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The information in this booklet, as well as a wealth of other information concerning the Physics Department, its faculty and their research, course offerings, calendars for colloquia, seminars and special events, etc. can be found on the Department Web site and associated links.

http://physics.uchicago.edu/

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 as to which courses to take and how to plan your graduate program. 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. At these meetings, you should obtain a signature on the registration program card required for registering. In addition, you may not drop or add a course without consulting the committee. The Advisory Committee consists of instructors of the first-year graduate courses and other select faculty with departmental representation by David Reid and Stuart Gazes.

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 include 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). These courses are not required but are strongly recommended unless you have already mastered these topics at the graduate level.

It is required that students fulfill the experimental physics requirement (see section III) during their 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></td>
</tr>
<tr>
<td>P330</td>
<td>P342</td>
<td>P334*</td>
<td></td>
</tr>
<tr>
<td>P341</td>
<td>P352</td>
<td>Elective</td>
<td>P399/499*</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 passed the candidacy exam and 499 if you have.

Further Remark

If you never took courses equivalent to our advanced undergraduate courses Physics 197, 234, 235, 236, 237, or Math 273 (Differential Equations), 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:
The Physics Department Colloquia are held on Thursday afternoons at 4:15 PM in KPTC 106 following the weekly Departmental coffee/tea that begins at 3:45 PM in KPTC 206. The tea 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 course of the year a broad range of research topics in physics is covered and these colloquia serve a very 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. Demonstration of a satisfactory level of understanding of the fundamental principles of physics by either
   
   (a) Passing the Ph.D. candidacy examination at the Master's level, or higher. (See discussion in Section III.)

   or

   (b) 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 completed the equivalent of any of these graduate courses elsewhere, 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 years).

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. Passing the Ph.D. candidacy examination at the "P" level.

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 examination, the experimental physics requirement (Physics 334 or 335), the post-candidacy course requirements, and the preparation and defense of a Ph.D. thesis.

THE CANDIDACY EXAMINATION

The candidacy exam is a written exam consisting of 12 problems given in two sessions on consecutive days. It is given every Autumn (in September) and in the Spring. Copies of questions from past written examinations are available in the Crerar Library. You can also download PDFs of the old exams (often with solutions) from Crerar's online reserve (using computers on the campus network only).

The candidacy exam tests your understanding of the fundamental principles of physics. The questions on the exam involve basic concepts and techniques introduced in advanced undergraduate courses, but may require a higher level of sophistication than problems normally encountered in undergraduate courses. Therefore, one way to help prepare for the exam is to take the standard menu of first-year graduate courses. You may take the exam any time it is offered and you must pass the exam by the end of the September two years after matriculation. If the candidacy exam is not passed within this two-year period, the student will no longer be eligible for admission to Ph.D. candidacy status in the Department of Physics.

In addition to fundamental material on classical mechanics, quantum mechanics, electrodynamics, and thermodynamics/statistical physics, the exam may include questions concerning experimental techniques and data analysis methods or questions that test the student's ability to judge or estimate the magnitude of physical effects and to exercise techniques useful in physics; e.g., probability and statistics. However, problems whose solutions depend on tricks, highly specialized techniques, or require time-consuming calculations are avoided. A list of the values of fundamental constants is provided with the examination. Students may also bring one (1) letter-sized sheet of handwritten notes (both sides permitted).

The grades of the candidacy examination, "P", "M", and "F", mean the following:

1. The grade "P" indicates that the student has passed the examination at a high level, and is thereby eligible to begin research leading to the Ph.D.
2. The grade "M" is given if the student's performance was high enough to warrant award of the S.M. degree, but not high enough to start Ph.D. research.

3. The grade "F" indicates failure.

As stated above, the candidacy exam must be passed by the September two years after matriculation. Within this time period, you will have 5 opportunities to take the exam. There is no penalty for attempting the exam any time it is offered; i.e., taking the exam and failing it does not reduce the number of future opportunities you will have to pass the exam. Nevertheless, taking and failing the candidacy exam is not a pleasant experience, so we do not recommend that you attempt the exam unless you have studied for it and feel sufficiently well prepared to pass it. Well prepared students are encouraged to take the exam upon entry. All students are required to attempt the exam by the September one year after matriculation.

Excellent ways to prepare for the exam are: (i) To practice solving problems given on previous exams (copies of which are available in Crerar library). (ii) To take the first-year graduate courses in classical mechanics, quantum mechanics, electrodynamics, and statistical physics. (iii) To review textbooks and course notes from advanced undergraduate and graduate level courses in the relevant subjects. The formation of informal study groups to prepare for the exam is encouraged. Normally, at least a month or two of fairly intense study and preparation is recommended. Although few students preparing for the exam describe it as an enjoyable experience, many of the advanced students will tell you that they credit their preparation for the exam with helping them to expand and consolidate their knowledge of physics in a way that goes beyond what can be done by taking individual 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: To maintain an up-to-date program, 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
   - 367 Soft Condensed Matter *(under consideration in September 2013)*

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

+ 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. Autym Henderson, Graduate Affairs Administrator, at the Department Office (KPTC 201).

e-mail address: David D. Reid - dreid@uchicago.edu (773) 702-3067
Autym Henderson - amhenderson@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>Autumn</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>Winter</td>
</tr>
<tr>
<td>353</td>
<td>Advanced Statistical Mechanics</td>
<td>Spring</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 the 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>
</tbody>
</table>

* Offered in alternate years