

Graduate Student Handbook

Department of Physics

August 2007

Welcome to the Washington University Department of Physics!

This handbook provides information which will help you understand the structure of the graduate program here. The information you will find here is complemented by information from faculty advisors and other written documents. However, this handbook is the most up-to-date source of information on the topics it discusses.

Section I contains the formal requirements for obtaining the M.A. and the Ph.D. in our department. These requirements provide the basic framework for each graduate student's program. The specific content of each student's program is determined by the student in consultation with the graduate student advisor, and later, the research advisor. The remainder of the information in this handbook is provided to facilitate the detailed planning of the program.

Graduate students will meet with their graduate student advisor before each semester begins for consultation. Upon entering the program, and prior to the initial advising, a diagnostic examination is given to entering graduate students for placement purposes. This is discussed in section II. The results are used by the graduate student advisor only. Sections III and IV contain essential information on the curriculum; they should be consulted carefully in planning coursework. Section IV is particularly important for long-term planning.

Perhaps the most important decision that each graduate student must make is the choice of a research topic. The Physics Colloquia and Seminars, described in

section V, is an opportunity for graduate students to become familiar with the research programs in our department.

All graduate students must satisfy the teaching requirement described in section VI. Additional information on the duties, responsibilities and evaluation of teaching assistants will also be found there.

The procedure for qualification to Ph.D. candidacy is described in section VII. Students should study this section carefully. This section contains essential information for all graduate students who have not yet qualified for candidacy.

Section VIII discusses the changes in the advising process which take place after qualification for Ph.D. candidacy, including the role of a faculty committee which will monitor the student's progress towards the Ph.D.

I. Requirements for the M.A. and the Ph.D.

Students are normally accepted for graduate work towards the Ph.D., although students are occasionally accepted to work towards the M.A. our students arrive with diverse backgrounds and interests. In each entering class, we have students who are ready to take advanced courses and begin research as well as students who need the material presented in 400-level courses. In order to accommodate the needs of this diverse group of students, no particular course is required for all students. Suggested curricula (see section III) have been prepared by the faculty and should be consulted for guidance.

- Requirements for M.A.

1. 30-semester hour of satisfactory course credits.
2. At least 24 in classroom or seminar courses at the 400 level or higher
3. Either acceptable performance, at the Master's level, on all sections of the written qualifying examination for the Ph.D. or preparation of a Master's thesis, approved by the thesis advisor. In this case, the course requirement is reduced from 30 to 24.
4. Maintenance of a grade average of B or better.

- Requirements for Ph.D.

1. 72 hours of satisfactory course credits at the 400 level or higher.
 - a) at least 36 in classroom or seminar, of which at least 18 must be in 500-level courses
 - b) not more than 36 in research
2. Admission to candidacy using the Ph.D. qualification procedure detailed in section VII.
3. Preparation of written thesis and an oral defense of that thesis.

4. Experience and demonstrated competence in teaching physics under the procedure detailed below.

II. Diagnostic Placement Examination

In order to better advise entering graduate students on course selection, a diagnostic placement examination is given to all students entering our graduate program prior to the advising procedure. This examination is in a take-home, open-book format, to be completed by the students prior to meeting with the graduate advisor. The results of this examination will be used by the graduate advisor only for diagnostic purposes, and will not be available for use in later evaluations. The examination will cover material at the level of a typical undergraduate curriculum.

III. Guidelines for Course Selection

Students must plan their curriculum, after consultation and approval by the graduate advisor. In addition to their other classes, all first-year graduate students should enroll in Physics 582, Research Seminar, and Physics 597, Teaching Methods in Physics, in the fall semester. Coursework must prepare for completion of the qualification procedure and the beginning of research. Faculty in each major research area has contributed guidelines for course selection. These guidelines have been compiled below. We also note that the following opportunities and alternatives exist in the curriculum:

- Students who are well prepared in a given area may wish to take advanced courses in that area, or take extra courses in different areas.
- Many students have found that 400-level courses can be helpful in enhancing basic skills in particular areas. It may be possible to substitute one or more 400-level courses for similar courses at the 500-level. Graduate students generally should not take 400-level courses when they have already taken substantially similar courses as undergraduates. Taking 400-level courses requires permission from the graduate advisor, and students taking these courses with permission may be denied graduate credit at the department's discretion.
- Special topic courses (Physics 589 and 590) are frequently offered and represent excellent opportunities to learn advanced and specialized material. These courses are taught by visiting faculty and research associates as well as regular faculty.

- Although 36 units of course work are the minimum required for the Ph.D., additional courses can be taken. Students may also audit courses, on a formal or informal basis. This extends the opportunities graduate students have to learn advanced material.

Course Guidelines

Astrophysics and General Relativity

1. Expected

501,502: Methods of Theoretical Physics I & II

523,524: Quantum Mechanics I & II

505,506: Classical Electrodynamics I & II

529: Statistical Mechanics I

557: Gravitation and Cosmology

558: Relativistic Astrophysics

2. Strongly Recommended:

at least four of

507: Classical Mechanics

542: Nuclear Physics

546: Galactic Astrophysics

547: Intro. to Elementary Particles

556: Stellar Astrophysics

551,552: Relativistic Quantum Mechanics and Field Theory

3. Recommended:

503,504: Advanced Math Methods

540: Quantum Theory of Many Particle Systems

Condensed Matter / Material Physics (Experiment)

1. Expected

472: Introduction to Solid State Physics

(if not taken previously)

501: Methods of Theoretical Physics I

523,524: Quantum Mechanics I & II

529: Statistical Mechanics I

549,550: Solid State Physics I & II

2. Recommended dependent on research interests

505,506: Classical Electrodynamics I & II

530: Statistical Mechanics II

534,590: NMR and Advanced NMR

537,539: Materials Physics I & II

Condensed Matter (Theory)

1. Expected

472: Introduction to Solid State Physics

(if not taken previously)

501,502: Methods of Theoretical Physics I & II

505,506: Classical Electrodynamics I & II

523,524: Quantum Mechanics I & II

529: Statistical Mechanics I

Either

(1) 530: Statistical Mechanics II

(2) 537 Materials Physics I

549,550: Solid State Physics I & II

2. Relevant but optional:

Either

(1) 530: Statistical Mechanics II

(2) 537 Materials Physics I

474: Intro. to Nuclear and Particle Physics

540: Quantum Theory of Many Particle Systems

551,552: Relativistic Quantum Theory I and II

Experimental Space Science

1. Expected

501,502: Methods of Theoretical Physics I & II

505,506: Classical Electrodynamics I & II

523,524: Quantum Mechanics I & II

529: Statistical Mechanics I

542: Nuclear Physics

2. At least two of:

545: Solar System Astrophysics

546: Galactic Astrophysics

555: Astrophysical Plasmas

556: Stellar Astrophysics

557: Gravitation and Cosmology

558: Relativistic Astrophysics

Many-Body and Nuclear Theory

1. Expected

501,502: Methods of Theoretical Physics I & II

505,506: Classical Electrodynamics I & II

523,524: Quantum Mechanics I & II

529,530: Statistical Mechanics I & II

540: Quantum Theory of Many-Particle Systems

542: Nuclear Physics

2. Strongly Recommended:

at least three of

551,552: Relativistic Quantum Mechanics and Field Theory

557,558: Gravitation, Relativity and Relativistic Astrophysics

549,550: Solid State Physics I & II

3. Recommended:

503,504: Advanced Math Methods

507: Classical Mechanics

547,553,554: Particle Physics

Particle Physics and Quantum Field Theory

1. Expected

501,502: Methods of Theoretical Physics I & II

505,506: Classical Electrodynamics I & II

523,524: Quantum Mechanics I & II

529,530: Statistical Mechanics I & II

551, 552: Relativistic Quantum Mechanics and Field Theory

2. Strongly Recommended:

at least three of

503,504: Advanced Math Methods

540: Quantum Theory of Many-Particle Systems

542: Nuclear Physics

557: Gravitation and Cosmology

558: Relativistic Astrophysics

549,550: Solid State Physics I & II

3. Recommended:

547,553,554: Particle Physics

Biophysics

Biomedical Imaging Track

1. Expected

501 Methods of Theoretical Physics I

471 Quantum Mechanics or 523 Quantum Mechanics I

412-422 Electricity and Magnetism or 505-506 Classical Electrodynamics

463 Statistical Mechanics and Thermodynamics or 529 Statistical Mechanics

2. Strongly recommended

472 Solid State Physics or 549 Solid State Physics I

3. Recommended

534 Magnetic Resonance or 535/589 Topics in Ultrasonics

502 Methods of Theoretical Physics II

524 Quantum Mechanics II

Neurophysics Track

1. Expected

501 Methods of Theoretical Physics I

471 Quantum Mechanics or 523 Quantum Mechanics I

412-422 Electricity and Magnetism or 505-506 Classical Electrodynamics

463 Statistical Mechanics and Thermodynamics or 529 Statistical Mechanics

2. Recommended

502 Methods of Theoretical Physics II

472 Solid State Physics or 549 Solid State Physics I and/or
550 Solid State Physics II
537/539 Materials Physics I/II
455 Physics of Vision
Biology 4501 Biochemistry
Biology 334 Cell Biology
Biology 3411 Biological Principles of the Nervous System
Biology 554 Neural Sciences

Theoretical Track

1. Expected

501-502 Methods of Theoretical Physics I and II
463 Statistical Mechanics and Thermodynamics
529 Statistical Mechanics
412-422 Electricity and Magnetism or 505-506 Classical Electrodynamics
471 Quantum Mechanics or 523 Quantum Mechanics I

2. Recommended, depending on specialty

427 Introduction to Computational Physics
450 Physics of the Brain
455 Physics of Vision

472 Solid State Physics or 549 Solid State Physics I and/or
550 Solid State Physics II
Biology 334 Cell Biology
Biology 3411 Biological Principles of the Nervous System
Biology 554 Neural Sciences
Biology 5641 Computational Neuroscience
Biomedical Engineering 561 Proteins as Nanomachines
Biomedical Engineering 590 Molecular Thermodynamics and Kinetics
Systems Science and Mathematics 570 Random Variables and Stochastic
Processes I
Electrical Engineering 431 Control Systems I
Electrical Engineering 445 Digital Signal Processing

IV. Course Schedule

The scheduling of graduate courses is very important in planning each individual graduate student's program. Graduate students should plan their curricula on the basis of the schedule of courses given below. Note however that the schedule represents the faculty's goals for course offering; in practice, due to sabbaticals or other exigencies, some courses may be offered less often than shown below.

Schedule of 400 & 500 Level Courses

411:	Mechanics I	Every Year
421,422:	Electricity and Magnetism I & II	Every Year
427:	Introduction to Computational Physics	Every Year
455:	Physics of Vision	Every Other Year
463:	Statistical Mechanics and Thermodynamics	Every Year
471, 473:	Quantum Mechanics I & II	Every Year
472:	Solid State Physics	Every Year
474:	Nuclear and Particle Physics	Every Other Year
476:	Astrophysics	TBA
501,502:	Methods of Theoretical Physics I & II	Every Year
503,504:	Advanced Math Methods	Every Other Year
505,506:	Classical Electrodynamics I & II	Every Year
507:	Classical Mechanics	TBA
523,524:	Quantum Mechanics I & II	Every Year
529:	Statistical Mechanics I	Every Year
530:	Statistical Mechanics II	Every Other Year
532:	Paramagnetic Resonance	To Be Arranged
534:	Magnetic Resonance	Every Other Year
535:	Ultrasonics	To Be Arranged
537:	Material Physics I	Every Other Year

539:	Material Physics II	Every Other Year
540:	Quantum Theory of Many-Particle Systems	Every Third Year
542:	Nuclear Physics	Every Third Year
545:	Solar System Astrophysics	To Be Arranged
546:	Galactic Astrophysics	To Be Arranged
547:	Intro. to Elementary Particle Physics	Every Third Year
549:	Solid State Physics I	Every Year
550:	Solid State Physics II	Every Other Year
551,552:	Relativistic Quantum Mechanics/Field Theory	Every Other Year
553,554:	Particle Physics	To Be Arranged
555:	Astrophysical Plasmas	To Be Arranged
556:	Stellar Astrophysics	To Be Arranged
557:	Gravitation and Cosmology	Every Other Year
558:	Relativistic Astrophysics	Every Third Year
590:	Nuclear Magnetic Resonance II	Every Other Year

V. Physics Colloquia and Seminars

First year students should enroll in Physics 582, Research Seminar, in the spring, for one unit of credit. The Physics Department also has regular lecture series in which visitors and faculty present some of the most interesting and important issues in their research areas. The lectures vary in level, but colloquia are intended to be of interest to all graduate students and faculty. These lectures can expose new graduate students to a wide variety of important research topics, which can aid them in choosing a research direction. At the same time, graduate students, postdoctoral fellows and faculty have an opportunity to find out what their colleagues are doing, and keep abreast of the latest results in other fields. First year graduate students should plan to attend. Another valuable source of information is the graduate student seminar series, in which advanced graduate students take turns presenting their research in an informal setting. Refreshments are served prior to all seminars and colloquia.

VI. Teaching Skills and the Graduate Teaching Requirement

Teaching and presentation skills are essential for success in teaching and communicating research results. Students desiring to improve their language skills may wish to take advantage of University resources, including courses in English as a Foreign Language.

Graduate Teaching Requirement

All graduate students must satisfy the Graduate School teaching requirement, which is currently being revised. A large portion of this requirement is satisfied by participating in the instruction of an introductory, calculus-based, physics course. First-year graduate students will enroll in Physics 597, Supervised Teaching of Physics, for the Fall Semester, for which they will receive one unit of credit. First-year students will also participate in weekly meetings, where they will receive instruction and practice in teaching skills and techniques, including:

- Lecture preparation
- Oral presentation skills
- Integration of laboratories and lectures
- Laboratory skills
- Test and quiz design
- Proctoring and grading skills
- Course design and syllabus preparation

Each first-year student will be mentored by an experienced TA, and will participate in teaching one lab section per week with that mentor. First-year students will make several formal presentations during the semester to peers in Physics 597 and to undergraduates in their lab section. Graduate students entering with advanced standing should consult with their graduate advisors to determine if this portion of the teaching requirement has been satisfied by prior teaching experience. The remaining portion of the graduate school teaching requirement is typically met by research presentations after qualifying for Ph.D. candidacy and joining a research group.

Policy for the Instruction of Teaching Assistants

All first-year students will enroll in Physics 597 Teaching Methods in Physics. First-year students who are TAs in the spring should also enroll in Physics 598.

Lab assistants will be evaluated on the basis of their physics teaching skills, their interaction with individual students, their ability to evaluate student performance. The faculty supervisor of the laboratory will provide regular feedback to the lab assistants.

Graders should provide clear, organized solutions to problem sets and examinations. They should be available to students for discussion of the solutions and explanation of grading. Supervising faculty will work closely with graders, and provide periodic evaluations of their work and suggestions for improvement.

Graduate students running help sessions and recitation sections will be evaluated on the basis of their physics teaching skills, their interaction with

individual students and their ability to evaluate student performance. Supervising faculty will monitor the teaching performance regularly, and make suggestions for improving teaching skills.

VII. Ph.D. Qualification Procedure

Qualification for Ph.D. Candidacy is based on satisfactory performance in important graduate physics classes and passing an oral exam on advanced material.

Course Requirements

In order to qualify for Ph.D. candidacy, students must take a total of six core 500-level courses. The six courses must include the four courses 501, 505, 523, and 529, and at least two of 502, 506, 507, and 524. Students must have taken five of these 500-level courses by the end of the third semester, and six by the end of the fourth semester. Students must maintain a B average in these courses, and have at most one grade lower than a B- in these courses. Students may take no more than four 400-level classes without the permission of the graduate studies committee. In exceptional cases, course requirements and deadlines may be modified at the discretion of the graduate studies committee.

Students with previous graduate work, e.g., a Master's degree in physics, may petition the graduate studies committee for a waiver of some or all of the course requirements portion of the qualification procedure. Note that graduate students on the graduate studies committee do not participate when individual students are discussed.

Oral Examination Requirement

Students are required to pass an oral examination on advanced physics at a level appropriate for a student beginning research in that area. This examination will be administered by a committee of three physics faculty members. The examination should demonstrate a basic understanding of a major topic of current research in the selected area of study.

The committee must be chosen and approved by the chair no later than the end of the examination period of the student's third semester. The chair of this committee will normally be the student's prospective research advisor, who will assist the student with choice of topic, selection of committee members, et cetera.

However, arranging to take the oral examination is the responsibility of each student, and failure to do so in a timely manner may result in termination from the program. This oral examination must be taken by the end of a student's fourth semester. A student who fails the initial oral examination may take a second oral examination, to be completed no later than the end of the student's fifth semester.

VIII. Continuation of Ph.D. candidacy

After admission to candidacy, the thesis advisor has primary responsibility for directing the candidate's research. It is the student's responsibility to find a thesis advisor in a timely manner. The interaction of thesis advisor and Ph.D. candidate is determined both by the character of the research, and the styles and preferences of the individuals involved. In a large research group, a student may interact primarily with other graduate students or with postdoctoral fellows, particularly in the earlier stages of research. Some research groups hold regular lab meetings to discuss planning, progress and problems. In the late stages of thesis research, a student might work with the advisor on a daily basis. For some advisors, daily contact is the norm, while others prefer regularly scheduled weekly meetings. The collaborative character of a research project requires that both graduate student and advisor develop a good working relationship which supports the student's needs and goals.

The three-member faculty committee appointed for each student is responsible for monitoring and assisting progress towards the Ph.D. This committee will normally be chaired by the thesis advisor. In the absence of a thesis advisor, the committee will direct the student in finding a thesis advisor and/or a research topic. The members of the committee are sources of advice and encouragement for the student. It is the student's responsibility to take advantage of their experience, knowledge and perspective. This is particularly important in the later stages of the thesis project, as the thesis is written and students prepare to enter the job market.

Each faculty advisory committee will meet at least once per year to discuss the student's progress towards the Ph.D. The format of the meeting is up to the discretion of the committee. Many committees will require a presentation, either written or oral, by the student at this time. A written report will be made by the committee annually to the department chair on the student's progress using the evaluation form available from the graduate secretary or the departmental web site. This will normally occur before February 1st of each year, in order to meet graduate school deadlines. When a student's progress is deemed unsatisfactory by the committee, it will meet frequently and require continuing progress reports.

In the unusual case of unsatisfactory progress, the committee may recommend any of the following:

1. the student withdraw from the graduate school
2. the chairman or research supervisor cut off funding
3. the faculty remove the student from candidacy

As the thesis project nears completion, the graduate student and advisor should make sure that all requirements for graduation have been met. The Office of the Dean of the Graduate School can provide information on the format of the written thesis; TeX and LaTeX templates are available. Ms. Julia Hamilton (Physics Dept. Office, x5-6250) will assist in the necessary scheduling and paperwork.