to be excused from the course. If the petition is approved, PY 581 must be replaced with a four-credit lecture course. Up to eight qualifying lecture courses may be transferred from other universities, so long as they have not been used previously to satisfy the requirements of an undergraduate degree at Boston University or elsewhere. Of these, only two may be credited toward a Master's degree. For details, consult

<http://www.bu.edu/academics/grs/policies/transfer-of-credits/>

In addition to the 16 required four-credit courses, PY 699 must be taken each semester by all students serving as Teaching Fellows. The Scholarly Methods course, PY 961, must be taken by all first year students.

A student with more than two grades below B $\square$  in any of the 16 required four-credit courses will be terminated from the program.

### 3. Written Comprehensive Exam

The Written Comprehensive Exam consists of two parts and is given twice each year, in September and January, in the week before the Fall and Spring semesters begin. Part 1 includes questions on classical mechanics, thermodynamics and statistical mechanics, and general physics. Part 2 has questions on electromagnetism and quantum mechanics. The exam tests knowledge at roughly the 500-course (advanced undergraduate – beginning graduate) level. Consult the departmental study guide <https://physics.bu.edu/grad/page/phys-graduate-resources> for more information. Possible grades on each part are Fail, Low-Pass, or High-Pass. PhD recipients are required to achieve High-Pass on each part. Students are expected to take the exam initially no later than September of their second year of study. Each time the exam is taken, students must attempt all parts not yet High-Passed. If a High-Pass is not achieved on both parts after two official attempts, the student will be terminated from the PhD program.

A single early *free shot* attempt at the exam may be taken *once*, in *either* September or January of the first year. Fail or Low-Pass results for this exam will not count toward the two required attempts. However, if a High-Pass is obtained on either or both parts, these results will be counted. Two required attempts (beyond the optional free shot) are allowed, the first required attempt in September of the second year, and the second and final attempt in January of the second year.

### 4. Research Project and Preliminary Oral Exam

Students should begin working with a faculty member no later than one semester after achieving High-Pass on both parts of the Written Comprehensive Exam. A project of about one semester duration will be identified that will enable the student to begin the process of carrying out PhD-level research. The student will present the results of this research project at the Preliminary Oral Exam, which must be taken no later than the end of the third year of graduate study. A student must High Pass both parts of the Written Comprehensive Exam and complete PY 581 (or received a waiver) in order to take the Preliminary Oral Exam.

The purposes of the Preliminary Oral Exam are: to enable faculty to determine a student's research potential, to test the student's depth and breadth of knowledge, and to allow a student to explore a research field. The exam is conducted by a committee that consists of four faculty members, and includes the faculty supervisor. The committee is proposed by the student and the student's supervisor, and must be approved by the DGS. The committee includes one member other than the advisor who is familiar with the subject matter of the research project, one member in the opposite technical discipline (theory or experiment), and one member from outside the student's research field. The committee should be finalized at least *three weeks* prior to the exam. The student must submit a one-page abstract to the committee at least *two weeks* before the exam. The exam consists of two parts. The first is an oral presentation of the project that should last no more than 45 minutes. The presentation should be accessible to a non-specialized audience, and interruptions should be made only for clarification of minor points. During the second part of the exam, which includes only the student and the committee, the student will be questioned on details of the presentation, his/her understanding of related areas of physics, the basic physics principles associated with the project, and the relevance of the project to a broader context. The entire exam will typically last 1.5-2 hours. Following the exam, the committee privately decides on a grade of Pass or Fail. A Pass grade permits the student to advance to PhD Candidacy and continue research. In the case of a Fail grade, the committee submits its assessment of the student's performance to the DGS. Based on this assessment and the student's other indicators of academic progress, the DGS and the Graduate Committee will decide if the student is allowed an additional attempt at the exam. If an additional attempt is not allowed, the student will be terminated from the program.

## **5. Selection of Research Advisor and PhD Committee**

PhD research is normally carried out under the guidance of a faculty member in the Physics Department of Boston University.. A student may continue his/her association with the faculty advisor for the Preliminary Oral Exam. The student's advisor becomes the First Reader for the PhD dissertation. The PhD Committee consists of the First Reader, Second Reader, Committee Chair, and two other members. The five committee members should include one who works in the opposite technical discipline of the student's field (theory or experiment) and one who works in a different field. A student wishing to work with a faculty member outside the Department must first consult with the DGS. GRS policy requires at least two committee members, including the Chair, to be from the Physics Department. By special appointment, approved by the Dean of GRS, up to two committee members may be from outside Boston University. The membership of the PhD Committee must be approved by the DGS. The selection of the advisor and PhD Committee must be made no later than the end of the Fall semester of the student's fourth year at Boston University.

## **6. Interim Progress Report**

The student must submit an Interim Progress Report to the DGS by the end of the Spring semester of the student's fourth year at Boston University. This report is a three to five page (single spaced, 12-point font) description of the student's PhD research activities. It should include the anticipated research scope, research accomplishments, and time scale for completion of the PhD. The report should be prepared in consultation with, and approved by all members of the PhD Committee.

## **7. Dissertation Prospectus**

The Dissertation Prospectus is prepared in consultation with the student's PhD Committee. It should be submitted to GRS, with approval by the Readers, the DGS and Physics Chair, approximately *seven months* before the Final Oral Exam, and no later than the Fall semester of the student's seventh year at Boston

University. This document must be four to six pages (single spaced, 12-point font) long, and must provide a clear statement of the problem being studied and a self-contained discussion of the research techniques being used. It should also include an outline of the dissertation, with a listing in bullet style of sections and subsections of the dissertation. The section and subsection headings should be augmented with one or two explanatory sentences.

## 8. Departmental Seminar

The student is required to give a generally accessible seminar related to the dissertation project as part of a *Graduate Seminar Series*. The seminar must be attended by all five members of the PhD Committee, and all faculty and students are encouraged to attend. The seminar should be presented shortly after the Dissertation prospectus is prepared, and no later than *six months* before the Final Oral Exam.

At the conclusion of the seminar, the PhD Committee will meet privately with the student to discuss the quality, quantity and schedule of research required for completion of a satisfactory PhD dissertation.

## 9. Dissertation and Final Oral Exam

The PhD Dissertation must contain an account of original research and results conducted by the candidate. It should contain a critical evaluation of prior research in the field, and must place the results of the research in perspective regarding the prior research in the field and the future directions of research in the field. It must be a cohesive document, rather than a compilation of reports or publications. The writing of the dissertation should begin no later than the time of the Departmental Seminar presentation, and the First and Second readers should be informed of progress and provide feedback as required. The student should write a first draft of the dissertation and submit it to the First and Second Readers no later than two months before the Final Oral exam. A properly formatted draft of the thesis must be submitted to the Readers and GRS at least *three weeks* prior to the Final Oral Exam.

The student must write and get approval of a Dissertation Abstract prior to scheduling the Final Oral Exam. The abstract cannot exceed 350 words, and must describe the research project, methods, results and content of the dissertation. It must be approved by the Readers, the DGS and the Physics Chair, and must be submitted to GRS no later than three weeks before the final Oral exam.

The Final Oral Exam, which must be attended by all five members of the PhD Committee, is formally scheduled through the Physics Department Office, which notifies GRS. The exam consists of two parts. The first is open to the public and consists of a formal presentation of the research that should last no more than 45 minutes. The talk should be accessible to a non-specialized audience, with emphasis on clarity of presentation. Interruptions are allowed only for clarification of minor points. The audience is excused for the second part, which involves a questions posed to the candidate by the PhD Committee. The candidate will be asked to defend the dissertation in detail and may be questioned on the background, scope, limitations of the work, completeness of data or calculations, and the validity of the conclusions. At the end of the second part, the PhD Committee privately decides on a Pass grade or a Fail grade. In the case of a Pass grade, the title page of the PhD Dissertation is signed by the Readers, and is submitted to GRS. In the case of a Fail grade, the PhD Committee and candidate formulate a plan for revisions, corrections, and/or additional work that will lead to an acceptable dissertation.

## APPENDIX: PhD Distribution Requirements

A student with research specialty in Category I subjects must take 2 distribution courses in Category II, and vice versa. Only one starred (\*) item may count toward the distribution requirement. A student may also *with prior permission from the DGS* be allowed to satisfy the Distribution requirements by taking approved graduate courses in other science and engineering departments. The third column indicates the frequency and the semester that the course is normally offered (A: annual, B: biannual, D: upon sufficient demand; 1: fall, 2: spring). Two-semester courses marked A/D indicate that the first is offered annually, while the second is offered by demand. The department publishes the actual course schedule annually.

**Category I: Elementary Particle, Computational, and Mathematical Physics**

PY502*	Computational Physics	A/1
PY522*	Electromagnetic Theory II	A/1
PY621*	Advanced Computational Physics	A/2
PY551	Introduction to Particle Physics	A/2
PY713/714	Quantum Field Theory I & II	A/D
PY751/752	Particle Theory I & II	A/D
PY561	Introduction to Nuclear Physics	D
PY701/702	Advanced Mathematical Physics	D
PY731	Theory of Relativity	D
PY761/762	Nuclear and Intermediate-Energy Physics	D
PY811	Advanced Quantum Field Theory	D

**Category II: Biophysics, Computational, and Condensed-Matter Physics**

PY502*	Computational Physics	A/1
PY522*	Electromagnetic Theory II	A/1
PY621*	Advanced Computational Physics	A/2
PY542	Statistical Mechanics II	A/1
PY543	Introduction to Solid State Physics	A/2
PY741/742	Solid State Physics I & II	A
PY743	Low Temperature Physics	B/1
PY744	Polymer Physics	B/1
PY747	Advanced Statistical Mechanics	B/2
PY771	Biophysics	B/1
PY841	Symmetry in Solid State Physics	D
PY842	Many-Body Topics in Solid State Physics	D