

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 each) of financial support for students who maintain *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 (but not guaranteed) to students who are working productively toward the PhD degree. The time limit for completion of the PhD is seven years (exceptions require a petition to GRS). Please note: The Physics Department no longer requires a Comprehensive Examination. The following achievements are required to maintain Satisfactory Academic Progress:

Generally at the End of First Year

- Completion of the *core courses* PY501, PY511, PY512, PY521, and PY541, each with a grade B– or better.
- Students who have completed the equivalent of these graduate level courses can satisfy the core course requirement by filing a petition immediately upon entering the graduate program, choosing one of three alternatives: (i) retake one or more core physics courses at Boston University; (ii) present evidence of prior satisfactory performance equivalent core course(s); or (iii) opt for an oral proficiency examination to be administered by a faculty committee appointed by the DGS. Additional details are listed in Section 3.

No Later than End of Second Year

- Show evidence of competence by achieving at least an **average grade** of B in the core courses with no grade lower than B–.

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 Dissertation 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 Dissertation 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 GRS.
- *Departmental Seminar*, a presentation of PhD research to the PhD dissertation committee and an audience of departmental students and faculty. It must 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.* Deadlines for specific graduation dates and detailed rules are available from GRS.

2. Course requirements

Sixteen 4-credit courses are required with grades of B– or higher. These include the *core courses* Quantum Mechanics I & II (PY 511-512), Electrodynamics I (PY 521), Mathematical Physics (PY 501), Statistical Physics & Thermodynamics (PY 541), and Advanced Lab (PY 581).

Students who have completed the equivalent of the graduate courses as part of a Masters degree elsewhere may also formally apply for transfer of credit as determined by GRS rules.

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. Distribution requirements may be satisfied by taking approved graduate level courses in other science and engineering departments. Up to six non-lecture courses may be applied to the 16-course requirement, but 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 the faculty member in charge of PY 581 to be excused from this course. If the petition is approved, PY 581 must be replaced with a 4-credit lecture course. Up to four qualifying lecture courses may be transferred from other universities, as long as they have not been used previously toward any other degree, and only if they were taken during the senior year of college. 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 sixteen required 4-credit courses, all students who serve as Teaching Fellows must take PY 699 each semester. All first-year students must also take the Scholarly Methods course, PY 961.

A student with more than two grades below B– in any of the 16 required 4-credit courses will be terminated from the PhD program.

An average grade of B or better must be achieved in the five core courses in order to qualify for the PhD program, with no grade lower than B–.

3. Demonstration of Proficiency in Physics

Each student is required to demonstrate proficiency through course work by maintaining an average grade of at least B in the five core Physics courses, with no grade lower than B–.

Students who fail to achieve the qualification standard during the first year may be asked to re-take the course, for credit or audit, and to re-take the final examination in the second year. Students who are unable to achieve the qualification standard at the end of the second year will be terminated from the program.

Students who have already taken the equivalent of one or more of the core physics courses may petition to alternatively demonstrate proficiency by one of three alternatives: (i) retake one or more core courses at Boston University; (ii) present evidence of satisfactory performance in the equivalent core courses, corresponding to a minimum grade of B– and at least an average grade of B in the equivalent core courses; (iii) opt for an oral examination. The petition should be filed immediately upon entering the graduate

program. Under exceptional circumstances, the DGS may decide to accept a late filing of the petition. Determination of satisfactory performance is made by a faculty committee appointed by the DGS. If the committee judges that either options (ii) or (iii) are not satisfied for one or more courses, the student will be required to enroll in the appropriate course.

A student who has failed to achieve the qualification standard may file a petition to the DGS to appeal termination from the program because of exceptional extenuating circumstances.

4. Selection of Research Project and Preliminary Oral Examination

Students are strongly encouraged to begin research with a faculty member in the Physics department as early as possible. In order to demonstrate Satisfactory Academic Progress, a student needs to identify a faculty research advisor no later than the end of the Second year.

The advisor and student jointly formulate a research project of about one semester in duration. The student presents the results of this project at the Preliminary Oral Exam, which must be held *no later than the end of the third year of graduate study*. A student must meet the course qualification standard and complete PY 581 (or receive a waiver) to take the Preliminary Oral Exam.

The purposes of the Preliminary Oral Exam are to enable faculty to determine a student's research potential and to test the student's depth and breadth of knowledge. A committee of four faculty members, which includes the student's supervisor, conducts the exam. The committee is proposed by the student and the student's supervisor, and must be approved by the DGS. The committee includes one member, in addition to 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 before* 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 lasting no longer than 45 minutes. The presentation should be accessible to a non-specialized audience, and interruptions should be made only for clarifications. 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 broader context of the project. 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. A second failure of the Preliminary Oral Exam will result in the student's termination.

5. Selection of PhD Dissertation Committee

PhD research is normally carried out under the guidance of a faculty member in the Boston University Physics Department. A student may choose to 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

Dissertation 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 (theory or experiment) and one who works in a different field. A student wishing to work with a faculty member outside the Physics Department must first consult with the DGS. GRS policy requires at least two committee members, including the Committee Chair, to be from the Physics Department. By special appointment that is 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 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 Dissertation Committee.

7. Dissertation Prospectus

The Dissertation Prospectus is prepared in consultation with the student's PhD Dissertation Committee. It should be submitted to GRS, after approval by the Readers, the DGS and Physics Department Chair, approximately *seven months* before the Final Oral Exam, and *no later than the Fall semester of the student's seventh year*. This document must be four to six pages long (single spaced, 12-point font), and must provide a clear statement of the problem being studied and a self-contained discussion of the research techniques. It should also include an outline of the dissertation, with a bullet-style listing of its sections and subsections. These 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*. All five members of the PhD Dissertation Committee must attend the seminar; other 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 Dissertation Committee will meet privately with the student to discuss the quality, quantity and schedule of research required for the 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, place the results of the PhD research in perspective, and discuss future research directions. 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. The First and Second readers should be informed of progress and provide feedback as required. The student should provide a first draft of the dissertation 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 obtain 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 dissertation contents. It must be approved by the Readers, the DGS, and the Physics Chair, and must be submitted to GRS *at least three weeks before* the Final Oral Exam.

Students are required by GRS to undergo a Final Oral Examination in which they defend their dissertations as valuable contributions to knowledge in their fields and demonstrate a mastery of their fields of specialization in relation to their dissertations. The Final Examining Committee is composed of five or more professorial faculty members including members of the PhD Dissertation Committee. The Final Oral Exam, which must be attended by all five members of the PhD Examining Committee, is formally scheduled by the Physics Department Office, which notifies GRS. The exam consists of two parts. The first is open to the public and consists of a 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 should occur only for minor clarifications. The audience is excused for the second part, in which the PhD Examining Committee asks the candidate to defend the dissertation, including 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 Examining Committee privately decides on a Pass 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 Examining Committee and the 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

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|-----------|---|-----|
| 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

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|--------|------------------------------------|-----|
| PY502* | Computational Physics | A/1 |
| PY522* | Electromagnetic Theory II | A/1 |
| PY571 | Introduction to Biological Physics | A/2 |
| PY621* | Advanced Computational Physics | A/2 |
| PY542 | Statistical Mechanics II | A/1 |

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|-----------|---|-----|
| 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 |