

GRADUATE BOOKLET

Physics / Applied Physics

This booklet contains rules, guidelines and general information about graduate studies in the Physics Department at Texas Tech University. It does not replace the graduate catalog, and students are responsible for looking up detailed procedures in official documents.

I. General comments: Admission, deadlines, research advisors, priorities, etc.

II. Minimum requirements: Credit hours and other requirements for degree candidates.

III. Courses offered: List of courses, scheduling, etc.

IV. Milestones: Qualifier, Research Proposal, Thesis or Dissertation Defense.

Appendix A: Physics Department Policy on Graduate Enrollment Hours.

February 2006

This document replaces the previous versions of the Graduate Booklet.

Each graduate student is subject to the rules in the Graduate Booklet which was in effect at the time (s)he joined our graduate program. A student may elect to use the rules in a later version of the Graduate Booklet, but not an earlier version.

I. GENERAL COMMENTS

1. Prelim and Admission Standards: The Physics Department at TTU requires every prospective graduate student to take the Advanced GRE in Physics. For PhD candidates, this examination and an interview with the Graduate Advisor constitute the Preliminary Examination ('*Prelim*'). If a student is recruited prior to taking the Advanced GRE in Physics, (s)he may be *conditionally* admitted but must take this examination not later than six (6) months after coming to TTU.

2. Registration: Incoming PhD students register as MS students until they pass the Qualifier (§IV.1).

3. Leveling Courses: On the basis of the transcripts, GRE scores, and the interview, the Graduate Advisor defines the graduate course curriculum for each student and may recommend leveling courses in one or several of the four core areas: Quantum Mechanics, Electromagnetic Theory, Classical Dynamics, and Statistical Mechanics. The leveling courses are junior- or senior-level undergraduate courses. It is expected that graduate students pass leveling courses with a B average or better.

4. Full-time enrollment: The departmental requirement for full-time enrollment in the spring and fall semesters is 9 hours/semester and at least 3 hours in one summer term. Doctoral students who are nearing the end of their Ph.D. may register for less than 9 hours in accordance with Graduate School rules. Enrollment in more than 13 hours per long semester or more than 6 hours per summer term requires approval from the Dean of the Graduate School. Students participating in the MS in Applied Physics, Internship option (MSI) program are subject to the same requirements while on campus. They are required by the Graduate School to register for 9 hours per long semester and 3 hours per summer semester while off campus (during an internship).

5. Partial tuition/fee waiver: Teaching Assistants (TAs) and Research Assistants (RAs) on 50% appointment and students on a scholarship (annual minimum: \$1,000) may have out-of-state tuition waived. A portion of the in-state tuition and fees may also be waived by an amount set by the University annually. The form (departmental office) must be completed and signed by the Chairman. Since the policy on that matter changes frequently, please check the current policy with the Graduate School.

6. Foreign TAs: Foreign students who wish to have a TA must successfully complete the foreign TA workshop which is offered each August. They may be required to enroll in the appropriate English course(s) and perform satisfactorily in the immediately following fall semester. If a foreign student fails the first TA workshop, his/her financial support may be substantially reduced. The TA is then re-evaluated at the end of the semester. No improvement will jeopardize the financial assistance.

7. Residence requirements: Please consult the Graduate School catalog residency requirements.

8. Transfer credit: Students entering with an MS or MA degree from another university will have their records examined by the Graduate Advisor for transfer of credit. The Graduate School limits the number of hours that can be transferred. The Graduate Advisor recommends courses to be taken.

9. Minimum Grade Point Average (GPA): Graduate students are required to have an overall GPA of 3.0. The student is placed on *probation* whenever the semester GPA falls below 3.0. The student is *suspended* if the following semester GPA remains below 3.0 (see graduate catalog for more details). To obtain the MS or PhD, the overall GPA must be *at least* 3.0. Graduate students must have a B average in the core courses (§III.3). In order to qualify for an internship, students in the MSI program must be in good academic standing (normally a 3.0 GPA or better).

10. Deadlines: Degree candidates must observe Graduate School deadlines for filing various required forms, taking final examinations and submitting theses or dissertations. The deadlines are listed each year on the University website (University Calendar).

11. Assignment of Research Advisor: Each new student pursuing a graduate degree in physics is encouraged to associate with a Research Advisor no later than their second semester. New students are encouraged to consult with the Graduate Advisor regarding their research interests. To encourage involvement in research activities, all students should take PHYS 7000 (Graduate Research, minimum 1 credit hour) in the section assigned to their Research Advisor. Students may change Research Advisor upon consultation with the Graduate Advisor and their current Research Advisor. By the beginning of the second academic year, graduate students are expected to be engaged in research. Satisfactory progress in research is a factor when assigning TAs and other departmental support.

12. Priorities for incoming students:

a. PhD students

- * initially register as an MS student
- * take the core courses and some tools courses
- * pass the Prelim if admitted conditionally (must be done during the 1st semester)
- * submit a MS Degree Plan to the Graduate School by the end of the 1st semester
- * select a Research Advisor
- * take the Qualifier after 2 (1 or 3) long semesters for students arriving in the spring (fall)
- * register as a PhD student, select a Committee; file a Degree Plan (shortly after passing the Qualifier)
- * prepare and defend a PhD Research Proposal (within one year of passing the Qualifier).

b. MS students

- * take the core courses and some tools courses
- * pass the Prelim if admitted conditionally (during the 1st semester)
- * file a MS Degree Plan with the Graduate School by the end of the 1st semester.

Thesis option:

- * select a Research Advisor and a MS Committee
- * become active in research as early as possible
- * prepare and defend an MS thesis.

Non-Thesis option:

- * take the Qualifier at the first opportunity after 2 long semesters.

c. MSI students

- * complete six required courses (two semesters)
- * file the MS Degree Plan by the end of the second semester
- * internship (minimum of 6 months, typically summer + fall)
- * second spring semester: complete the required courses, Departmental Report.

13. Plagiarism in research papers as well as research- or class-related reports is serious Academic misconduct. *This violation includes, but is not limited to, the use by paraphrase or direct quotation of the published or unpublished work of another person without full and clear acknowledgment. It also includes the unacknowledged use of materials prepared by another person or agency engaged in the selling of term papers or other academic materials.*

14. Progress review: All doctoral students undergo a formal progress review after three years in the program and every year after that. If progress is deemed unsatisfactory, the student may be terminated by the Graduate School. This review is normally the responsibility of the Research Advisor.

II. MINIMUM REQUIREMENTS

1. MS in Physics, thesis option: Minimum 24 hours of course credit plus 6 hours of thesis research with a minimum of 18 course hours in the department. All candidates present a thesis on a research problem and take a final oral examination.

2. MS in Physics, non-thesis option: Minimum 36 hours of course credit, including PHYS 7000 (maximum 6 hours), with at least 24 hours in the department, plus passing the Comprehensive Master's final Examination which, in this case, is the same as the Qualifier (§IV.1).

3. MS in Applied Physics, thesis option: Minimum 24 hours of course credit with a minimum of 9 hours in a specified applied area (sub field of physics or related discipline). Master's thesis in that area (6 hours thesis credit), and a final oral defense are required.

4. MS in Applied Physics, internship option (MSI): 36 credit hours, of which 12 are related to the internship and the Report. Students must have completed a Bachelor's degree in Physics or a closely related field, and have a strong background in quantum mechanics and electromagnetic theory. If the physics background is insufficient, leveling courses must be completed prior to entering the phase of the program described in §I.11.c. Students normally take 5 graduate courses from the list in §III.7 plus the appropriate electives.

Note that ...

* Option 2 is intended for students who are pursuing a PhD in Physics. We encourage every PhD student to write an MS thesis.

* A student selecting any of these options may designate a Minor, which consists of a minimum of 6 hours credit in a related area and any additional requirements of the Minor Department.

* MS degree plans, prepared in consultation with the Research Advisor, must be signed by the Graduate Advisor and filed by the end of the first semester (forms available on line: '*Program for the Master's Degree and Admission to Candidacy*'). In the case of the non-thesis option, the plan is prepared in consultation with the Graduate Advisor or the Research Advisor.

* The MS Thesis (or MSI Departmental Report) Committee consists of at least two Professors from the Physics Graduate Faculty.

* The MS degree should be completed within about 4 semesters.

5. PhD in Physics: Minimum of 60 hours of course credit (including PHYS 7000) beyond the BS. At least 39 of these hours should be from 53xx, 63xx, or 73xx. In addition, 12 hours of PHYS 8000 are required. With the approval of the Research Advisor and the Graduate Advisor, up to 9 of these hours may be taken outside the department. Before enrolling in any graduate course, the student should consult with the Research Advisor and the Graduate Advisor. The Qualifier and the PhD Proposal Defense must be passed. After passing the PhD Proposal Defense, the student is considered by the Graduate School as an official PhD candidate, and the PhD Dissertation Defense must be completed within four (4) years (it will often be completed before that time).

6. PhD in Physics, Applied Physics Option: Same as §5 except that the content of the curriculum needs to be worked out between the student and his Research Advisor, in consultation with the PhD Committee. Courses must include 15 hours within a designated Applied Physics area which should be listed as a minor in the degree plan. This will be treated as a minor *within physics* unless the student requests an official Minor in the other department's program. In this case, the student's advisory committee must include a Graduate Faculty member from the Minor area, and the student must be tested over the Minor area in the qualifying examination. The student may then elect to have the Minor shown in the official transcript.

Note that ...

* The **Degree Plan** lists course requirements, dissertation topic, and the student's Doctoral Advisory Committee. It must be prepared in consultation with the Research Advisor on the standard form 'Doctoral Proposal and Report of Preliminary Examination', and be signed by the Graduate Advisor. A copy of this document must be given to the Graduate Advisor. This document must be filed prior to the PhD research proposal defense. The appropriate timing is immediately after passing the Qualifier.

* The **PhD committee** consists of a minimum of four members of the Graduate Faculty, at least three of which must be graduate faculty members of the Physics Department. The student should meet with each Committee member on a regular basis, individually or collectively, normally once a semester or more, to discuss difficulties and progress. It is the responsibility of the student's Research Advisor, of each Committee member, and of the student to make sure that these interactions actually take place.

* Each PhD candidate must write a **PhD Research Proposal** (§IV.2) and defend it before the PhD Committee within one year following the successful completion of the Qualifier examination. A delay can be granted in exceptional circumstances.

* After passing the Qualifier, the progress of each PhD candidate is evaluated on a yearly basis by his/her Committee. The result of this evaluation is reported to the Graduate Advisor.

* After completing the research and writing the dissertation, the candidate makes a public **Oral Defense** of the dissertation before the Advisory Committee, a representative of the Graduate School, and other interested persons. The Defense is a formal occasion to be scheduled in such a way that a maximum number of faculty and graduate students can attend.

III. COURSES AND SCHEDULING

1. Advance registration: No graduate course can be taught unless at least 5 graduate students are registered in it. In order to avoid last minute cancellations, the Physics Department *requires* that all continuing graduate students complete their registration early. This does not require students to make payments to the Bursar's Office prior to the deadline. The students will be advised by the Graduate Advisor if some courses have to be dropped and others consolidated. The details of the curriculum *must be* worked out with the Research Advisor or the Graduate Advisor. The courses listed below conform to the current catalog.

2. Required courses: Every semester, all TAs must take **PHYS 5104** (Instructional Laboratory Techniques, pass/fail). All full-time graduate students must take **PHYS 5101** (Seminar, pass/fail) during their first four (4) semesters at TTU. All graduate students are expected to continue to come regularly to the seminar beyond the 4th semester.

3. Core courses: For the MS and Ph.D. degrees in Physics, all graduate students pass the following 'essential core courses' with a minimum 3.0 overall average. A course may have to be taken again to satisfy this requirement. MSI students, see §III.7.

PHYS 5301	Quantum Mechanics I	PHYS 5303	Electromagnetic Theory
PHYS 5305	Statistical Physics	PHYS 5306	Classical Dynamics

All PhD candidates also take

PHYS 5302	Quantum Mechanics II	PHYS 6306	Advanced Electromagnetic Theory
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4. Tools courses: The two 'tools courses' should be taken as soon as possible:

PHYS 5307	Methods in Physics	PHYS 5322	Computational Physics
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5. Specialized courses: All MS students normally take at least two and all PhD students at least four (two outside their main research area) of the following courses:

PHYS 5304	Solid State Physics
PHYS 5309	Atomic and Molecular Physics
PHYS 5311	Nuclear Physics
PHYS 5335	Physics of Semiconductors
PHYS 5336	Device Physics
PHYS 7304	Condensed Matter Theory
PHYS 5300	Special Topics

Special Topics include: Advanced Statistical Mechanics, Advanced Quantum Mechanics, Biophysics, Group Theory, Laser Physics, Molecular Spectroscopy, Optoelectronics, Particle Physics, Plasma Physics, Problem Solving, Surface Physics, and others

Note that...

- * More than one PHYS 5300 course may be taught during the same semester.
- * The student should request that the grade transcript show the particular course title.

6. Research courses:

PHYS 6000	Master's Thesis
PHYS 7000	Research
PHYS 8000	Doctor's Dissertation

Note that ...

- * PHYS 7000 courses get a letter grade but PHYS 6000 and 8000 are assigned the grade CR (credit) until the semester in which the research is completed. Then, a standard letter grade is assigned.
- * PhD students must accumulate 30 credit hours before being allowed to sign up for PHYS 8000. Until then, they may sign up for PHYS 7000.

7. Courses for MSI students: The MSI program is in semiconductor physics. Students normally take 5 of the following courses:

PHYS 5301 **Quantum Mechanics**
PHYS 5322 **Computational Physics**
PHYS 5330 **Semiconductor Materials and Processing**
PHYS 5332 **Semiconductor Characterization and Processing Laboratory**
PHYS 5335 **Physics of Semiconductors**

Internship-related courses:

PHYS 5001 **Master's Internship in Applied Physics (9 hours minimum)**
PHYS 6002 **Master's Report (3 hours minimum)**

Example: a PhD curriculum in condensed matter physics might be: 5301, 5302, 5303, 5304, 5305, 5306, 5307, 5309, 5322, 6306, 7304, 6 hrs 5300, 4 hrs 5101, 17 hrs 7000, 12 hrs 8000.

8. First two-semester schedule: Unless leveling courses are needed, we recommend the following for students arriving in the fall of 2006 (MSI students consult with the Graduate Advisor):

fall '06:

5101 **Seminar**
5301 **Quantum Mechanics I**
5306 **Classical Dynamics**
5307 **Methods in Physics**
English (for foreign students)

spring '07:

5101 **Seminar**
5303 **Electromagnetic Theory**
5305 **Statistical Physics**
5322 **Computational Physics**

9. Tentative Schedule: PHYS 5001, 5101, 5104, 6000, 6002, 7000, and 8000 are offered every semester. Core and tools courses are normally offered every spring or fall. The courses offered every second spring or fall are denoted with a *. More than one 5300 course may be offered during any given semester, but a particular topic taught as a 5300 course may be offered only occasionally. Please, check which 5300 course(s) is (are) offered in each semester.

fall '06

5300 **Special Topic**
5301 **Quantum Mechanics I**
5306 **Classical Dynamics**
5307 **Methods in Physics**
5311 ***Nuclear Physics**
5330 **Semiconductor Materials Processing**
5335 **Physics of Semiconductors**
6306 **Advanced Electromagnetic Theory**

spring '07

5300 **Special Topic**
5302 **Quantum Mechanics II**
5303 **Electromagnetic Theory**
5305 **Statistical Physics**
5304 ***Solid State Physics**
5322 **Computational Physics**
5332 **Semiconductor Characterization Proc. Lab.**
5336 **Device Physics**

fall '07

5300 **Special Topic**
5301 **Quantum Mechanics I**
5306 **Classical Dynamics**
5307 **Methods in Physics**
5309 ***Atomic and Molecular Physics**
5330 **Semiconductor Materials Processing**
5335 **Physics of Semiconductors**
6306 **Advanced Electromagnetic Theory**

spring '08

5300 **Special Topic**
5302 **Quantum Mechanics II**
5303 **Electromagnetic Theory**
5305 **Statistical Physics**
5322 **Computational Physics**
5332 **Semiconductor Characterization Proc. Lab.**
5336 **Device Physics**
7304 ***Condensed Matter Theory**

IV. MILESTONES

The written/oral Qualifier and the PhD Doctoral Proposal constitute the PhD Qualifying Examination.

1. The Qualifier:

* This pass/fail examination is required by the Graduate School for admission to PhD candidacy. It also serves as the final examination for the MS degree, non-thesis option. Its purpose is to test the candidate's understanding of physics and potential for PhD research.

* The Qualifier can be taken at most twice, on consecutive occasions. Failing the Qualifier on the second attempt will automatically result in the student being dropped by the Graduate School from the PhD program in Physics.

* The Qualifier is offered once a year, just before the beginning of the spring semester. A student who enters the Graduate Program in the spring must take the Qualifier after two semesters. Students arriving in the fall can elect to take it after one or three semesters. If a student arriving with an MS degree transfers credit for the core courses, (s)he takes the Qualifier at the earliest opportunity. A 'no-show' (not taking the Qualifier within the time frame prescribed above) is equivalent to failing that Qualifier. Any exception to this schedule must be approved in advance by the Graduate Advisor.

* The first part of the Qualifier consists of a written exam and is administered by a committee appointed by the Department Chairman. It is prepared and conducted in the spirit of a unified examination to enable students to demonstrate their understanding of physics through a series of problems. It is administered during three consecutive afternoons. The entire Physics Graduate Faculty contributes to the problem selection and to the grading. The exam covers general physics and the graduate core courses. The major areas are: General Physics, Classical Mechanics, Quantum Mechanics, Electromagnetic Theory and Statistical Physics. Mathematical methods will be evaluated on the basis of problems within these areas.

* Each problem is independently graded by two members of the Physics Graduate Faculty, and the Chairman of the Qualifier Committee compiles the results. Students with an average score of 60.0% or above *pass*, those with an average score below 45.0% *fail*. The students with a score between these two limits take an *oral examination*, typically within ten days of the written examination. A score of at least 50% on the written examination means passing the Comprehensive Master's Examination.

* The oral examination is administered by the Qualifier Committee. The examiners are the members of the Qualifier Committee and the Research Advisor of the candidate. If the Research Advisor is one of the Committee members, an additional examiner is selected by the Chair of the Qualifier Committee. The Research Advisor may participate in the examination and in the subsequent deliberations, but does not vote on whether to pass or fail the candidate. During the exam, the student is asked questions on a variety of topics which may include material covered in the written part of the Qualifier. Immediately following this exam, the Committee decides whether the student passes or fails the Qualifier. The deliberations may include all aspects of the student's performance at Texas Tech.

* Following the oral examinations, the Chairman of the Qualifier Committee submits a report to the Departmental Chairman and the Physics Graduate Faculty. He notifies in writing the candidates and the Graduate Advisor of the outcome of the Qualifier (P/F). At the student's request, the Graduate Advisor may discuss the areas of strengths and weaknesses on the examination.

2. The PhD Research Proposal:

* After passing the Qualifier and prior to defending the PhD Proposal, PhD students must file their degree plan with the Graduate School ('*Doctoral Proposal and Report of Preliminary Examination*').

* The candidate writes a research proposal covering the PhD project and defends it orally before the PhD Committee. The length of the Proposal should be less than 15 double-spaced (typed) pages, including references, figures, and tables.

* The intent of the Research Proposal is to demonstrate that (s)he understands the relevant scientific background, how the proposed research fits into the general field, and has original ideas about what kind of research could be done to expand the 'state-of-the-art', bring in new information, or provide an original perspective on a problem. An adequate search of the relevant literature is expected.

- * The written research proposal must be approved by the Research Advisor, and then submitted to each Committee member not less than ten (10) days before the date of the presentation.
- * The oral presentation by the candidate (typically 30 minutes) is followed by questions from the Committee. Immediately following the presentation, the Committee deliberates and decides whether the candidate has successfully defended the proposal. If not, the candidate may repeat the defense one additional time within one semester.
- * The Research Advisor notifies the Graduate Advisor in writing that the student has successfully defended the Research Proposal. The Graduate Advisor then notifies the Graduate School that the candidate successfully passed the PhD Qualifying Examination and is officially a PhD candidate.

3. Thesis and Dissertation Defense:

- * After completing the research and writing the thesis or dissertation, the candidate makes a public oral defense of his/her research before the Advisory Committee, an official delegate from the Graduate School (for PhD dissertations), and other interested persons. This defense is a formal occasion which should be attended by the faculty and graduate students.
- * The Graduate School requires that the defense be scheduled at least *three weeks* before the deadline for the submission of the copy of the manuscript to the Graduate School.
- * The candidate must provide every member of his/her Committee with a copy of the thesis or dissertation at least 2 weeks before the defense. Although this copy need not be a final version, it must have been approved by the candidate's Research Advisor.
- * The Defense *must* be announced to the Physics Faculty at least two weeks prior to the date of the defense. The announcement consists of the name of the candidate, the title and abstract of the research, the list of committee members, and the date and location of the defense.
- * A copy of the candidate's thesis or dissertation *must* be available in the Physics Office at the time the announcement is made.
- * The Defense should be scheduled in such a way that a maximum number of faculty and graduate student can attend.

4. MSI Departmental Reports:

- * MSI students must also complete internships in industry and/or a National Laboratory (the existing program is with semiconductor companies) for at least 6 months (e.g., summer + one semester).
- * The student writes the MS report following the internship period. It is written *in lieu* of the MS thesis, and is intended to emphasize the fundamental principles underlying the internship project.
- * The report will be presented in an oral examination similar to the MS thesis defense. A panel of at least 2 faculty members with relevant expertise will read the report and participate in the examination. The internship sponsor will be encouraged to participate in the defense. A copy of the accepted report is kept on file in the department.

Appendix A: Physics Department Policy on Graduate Enrollment Hours

Effective: March 1, 2004

Changes in Graduate School policy have led to some minor updates to departmental policy and practice regarding the numbers of enrollment hours required for graduate students. This document represents departmental policy as of the above date.

Full time enrollment as defined by the Graduate School is a minimum of 9 hours during any regular semester and 3 hours during any short summer session (6 hours for a single long summer session). Special reductions may occasionally be allowed for students nearing completion of their final degree. Any modification requires approval from the Graduate School.

A maximum of 13 hours in a regular semester and 6 hours per summer session is allowed by the Graduate School. Students wishing to enroll in more hours must receive special permission from the Graduate School. Minimum on-campus enrollments are 6 hrs per regular semester and 3 hrs per summer session.

A one year residence requirement for PhD students is satisfied by enrollment in a minimum of 24 hours during a 12 month period, such as 12+12 in two long semesters or 9 in each semester +6 in the summer. This has to be done one time during a students PhD program.

Official Policy is that a graduate student must be enrolled full time any each session during which they receive a Graduate Teaching Assistantship (TA) or Research Assistantship (RA). Requests for deviation from this policy may be considered, but have seldom been approved.

If dropping a course causes a student to fall below the full time requirements, permission is required from the Graduate School in order for the Assistantship to continue. Under some circumstances, the Department can arrange adding Research related hours after the student initiated Add/Drop deadlines in order to avoid this problem.

Every graduate student must be enrolled each semester and at least one summer session each year to satisfy the continuous enrollment requirements of the University.

The Department's practice is to require 3 hours in a regular semester and 1 hour in either summer session to satisfy this minimum enrollment for unsupported students who are not on campus.

The Department requires students in their first 4 semesters to sign up for PHYS 5101 and all TA's must take Phys 5104, thus the typical enrollment is 10 or 11 hours for the first few semesters.

Because the official policies may be modified at any time, students and advisors should consult the relevant University OP's and the latest Graduate Enrollment Management Policy statements regarding any changes in official University or Graduate School policies and any special provisions with respect to maximum program hours.