

**NEW YORK UNIVERSITY**  
**DEPARTMENT OF PHYSICS**

**Advanced Degree Programs**

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## **1. Ph.D. PROGRAM**

The Ph.D. is designed to enable students to prepare for and carry out research in physics at the frontier of knowledge. The Department encourages entry into dissertation research under the supervision of a faculty member as soon as sufficient mastery of the fundamental principles and techniques of physics has been attained. Depth and breadth within the larger context of contemporary physics are promoted by a flexible set of course requirements. Numerous seminars and the weekly Physics Colloquium provide an excellent opportunity for students to keep abreast of recent developments across the full spectrum of physics research. Special talks by faculty members describing their research programs help students learn about research activities in the department. The Physics Department website is also a source of information on faculty research interests and activities.

## **2. Ph.D. REQUIREMENTS**

The Ph.D. requirements are designed to help the student achieve the program goals. Milestones (with some flexibility where appropriate) are designed to insure that progress is made in a timely manner. A terminal M.S. degree (see section 3) is sometimes an option when these requirements are not met.

### ***2.1 Core course requirements***

The aim of the core course requirements is to certify the student's mastery of a traditional body of basic principles and problem-solving techniques generally considered to be an essential part of a research physicist's training. To this end, a student in the Ph.D. program is required to get a B or better in each part of 5 core subjects:

- Dynamics (PHYS-GA-2001)
- Statistical Mechanics (PHYS-GA-2002)
- Electromagnetism (PHYS-GA-2005)
- Quantum Mechanics I and II (PHYS-GA-2011, 2012)
- Computational Physics (PHYS-GA-2000)

### ***2.2 Options for satisfying core course requirements***

A student who has already taken a course elsewhere equivalent to one of our core courses may satisfy that portion of the core course requirement in one of two ways:

- 1) by achieving a grade of B or better in the relevant preliminary examination given just before the start of the fall and spring terms. Quantum Mechanics 1 and Dynamics exams are offered late August – early September, and Quantum Mechanics 2, Statistical Physics, and Electromagnetism exams are offered in late January. Each of these core courses has recently been revised to reflect the current state of the field. Students should therefore carefully check the course syllabi to determine whether an outside course is indeed equivalent to a core course before signing up to take and preparing for the exam. Each examination (with the exception of the one in Computational Physics) is designed to be

completed in approximately 2 hours (3 hours are allowed, to avoid time pressure), and covers the material of the corresponding course at the level of the midterm and final examinations. The format of the examination in Computation Physics will be determined by the course instructor. It may involve take-home projects as well as an explanation of computer codes developed.

- 2) Students holding an MS degree or equivalent degree who cannot attend the fall semester preliminary exams can ask the Director of Graduate Studies to be excused from some or all of the fall semester core courses. Such students must submit transcript and syllabi from their institution of origin, proving that they have successfully completed courses analog to our core courses. The Graduate Studies Committee will evaluate those documents and the teachers of fall semester core courses shall interview the students. The Graduate Studies Committee may elect also to further test the student by an oral exam. If the students are cleared by core course instructors and by the Graduate Studies Committee, they shall be allowed to substitute a more advanced course for the core courses. Each core course will be substituted by an advanced course in the area that best fits the student's academic progress, as determined by the Graduate Studies Committee. A student must earn a grade of B or better in such a course to satisfy the core course requirement.

### ***2.3 Deadline for core course requirements***

To be considered to be making satisfactory progress toward the Ph.D., a student must complete all core course requirements by the beginning of his/her second year. If a student fails to get a B or better in a core course during his/her first academic year, he/she is obliged to take the relevant preliminary examination just prior to the start of his/her second year. If one or more of the core course requirements are not satisfied at the start of the student's second year, the Ph.D. Qualification Committee will review the student's entire record and will decide what action to take. Such action might include a recommendation to the Graduate Studies Committee that the student be discontinued from the Ph.D. program. The Graduate Studies Committee can terminate a student from the program.

Under special conditions, and for the purpose of engaging sooner in research or taking another course necessary to begin research, students may defer one core course in each semester to the second year. Doing so requires permission from the Director of Graduate Studies (DGS), the two faculty advisors, and the research mentor, along with a paragraph describing the proposed research. It also generally requires a stronger than average incoming record.

### ***2.4 Experimental Physics requirement***

Students are required to have experience in experimental physics. This requirement may be satisfied by taking the course PHYS-GA-2075, Experimental Physics. A student who passed a course comparable to PHYS-GA-2075 at another institution may petition the Director of Graduate Studies to be excused from the Experimental Physics Requirement. To be excused, the student must submit to the current instructor for PHYS-GA-2075 the syllabus of the equivalent course. The instructor will then interview the student and forward a recommendation to the DGS.

Alternatively, a student may conduct an independent Experimental Project and take an oral examination on the project. Students conducting a project are strongly encouraged to complete the project by October of their second year, and not later than December of their second year. If this deadline is not met, the student will be required to take the Experimental Physics course.

There are several ways to meet this requirement, listed below.

- An independent experimental project with one of the experimental faculty.
- A research project with one of the astrophysics or phenomenological faculty analyzing observational or experimental data.
- A research project done in a research position with an experimental group can be written up as a project.

The general level of effort expected is about 100 hours. A project proposal (~ 1 page) must be approved by the student's research project advisor and primary faculty advisor to assure that the project meets the goal of acquainting the student with modern experimental aspects of our field. Whatever the nature of the work, the student is expected to be well versed in its general experimental background. For example, if the student has done work analyzing data already available, the student is expected to be familiar with the apparatus used to take the data.

In each case, a written report will be submitted, at least several weeks prior to the oral exam. The length and format are flexible, but typically comparable to a Letter-type journal, although there are no restrictions. It is advisable that the level be aimed at physicists who are not expert in the field.

Oral presentations are approximately 15 minutes - the main purpose is for the committee to ask questions on the experiment to ascertain the student's understanding of the physics and the technical aspects. The committee will have previously reviewed the written report. Blackboard, overhead transparencies or laptops can be used for the oral presentations.

## ***2.5 Course requirements beyond the core***

A student is required to take at least 6 courses in the Physics Department beyond the core level, not including research and reading courses or the Practicum. At least two of these courses must be outside the student's research area, as determined by the student's advisors (see section 2.7) and the DGS. Students whose research would benefit from an advanced science course outside of the physics department may propose to have this course counted toward this requirement. This request should be made in writing addressed to the student's advisor and the DGS (an e-mail is acceptable for this). The message must explain how the course content relates to the student's thesis topic and research. This request must be made prior to enrolling in the course.

## ***2.6 Requirements of the Graduate School of Arts and Science***

A student must also satisfy the following course requirements of the Graduate School of Arts and Science: completion of 72 points of graduate credit (at least 32 in residence at the Graduate School) and a cumulative GPA of B (3.0) or better.

## ***2.7 Advising***

### **2.7a Approval of Course Program:**

#### ***Prior to Formation of a Thesis Committee:***

Upon entry into the Ph.D. program students will be assigned two faculty advisors. The advisors are selected based on the student's expressed areas of interest, with one being in the area of primary interest, considered the student's primary advisor, and the other having a complementary perspective. Both advisors are expected to review and approve the student's course selection. In addition, these advisors serve as a source of information about research and activities in the department. Students are advised to meet frequently with their advisors, at a minimum twice during the academic year, during the registration periods for the fall and spring semesters.

#### ***After the Formation of a Thesis Committee:***

After the formation of a thesis committee a subset of the thesis committee (at least two faculty on the committee, one of whom is the student's thesis advisor) are expected to review and approve the student's course selection.

### ***2.7b Formation of a Thesis Committee***

By the beginning of May of the student's second year, the student is expected to have arranged for thesis supervision with a member of the Physics faculty. Shortly thereafter (within a few months) a four-person Thesis Committee, chaired by the thesis advisor is set up. The membership of the Thesis Committee is proposed by the advisor in consultation with his/her student, and must be approved in writing by the DGS to insure breadth and level of expertise. The student's thesis committee must include a physics faculty member outside the student's research field to insure breadth. It is desirable for the students pre-thesis advisors to be on the Thesis Committee, to maximize continuity, when possible.

Students conducting a thesis with a faculty member outside of the physics department must have an in-house faculty advisor. Their thesis committee will consist of five faculty members, with four faculty members from the physics department.

Within the first month that classes are in session following its formation, the Thesis Committee will meet with the student and discuss his/her course of study, preliminary research plans, and the timing and scope of the Oral Qualifying Examination (see below). The committee will conduct an annual review of the student's progress, normally in January.

Students who have not found a thesis advisor by the end of May of their second year may request a 6 month extension in writing from the DGS. This request should include the student's areas of interest and faculty with whom he/she has conducted trial projects. Note that such students should have a prospective thesis advisor and be conducting a trial project. A further 6 month extension may be requested in writing under exceptional circumstances, to May of a student's

third year. Students who have not found thesis advisors by May of their 3<sup>rd</sup> year in the program will be asked to leave the program.

Note that for student's entering the program in January the deadline to have arranged for thesis supervision is December of the student's second year and other deadlines shift accordingly.

## ***2.8 Oral Qualifying Examination***

The Qualifying Examination marks the student's formal entry into dissertation research under the supervision of a their thesis advisor. It takes place after the student has already embarked on preliminary research with his or her advisor, and is administered by the student's Thesis Committee. Students are expected to arrange a meeting of their thesis committee before the oral qualifying exam. The purpose of this meeting is to present the committee with an overview of the thesis topic. The Thesis Committee will then inform the student of the physics they may be questioned on in the oral exam. Generally, the range of topics questioned will be broad in scope and include knowledge from advanced course work a student has taken in their field of research.

The deadline for taking the Oral Qualifying Examination is May 15th of a student's third year. An extension may be requested in writing from the DGS. Students who have not completed this requirement by the deadline set by the DGS will be terminated from the Ph.D. program.

The examination itself consists of a prepared talk by the candidate followed by a question period. The aim is to examine the student's mastery not only of the specific area of the student's intended research, but also of related areas of physics, and of (relevant) general principles of physics. The Committee decides whether the candidate has demonstrated the preparation and skills needed to do original scientific research in the proposed area.

## 2.9 Annual review, progress report, thesis proposal

Starting in a student's second year there is an annual review of their progress toward the Ph.D. Prior to the formation of a Thesis Committee, the review is conducted by the student's two faculty advisors. The student presents his advisors with a brief (~1 page) statement of his/her research interests and a summary of any research projects they have conducted in the past year. In later years, the student's Thesis Committee or a subset of the thesis committee (at least two faculty on the committee, one being the student's thesis advisor) conducts the review. The oral qualifying examination is the student's annual review the year they take the exam, typically their 3<sup>rd</sup> year in the program. The first annual progress report following the Qualifying Exam includes a formal (brief 2 page written) proposal for the student's thesis research. In subsequent years the student gives a short (15 minute) oral presentation of his/her progress. These progress reports inform the committee on progress toward completion of the thesis, as well as on any significant modifications of the original proposal.

## 2.10 Oral Thesis Defense

The final approval of the student's thesis, and the oral thesis defense, is conducted by the student's Thesis Committee, augmented by one additional faculty member. Students are required to submit a near final draft of their thesis 3 weeks prior to the time they plan to present their oral thesis defense. Students must present the graduate secretary with 5 copies of the draft to schedule their thesis defense. A final draft of the thesis must be distributed to the thesis committee 1 week prior to the oral defense. Three members of the examining committee, including the student's advisor, serve as readers of the dissertation.

The oral defense is similar to that of a professional physicist presenting their research at a seminar. The talk is open to public and announced on the weekly Department seminar schedule. It consists of a presentation of about 40 minutes by the candidate, with free ranging questions by the committee and other attendees. After the committee has finished its examination it meets privately to discuss the defense and then informs the candidate of its decision. The committee may require revisions to the thesis, ranging from minor corrections to major revisions.

## 2.11 Graduate Student Timeline

A typical graduate student timeline is as follows:

	Year 1	2	3	4	5
Fall	<b>Core Courses</b> <ul style="list-style-type: none"> <li>• Comp. Phys</li> <li>• Dyn.</li> <li>• QM I</li> </ul> Practicum Req.	<b>Adv. Courses</b> <ul style="list-style-type: none"> <li>• 1-3 courses</li> <li>• Research (Trial projects)</li> </ul>	<b>Adv. Courses</b> <ul style="list-style-type: none"> <li>• 1-3 courses</li> <li>• Research</li> <li>• <b>Oral qualifying exam</b></li> </ul>	<b>Thesis Research</b> <ul style="list-style-type: none"> <li>• Elective course, special topics, etc.</li> <li>• <b>Annual Review Thesis proposal</b></li> </ul>	<b>Thesis Research</b> <ul style="list-style-type: none"> <li>• <b>Annual Review Prog. report—oral presentation</b></li> </ul>
Spring	<ul style="list-style-type: none"> <li>• E&amp;M</li> <li>• Stat. Phys.</li> <li>• QM II</li> </ul>	<ul style="list-style-type: none"> <li>• 1-3 courses</li> <li>• Research</li> <li>• <b>Choose advisor &amp; thesis comm.</b></li> </ul>	<ul style="list-style-type: none"> <li>• 1-3 courses</li> <li>• Research</li> </ul>	<b>Thesis Research</b> <ul style="list-style-type: none"> <li>• Elective course, special topics, etc.</li> </ul>	<b>Thesis Defense</b>
Summer	Research (trial) Exp. Phys. Req	Research	Research	Research	

### 3. M.S. REQUIREMENTS

All candidates for the M.S. degree must achieve 32 points of credit, at least 24 in residence at the Graduate School, at least 20 points in the Physics Department, and a GPA of B (3.0) or better. They are further required to pass at least 5 of the following 7 courses:

- Dynamics (PHYS-GA-2001)
- Statistical Physics (PHYS-GA-2002)
- Electromagnetism (PHYS-GA-2005)
- Quantum Mechanics I and II (PHYS-GA-2011, 2012)
- Experimental Physics (PHYS-GA-2075)
- Computational Physics (PHYS-GA-2000)

#### **Option A: Report**

The report is a comprehensive review article based on the literature in a specialized field of physics, prepared under supervision of a faculty advisor. In addition to submitting the report, students choosing this option must receive credit for 9 regular courses (one-semester, 4-point courses, not including reading and research).

#### **Option B: Thesis**

The thesis is based on physics research (experimental or theoretical) supervised by a faculty advisor, demonstrating originality and comprehensiveness but these may be at a level below that required for Ph.D. research. In addition to the standard course requirements, the student is expected to enroll in one semester of a research course.

M.S. candidates are permitted to take at most 2 courses outside the Department, with permission of the Director of graduate Studies.

#### **Option C: Examination**

In addition to receiving credit for eight regular courses (one-semester, 4-point courses, not including reading and research), a student choosing this option must pass the core courses with an average grade of B or better. For each course, the student has the option of

1. enrolling in the course;
2. taking the midterm and final examination of the course if the student is not enrolled; or
3. taking the relevant preliminary examination given just before the start of the fall and spring terms.



#### **4. FULL-TIME STATUS**

To allow students to begin their research soon after admission, full-time status will require at least 8 credits of course work per semester for the first year. In second year students engaged in trial research projects will be required to take 4 credits of course work per semester, provided that with their research projects and course work combine to require at least 40 hours per week. Thereafter, full-time status is assigned when courses or research combine to require at least 40 hours per week.

#### **5. MAINTAINING MATRICULATION**

A student who has completed course and language requirements may remain registered either by the payment of the Maintenance of Matriculation fee each semester (2 times a year) or by registering for a single course in any semester (once a year). (Note: A summer session course is considered to be part of the school year begun the previous September).

Students maintaining matriculation, if they qualify, may be certified as "full-time" or "half-time" for a limited period by completing a "full-time/half-time" maintaining matriculation form, and having the approval of the appropriate department and Graduate School officers. Students who wish further information on this point should consult the Director of Graduate Studies.