THE UNIVERSITY OF CHICAGO
DEPARTMENT OF PHYSICS

INFORMATION FOR ENTERING GRADUATE STUDENTS

2015 – 2016
I. GENERAL INFORMATION

ADVISORY COMMITTEE
Members of the Advisory Committee will meet with you during orientation week preceding the Autumn Quarter registration. This committee advises you concerning course registration, how to plan your graduate program, and other matters. The Advisory Committee 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 committee.

In addition to the Advisory Committee, you will be assigned a separate faculty advisor with whom you are also encouraged to meet during orientation week or early in the Autumn Quarter. After your first year, you will be required to meet with your assigned faculty advisor annually until you have established a Ph.D. committee with a faculty research advisor. Your research advisor then takes over the role as your department faculty advisor. Associated with these annual meetings is a short annual report on your progress through our graduate program that must be signed by your advisor.

COURSES
The numbering system of courses in the Physics Department indicates the level of the courses.

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

The official numbers assigned to these courses contain an additional two numbers (usually zeros) at the end; e.g., Physics 121 is officially listed in the University publications as Physics 12100. We often follow the “old” 3-digit designation in this document.

A list of regularly offered graduate courses is given in the Appendix. A set of outlines for most of the courses regularly offered by the Department 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, it would be wise to check with the instructor.
to see if the topic will actually be covered.

A FEW REMARKS ABOUT COURSE GRADING
1. 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 -.

2. At the instructor's option, grades of "P" or "F" may be given in all other 400-level courses.

3. 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" must be removed as soon as possible and definitely before applying for an S.M. or a Ph.D. degree.

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). Some or all of these courses may be required to achieve candidacy status depending on the results of the graduate diagnostic exam.

It is required that the experimental physics requirement (see section III) be fulfilled the first year.

A normal first year curriculum would look as follows.

<table>
<thead>
<tr>
<th>AUTUMN</th>
<th>WINTER</th>
<th>SPRING</th>
<th>SUMMER</th>
</tr>
</thead>
<tbody>
<tr>
<td>P316</td>
<td>P322</td>
<td>P323</td>
<td>P399/499*</td>
</tr>
<tr>
<td>P330</td>
<td>P342</td>
<td>P334/335*</td>
<td></td>
</tr>
<tr>
<td>P341</td>
<td>P335*</td>
<td>P352</td>
<td></td>
</tr>
</tbody>
</table>

* 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 summer, take 399 if you have not achieved candidacy and 499 if you have.

Further Remark
If you never took certain core material at the advanced undergraduate level, high priority should be given to removing these deficiencies. The Advisory Committee will advise accordingly.

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

http://efi.uchicago.edu/events/index.shtml
http://event.uchicago.edu/maincampus/

The Physics Department Colloquia are held on Thursday afternoons at 4:00 PM in 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 4:00 PM usually in KPTC 206. In this series, faculty members of various research groups discuss their research at a level intended for first-year graduate students. This is an ideal opportunity for you to meet the faculty and to learn about the wide range of research being conducted. Refreshments are provided and there is plenty of opportunity for questions.

In addition, each of the Research Institutes and most 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.

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 the university's statement on academic integrity. Please read this statement and abide by its message.

As students and faculty of the University of Chicago, we all belong to an academic community with high scholarly standards of which we are justly proud. Our community also holds certain fundamental ethical principles to which we are equally deeply committed. 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 or cheating, offenses punishable under the University’s disciplinary system. Because these offenses undercut the distinctive moral and intellectual character of the University, we take them very seriously; punishments for committing them may range up to permanent expulsion from the University of Chicago. The College, therefore, expects that you will properly acknowledge your use of another’s ideas, whether that use is by direct quotation or by paraphrase, however loose. In particular, if you consult any written source and either directly or indirectly use what you find in that source in your own work, you must identify the author, title, and page number. If you have any doubts about what constitutes “use,” consult your instructor and visit www.college.uchicago.edu/academics/discipline.shtml.
II. SUMMARY OF THE DEGREE REQUIREMENTS

REQUIREMENTS FOR 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 Physics 334 (Advanced Experimental Physics), or Physics 335 (Advanced Experimental Physics Project). (See discussion in Section III.)

3. Passing nine approved courses with a minimum grade point average of 2.5. These must include Physics 316, 322, 330, 341, 342, and 352, in addition to Physics 334 or 335. If a student has tested out of any of these graduate courses via the graduate diagnostic exam, the Department may approve changes in this list according to the student's best interest. The full list of nine courses must be approved by the Department. Note that none of the courses may be reading or independent study.

   Important Note: The application for S.M. degree may be filed only after Physics 334 or 335 has been completed and a letter grade assigned. The S.M. degree may be taken at the student's option, but it is not necessary for the continued study toward the Ph.D. degree.

REQUIREMENTS FOR THE PH.D. DEGREE

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 completing Physics 334 (Advanced Experimental Physics), or Physics 335 (Advanced Experimental Physics Project). (See discussion in Section III).

3. Advancement to candidacy.

4. Passing four of the regularly offered intermediate level Post-Candidacy "required" courses (see discussion in Section III 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 Executive Officer and your Ph.D. Committee must approve these courses. Note that Reading 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 the thesis, or a paper based upon it, for publication in a high quality research journal.
III. 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.

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. Advancement to candidacy must be achieved by the end of the spring quarter of the student’s second academic year in the program.

The Graduate Diagnostic Examination
A committee of faculty members and the department's Executive Officer, 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 strongly encouraged, but not strictly required, to take this examination. Taking the exam will help us better 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 encouraged 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 to be 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.

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

THE EXPERIMENTAL PHYSICS REQUIREMENT (PHYSICS 334 or 335)
The Department requires that each Ph.D. student demonstrate competence in advanced techniques and methods of experimental physics either by passing Advanced Experimental Physics (Physics 334) or by performing an Advanced Experimental Physics Project (Physics 335). This requirement must be satisfied in the first year of study.
Physics 334
It is the purpose of this course 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 a menu of about ten selections, each providing the opportunity for a comprehensive experimental study of an important physical 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.

Physics 335
The Advanced Experimental Physics Project is an alternative to Physics 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 an electronics course.

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 the end of October. They must register for Physics 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 in the spring quarter (followed by a dinner for faculty and first-year students).

POST-CANDIDACY COURSE REQUIREMENTS
Each student must:
• Take a total of 4 courses from the "menu" 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
NOTE: 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
   361 Introduction to Solid State Physics
   366 Advanced Solid State Physics\textsuperscript{+}
   367 Soft Condensed Matter\textsuperscript{+}

B. Particle Physics
   363 Introduction to Particle Physics
   443 or 444 (Not both) Introduction to Quantum Field Theory I or II
C. Large Scale Physics
   364 General Relativity
   371 Introduction to Cosmology+
   372 Space Physics and Astrophysics+

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

+ \textit{offered in alternate years}

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 Chairman, a 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 a level comparable to Physics Department "400-level" courses 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.

THE PH.D. THESIS

The Ph.D. Thesis Committee

1. Formation of Ph.D. Committee:
   After you pass the candidacy examination, 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 Physical Sciences Division 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 “departmental sponsor”. After a research sponsor is found, the Executive Officer will, in consultation with the sponsor, appoint a committee of at least four faculty members (including the sponsor) to serve as your Ph.D. Committee. The research sponsor serves as Chairperson.

   The precise timing of the formation of the Ph.D. Committee is not always straightforward. It is common for a student to be initially accepted by a sponsor only on a “trial basis”, and it would be reasonable to wait for the commitment to the student to be more definite before forming the Committee. However, the Committee should be formed no more than one year after the student first joins a group. If a student does not have a Ph.D. Committee by the beginning of the winter quarter of his or her third year, the Executive Officer will schedule a meeting with the student to determine if intervention by the Chairman may be required.
2. First Meeting of the Ph.D. Committee:
As soon as possible after the formation of your Ph.D. Committee, a “first meeting” should be held. The purposes of the first meeting are: (1) to get acquainted, (2) to check that the course requirements have been met or, if not, to agree upon what courses will be taken in the future, and (3) to discuss your proposed research plans. If some research has already been undertaken, it would be appropriate to give the Committee a short presentation of this work. However, this is not required, and you and your sponsor should not wait until some significant piece of research has been finished before calling the first meeting. At the first meeting you should complete an RTC (Report of the Thesis Committee) form, obtainable in the Physics Department Office, have it signed by each member of the Committee, and return it to the Department Office. You also must attach a one-page summary of the meeting. In most cases, this will consist of a summary of your research or a research prospectus.

3. Pre-Oral Meeting of the Ph.D. Committee:
At least 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 (if the Committee did not already certify them as having been satisfied at the time of the first meeting). During the meeting, you must give a brief 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. In addition, it must be specified at this meeting whether the thesis will consist of a single-authored publication or whether it is proposed to be a jointly authored publication. If a jointly authored publication is planned, the Committee must approve this on the RTC form. In addition, for a jointly authored thesis, you will be required to write a single-authored expanded version of the thesis (see below).

4. The Ph.D. Thesis:
The Ph.D. thesis consists of a paper that must be submitted to a research journal of high quality and must be judged by the full Thesis Committee to be suitable for publication in such a journal. In the case of a single-authored paper, the thesis is the manuscript submitted for publication, plus any supplementary appendices augmenting the presentation which might not be appropriate in a published paper. In the case of a jointly authored paper that has been or will be submitted for publication, the thesis must be an extended version, written solely by the student and describing in detail his or her contributions to the published work. Formatting guidelines are given below.

5. 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.
Formatting Guidelines

A. Format of Thesis Submitted to Committee

(1) Copies of the thesis may be given to the Ph.D. Committee in any reasonable format. Copies must be distributed at least 2 weeks before the final oral examination. In the case of a jointly authored paper you should submit a copy of the jointly authored paper as well as the extended version.

(2) 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.

(3) Credit should also be given to any fellowship or traineeship held during the research period, as well as any other sources of support.

(4) The thesis submitted to the committee may contain details of experiments and computations, which are often more detailed than required in a publication. In this case, the thesis shall consist of a copy of the proposed published paper plus the added material attached as appendices.

B. Formal Submission of Required Materials

You can find the most current information about this at the following url:
http://www.lib.uchicago.edu/e/phd/

NOTE: Inquiries regarding the graduate program in physics should be addressed to David D. Reid, Executive Officer, or Ms. Amy Schulz, Graduate Affairs Administrator, at the Department Office (KPTC 201).

e-mail address: David D. Reid - dreid@uchicago.edu (773) 702-3067
Amy Schulz - aschulz@uchicago.edu (773) 702-7007
Fax number: (773) 702-2045
**APPENDIX: REGULARLY OFFERED GRADUATE COURSES**

An outline of the course content, prerequisites and textbooks for most courses is given in the Course Outlines posted online.

<table>
<thead>
<tr>
<th>Course Number (PHYS)</th>
<th>Topic</th>
<th>Quarter Offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>316</td>
<td>Classical Mechanics</td>
<td>Autumn</td>
</tr>
<tr>
<td>317</td>
<td>Symplectic Methods of Classical Dyn*</td>
<td>Winter/Spring</td>
</tr>
<tr>
<td>322</td>
<td>Electrodynamics I</td>
<td>Winter</td>
</tr>
<tr>
<td>323</td>
<td>Electrodynamics II</td>
<td>Spring</td>
</tr>
<tr>
<td>330</td>
<td>Mathematical Methods of Physics I</td>
<td>Autumn</td>
</tr>
<tr>
<td>334</td>
<td>Advanced Experimental Physics</td>
<td>Spring</td>
</tr>
<tr>
<td>341 – 342</td>
<td>Quantum Mechanics I – II</td>
<td>Autumn/Winter</td>
</tr>
<tr>
<td>352</td>
<td>Statistical Mechanics</td>
<td>Spring</td>
</tr>
<tr>
<td>353</td>
<td>Advanced Statistical Mechanics</td>
<td>Autumn/Winter</td>
</tr>
<tr>
<td>361</td>
<td>Solid State Physics</td>
<td>Autumn</td>
</tr>
<tr>
<td>363</td>
<td>Elementary Particle Physics</td>
<td>Spring</td>
</tr>
<tr>
<td>364</td>
<td>Introduction to General Relativity</td>
<td>Winter</td>
</tr>
<tr>
<td>366</td>
<td>Hard Condensed Matter Physics*</td>
<td>Winter</td>
</tr>
<tr>
<td>367</td>
<td>Soft Condensed Matter Physics*</td>
<td>Winter</td>
</tr>
<tr>
<td>371</td>
<td>Introduction to Cosmology*</td>
<td>Spring</td>
</tr>
<tr>
<td>372</td>
<td>Space Physics and Astrophysics*</td>
<td>Spring</td>
</tr>
<tr>
<td>385</td>
<td>Advanced Mathematical Methods</td>
<td>Winter/Spring</td>
</tr>
<tr>
<td>386</td>
<td>Advanced Methods of Data Analysis*</td>
<td>Spring</td>
</tr>
<tr>
<td>399</td>
<td>Preparation for Candidacy</td>
<td>All</td>
</tr>
<tr>
<td>443 – 445</td>
<td>Quantum Field Theory I – III</td>
<td>Aut./Wint./Spring</td>
</tr>
<tr>
<td>483 – 484</td>
<td>String Theory I – II*</td>
<td>Winter/Spring</td>
</tr>
<tr>
<td>491</td>
<td>Biological Physics</td>
<td>Winter</td>
</tr>
<tr>
<td>499</td>
<td>Advanced Research in Physics</td>
<td>All</td>
</tr>
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</table>

* Offered in alternate years