Information for Entering Graduate Students

The University of Chicago
Department of Physics
2019 - 2020

Contents

1 General Information

1.1 First-year Advising

Department advisors will meet with you during orientation week preceding your Autumn Quarter registration. They will advise you concerning course registration, how to plan your first year, and other matters. The department must approve your curriculum each quarter during your first year. Therefore, additional meetings will be held before registration of each of the succeeding quarters. In addition, you may not drop or add a course without consulting the department.

1.2 Courses

The numbering system of courses in physics indicates the level of the courses.

Phy Sci	100 - 120	Introductory Physical Science (non-science majors)
Physics	121 - 150	Introductory Courses
Physics	151 - 297	Intermediate and Advanced Undergraduate Courses
Physics	300 - 399	Introductory and Intermediate Graduate-Level Courses
Physics	400 - 499	Advanced Graduate-Level Courses

The official numbers assigned to these courses contain an additional two numbers (usually zeros) at the end. We often follow the former 3-digit designation in this document.

A list of regularly offered graduate courses is given in the Appendix. A set of outlines for many of our courses is posted online. Instructors usually adhere to the content and level specified in the Course Outline - but not always! If you are interested in taking a course on account of its coverage of a particular topic, you should check with the instructor to see if the topic will actually be covered.

1.3 A Few Remarks About Grading

- Quality grades (A through F) are normally given in all 300-level physics courses and in 443 - 444. If the instructor so desires, some letter grades may be modified with a + or −.
- At the instructor's option, grades of P or F may be given in all other 400-level courses. A grade of P is sufficient to satisfy a Category E requirement (see section 3.4).
- An I (Incomplete) can be given only if the major part of the student's work is of passing quality, but for some acceptable reason a minor portion was not completed. The instructor giving the I must be willing to supervise its removal. An I should be removed as soon as possible, preferably before applying for an S.M. or a Ph.D. degree.

1.4 First-year Graduate Courses

The standard first-year graduate courses are Classical Mechanics (316), a two-quarter sequence in Electricity and Magnetism (322 - 323), Mathematical Methods (330), a two-quarter sequence in Quantum Mechanics (341 - 342), and Statistical Mechanics (352). With the exception of Mathematical Methods (330), these courses may be required to achieve candidacy status depending on the results of the graduate diagnostic exam. If you never took certain core material at the advanced undergraduate level, high priority should be given to removing these deficiencies. Please discuss this with the department advisors.

The experimental physics requirement (see section 3.3) must be fullfilled during the first year. A typical first year curriculum would look as follows:

Autumn	**Winter**	**Spring**	**Summer**
PHYS 316	PHYS 322	PHYS 323	PHYS 390/499*
PHYS 330	PHYS 342	PHYS 334/335*	
PHYS 341	PHYS 335*	PHYS 352	

* If you choose to take *Advanced Experimental Physics Project* (335) in lieu of registering for 334, then you must register for 335 in winter and spring. In the autumn quarter, registration for 335 is optional, but is encouraged if you are certain that you will be doing 335. In the summer, take 390 if you have not achieved candidacy and 499 if you have.

1.5 Colloquia and Seminars

It is very important that you be exposed to the rich spectrum of problems of present-day research. For this purpose, a variety of colloquia, seminars, and guest lectures are held every week throughout the academic year. Consult the following web sites for up-to-date listings:

https://physics.uchicago.edu/events/
https://efi.uchicago.edu/events/
https://jfi.uchicago.edu/events.html
https://astrophysics.uchicago.edu/events/category/colloquia/

The Physics Department Colloquia are held on Thursday afternoons at 3:30 PM in the Maria Goeppert-Mayer Lecture Hall (KPTC 106) with a reception afterwards in KPTC 206. The reception is a good time to get acquainted with other graduate students at all levels and with members of the faculty and academic staff. The list of colloquium speakers usually includes distinguished scientists from outside the University as well as members of our own faculty. During the year a broad range of research topics in physics is covered and these colloquia serve an important role in the intellectual life of the Department.

In particular, first-year graduate students are expected to attend the Friday Physics Lectures at 1:30 PM in KPTC 206. In this informal series, faculty members of various research groups discuss their research at a level intended for first-year graduate students. Our goal is for you to meet the faculty from all areas of research (beyond just your own research interest) and to learn about the wide range of work being conducted by our faculty, students, and postdocs.

In addition, each of the Research Institutes and many of the larger research groups hold weekly specialized seminars. Speakers and topics are posted on the Department's bulletin boards and on the above websites.

1.6 Statement on Academic Integrity

The University of Chicago and the Department of Physics take the issue of academic honesty very seriously. As one of our graduate students, you are an important member of our intellectual community of scholars. Therefore, it is expected that you will know and abide by the principles of academic integrity that we strive to uphold. Below is a statement on academic integrity at the University of Chicago taken from various University sources. Please read this statement and abide by its message:

> All members of the University of Chicago belong to a tradition dedicated to the pursuit and cultivation of learning. A few simple principles - academic honesty, mutual respect and civility, personal responsibility - lie at the heart of our intellectual community. Each of us - students, faculty and staff - is pledged to live up to these standards and to support each others' efforts in this regard. We believe it is contrary to justice, to academic integrity, and to the spirit of intellectual inquiry to submit the statements or ideas or work of others as one's own. To do so is plagiarism and undercuts the distinctive moral and intellectual character of the University. These principles apply equally well to other forms of cheating, such as cheating on exams and other course assignments, and any behaviors counter to ethical practices.

1.7 Statement on Conduct and Personal Responsibility

The following statement is an excerpt from The University of Chicago student manual. Please also read this statement and abide by its message:

> The University of Chicago is a community of scholars dedicated to research, academic excellence, and the pursuit and cultivation of learning in an environment where the free and open expression of ideas and critical questions are paramount. Every member of the University - student, faculty, and staff - makes a commitment to strive for personal and academic integrity; to treat others with dignity and respect; to honor the rights

and property of others; to take responsibility for individual and group behavior; and to act as a responsible citizen in a free academic community and in the larger society. Any student conduct, on or off campus, of individuals or groups, that threatens or violates this commitment may become a matter for action within the University's system of student discipline...

2 Summary of the Degree Requirements

2.1 Requirements of the S.M. Degree

Entering graduate students with an A.B. or equivalent degree from a college or university can obtain the Master's degree by fulfilling the requirements listed below.

(1) Satisfaction of the University residence requirement by full-time registration for a minimum of three quarters (one academic year).

(2) Satisfaction of the Departmental experimental physics requirement by satisfactory completion of PHYS 334 (Advanced Experimental Physics), or PHYS 335 (Advanced Experimental Physics Project). (See discussion in Section 3.3.)

(3) Passing nine approved courses with a minimum grade point average of 2.5. These must include PHYS 316, 322, 330, 341, 342, and 352, in addition to PHYS 334 or 335. The Department may approve changes in this list according to the student's best interest. Students receive credit toward the S.M. degree for any course they test out of via the graduate diagnostic exam. Note that none of the courses may be reading or independent study.

Important Note: The application for the S.M. degree may be filed only after PHYS 334 or 335 has been completed and a letter grade assigned. This requirement also corresponds with requirement (1) above. Therefore, the earliest quarter for which the degree can be attained is normally the summer following the first academic year. The S.M. degree may be taken at the student's option, but it is not necessary for continued study toward the Ph.D.

2.2 Requirements of the Ph.D. Degree

(1) Satisfaction of the University residence requirement by full-time registration for a minimum of three quarters (one academic years).

(2) Satisfaction of the Departmental experimental physics requirement by completing PHYS 334 (Advanced Experimental Physics), or PHYS 335 (Advanced Experimental Physics Project). (See discussion in Section 3.3).

(3) Advancement to candidacy.

(4) Passing four of the regularly offered intermediate-level Post-Candidacy courses (see discussion in Section 3.4 for details). These must be passed with at least a B- average (2.7 GPA) and with no grade less than a C.

(5) Passing two additional elective courses at the 400-level in physics or in a related field (Category E courses). The department and your Ph.D. committee must approve courses from other departments. Note that Reading, Research, and Independent Study courses may not be used to satisfy this requirement.

(6) Writing a Ph.D. thesis, passing a final oral Ph.D. examination, and submitting a paper based upon your thesis research, for publication in a high-quality research journal.

3 Details of the Ph.D. Requirements

Below, we provide a detailed description of the candidacy process, the experimental physics requirement (Physics 334 or 335), the post-candidacy course requirements, and the preparation and defense of a Ph.D. thesis.

3.1 Achieving Candidacy

A student will advance to candidacy after displaying graduate-level proficiency in core areas and techniques of physics by demonstrating satisfactory performance on the graduate diagnostic exam (GDE), by satisfactory performance in core graduate courses, or by a combination of the two. When taking a course for candidacy, the determination of whether the student's performance was sufficient for candidacy is at the discretion of the professor who taught the course. This determination is independent of the letter grade awarded to the student. Advancement to candidacy must be achieved by the end of the spring quarter of the student's second academic year in the program.

3.2 The Graduate Diagnostic Exam

A committee of faculty members and the department's Director of Graduate Studies, the Candidacy Committee, are responsible for making up the GDE. It is generally administered two weeks prior to the beginning of the autumn quarter. The problems on the exam will be of the type and level expected on assignments and exams in the core graduate courses.

Entering graduate students are welcomed, but not required, to take this examination. Taking the exam may help identify areas of strength and weakness, and allow students to place out of courses in subjects where they have sufficient knowledge. The exam will take place over four (4) days, four hours per day, with each day focused on one of the four subjects: classical mechanics, electricity and magnetism, quantum mechanics, and statistical mechanics. While students are

welcome to attempt the examination in all four areas, they are free to choose only certain areas if it seems appropriate.

Based on the results of the GDE, the Candidacy Committee will make one of the following determinations:

- The student has sufficient mastery in all subjects and is immediately advanced to Ph.D. candidacy.
- The student has sufficient mastery in some specified areas. The student will advance to candidacy after satisfactory performance in graduate courses specified by the committee.
- The student has not displayed sufficient mastery in any subject and must take the full slate of core graduate courses to achieve candidacy: PHYS 316, 322, 323, 341, 342, and 352.

To prepare for the exam, we recommend that students review the highest level of coursework done in each subject of the core graduate courses.

3.3 The Experimental Physics Requirement

The Department requires that each Ph.D. student demonstrate competence in advanced techniques and methods of experimental physics either by passing Advanced Experimental Physics (PHYS 334) or by performing an Advanced Experimental Physics Project (PHYS 335). This requirement must be satisfied in the first year of study.

3.3.1 Physics 334

The purpose of this course is to merge theoretical knowledge with experiments under conditions approximating a research environment. The student is expected to spend about 10 hours per week on the course. Normally, each student completes two experiments from about ten options, each providing the opportunity for a comprehensive experimental study of an important phenomenon. The student is required to write a formal report on each experiment performed and to make an oral presentation on at least one of them. This course is offered only in the spring quarter.

3.3.2 Physics 335

The Advanced Experimental Physics Project is an alternative to PHYS 334 that enables a student to work directly with an experimental group. The student must find a faculty sponsor and agree upon a research project. The projects must be of sufficient scope that they introduce students to several (but not necessarily all) aspects of an experiment - building the equipment, data taking, analysis, and presentation. At the discretion of the faculty supervisor, the student may augment the research experience with a short shop course, or electronics training.

The project may be spread over 2 or 3 quarters but the total integrated workload should correspond to one (1) one-quarter course. Students must formally declare their intention to perform an Advanced Experimental Physics Project by an announced deadline (usually the end of October). They must register for PHYS 335 in winter and spring. The major portion of the work is normally done in winter quarter. If the student holds an RA, the project must be separate from the RA work. A final presentation will be made to the entire Department in the form of a poster session near the end of the spring quarter.

3.4 Post-candidacy Course Requirements

Each student must:

- Take a total of 4 courses from the options below of intermediate graduate courses in Categories A, B, C, and D with at least one from each of the categories A, B, and C. These must be passed with at least a 2.7 GPA (B-) and with no grade less than a C.
- Take 2 courses from category E (Advanced Electives).

Course Categories

The following course categories are continually under review. It is possible that the Department may make some minor adjustments to the lists by allowing additional options.

A. Condensed Matter
   PHYS 361 Introduction to Solid State
   PHYS 366 Advanced Solid State$^+$ (AKA: Hard Condensed Matter)
   PHYS 367 Soft Condensed Matter$^+$

B. Particle Physics
   PHYS 363 Introduction to Particle Physics
   PHYS 443 or 444 Introduction to Quantum Field Theory I or II (not both)

C. Large Scale Physics
   PHYS 364 General Relativity
   PHYS 371 Introduction to Cosmology$^+$
   PHYS 372 Space Physics and Astrophysics$^+$

D. Intermediate Electives
   PHYS 317 Symplectic Methods of Classical Dynamics
   PHYS 353 Advanced Statistical Mechanics
   PHYS 385 Advanced Mathematical Methods
   PHYS 386 Advanced Methods of Data Analysis$^+$

$^{+}$ *Usually offered every two years (under review for P367).*

E. Advanced Electives

This category consists of all Physics Department courses bearing a 400-level course number, with the exception of Physics 443, 444, and 499. In addition, with the authorization of the student's Ph.D. Committee and with the approval of the Department, a physics-related course in another department may be designated as a Category E course for an individual student on a case-by-case basis provided that (1) the course is taught at the highest level of graduate courses offered by that department and (2) the Ph.D. Committee feels that it is in the student's best interest to take this course rather than a Physics Department course.

New: Beginning in autumn 2019, students may petition to use an appropriate course offered by another department for their fourth post-candidacy course. For example, a student may request that a graduate course in ASTR be counted as a second category C course. Approval is on a case-by-case basis pending the topic and level of the requested course.

3.5 The Ph.D. Thesis and Defense

3.5.1 The Thesis Committee

After you achieve candidacy, it is your responsibility to find a member of the Physics Department faculty to serve as your Ph.D. thesis sponsor. You may also seek a faculty sponsor from another department of the University, from Argonne National Laboratory, or Fermi National Accelerator Laboratory. In such a case, a Department of Physics faculty member must be found to serve as Department Sponsor. The precise timing for finding a thesis sponsor is not always straightforward. It is common for a student to be initially with a sponsor on a trial basis before it is decided that the student will do his or her thesis with that sponsor. The research sponsor serves as Chair of your committee.

By department policy, students must have a thesis committee by the end of their second academic year in the program. For students who do not have a thesis sponsor by this time, a committee will be appointed by the department and serves more of an advisory role as the student continues through the program. Once such a student has an identified thesis sponsor, a new (final) thesis committee will be formed as appropriate. For students who have a thesis sponsor, a committee is formed in consultation between the student, the research sponsor, and the department.

Students are required to meet with their thesis committees at least once per year until they graduate. In these annual meetings you should

- discuss your academic progress. If any course requirements have not been met you should discuss your plans for completing these requirements.

- update the committee on your research. You should briefly discuss research you've done since the last meeting (if applicable), research you are currently doing, and your research plans for the future.
- seek any suggestions your committee members may wish to give as you move forward.

For each of these annual meetings, you will need to provide a brief report to the department. More information on the report will be provided at a later date.

3.5.2 The Pre-oral Meeting

Approximately one quarter prior to the oral defense, a "pre-oral" meeting of the Ph.D. Committee must be held. The main purpose of this meeting is to assure that the thesis will be of appropriately high quality. At this meeting, the Committee must formally approve the thesis topic and title, and also certify that the course requirements have been satisfied (unless already certified at a previous meeting). During the meeting, you must give a description of the thesis work and the primary new results that have been obtained. If the Committee has any concerns about the proposed nature and scope of the thesis, these should be raised at this meeting.

3.5.3 Final Oral Examination

When the thesis is completed, the Committee must be convened for the final oral examination. Copies of the thesis must be submitted to each member of the Committee and to the Physics Department at least two weeks prior to the meeting. You must bring a copy of the "Report of Final Examination for the Degree of Doctor of Philosophy" form (obtainable from the Department Office) to the meeting. The members of the Ph.D. Committee must sign the form at the end of the examination, and you must then return it to the Physics Department Office.

3.5.4 The Thesis Document

Copies of the Ph.D. thesis may be given to the Ph.D. Committee in any reasonable format. These copies must be distributed at least 2 weeks before the final oral examination. The final Ph.D. thesis must be written and formatted according to the guidelines set by the Dissertation Office. The most current information on how to format and submit your thesis can be found at the following url:

https://www.lib.uchicago.edu/research/scholar/phd/

You must separately submit a paper, based on your thesis research, for publication. The paper to be submitted for publication must identify the Department of Physics as the author's affiliation. In addition, the affiliation with other research institutes should be stated as appropriate. Credit should also be given to any fellowship or traineeship held during the research period, as well as

any other sources of support. While submission of the paper is required, the paper need not be accepted for publication prior to graduation. Also keep in mind that the published paper cannot replace the formal thesis.

4 Appendix: Regularly Offered Graduate Courses

An outline of the content, prerequisites, and textbooks for most of these courses is posted online. For some of these courses the quarter in which it is offered may vary from what's listed below.

Course (PHYS)	**Topic**	**Quarter Offered**
316	Classical Mechanics	Autumn
322 - 323	Electromagnetism I - II	Winter - Spring
330	Math Methods	Autumn
334	Adv Experimental Physics	Spring
335	Adv Experimental Project	A - W - S
341 - 342	Quantum Mechanics I - II	Autumn - Winter
352	Statistical Mechanics	Spring
353	Adv Statistical Mechanics	Autumn
361	Solid State Physics	Autumn
363	Intro to Particle Physics	Spring
364	Intro to General Relativity	Winter
366	Adv Condensed Matter$^+$	Winter
367	Soft Condensed Matter$^+$	Winter
371	Intro to Cosmology$^+$	Spring
372	Astrophysics$^+$	Autumn/Spring
385	Adv Math Methods	Winter/Spring
386	Adv Data Analysis$^+$	Winter/Spring
390	Prep for Candidacy	All
426	Fluid Dynamics$^+$	W/S
443 - 445	Quantum Field Theory I - III	A - W - S
483 - 484	String Theory I - II$^+$	Winter - Spring
491	Biological Physics$^+$	A/W/S
499	Adv Research	All

$^+$ *Offered every two years.*