

Rensselaer Polytechnic Institute

Department

of

Physics, Applied Physics and Astronomy

Graduate Student Handbook:

Information for Graduate Students in
Physics

December 2011

Graduate Program Handbook

The information on the following pages is intended to help graduate students in Physics at Rensselaer to have a successful, pleasant, and productive experience in the Department. For answers to questions not covered here, students may inquire of fellow graduate students, their advisors, the Chair of the Graduate Program Committee, the Chair of the Department, or the Dean of the Graduate School. In addition, students should be familiar with the relevant sections of the Graduate Bulletin and the Handbook for Students. ***It should be noted that the Graduate Program Handbook and the Qualifying and Candidacy Examination Handbook contain rules specific to the graduate program in Physics which do not appear anywhere else.***

The graduate program in Physics at Rensselaer is embedded in a larger academic environment consisting of both graduate and undergraduate programs in many fields, mostly in the sciences and engineering, but including also management, architecture, the humanities and the social sciences. While the usual program of a graduate student is a highly specialized one compared to most undergraduate programs, substantial opportunities exist, both in principle and in practice, for students to undertake programs of study and research which span one or more fields, while remaining formally attached to the Physics Department.

These pages contain a digest of some of the Rules and Regulations of the Graduate School at Rensselaer Polytechnic Institute as well as a statement of the particular requirements in the Department of Physics. It is our feeling that in graduate work, rules and regulations should play a minor role; but that some are nevertheless necessary and should be clearly understood by all concerned. The Department of Physics offers programs in physics leading to the graduate degrees of Master of Science and Doctor of Philosophy. The requirements for each of these degrees will be discussed.

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I. Graduate Program Committee

The overall graduate program in physics is administered by the Department's Graduate Program Committee (GPC). Questions or suggestions for the committee may be addressed to any member. All approvals of plans of study, transfer credits and for credit for Master's degrees completed at other institutions will also be given by the GPC. Formal requests concerning student status, special permission, etc., should be directed to the Chair of the Committee. Questions may also be directed to the Chair and the Associate Chair of the Department.

Current Committee Members are:

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II. Faculty-Student Interaction

As a graduate student, your status is quite different from that of an undergraduate student, particularly in relation to the faculty. The faculty will, formally, demand a much higher level of effort and achievement on your part than is customary for undergraduates. This is in response to your expressed interest in becoming an "expert" in your chosen field of study, and in acknowledgement of and with respect for your proven ability to do advanced work in the field.

In return, the faculty accepts you as a "junior colleague" in a variety of ways. If you are a teaching assistant you will find that you are performing duties, which are essentially the same as those of many of the faculty. Your opinions and contributions will be sought and valued at the regularly-held meetings of instructors in the courses, and you will be responsible for such things as test question generation and grading, alongside the senior faculty. In your own course work, faculty members will generally take quite seriously your need for outside assistance, or for guidance in pursuing topics of interest to you, which go beyond those covered in a particular course. When you become associated with a particular faculty member in a research project, your efforts and contributions are likely to put you into an extremely close and mutually dependent relationship with your research supervisor and other faculty and students working on the project. To differing degrees the student and the faculty member accept responsibility for the successful outcome of these efforts.

Apart from these relatively formalized interactions, opportunities exist for informal and social interactions, which contribute to the pleasantness of students' life as graduate students in physics. Students and faculty organize parties and informal social events, both Department-wide and within smaller groups such as research projects. The sense of community, which a small-city campus such as that of Rensselaer makes possible, encourages a variety of group and individual informal relationships and activities. Since the Department is of moderate size, with a graduate-student-to-faculty ratio of approximately two-to-one, casual interactions occur readily and frequently, limited only by the individual's inclination and preferences.

III. Informal Aspects of the Graduate Program

In addition to the usual academic courses and the necessary research involvement, students will find that there are a number of other activities within the Department, which can contribute in a major way to their development as scientists.

1. Probably the most important single mode of learning for any student who aspires to become a serious scientist is self-study by reading books and journal articles. Familiarity with the general literature of physics and with the specific literature of the area of the student's specialization is an absolute essential. Students taking formal courses should read in books other than the assigned texts, and students engaged in research should be reading current journals to learn what others in the same and related fields are doing. The hallmark of the productive scientist is a never-ending curiosity about the natural universe.
2. The Department presents, almost every week of the regular academic terms, the Physics Colloquium, Wednesdays at 4 PM, at which scientists, usually from other laboratories, discuss results of their recent research activities. Although these talks are not always completely intelligible to first year graduate students in physics, they provide an excellent way for a student to discover how research physicists do their work. One also learns, over the months, the nature of various fields of research in physics and gets a feeling for where the forefront of investigation is in these fields. Students and faculty are expected to attend the regular colloquia, not only those in their own area of specialization.
3. The various subgroups within the Department in particular research areas regularly organize seminars, at which both students and faculty, as well as outside visitors, present and discuss talks on topics of current interest in these areas. Most seminars meet once a week. Students may, with their advisor's permission, register for academic credits in these seminars. They will then normally be expected to present one or more formal talks themselves.
4. The Department organizes a meeting, usually in October, for first-year students to provide information about the research going on in the Department and the opportunities for graduate students to undertake thesis projects in various areas.
5. The Department maintains the H.B. Huntington Computer Laboratory in Room 1C28 of the Science Center. The Lab is intended for quiet study. The Lab will be open throughout the day M-F (usually 8:30 AM- 5:00 PM). During this time, anyone may use the lab. During weekends or evening hours, the lab will be locked although after-hours access is available for graduate students.

6. The Institute library collection (housed in the Folsom Library building a short distance west of the Science Center building) has a very good collection of physics books and journals, as well as many useful books and journals in related fields, as well as a wide selection of electronic journals. Interlibrary loan arrangements can be used for rare materials not in the library, and arrangements can be made at the library for use of the libraries of neighboring institutions when that is necessary.
7. Other departments and groups in the Institute present colloquia and seminars which are open to all. Notices appear frequently on bulletin-boards, Reviews, Poly, and students are encouraged to attend any which seem to be of possible interest.
8. Occasionally a group of students may organize, on their own initiative, a study group on a topic not normally available in formal courses. These may meet with or without informal participation by faculty members.

Regulations & Procedures

-Course Selection-

On entering Graduate School each student is assigned to an academic advisor who is a member of the Department faculty. Upon arrival, each entering student must consult with the academic advisor and the Graduate Program Committee to agree on a Plan of Study for the degree. The latter should be filed with the Graduate School during the first three weeks of the Fall Semester. Students with deficient backgrounds may be advised to take certain undergraduate courses. If the advisor feels that such remedial work will delay the student's progress through various requirements, (e.g. Qualifying and Candidacy Exams), the student, the advisor, and the GPC will agree on a written schedule to meet these requirements. Deviations from the Plan of Study must be approved in advance in writing by the Graduate Program Committee in order for the student to remain in good academic standing. Note that the department will not supply tuition waivers for courses outside of the Plan of Study unless the course is approved in advance in writing by the advisor and Graduate Program Committee and the student's Plan of Study modified accordingly.

IV. Regulations & Procedures

-Choosing Research Work-

The introduction to research should normally occur in the second semester of graduate work for all but remedial students. Therefore, every student should enroll for at least one unit of Topics in Physics (Phys 6960) or Reading in Physics (Phys 6940) during each semester after the first. This is to be done in a formal way after discussing with research professors in physics or related subjects what their topics of research are, and then being accepted by one of these professors to work with him or her. During the fall a meeting for first-year graduate students is held, at which time the available research opportunities are described. Failure to enroll and actually engage in research at this time may prejudice the student's career in this Department. The choice of research field and project at this time may well be tentative, and students are free to change fields when they have gained more experience and solidified their interests. When a student has selected a research supervisor, and the supervisor has agreed to take on a student, they should inform the Graduate Program Committee Secretary. When a student selects a research supervisor, that supervisor usually becomes the student's academic advisor. The Secretary of the GPC should be officially notified by the student if the academic advisor is changed. Typically, a research advisor will be using her/his grant or contract money to support a student. A student who changes research advisors will generally have to begin a new research project which will extend the length of time necessary to complete his/her thesis. For all these reasons, we encourage students to begin the selection of a research advisor early in their career at Rensselaer. We also encourage the student and her/his research advisor to take steps as early as possible to form a definite commitment about whether the relationship will work out. For these reasons, the GPC has chosen to establish several guidelines which we encourage both graduate students and faculty to follow.

1. The GPC requires that students file a research plan by the end of March in their second year. This research plan should normally indicate a research advisor, some indication of the research topic, and planned mechanisms for support of the research. Students are strongly encouraged to begin this selection process in the spring of their first year at Rensselaer, and normally the first summer provides an opportunity to begin a trial research project with an advisor. Students who are unable to meet this requirement should notify the GPC in advance of the deadline and the committee will try to help them.
2. Once a student starts working on a research assistantship, the student may still choose to change advisors if the student finds that his/her research is unsuitable for his/her goals or feels that the relationship is unsuitable. However, before a student formally accepts a position with another advisor as an RA, the student and the new advisor should consult with the previous advisor so as to arrange the transfer with the minimum amount of disruption.

3. If an advisor (or student) decides that a student should not continue in his/her research program, the department will make all reasonable attempts to provide "bridge" support until the student is able to find a new advisor presuming that the student remains in good academic standing. However, one of the reasons that a research advisor may decide to terminate support is because he/she feels that the student is not making good progress toward an advanced degree (either the M.S. or Ph.D.). In this case, the GPC, after meeting with the student, may decide to recommend that the student withdraw from the Physics Graduate Program.

Students working with research supervisors outside the department are subject to some additional regulations. They must designate a member of the Physics Department to serve as the official advisor for the research. That department member will become the student's academic advisor, and will chair the student's candidacy and PhD thesis committees. In general, students working with research supervisors outside the department must be supported by RA's or external fellowships.

IV. Regulations & Procedures

-Graduate Academic Standing-

In order to remain in good academic standing the student must take the courses agreed upon in the Plan of Study and should maintain a "B" average (3.0 GPA). Normally in the first two years of graduate study each full time student will take a minimum of two courses per semester. This is a minimum requirement. A student should discuss any C's with his/her advisor. In the first year any student with a C should discuss the problem with the advisor and the Chair of the Graduate Program Committee before the beginning of the winter (or summer) recess. The renewal or continuation of a student's assistantship will depend on remaining in good standing in each succeeding semester. A grade of F in any semester is sufficient grounds for immediate withdrawal of an assistantship.

In addition to maintaining grades, graduate students must carry out their teaching and/or research duties to the satisfaction of the appropriate faculty. To remain in good standing students must also pass the Qualifying and Candidacy Exams at the appropriate times.

Academic dishonesty

Academic dishonesty is considered a very serious offense in the Physics Department graduate program. Therefore, any substantiated case of academic dishonesty will be dealt with unequivocally. Examples of academic honesty are explicated in the written Institute's Academic Policies and Procedures, and the Student Handbook.

Some specific Physics Department penalties for substantiated academic dishonesty are as follows:

1. Cheating on an examination or course assignment in one of the categories listed in the above documents will result in an automatic failing grade for the course.
2. A second case of substantiated academic dishonesty will result in automatic immediate termination in the graduate program, including immediate termination of all student financial support.
3. Academic dishonesty in the qualifier examination will result in automatic failure of the examination, and termination in the graduate program, including immediate termination of all student financial support.

The decision regarding the veracity of any cases of suspected academic dishonesty will be made by a committee composed of two members each from the physics graduate student council and the physics graduate program committee. There is in all cases a right of appeal from the Department Chair, the Dean of the School of Science, and eventually the Provost, according to the procedures written in the Student Handbook.

Regulations & Procedures

-Teaching Requirements-

The Department of Physics considers teaching as an important part of the education of a physicist. Each graduate student is required to attend the orientation program for new students and is required to be engaged in some aspect of the teaching program at some time during his or her graduate career.

V. Requirements for a -Master's Degree in Physics-

The Master's degree requires thirty (30) credits of graduate work of which a minimum of twenty one (21) shall be in course work.

Course Requirements:

A candidate for the M.S. degree in physics is expected to take at least three (3) of the following four courses. One of these three must be Quantum Mechanics I.

PHYS 6410: Electrodynamics (4 credits)

PHYS 6510: Quantum Mechanics I (4 credits)

PHYS 6520: Quantum Mechanics II (4 credits)

PHYS 6590: Statistical Mechanics (4 credits)

Grades in these courses lower than "B" are causes for concern even though a student may be maintaining an overall "B" average. When such a situation arises the student should consult his or her advisor, and some definite decision should be recorded as to what remedial steps are necessary.

The cumulative GPA for all courses applied towards a master's degree must be 3.0 or higher.

The remainder of the course program will be selected by the candidate in consultation with the advisor and must be approved in advance by the Graduate Program Committee. There are particular requirements for students specializing in Astrophysics or Biophysics.

Research Requirements

Some research activity is required for the M.S. degree. There are two options for formalizing this:

1. Master's Thesis

Master's candidates choosing to write a thesis are expected to formulate a thesis problem in consultation with their research advisors. Once the topic has been chosen, an advisory committee of three faculty members is appointed. The advisor is chairperson, the other two members are chosen by the candidate and advisor in consultation. The secretary to the Graduate Program Committee should be notified in writing of the composition of this committee. This committee is responsible for giving final approval to the thesis. The student must file the thesis title with the secretary to the Graduate Program Committee at the beginning of that semester in which it is expected that the degree will be awarded. To receive a degree at the end of any semester, the student must be registered for that semester.

The original copy of the thesis approved and signed by the thesis committee must be deposited in the Graduate School Office before the date specified in the Institute calendar. The Graduate School requires a fee for thesis binding to be paid by the Master's degree candidate. A duplicate copy of comparable quality must be placed in the Physics Library.

Once the thesis is completed from six (6) to nine (9) credits will be awarded for the research.

2. Research Project

The student may elect a research project. This project will be carried out under the supervision of a Physics Department faculty member. That faculty member will be solely responsible for approving the completion of the project. The student needs to submit a written master's report (Click here: [Master's Report Guidelines](#)) to the research advisor and a copy sent to the chair of GPC at the end. Upon successful completion of the project, the student will receive 3 credits towards the master degree. Therefore, 27 credits of course work will be required to reach the necessary 30 credits.

VI. Requirements for a -Master's Degree in Astronomy-

Completion of the M.S. in astronomy requires 30 credits of graduate work beyond the bachelor's degree, including a minimum of 21 credits in course work. At least 15 credits must be at 6000 level or above. The cumulative GPA for all courses applied towards a master's degree must be 3.0 or higher.

Course work should meet the needs of the individual student, but must include

- (1) One course from: PHYS 6410 (Electrodynamics), PHYS 6510 (Quantum Mechanics), PHYS 6520 (Quantum Mechanics II), PHYS 6590 (Statistical Physics)
- (2) Two courses from ASTR 4120 (Observational Astronomy), ASTR 4220 Astrophysics, ASTR 4240 Gravitation and Cosmology, ASTR 4510 Origin of Life: A Cosmic Perspective, ASTR 6250 Interstellar Medium, ASTR 6960 Special Topics in Astronomy and Astrophysics
- (3) Three semesters of ASTR 6900 Astrophysics Seminar
- (4) A six to nine credit formally presented thesis or multiple-semester project in astronomy or astrophysics

VII. Requirements for a -PhD in Physics-

The Doctor's degree requires a total of seventy-two (72) credits after the Bachelor's degree or forty-two (42) credits beyond the Master's degree. The emphasis is on research which produces new scientific knowledge of significant character.

Course Requirements

There is no stated minimum number of course credits. Most students take about forty-five (45) credits.

1. Core courses

All candidates for the Ph.D. must take a basic core of graduate courses including the following:

PHYS 6410: Electrodynamics (4 credits)
PHYS 6510: Quantum Mechanics I (4 credits)
PHYS 6520: Quantum Mechanics II (4 credits)
PHYS 6590: Statistical Mechanics (4 credits)

Math 6600, Methods of Applied Mathematics, should be taken by all students who have not already learned this material.

Grades in the graduate "core" courses lower than "B" are a cause for concern even though the student may be maintaining an overall "B" average. When such a situation arises the student should consult the advisor and some definite decision should be recorded as to what remedial steps are necessary.

2. Other Required Courses

In addition to the above sequence of core courses, there are the following doctoral course requirements. Each student must take 14 additional credits of technical electives at the 4000 and 6000 level, as approved by the student's advisor and the Graduate Program Committee. A list courses that have already been approved by the Graduate Program Committee is given below. Research-oriented reading classes and independent study classes do not fulfill this requirement. Remedial undergraduate classes that are prerequisites for the graduate core courses or provide training for the qualifying exams do not fulfill this requirement. Courses that are graded pass/fail do not fulfill this requirement.

Of these 14 credits of technical electives, at least 7 credits must have a PHYS or ASTR prefix, and at least 7 credits must be at the 6000 level (a single class can be counted towards both requirements).

Note, PHYS-6530 Quantum Mechanics III is strongly recommended for all students. (All theory students should take this course). There are special requirements for students specializing in astrophysics and biophysics.

Colloquium Requirements:

For the PhD in Physics, students are required to attend the Physics Colloquium. This requirement is met by registering for, and passing, the one-credit colloquium course as listed in the course catalog. This course must be passed at least four times, prior to graduation. The criteria for passing the courses are decided by the instructor.

Pre-approved PhD Course Electives:

ASTR 4220: Astrophysics
ASTR 4240: Gravitation and Cosmology
ASTR 4250: Interstellar Medium
PHYS 4620: Particle Physics
PHYS 6530: Quantum Mechanics III
PHYS 6710: Theory of Solids I
PHYS 696X: Topics in Physics
ASTR 4120 Observational Astronomy
CHEM 4110 Instrumental Methods of Analysis
CHEM 4420 Microscopic Physical Chemistry
CHME 4010 Transport Phenomena 1
CHME 4020 Transport Phenomena 2
CSCI 4260 Graph Theory
CSCI 4020 Computer Algorithms
CSCI 4800 Numerical Computing
CSCI 4820 Introduction to Numerical Methods for Differential Equations
CSCI 6100 Machine and Computational Learning
CSCI 6360 Parallel Computing
CSCI 6390 Database Mining
CSCI 6470 Database Systems for Engineering Applications
CSCI 6800 Computational Linear Algebra
CSCI 6820 Numerical Solution of Ordinary Differential Equations
CSCI 6840 Numerical Solution of Partial Differential Equations
CSCI 6860 Finite Element Analysis
CSCI 696X Comp. Analy. Of Social Processes
ECSE 4320 Plasma Engineering
ECSE 6220 Physical Foundations of Solid State Devices
ECSE 6230 Semiconductor Devices and Models

MANE 4340 Physics of Radiology
MANE 4360 Introduction to Fusion Devices and Systems
MANE 4480 Physics of Nuclear Reactors
MANE 6480 Health Physics
MANE 6790 Mathematical Applications in Nuclear Engineering and Engineering Physics
MATH 4040 Introduction to Topology
MATH 4090 Foundation of Analysis
MATH 4100 Linear Algebra
MATH 4120 Fundamentals of Geometry
MATH 4150 Graph Theory
MATH 4300 Introduction to Complex Variables: Theory and Applications
MATH 4400 Ordinary Differential Equations and Dynamical Systems
MATH 4500 Methods of Partial Differential Equations of Mathematical Physics
MATH 4700 Foundations of Applied Mathematics
MATH 6200 Real Analysis
MATH 6490 Introduction to Stochastic Differential Equations
MATH 6490 Monte Carlo Simulations
MATH 6600 Methods of Applied Mathematics
MATH 6220 Perturbation Methods
MATH 6640 Complex Variables and Integral Transforms with Applications
MATH 6790 Intro. Stochastic Processes
MATH 6790 Markov Chains & Monte Carlo
MTLE 4100 Thermodynamics of Materials
MTLE 4150 Kinetics in Materials Systems
MTLE 4160 Semiconducting Materials
MTLE 4200 Properties of Engineering Materials 1
MTLE 4250 Properties of Engineering Materials 2
MTLE 6030 Advanced Thermodynamics
MTLE 6040 Principles of Crystallography and X-ray Diffraction
MTLE 6080 Electron Diffraction
MTLE 6110 Diffusion
MTLE 6120 Advanced Electronic Properties of Materials
MTLE 6220 Advanced Semiconducting Materials
MTLE 6300 Integrated Circuit Fabrication Lab
MTLE 6400 Vacuum Techniques
MTLE 6420 Surface Phenomena
MTLE 6500 Modeling of Materials
PHYS 4240 General Relativity
PHYS 4720 Solid State Physics
PHYS 4810 Computational Physics

The Doctor's degree requires a total of seventy-two (72) credits after the Bachelor's degree or forty-two (42) credits beyond the Master's degree. The emphasis is on research which produces new scientific knowledge of significant character.

Qualifying and Candidacy Examinations

Although the incoming student may specify an intention to pursue a program leading to the Ph.D. degree, admission to the program is granted only after: (a) satisfactory completion of the core course requirements, (b) selection for qualification, and (c) passing the candidacy examination. Selection for qualification is based mostly on performance on a two-part written qualifying examination which covers the material in the advanced undergraduate courses. Passing this written examination at a well-defined level of performance is sufficient to pass the qualifying process. If a student has not achieved a clear pass on the written examination but has performed near the passing level, the qualifier examine committee will also consider performance in course work and, to a limited extent, research work in selection for qualification. The candidacy examination is taken in the third year and is based on progress in and preparation for research. Students should consult the Qualifying and Candidacy Examination Handbook for further details.

Waiver of Thesis Requirement for Master's Degree for Ph.D. Candidates

A student, who has completed the Candidacy Examination satisfactorily, may apply for award of the Masters of Science degree with waiver of thesis requirement, provided the requirements for the Master's degree including 30 credits of appropriate course work are otherwise satisfied. To do this the student should request the advisor to certify by memorandum to the Chair of the Department Graduate Program Committee that the advisor is satisfied that the student is capable of doing research, and should fill out the required degree diploma card in the office of the Registrar before the required time for the semester in which the degree is to be awarded, and pay the required fee. The student must be registered for the semester, as well.

Thesis Requirements

The requirement for the thesis dissertation for the doctoral degree (Ph.D.) is that it must demonstrate that the student has undertaken scientific research and accomplished the discovery of significant new information in the field of study. The student must have made the major contribution to the carrying out and evaluation of the work, and should have made substantial contribution to its selection and initiation as well. It is, of course, recognized that the process is learning and teaching interaction. Therefore, it is to be expected that the student's advisor will provide substantial guidance both in selection of a thesis topic and in its carrying out. However, the student, the advisor, and the doctoral committee (see below) should be quite clear that the evaluation of the student's work is to be based on what the student did at all phases of the work, which should be clearly distinguished from what the advisor or other collaborators did. To avoid later confusion, it is in fact especially advisable for the student to make written notes, dated, concerning the earliest discussions with the advisor and others about choice of a thesis topic and methods of approach. This is in addition to normal orderly data-keeping procedures associated with any respectable research program.

1. Doctoral Committee

The student is to be guided in his or her research by an advisor and by an advisory committee which is made up of at least four tenure track RPI faculty members. Of these four, three members must have appointments in the physics department and one member must be a RPI faculty member from outside the physics department. These members are chosen by the student and the advisor in consultation with the Chair of the Graduate Program Committee and are approved by the Dean of the Graduate School. The advisory committee should be formed by the end of the student's fourth semester and the committee should be kept informed of the student's progress. This committee gives the final approval of the PhD thesis.

2. Presentation of Thesis

The Doctor's thesis is a formally written dissertation describing the work done by the student. It should be written at a level such that another student wishing to continue the work could understand what had been done. The thesis must conform to the rules laid down in the Rensselaer manual: "Thesis Writing" which can be obtained in the Graduate School Office. The preparation of a thesis is a particularly important step in the education of a full-fledged scientist. In preparing the final draft in consultation with the advisor and the advisory committee the student obtains insight into the care and precision that the profession requires in the writing of a scientific paper.

Normally the student should prepare a few pages of manuscript and have the advisor check it so that both student and advisor understand what is required. The student then prepares the manuscript, consulting with the advisor as is mutually agreed. The advisor should approve the entire draft of the thesis before it is given to the thesis committee.

In order to allow the committee sufficient time to read the thesis and not to delay the student unnecessarily, the student is to observe the following procedure:

One month before the intended date for the thesis presentation, the student must get an agreement from his/her committee on -

- When committee members will receive copies of the thesis.
- When the student will visit them for their comments.
- The date of the examination.

Normally, the thesis should be given to the committee three weeks before the examination, and it should be returned to the student about one week before the examination to allow time to make alterations. The committee members should not be asked to try to read a thesis in less than one week. The student should schedule the thesis examination and the finishing of the thesis so that the deadlines set by the Graduate School are met without unduly inconveniencing the committee. The examination is open to any interested persons. The candidate is expected to give a well-prepared summary presentation of the

research in about 15-25 minutes, and then must answer questions put to him/her by committee members and others present, as called on by the committee chair.

The thesis must be accompanied by an abstract of less than 600 words.

3. Publication of Thesis

A serious effort should be made to publish all theses (possibly in more compact form, as appropriate) in the regular scientific literature. The credit line should read, "This paper is based on thesis submitted to the faculty of Rensselaer Polytechnic Institute in partial fulfillment of the requirements for the degree of (month and year)". At the time of the defense, the committee must be satisfied with the student's progress towards a published paper.

4. Fees

Candidates for the Ph.D. pay a nominal fee for binding and processing of the thesis. For more information <http://gradoffice.rpi.edu/update.do>

VI. Requirements for Specializing in Astrophysics

Graduate students specializing in astrophysics are subject to the same minimum requirements with respect to "core" curriculum and examinations as other graduate students in physics. Masters level students are required to take two semesters of Astrophysics Seminar, and at the Ph.D. level students are required to take four semesters of Astrophysics Seminar. Typically, these are taken in the second and third years of graduate study. At the Master's level, the astrophysics program will also include certain electives in astrophysics and the thesis research will be on an astrophysical topic. At the Ph.D. level, advanced electives in astrophysics, physics and mathematics are also to be taken, and the candidacy examination will emphasize topics in astrophysics. As with the Master's thesis, the Ph.D. thesis research will be on an astrophysical topic.

Certain of the electives may be from the Department's offerings at the senior undergraduate level. In all cases, advanced physics and astrophysics electives will be selected with the help of the student's advisor.

VII. Requirements for Specializing in Biophysics

Graduate students specializing in biophysics are subject to the same minimum requirements with respect to "core" curriculum and examinations as other graduate students in physics. At the Master's level, the biophysics program will include certain electives in biophysics, and the thesis research will be on a biophysical topic. At the Ph.D. level, advanced electives in biophysics would be taken, and the candidacy examination will emphasize topics in biophysics. As with the Master's thesis, the Ph.D. thesis research will be on a biophysical topic.

All students with weak background in biology are strongly urged to familiarize themselves, on an independent-study basis, with the contents of a typical introductory course in biology and to take, as remedial preparation, a course in physiology similar to BIOL-4270, Human Physiology. In all cases, advanced physics and biophysics electives will be selected with the help of the student's advisor.

VIII. Guidelines for Out-of-Department Master's & Doctoral Research

The intent of these guidelines is to ensure that thesis research done outside the Physics Department for a graduate degree in physics has an appropriate physics orientation as well as appropriate level and scope.

Initial Sign-Up for Research Credits

Initial sign-up for research credits with an out-of-department faculty member requires approval of the Physics Graduate Program Committee. At the time of this initial sign-up, the out-of-department advisor receives a copy of these guidelines. The Graduate Program Committee Chair discusses with the advisor the Physics Department's position regarding out-of-department research.

Master's Thesis Committee

The committee will normally have three members, including the Thesis Advisor. The two additional members will be from physics.

Doctoral Thesis Committee

The committee will normally have at least 4 members, which will include the Thesis Advisor and the Physics Advisor, who will chair the committee. At least three of the members are to be from the Physics Department. One member must be outside the department.

Initial Approval of Doctoral Thesis Program

This should occur as soon as possible after the candidacy examination is passed. The student shall present a short written statement of the proposed thesis program to the committee, and meet with the committee to discuss this program. The committee must be satisfied as to the proposed thesis topic and plan of attack, and especially regarding the physics content and objectives.

Reporting of Progress

The student shall be responsible for keeping the committee members informed about research progress. At the committee's discretion, a brief written report of research progress may periodically be required.

Financial Support

It is expected that a student working outside the Physics Department will receive financial support from the research advisor after the first full semester of work. Other arrangements must be approved by the Chair of the Graduate Program Committee.

IX. Graduate Financial Aid

Financial aid is available to graduate students in several forms. Once offered, the Department will make an effort to continue to provide financial aid, to a maximum of two years, for those students in good standing who are enrolled in the Ph.D. program. Ph.D. students beyond the second year are expected to have shifted support from teaching to research assistantships. For those students in good standing in the M.S. program, financial aid will be provided, in so far as possible, up to two years stipend and 30 credits tuition waiver. First priority for teaching assistantships goes to first and second year students in good academic standing. Extension of a teaching assistantship support beyond two years will depend on the department's need for teaching assistants.

Teaching Assistantships

For incoming students, the Graduate Teaching Assistantship is the most common form of aid. It includes a salary for teaching 4 to 8 contact hours per semester (about 20 clock hours per week) plus a waiver of tuition up to a minimum of 9 credit hours per semester and a maximum of 30 credit hours for the year. Fees will be paid by the student. The assistantship is for the academic year only. The tuition waiver can only be applied to courses which satisfy the Plan of Study approved by the Graduate Program Committee.

Students whose native language is not English will be evaluated by the Coordinator of English Language Services in the Learning Center. Special courses in English as a second language may be recommended as a result of the evaluation. It is expected as a condition of employment that the student will make a good faith effort in such courses. Continuation of assistantships in the second semester and future renewals are dependent upon certification that the student attended class regularly, worked diligently, showed improvement, and passed the English Speak Test.

Research Assistantships

Research assistantships are available to many of our graduate students. Tuition is usually also covered. The availability of research assistantships depends upon individual research professors and is subject to the needs of contracts and interests of students. Research assistantships are normally given for the academic year, and in addition, summer support is often also available.

Summer Support

The major support is through research assistantships (RA's). Students should apply for RA's directly from potential research advisors.

Fellowships

Rensselaer has some fellowship support for new students which take the form of full support to a few outstanding students and "topper" awards in addition to a teaching assistantship. Tuition scholarships and loans may also be available through the Graduate School Office and Financial Aid Office. Outstanding students are nominated for industrial or private foundation fellowships as they become available.