

YALE UNIVERSITY  
Department of Applied Physics

Guidelines for the  
Ph.D. Degree in  
Applied Physics

*January 2023 Effective for incoming students in 2023*

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Ph.D. Degree

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Dear Graduate Student in Applied Physics,

Welcome to Yale University, the Graduate School of Arts and Sciences, and the Department of Applied Physics. You have completed a rigorous application process and now begin a journey of learning and exploration leading to the Ph.D. degree in Applied Physics.

We have prepared this document for your journey, as there are critical milestones and requirements to be met. We urge you to read this document carefully, paying attention to the various requirements and deadlines. These are explained in the text, but most of them are also summarized in the appendices. The responsibility of meeting these requirements in a timely fashion is ultimately yours, and we ask that you track them carefully throughout your time at Yale.

As the departmental Director of Graduate Studies, I work with the Graduate Registrar, Alex Bozzi ([alexander.bozzi@yale.edu](mailto:alexander.bozzi@yale.edu)), to assist you in your journey. Please feel free to contact either of us at any time.

I wish you the best of luck with your studies.

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## Program Overview

A Ph.D. in Applied Physics at Yale is designed to certify two distinct educational attainments: mastery of the subject matter and demonstrated ability to make original research contributions to the field, in addition to training as a professional in the field of applied physics.

Graduate students pursuing this degree are required to follow the guidelines in this document as well as all of the rules and procedures of the Graduate School of Arts and Sciences and of the University. Some of those rules and procedures are included in this document, and others are in the “Policies and Regulations” in the *Bulletin of the Graduate School of Arts and Sciences* <https://gsas.yale.edu/academic-requirements/policies>. Throughout their graduate career, the student is always expected to be in good standing, as described in detail below.

Faculty in the department are committed to mentoring graduate students throughout their time at Yale. A detailed set of guidelines for mentoring is given in Appendix 2 of this document. Graduate students should always feel free to reach out for advice from any departmental faculty or staff member throughout their graduate career. Students are especially encouraged to reach out to their advisors, their Committee members, the Director of Graduate Studies (DGS), and the Graduate Registrar, all of whom have specific responsibilities related to students’ progress through the program. Students are also welcome to contact the Department Chair at any time.

Outside of the department, students are also encouraged to take full advantage of the many resources available to them at the university to support their academic progress, their health and safety, and their happiness during their time at Yale. See <https://gsas.yale.edu/resources-students>, which lists many of these resources.

The department recognizes that a graduate student may face extraordinary circumstances during their time at Yale that impede their progress. When facing such circumstances, students are encouraged to communicate with their advisor, the DGS, the Department Chair, and staff at the Graduate School or elsewhere within the university. All of these people are available to help graduate students at Yale reach their highest potential within the degree program.

The Applied Physics Ph.D. degree requirements fall into two categories:

### **Part One: Academic Coursework**

The faculty assess the student’s ability to meet the established coursework requirements at the appropriate level and in a reasonable time. This assessment is carried out in several steps, as described in this document.

### **Part Two: Research**

The student achieves mastery of the chosen subject area and demonstrates an ability to perform original research. During Part Two, the student is expected to reach a point where they are able to demonstrate the appropriate mastery of their subject. The remaining requirements for a Ph.D. are the preparation and defense of a dissertation.

Importantly, the two educational goals of “mastery of the subject” and “originality of research contributions” are relative concepts and can only be judged against the established traditions of the University and the Department of Applied Physics. These Guidelines set minimum standards in the program of study that students are expected to meet, and most major milestones are summarized in Appendix 3.

## Procedures and General Requirements

### **1. Before Arrival and First-year Registration**

Upon acceptance of an offer of admission to the Ph.D. program, students are expected to read and proactively follow the rules and guidelines of the Applied Physics Department, the Graduate School, and the University. Students may choose to contact faculty in advance of arrival on campus, in order to explore research opportunities in advance of arrival. Some students may make arrangements with specific members of the faculty and with the department to begin research during an “early start” in the summer before the semester begins, although such an early start may not be possible for all students. All students should begin considering possible Research Advisors and class schedules before arrival on campus.

Students should plan to arrive on campus before the start of classes to take part in various orientation activities. Upon arrival, each student registers at the Graduate Registrar’s Office in Becton Center (15 Prospect Street), Room 403. They obtain from this office the latest information on course offerings and schedules (found at <https://courses.yale.edu/>) as well as other important materials, and the name of a First Year Advisor assigned to them. The First Year Advisor assists the student in meeting the course requirements of the first year. The student should confer with the First Year Advisor so as to arrive at a proposed course of study to satisfy the course requirements. The student should also feel free to consult the Graduate Registrar and the Director of Graduate Studies (DGS) with any questions. This process is to be completed before the final date for the submission of course schedules to the Graduate School. Students are to send the approved schedule and the Special Investigation Form to the Graduate Registrar. The forms are available for download on the Applied Physics departmental forms and guides page at <https://appliedphysics.yale.edu/academics/graduate-studies/forms-guides>.

### **3. Appointment of First Year Advisor**

Each entering graduate student has been matched with a First Year Advisor on the basis of research interest. At any time during the first year, if a student feels that a different First Year Advisor would be desirable, a new one can be appointed upon approval by the DGS. Students with concerns about their First Year Advisor assignment should contact the DGS.

### **3. Course Requirements**

Course requirements for the Ph.D. are governed by two general principles. First, students take courses to reach the level of competence in their chosen area of specialization needed to do high-quality research. Second, although depth of knowledge in the major field is essential, breadth of knowledge in related areas is just as important for a reasonably well-rounded education.

Courses at Yale typically last a full term, where “term” is defined as the fall or spring semester. There is no summer term. Course changes outside the add/drop period during the term may be permitted with the approval of the DGS. The last day to withdraw from a course or to change a course from credit to audit or from audit to

credit is determined by the Graduate School, and students are responsible for meeting the appropriate deadlines.

**Program of Study** At least 9 courses of one credit each are required. (Two half-credit courses may also be considered as a single one credit course to satisfy this requirement). Courses such as “Dissertation Research”, “Master’s thesis”, or “Seminar” do not count towards the 9-course requirement, but up to two terms of “Special Investigation” are acceptable. Courses counted toward the 9 course unit minimum must be full-credit graduate courses with clear technical, scientific, or mathematical focus that are related to applied physics in the judgement of the First Year Advisor or Research Advisor and the DGS. Three required core courses must be taken in the first year. The list of core courses and the detailed requirements are given in Appendix 1 of this document. Course schedules for each semester are given at <https://courses.yale.edu/>.

Exceptions to the usual course sequences may be appropriate for some students who are participating in programs such as the Integrated Graduate Program in Physical and Engineering Biology or who start the program under unusual circumstances. Such exceptions can be made with the approval of the DGS and the First Year Advisor.

The detailed program of study for each student is determined in consultation with the student’s First Year Advisor (or Research Advisor after the first year), who may suggest courses, sometimes in other departments, that should be taken (or audited). Students are expected to take four graduate courses that count toward the nine-course requirement in each semester of their first year. The remaining course requirements must be completed by the end of the second year unless an exception is approved by the DGS. Course selections are approved by the DGS, in consultation with the student’s advisor.

**Topics in Applied Physics Research (APHY 576) and Responsible Conduct in Research (APHY 590)** First year students must also take Topics in Applied Physics Research (first semester), which introduces students to research in the department, and the Responsible Conduct in Research for Physical Scientists (second semester), which discusses ethics and responsible conduct in scientific research. Topics in Applied Physics Research is designed to help students learn about research in the department and resources available to them in their research efforts. The Responsible Conduct in Research course is designed to fulfill the requirement stipulated by the National Science Foundation for all students and for all postdoctoral researchers funded by the NSF. Note that these courses may not be used to fulfill the nine-course requirement.

**Special Investigations (APHY 990)** During each semester of the first year, students are expected to register for a “Special Investigation” course, after reviewing the research opportunities available in different groups. A primary goal of the Special Investigation course is to help students identify a research program for dissertation research, and students should choose their Special Investigation advisor with that in mind.

The two Special Investigation courses are taken in the first two terms, and they can be with the same or different advisors. To register for such a course the student should discuss a specific project with a faculty advisor and prepare a brief outline (~100-200 words), and e-mail it to the Graduate Registrar. This form is turned in during the registration period and kept in the student’s file. The Special Investigation advisor can be the same person as the First Year Advisor. At the end of each term of Special

Investigation, the student gives a presentation to their Special Investigation advisor, either as a talk or as a written report with the format determined by the advisor. The advisor of the Special Investigation reports in writing on the student's performance using the Special Investigation Evaluation Form.

**Course Substitutions** Exceptionally well-prepared students may request to substitute more advanced courses for some of the required core courses. To invoke this privilege, the student must take and pass an exam on the subject (the "pass out exam" which is typically offered at the start of the semester). If extraordinary circumstances prevent a student from taking the pass-out exam, the students must provide evidence of excelling in a similar course either at another institution or at Yale. If the course was taken at another institution, it must be judged by the DGS, or another faculty member designated by the DGS, to be comparable in quality to similar courses offered at Yale. Students must request substitutions for a required core course in their first year. Course substitutions cannot be applied to more than two courses. Courses that are not taken because of substitutions do not appear on the student's transcript. A required core course must be substituted with a more advanced course in the same area, and such substitutions do not alter the total number of required courses for the degree.

**Course Waivers** For students who have started graduate work at another institution, equivalent graduate-level coursework completed elsewhere and taken while registered as a graduate student may enable a student to receive a waiver from one of the required courses and therefore reduce the number of courses required for the degree. Course waiver petitions must be approved by the DGS and the Graduate School, and students are expected to demonstrate mastery of the material following the same process as for a course substitution. No more than three courses can be waived, and waivers must be requested during their first year.

**Full Time Study** Students are to be engaged in full-time study. The requirement for full-time study is interpreted as 12 class hours per week (i.e., four full course units or three full lecture course units plus a Special Investigation, during the first year). If the student's advisor and the DGS find it advisable, one or more of these courses can be undergraduate courses; these courses, however, are not given credit toward the nine-course unit requirement for the Ph.D. Courses such as "Dissertation Research", etc., count toward the full-time study requirement. In fact, students beyond their first year who are spending most of their time on research generally sign up for enough hours of "Dissertation Research" so that their schedules show a total of 12 hours per term. Students may register for electives each semester.

#### 4. **Remaining in Good Standing**

While the department faculty are committed to the success of all graduate students in the program, students are required to meet certain expectations to remain in good standing. Students who are not in good standing may be asked to leave the program by the DGS, with the approval of the Department Chair and the Graduate School.

Central to remaining in good standing are academic status and research status, making steady and sufficient progress toward degree completion, and being in compliance with these guidelines and all of the rules and expectations of the Graduate School and the University. Academic status is based on the coursework requirements, as described in this section and elsewhere in this document. Research status is

demonstrated by progress in research activities and by meeting research requirements, also as described in this document.

In order to remain in good standing in the program, students are expected make steady progress in meeting their course requirements. Students must achieve the grade of Honors in at least two one-credit technical graduate courses related to topics in applied physics. Students must meet the Honors requirement by the end of the fourth term of full-time study (typically by the end of the second year). Courses such as “Master’s Thesis”, “Seminar”, or “Special Investigations” cannot be used to fulfill the requirement for two Honors grades. An extension may be granted on a case-by-case basis at the discretion of the DGS, in consultation with the student’s First Year Advisor or Research Advisor. Students are also expected to maintain an average grade of High Pass during their time at Yale, following the averaging methodology determined by the Graduate School. Note that grades assigned to graduate students at Yale are on a scale of “Honors”, “High Pass”, “Pass”, and “Fail”, with details given at <http://catalog.yale.edu/gsas/policies-regulations/academic-regulations/>.

At the end of each semester during the first year, the First Year Advisor consults with the advisor of the student’s Special Investigation (if that is a different member of the faculty). Subsequently, after obtaining information on the other grades the student received, the First Year Advisor informs the Graduate Registrar and the DGS if the student appears to be at risk of not making good progress in the graduate program. Such notification may also be provided by other members of the faculty who are interacting with the student, e.g., the Special Investigation advisor.

In cases of performance concerns during the first year, the DGS consults with the First Year Advisor and may make a determination that the student is at risk of no longer being in good standing in the program. Such concerns and a general evaluation of the student’s progress typically are communicated to the student personally by their First Year Advisor and confirmed in writing by the DGS at a point in time at the end of the first semester or during the second semester. The DGS also typically communicates a further course of action. Any student whose progress after the end of the second semester is not fully satisfactory is either asked to leave the program at the end of the academic year or given the option to return for a second year subject to specific conditions. These conditions typically include a date on which the student’s progress will be re-evaluated and a final decision concerning future studies in the department will be made. In those special cases in which a final decision is deferred beyond the end of the first year, a “Special Academic Oversight Committee” of three or more faculty members may be appointed to provide mentoring and monitor the student’s progress.

To remain in good standing, the student must advance to candidacy in a timely fashion as described below. Exceptions to that timeline must be approved by the DGS, in consultation with the Research Advisor and other faculty who have interacted with the student. In cases where an advanced student is otherwise not making sufficient progress toward the degree in the view of the Research Advisor, the student is encouraged to find another advisor to supervise their dissertation research. The DGS can provide advice for this effort, but if the student is unable to find another Research Advisor within one semester, after consultation with the Department Chair and the Graduate School, they are normally asked to leave the program.



## **5. Selection of Research Advisor and Commitment**

It is essential that students engage in full-time research at Yale during the summer following their first academic year. This research is evaluated in terms of independence of thought, depth of solution and demonstrated progress. To this end, the student must find a Research Advisor who is willing to supervise a project that is consonant with the research program of that faculty. Often the Research Advisor is the advisor from one of the terms of Special Investigation. Research Advisors must have an appointment in the Graduate School and be engaged in research that falls broadly within the subject of applied physics, although they do not need to be members of the department's faculty. Such arrangements should be finalized by April 1<sup>st</sup>, unless an alternate date has been agreed to by the DGS.

This arrangement, the Commitment, implies a mutual agreement between the student and the advisor to embark on a course of study and research leading to a Ph.D. thesis, beginning with the first-year summer research project. Both the student and the Research Advisor should consider the agreement to a Commitment carefully, including consideration of what funds will support the student's stipend and tuition. Under most circumstances, the Research Advisor is expected to support the student as a research assistant and is committing to do so. The student is choosing the Research Advisor as a mentor and is also choosing a field of research for their dissertation. There is considerable diversity in mentoring styles and types of research, and students should consider their personal interests and preferences in making this choice.

For students who find a Research Advisor in a department other than Applied Physics, the Research Advisor and the Research Advisor's home department will be responsible for securing funding for the student for the remainder of the student's time at Yale. This agreement by the Research Advisor and their home department must be obtained in writing, and it is the responsibility of the student, working with the Graduate Registrar, to ensure that the agreement is obtained.

In order to ensure good progress in the graduate program, it is strongly recommended that regular communication be maintained between the student and their First Year Advisor or Research Advisor. The responsibility for ensuring this communication rests with the student. Any student who has difficulty in maintaining that regular communication should inform the DGS, who can help facilitate clearer communication.

## **6. Temporary Commitment and Switching Advisors or Departments**

If arrangements for research projects do not develop into a Commitment by the end of the second semester, a "Temporary Commitment" for a specified period (usually the summer) must be requested. Such an arrangement still implies a tentative agreement between the student and the advisor to embark on a course of study and research leading to a Ph.D. thesis. By the end of the summer after the first year, a Temporary Commitment should evolve into a Commitment and the selection of a *permanent* Research Advisor should be finalized. In the unusual circumstance that a Commitment is not made by the end of the summer, the student may no longer be in good standing in the department.

Occasionally, an advanced student finds that the original choice of a Research Advisor is no longer consistent with their personal and professional goals, and the student wants to seek a new Research Advisor. Students in that situation are encouraged to communicate with the original Research Advisor to determine if the situation can be remedied without changing advisors. Students are also strongly encouraged to communicate with the DGS, who can help the student consider their options. If the student desires to switch to a new Research Advisor, they are expected to make a new Commitment as described above in order to stay in good standing in the program. A change of Research Advisor requires approval from the DGS, and may also require additional coursework, changes in Advisory Committee, or other actions by the student.

Each student has been admitted into the Department of Applied Physics. Occasionally, a student wishes to change departments within Yale. In order to change departments, the student must discuss this change with the DGS from each department; request a transfer; and obtain the approval of both DGSs and both Chairs, and the appropriate person within the Graduate School. After switching departments, the student is responsible for meeting all academic and research requirements in the new department, which may be different from those in Applied Physics.

## **7. Teaching Requirement**

A teaching experience is regarded as an integral part of the graduate training program at Yale University, and all Applied Physics graduate students are required to serve as a Teaching Fellow for two terms before admission to candidacy, typically during years two and three. Teaching duties normally involve assisting in laboratories or discussion sections and grading papers and are not expected to require more than ten hours per week. Students are not permitted to teach during the first year of study. In the infrequent event that a student requires additional support from the Graduate School, the student is expected to teach for up to an additional two terms, but typically is not required to teach more than four terms over their first five years.

After meeting this degree requirement, students may choose to teach for incremental compensation in later years. If the student undertakes work for incremental compensation, it is understood by all parties, and the graduate student explicitly agrees, that the time required for this activity neither interferes with nor reduces the amount of effort expected to be devoted and actually devoted to their academic/dissertation activities and maintains satisfactory progress towards the degree.

Teaching Fellow assignments are typically coordinated during the summer after the first year of study by the Graduate Registrar working with the DGS.

Graduate students whose native language is not English are required to meet the oral English proficiency standard before they may begin teaching. This standard may be met by either having received a bachelor's degree from an institution where the principal language of instruction is English, or by passing the SPEAK test, which is offered three times each year by the Yale Center for Language Study.

If a student was admitted to the program having earned a score of less than 26 on the Speaking Section of the Internet-based TOEFL, the student is required to take an English as a Second Language (ESL) course each semester at Yale until the Graduate

School's Oral Proficiency standard has been met. This must be achieved by the end of the third year in order for the student to remain in good standing.

## **8. Advisory Committee**

Each student is responsible for forming an Advisory Committee before taking the Area Examination described below. The student is also responsible for reporting the committee membership to the Graduate Registrar.

The Advisory Committee must include at least two faculty members in addition to the Research Advisor, who acts as chair. If the Research Advisor does not have a primary or secondary appointment in Applied Physics, the Advisory Committee should include at least one faculty member with a primary appointment in Applied Physics unless an exception is granted by the DGS. All faculty members are typically from Applied Physics or Physics and are selected in consultation with the Research Advisor and are subject to approval by the DGS. At least one of the Committee members should be selected whose research expertise is distinct from that of the Research Advisor, typically in a different subfield of physics or applied physics. The DGS can help address questions that arise regarding the composition of the committee in this regard. To ensure continuity, the committee should include at least two faculty members with tenure, unless an exception is approved by the DGS. With the approval of the DGS, a Committee member from outside the University may be added. Any outside Committee member must agree to make every effort to attend required meetings either in person or by video conference. An outside Committee member cannot also serve as the external reader.

As soon as the Advisory Committee is named and confirmed, the student should communicate their general plan of study and research to the Committee members and take advice on how to best progress toward the degree.

If a Committee member is no longer able to serve for any reason, or a student sees a need for different membership, the student should propose new membership to their Research Advisor. With the Research Advisor's approval, the change should be requested to be recorded by the Graduate Registrar, who may seek DGS approval.

## **9. Admission to Candidacy**

After completing coursework and other degree requirements, the next step toward a degree is admission to candidacy, indicating that the student is prepared to do original and independent research. To be admitted to candidacy, students must submit a written research prospectus and pass an "Area Examination". The purpose of this Area Examination is to ensure that the student has achieved both the appropriate breadth and depth of knowledge.

One part of the Area Examination consists of a summary by the student of their research activity and plans. At the discretion of the Research Advisor, this part may be public and questions may be allowed by any members of the audience and of the committee. The second part is restricted to questioning of the student by the committee members or any other member of the faculty, in closed session. The questioning focuses primarily on topics broadly related to the student's prospectus, with the goal

of determining if the student is prepared for the next stages of graduate study. Area Examinations normally should be scheduled during the academic year, so that interested faculty and students can attend. Students are notified promptly of the results of the examination.

The Area Examination should be passed and a written prospectus submitted to the Graduate Registrar by October 5th of the third academic year. If a student has faced unusual circumstances, this date can be extended to later in the third year, with the support of the Research Advisor and approval of the DGS. Students who anticipate needing such an extension are expected to request it as soon as the need becomes apparent.

At least 7 days prior to the exam date the student should circulate a draft of the dissertation prospectus to their Advisory Committee and notify the Graduate Registrar in writing. The prospectus should explain the student's planned dissertation research. It should also include a summary of research activity in which the student has already engaged, and sufficient background information for the committee members who are not already familiar with the work. The student is not formally committed to the plans outlined in the prospectus, but those plans should represent the student's current thinking regarding their dissertation research plans. The examination is announced publicly by the Graduate Registrar.

Shortly after passing the Area Examination, and always in consultation with all Advisory Committee members, the student makes necessary revisions to their dissertation prospectus and submits it to the Graduate Registrar. These two requirements should be accomplished during the academic year so that the faculty assessment may be made in a timely fashion.

At the latest, the student must be admitted to candidacy in the Graduate School by the end of the third year. A student is not permitted to register for a fourth year unless the Admission to Candidacy has been granted. A student who does not pass the Area Examination the first time is given a second opportunity to take it. The second exam must be taken and the results reported to the DGS and Graduate Registrar's Office by March 15<sup>th</sup>. If the student fails to pass the second time, they are normally considered no longer in good standing and asked to leave the program.

Because scheduling the Area Examination may be difficult, it is recommended that the student contact the Advisory Committee members prior to the start of the fall semester of the third year to ensure that a suitable date and time can be secured. Failure to adequately plan is not grounds for an extension of the deadline. Students who do not take the Area Examination prior to the October 5<sup>th</sup> deadline, and do not receive an extension from the DGS, typically lose the opportunity to take the exam a second time if the first exam is failed.

## **10. Research Progress Reports and Committee Oversight**

Each student is expected to proactively discuss and reach agreement on the goals and expectations for each year of graduate study with their Research Advisor and the members of their Advisory Committee. The planned expectations and achievements for each year build to a completed dissertation at the end of a target of five years.

Students are expected to demonstrate steady progress toward the dissertation, except for cases in which permission has been obtained for a leave of absence from the University. To this end, after admission to candidacy, the Graduate School requires annual Dissertation Progress Reports (DPR) each May 1<sup>st</sup>. Students should also prepare and distribute progress reports to their Advisory Committee members and seek feedback. Students may want to meet with the Advisory Committee as a whole, after consultation with the Research Advisor. Students may also want to meet with Advisory Committee members separately from the Research Advisor for feedback or in order to discuss any issues with mentoring or other circumstances that the student feels need to be addressed. Such issues can also be brought to the DGS at any time. The student must submit the on-line DPR in a timely fashion as determined by the Graduate School. The advisor, and then the DGS, review and comment on it.

As the student comes within six months of the anticipated completion of the dissertation, they should inform the Advisory Committee members of their plans and give the Committee members an opportunity to review the expected contents of the dissertation and offer advice on what is expected in the Final Examination and for acceptance of the dissertation.

The Research Advisor has primary responsibility for monitoring the student's progress and offering help and advice to students who appear to be encountering difficulties in making progress toward their degree. The Advisory Committee members should also notify the Research Advisor and the DGS if they have concerns that a student is not making good progress. When a Research Advisor has concerns about a student's progress, those concerns should be communicated to the student, and the student and the Research Advisor should agree on a plan for moving forward. In extreme cases, Advisory Committee members or the Research Advisor may recommend to the DGS that a student be asked to find a different Research Advisor or withdraw from the program. In such cases, the DGS can offer advice to the student about possible paths forward, but the student has the responsibility to find a new Research Advisor.

All students receiving financial support, either from Fellowships or as Assistants in Research, are reminded that such support carries with it definite obligations with respect to the active full-time course of study, and that continuation of support is generally contingent on satisfactory progress and good standing. Students receiving external fellowship support are responsible for fulfilling the requirements associated with that support, as well as all Yale requirements.

One important general deadline is the upper limit of seven years set by the Graduate School for the completion of all Ph.D. theses. Notifications requesting extension beyond a seventh year of study must meet all requirements of the University and also be made in writing to the Graduate Registrar by April 15<sup>th</sup> and should include the anticipated date of the thesis defense.

## **11. Seminars**

Communicating results and exchanging ideas is an essential part of any Ph.D. program and all successful careers after the degree is obtained. As such, all graduate students are expected to attend their departmental seminars. Beginning in the 3<sup>rd</sup> year, all graduate students are expected to present their research in a public seminar at Yale, or in a major technical conference outside of Yale (excluding area and presentations

associated with course work) at least once per year during their graduate student career.

## **12. Dissertation**

The dissertation must report original research in an area of applied physics, as judged by the faculty of the department, and demonstrate creative thought and scholarly achievement by the student. When the dissertation is completed, it is read by the Advisory Committee and one external reader to be selected by the Research Advisor in consultation with the DGS (collectively, the readers). The external reader should have no direct interest in the success or failure of the dissertation. If an Advisory Committee member is unable to perform this function, the student and the Research Advisor should find an appropriate substitute and inform the Graduate Registrar.

Each reader is required to submit a written report on the dissertation to the Graduate School. A copy of the report is sent to the Graduate Registrar's Office.

## **13. Final Examination (Dissertation Defense)**

The members of the student's Advisory Committee constitute the Examination Committee, chaired by the Research Advisor, to examine the student orally on the subject of the dissertation, and recommend acceptance or rejection of the thesis. This final examination is based on the final draft of the dissertation, copies of which should be given at least one week in advance to all Committee members and made available to all faculty members in Applied Physics on request. The student also is responsible for notifying the Graduate Registrar in writing and providing the Registrar with the draft dissertation and an abstract at this time. Other graduate faculty members may be substituted for members of the Examination Committee with the approval of the DGS and the Research Advisor, if such substitutions are needed for timely scheduling of the Examination.

The examination is announced publicly by the Graduate Registrar at least one week before it is held, and it is open to all who wish to attend. It consists of a summary by the student of their research activity, with questions by the Committee and members of the audience. The examination typically ends with a closed session for only the Committee and the student, during which the Committee can ask additional questions.

In addition to the public examination, the Committee members, either separately or collectively, may also wish to schedule a private meeting with the student for the purpose of clarifying specific details or correcting errors in the dissertation. Such a meeting should be scheduled prior to the public examination whenever possible.

The committee notifies the Graduate Registrar's Office in writing of the result of the examination and the recommendation regarding the acceptance of the thesis, using the appropriate Committee Action Form.

## **14. Submission of Dissertation**

Directions for Submission of Dissertation are on the University Registrar's Office website at: <https://registrar.yale.edu/students/dissertation-submission>.

## **15. Certification of Fulfillment of Ph.D. Degree Requirement**

After the Graduate Registrar's Office has received confirmation from the Committee Chair certifying that the student has passed the final examination, and a complete set of copies of the reader's reports from the Graduate School, the Graduate Registrar notifies the faculty in writing that the candidate has completed the departmental requirement for the Ph.D. degree.

If the Graduate Registrar receives no objection from a significant majority of the faculty within a week, the DGS certifies that the student has satisfied the requirements for the Ph.D. degree, and the Graduate Registrar notifies the Graduate School. Subsequent approval by the Graduate School is customary but should not be taken for granted, especially if there is a division amongst the readers. Official approval of the degree is signified by a letter from the Dean of the Graduate School.

## **16. Timetables and Deadlines for Commencement and Graduation**

There are several deadlines by which the various aspects of the above procedure must be completed to comply with the Graduate School rules, to avoid additional fees, and to ensure that the degree is awarded at the next Commencement. It is the student's responsibility to be informed of the deadlines and to ensure there is adequate time for faculty and staff to perform their duties. The appropriate information may be obtained from the Graduate Registrar or from the Graduate School.

## **17. Work External to the Degree, Vacations, and Leaves of Absence**

If a student undertakes work for incremental compensation, whether at the University or elsewhere, it is understood by all parties, and the graduate student explicitly agrees, that the time required for this activity neither interferes with nor reduces the amount of effort devoted to their academic/dissertation activities and the student would maintain satisfactory progress towards the degree. All part-time employment should be agreed upon by the Research Advisor. Part-time employment in excess of 10 hours per week requires permission from the DGS. International students should contact the Office of International Students and Scholars prior to contemplating part-time employment and must follow all rules associated with their visa status.

When a student takes a course unrelated to their degree progress, the effort must be considered incremental to the effort devoted to degree-related activities. Non-degree courses should be discussed with the faculty advisor before registration.

Students contemplating external internships should note that such internships require an official Leave of Absence from the University. Students must notify the Graduate Registrar's Office at least 2 months prior to the start of an internship to allow time to process all of the logistics. Please note that Leaves of Absence may result in loss of student status, loss of access to Yale facilities and loss of student health coverage under the Yale Health Plan.

Students are required to discuss with their Research Advisors the expectations for annual vacation time, and advisors should give clear indications of expectations.

Vacation plans should be communicated in writing by the student and provided with sufficient advance notice that the Research Advisor can indicate whether the plans are consistent with expectations or not. Vacation should not impede satisfactory academic progress, nor should it occur without sufficient notice to the Research Advisor. A significant failure in this arena could result in a loss of stipend or good standing in the graduate program.

Students may need to take leaves of absence from the University for a number of reasons, and they should consult carefully with their advisor, the DGS, and the Graduate Registrar regarding both how to initiate such a leave and how to return from such a leave. In these instances, the student must also be careful to follow other rules including those of the Graduate School and those associated with visa status (for international students)



## Appendix 1: Course Requirements

### 1. Overview and the Core Areas

The requirements for a Ph.D. in Applied Physics include passing at least nine course units. Courses such as “Dissertation Research”, “Master’s thesis”, or “Seminar” do not count towards the nine-course requirement, but two terms of “Special Investigation” are acceptable.

Other than the Special Investigation courses, the courses counting toward the nine-course requirement must be full-credit full term graduate courses from the list below. Full term graduate courses beyond the list may count toward the requirement, but those courses must have a clear technical, scientific, or mathematical focus that is related to applied physics in the judgement of the First Year Advisor or Research Advisor and the DGS. Advisor and DGS approval must be obtained in advance if a course beyond the list is intended to count toward the nine-course requirement. Schedules of available courses for each semester are at <https://courses.yale.edu/>.

Within the nine-course requirement, students must pass the three core courses, unless they are substituted or waived with approval by the DGS. Please see detailed rules in the degree guidelines for waiving or substitution.

Students must also take the Research in Applied Physics Seminar (APHY 576) and the Responsible Conduct in Research for Physical Scientists Seminar (APHY 590).

Students typically complete most of their course requirements in the first year, and sufficient progress toward meeting the course requirements is necessary to remain in good standing in the program. Note that the required courses are just the minimum, and students are strongly encouraged to consult with their Research Advisor about taking additional courses that are needed to facilitate their dissertation research.

### 2. The Corresponding Graduate Courses

**The required core courses are PHYS 502, 508, and 512 and are indicated below with an \*.**

**Courses that fulfil the nine-course requirement include:**

- *Electromagnetic Theory I (PHYS 502)\**
- Mathematical Methods of Physics (PHYS 506)
- *Quantum Mechanics I (PHYS 508)\**
- Quantum Mechanics II (PHYS 510)
- *Statistical Physics I (PHYS 512)\**
- Biological Physics (PHYS 523)
- Solid State 1 (APHY 548)
- Solid State 2 (APHY 549)
- Introduction to Dynamical Systems in Biology (PHYS 561)
- Modern Nanophotonics: Theory and Design (APHY 588)
- Quantum Information (APHY 601)
- Quantum Many-Body Theory (PHYS 610)
- Statistical Physics II (PHYS 628)
- Introduction to Superconductivity (APHY 633)
- Mesoscopic Physics (PHYS 634)

- Theory of Solids 1, 2 (APHY 650, 651)
- Principles of Optics (APHY 675)
- Introduction to Light-Matter Interactions (APHY 676)
- Noise, Dissipation, Amplification, and Information (APHY 677)
- Non-Linear Optics and Lasers (APHY 679)
- Quantum Optics (APHY 691)
- Techniques of Microwave Measurements and RF Design (PHYS 816)

### 3. Suggested Textbooks for Material Review

The following textbooks have been suggested by instructors of the most commonly-taken graduate courses as being indicative of the level of material taught in the courses. Review of these texts may be helpful for students planning their schedules.

#### Solid State Physics I & II

- N. Ashcroft and N. D. Mermin. *Solid State Physics*
- M. L. Cohen and S. G. Louie. *Fundamentals of Condensed Matter Physics*
- M. T. Dove. *Structure and Dynamics: An Atomic View of Materials*
- S. M. Girvin. *Modern Condensed Matter Physics*
- Charles Kittel. *Introduction to Solid State Physics*
- M. P. Marder. *Condensed Matter Physics*
- J. Singleton. *Band Theory and Electronic Properties of Solids*

#### Electromagnetic Theory I

- J. D. Jackson. *Classical Electrodynamics*
- A. Zangwill. *Modern Electrodynamics*

#### Quantum Mechanics I & II

- Albert Messiah. *Quantum Mechanics*
- J. J. Sakurai and J. J. Napolitano. *Modern Quantum Mechanics*

#### Statistical Physics I

- K. Huang. *Statistical Mechanics*
- M. Kardar. *Statistical Physics of Particles*
- L. D. Landau and E. M. Lifshitz. *Statistical Physics, Part I, Volume 5 of Course of Theoretical Physics*
- R. K. Pathria. *Statistical Mechanics*

### 4. Integrated Graduate Program in Physical and Engineering Biology (IGPPEB)

The Yale IGPPEB Program brings together faculty drawn mainly from four member areas (MB&B, MCDB, Physics, and SEAS). All faculty involved recognize the importance of interdisciplinary research at the interface of the biological and physical sciences, and they have developed interdisciplinary research collaborations among IGPPEB colleagues. Additional courses for students in this Ph.D. program are required, and those requirements do not change the required AP core courses listed above. Students should consult with the IGPPEB program for a list of required courses for that program and guidance as to timing for when courses should be taken. Such students may seek exceptions from the usual timing of courses in the Applied Physics program, in order to allow the added requirements.

## Appendix 2: Mentoring Guidelines

These guidelines\* represent the expectations for mentoring and guiding graduate students toward a successful degree completion. Since every student’s research is unique, and every faculty member has different approaches to mentorship, the approach under these guidelines naturally varies for each student. Graduate students and faculty are also encouraged to consult the *Yale Graduate School of Arts and Sciences Guide to Advising Processes for Faculty and Students*.

<b>Faculty</b>	<b>Graduate Students</b>	<b>Department</b>
INCLUSIVE & SUPPORTIVE ENVIRONMENT	INCLUSIVE & SUPPORTIVE ENVIRONMENT	INCLUSIVE & SUPPORTIVE ENVIRONMENT
<ul style="list-style-type: none"> <li>• Foster the overall wellbeing of students</li> <li>• Provide a safe and supportive environment for students within the research group</li> <li>• Recognize and respect students’ diverse backgrounds</li> <li>• Be sensitive to the power imbalance in the student-advisor relationship</li> <li>• Provide an example of ethical and professional behavior</li> </ul>	<ul style="list-style-type: none"> <li>• Interact ethically and professionally with other members of the university and broader academic community</li> <li>• Seek guidance when feedback is needed regarding academics or any other aspect of graduate study</li> <li>• Communicate about needs and concerns regarding academic and professional progress</li> </ul>	<ul style="list-style-type: none"> <li>• Foster the overall wellbeing of students</li> <li>• Provide students a safe, supportive environment that supports their academic and other needs</li> <li>• Connect students with appropriate university offices and resources</li> <li>• Help to avoid possible issues among students and to resolve problems or conflicts if they arise</li> </ul>
ACADEMIC PROGRESS	ACADEMIC PROGRESS	ACADEMIC PROGRESS
<ul style="list-style-type: none"> <li>• Guide students in developing academic and research skills including understanding of ethical and professional norms</li> <li>• Convey clear expectations for academic and research progress</li> <li>• Provide timely, constructive, and objective feedback and evaluations</li> <li>• Facilitate students’ timely academic and research progress</li> <li>• Advise students on expectations for academic integrity, responsible conduct of research and similar topics</li> </ul>	<ul style="list-style-type: none"> <li>• Be receptive to academic and research direction and feedback from advisors and others</li> <li>• Take responsibility for knowing and fulfilling degree requirements and other academic requirements</li> <li>• Take responsibility for knowing and following ethical and professional norms</li> <li>• Understand and follow department and university policies, including academic integrity, student conduct and responsible conduct of research</li> </ul>	<ul style="list-style-type: none"> <li>• Provide information about degree requirements, academic policies, and expectations</li> <li>• Share information about fellowships, awards and other academic opportunities</li> <li>• Monitor student academic progress and communicate with students and advisors regarding academic requirements</li> <li>• Inform students about department and university policies, including academic integrity, student conduct and responsible conduct of research</li> </ul>
CAREER DEVELOPMENT	CAREER DEVELOPMENT	CAREER DEVELOPMENT
<ul style="list-style-type: none"> <li>• Foster professional development to prepare students for a wide range of future employment options</li> <li>• Assist students in achieving their career goals</li> <li>• Encourage engagement in professional communities and meetings to foster potential career opportunities</li> </ul>	<ul style="list-style-type: none"> <li>• Identify professional development needs and pursue appropriate opportunities</li> <li>• Take initiative for career exploration and the job search</li> </ul>	<ul style="list-style-type: none"> <li>• Promote student engagement in professional development programs</li> <li>• Foster the professional development of students to prepare for a wide range of future employment options</li> <li>• Direct students to resources that can help them pursue and succeed in their careers of choice</li> </ul>

\*Guidelines are adapted from those used by the Physics Departments at the University of Illinois at Urbana Champaign and at Pennsylvania State University.

## **Appendix 3: Summary of Requirements and Milestones**

This summary, the table below, and the following flowcharts are presented for convenience and easy reference. The main text of the Guidelines provides the definitive statement of the requirements.

### **First and second semester**

- 4 classes each semester, including departmental core courses and Special Investigations (SI)
- Full-time research with a faculty member during the summer
- Agree on a Commitment with a Research Advisor
- Oral English proficiency standard (SPEAK test) met by the end of August
- Topics in Applied Physics Research (first semester) and Responsible Conduct in Research (second semester) Seminars

Students must have a High Pass average at the end of the first year.

### **Summers**

- Research under the supervision of the Research Advisor

### **Third semester**

- 1-2 classes
- Research
- Meeting teaching requirement

### **Fourth semester**

- 1-2 classes
- Research
- Select an Advisory Committee
- Meeting teaching requirement

Students must maintain the High Pass average, they must earn two grades of Honors, and they are expected to finish course requirements in the second year.

### **Fifth semester**

- Area Exam by October 5<sup>th</sup>
- Prospectus approved by October 5<sup>th</sup>
- Research

If a student fails the exam, they can normally take it again prior to March 15<sup>th</sup>.

### **Sixth semester**

- Retake area exam if the student failed the first time; have prospectus approved and be admitted to candidacy
- Research
- Completing teaching requirement if not already completed

### **Continuing**

- Research and preparation of dissertation
- Communicating progress to Advisory Committee
- Research Advisor approval of progress towards degree

### **Seventh year**

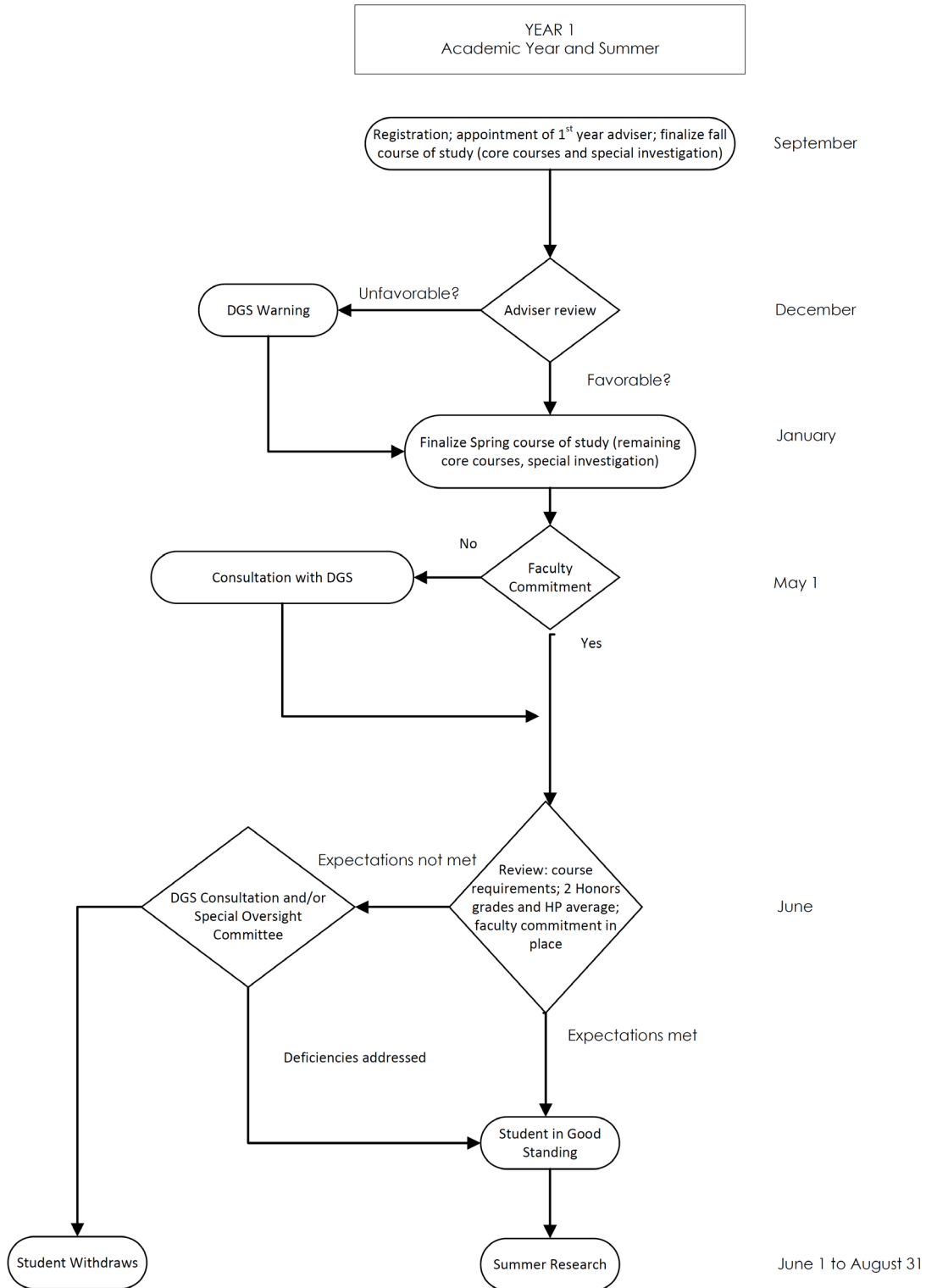
- Must make a notification for extended registration before Graduate School deadline

## Table of milestone events in the graduate program

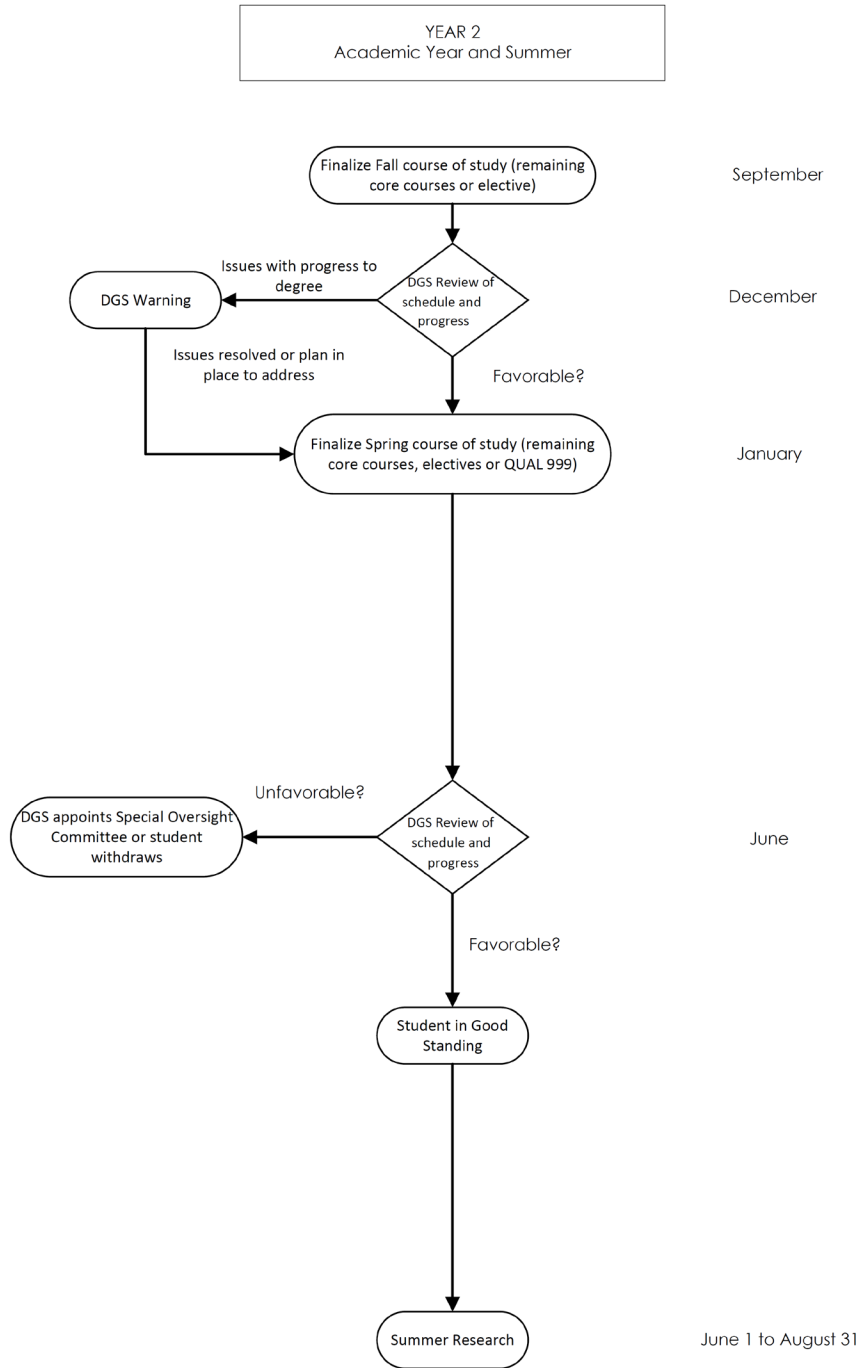
This table gives approximate times for many of the important actions that students must take as part of the Applied Physics degree program. Students are responsible for taking action on these and ensuring that all requirements are met. The table is provided for illustrative purposes only; exact dates and detailed requirements are given in the main text of the Guidelines.

Year	Approx. month	Student action	Advisor involvement	Registrar involvement	Comments
Pre-1	June-August	May perform "early start" research at Yale	Agree to supervise	Process appointment	May start as soon as admitted
Pre-1	August	Contact possible SI advisors			May start as soon as admitted
Pre-1	August	Demonstrate English proficiency			May start as soon as admitted
Pre-1	August	Request course waivers or substitutions; take related pass-out exam	Advise on classes		
Pre-1	August	Select classes	Advise on classes	Enrollment approval	
1	September	Start 1 <sup>st</sup> SI			
1	January	Start 2 <sup>nd</sup> SI			
1	January - August	Secure <i>Commitment</i> from Research Advisor and inform Registrar	Commit to student	Record <i>Commitment</i>	Should be complete by end of summer
1	September - May	Pass "Topics in Applied Physics Research" and "Responsible Conduct of Research"			
1	May	Start summer research			
2	April	Select research committee	Chair; advise on members	Record members	
2	May	Complete course requirements			
2	May	Complete teaching requirement			
2	April-August	Schedule area exam with committee; inform Registrar		Announcement and processing	
2-3	May - September	Take area exam	Chair committee	Record result	First attempt by October 5
4+	April	Update committee at least annually	Chair committee		Submit Dissertation Progress Report
4+		Write thesis	Review drafts		
4+		Schedule final exam with committee; provide thesis to review		Announcement and processing	
4+		Final exam		Processing	Thesis defense
4+		Submit dissertation after committee approval			

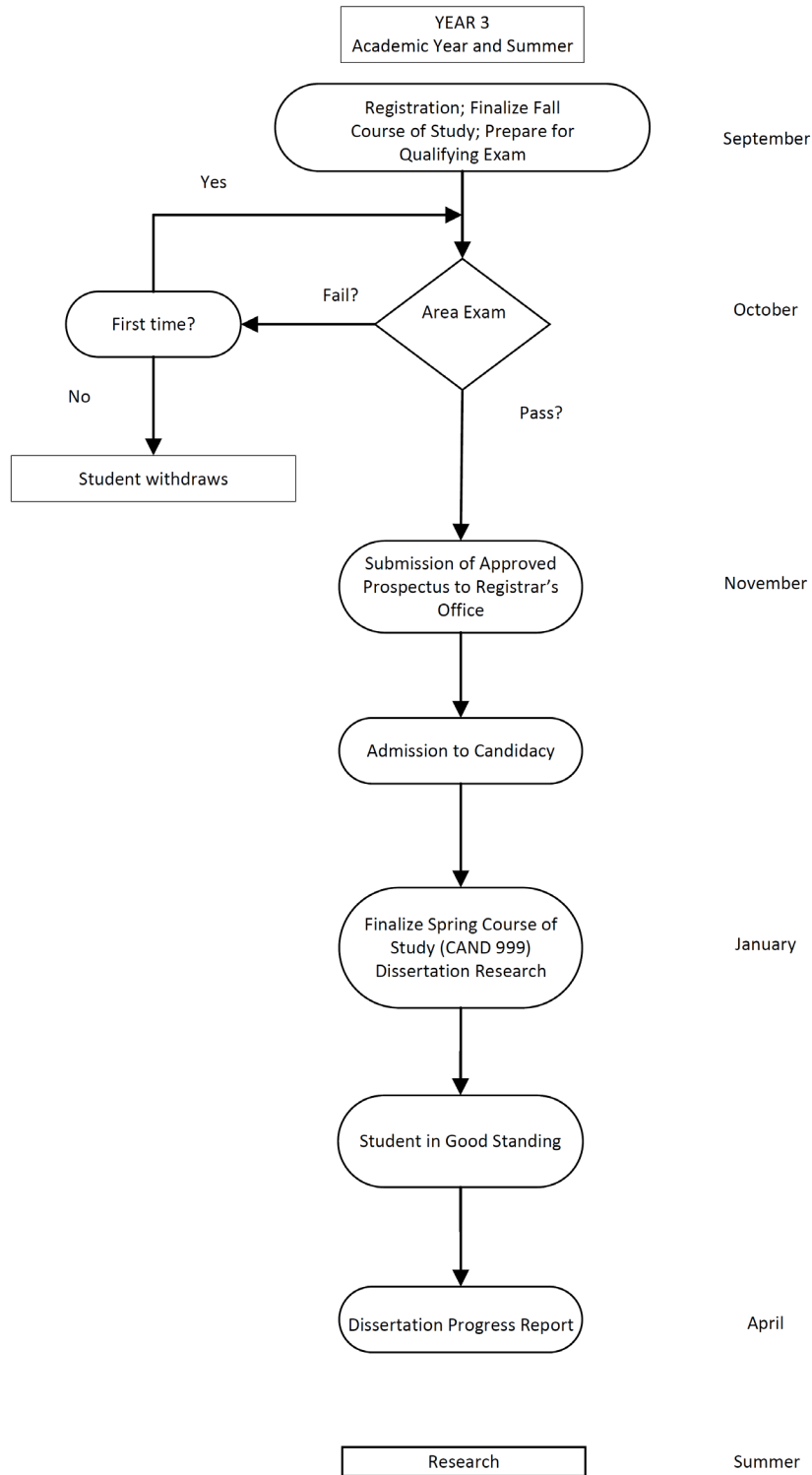
## Schematic flowchart of typical degree progress



## Schematic flowchart of typical degree progress



## Schematic flowchart of typical degree progress





## Schematic flowchart of typical degree progress

