

REQUIREMENTS FOR DOCTOR OF PHILOSOPHY IN ELECTRICAL ENGINEERING

1 Acceptance into the Ph.D. Program

- a. A Master's degree in Electrical and/or Computer Engineering from Vanderbilt or another accredited institution is normally required for entrance into the Ph.D. program. Academic performance for the Master's degree must show at least a 2.0/3.0 (or 3.0/4.0) GPA. The Graduate Record Examination must be taken and the aggregate score must total at least 300. In the event that the Master's degree is not in Electrical and/or Computer Engineering or from an accredited institution, acceptance will be based on consideration of GRE scores and letters of recommendation. All non-English-speaking students must score at least 88 on the TOEFL examination.
- b. Any student pursuing a Master's degree at Vanderbilt who wishes to continue work at Vanderbilt toward the Ph.D. must notify his or her advisor and the DGS in writing and obtain approval before enrolling in course work beyond that required for the Master's degree. Normally, no course work may be applied toward the fulfillment of the Ph.D. requirements until all requirements for the Master's degree are satisfied. Permission may be given to do so if progress toward the completion of the Master's degree is judged satisfactory by both the student's advisor and the DGS.
- c. Final acceptance into the Ph.D. program is based on a vote of the Department's graduate faculty.

2. Student Advisor and Committee Selection

- a. If, upon entering the Ph.D. program, a student does not have a Ph.D. advisor, the DGS shall assign one pro tempore. By the end of the first year in the Ph.D. program, each candidate is expected to consult with relevant faculty members to discuss possible research topics. The final selection of an advisor is a decision made by the student, his or her proposed advisor, and the DGS.
- b. Each Ph.D. student must have a Ph.D. Committee. The Committee is to be composed of at least five members of the Graduate School faculty. At least 50% of the Committee members shall be EE faculty, and at least one of the Graduate School Faculty Committee members shall have a primary appointment in a discipline other than EE. The student's Ph.D. advisor shall serve as chair of the committee. The committee is recommended by the student and the student's advisor with considerations for research and directions of academic growth. The committee must be approved by the DGS and the Dean of the Graduate School.
- c. The student's Ph.D. committee is to be selected and its membership is to be submitted to the DGS office and the Graduate School before the student may take the

Ph.D. preliminary examination. The committee is responsible for evaluating the progress of the student.

3. Course Requirements

a. A total of 72 hours is required for the Ph.D. Of these, at least 36 hours must be in course work with at least 24 of the 36 hours in EECE (exceptions can be made to this rule based on the recommendation of the student advisor if the student research topic requires taking additional courses outside EECS). The courses taken must also include one of the gateway courses in each of the following areas: electronics, computers, and signals and systems. An additional 12 hours is required in course work, which may include independent study, as specified by the candidate's advisor. Up to 24 hours of course work toward the Master's degree will normally be applied to this total on approval by the advisor. Up to 12 total hours of course work in the range 5250-5999 is allowed. At least 6 hours of coordinated study must be in a minor subject typically outside the Electrical and Computer Engineering Program. The remainder of the 72 hours may be in dissertation research hours, in special readings, and in transfer credit if applicable.

b. Up to 24 graduate credit hours may be transferred from graduate schools in approved institutions. Any graduate transfer credit taken in EECE or a closely related area in approved programs may be counted towards the 24 hour EECE course requirement defined in part 3.a. The student must obtain approval from his or her advisor and the DGS before submitting the request to the Graduate School.

4. Grade Requirements

The overall grade point average for formal course work applied toward the Ph.D. must be 3.0/4.0 or better. More than one "C" in courses in the field of major interest or more than one "U" in research is cause for review of the student's status and academic progress by his or her committee. One "F" is cause for termination from the program. Final decisions in such cases will be made by vote of the Department's graduate faculty as a whole.

5. Plan of Study

A student must file a study plan by the end of the first year in the Ph.D. program. This study plan is developed with and approved by the student's Ph.D. advisor and reported to the DGS. Significant changes in the study plan (e.g., change of research interest) must be approved by both the student's Ph.D. advisor and the DGS.

6. Maximum Course Load

A normal full-time load for graduate study is 9-13 hours per semester (6-9 hours in the summer session). In exceptional cases, a student may register for more than 13 hours (9 hours summer) with the approval of his or her Ph.D. advisor and the

DGS.

7. Progress Requirements and Evaluation

- a. At the end of each Spring semester, the Ph.D. student's academic progress shall be discussed with his or her Ph.D. advisor. The student will submit to the DGS a written report on his or her progress for the preceding year and plans for the next year.
- b. Each year, not normally later than June 1, progress of the student will be evaluated by his or her Ph.D. committee. Each student will be informed of the results of this evaluation if the progress is judged to be inadequate.
- c. A Ph.D. student not making satisfactory progress toward the degree may be dropped from the program as a result of this evaluation.
- d. Satisfactory progress may be demonstrated by successful completion of course work, completion of appropriate examinations and papers, and progress in choosing a research project, performing the research work, and writing the dissertation.
- e. Any final decision to drop a student from the program will be made by vote of the Department's graduate faculty.

8. Ph.D. Preliminary Examination

The purpose of the preliminary examination is to identify those students who are qualified to work towards the Ph.D. degree in Electrical Engineering. The preliminary examination will be given in the Fall and/or Spring semesters. A student must take this exam within one calendar year plus one semester after being admitted into the Graduate program. A student must register to take this exam with the EECS DGS at least six weeks prior to the exam. Upon registration, the student must inform the DGS of his/her main area of research.

- a. Procedures for students admitted after the Summer Semester of 2014

Overview: The EE preliminary exam is designed to evaluate the primary characteristics necessary for research, including logical thought, curiosity, motivation, technical insight, and expressiveness. Each student, including teaching assistants, must participate in a faculty-directed research project, which is sufficiently technical to be presented for the preliminary exam.

Exam Committee: The committee is appointed by the DGS and consists of four faculty members to include at least one faculty member from outside the candidate's core gateway area and the candidate's faculty adviser of record. Each committee member scores the candidate's oral and written work independently according to established

criteria (please see the rubrics on the following page).

Written Exam: The written document should be similar in form to a scientific paper, including formatting, figures (as necessary), and literature citations. A description of original research is welcomed but not required. The document must be solely authored, and the topic can be interpreted broadly. Examples of acceptable topic areas are (1) a description of research performed by the candidate, along with sufficient background to demonstrate an initial understanding of the work and its context in the field, (2) a review of relevant literature that may provide useful background for the candidate's future research, or (3) a paper that describes a scientific instrument in sufficient detail to demonstrate the candidate's knowledge of its functions and practical use. Only minimal content review is permitted by the adviser; detailed technical review is not permitted. The paper must be written clearly in English using single-spaced 12-point font, Times New Roman with 1-inch margins. The length should be between 2000 and 4000 words. The document should include appropriate figures, tables, and citations, which do not count against the word limit. Any material from outside sources must be fully and appropriately referenced. Documents not meeting the specified criteria will be returned without review.

Oral Exam: The oral exam is a scientific talk of no more than 20 minutes duration on the subject of the research described in the paper. All aspects are relevant, including demonstrated knowledge, technical quality of the presentation, and response to questions. Only minimal content review is permitted by the adviser; detailed technical review is not permitted. Any question on the research, its implications or background is permissible, and each committee member will judge all answers, not just those to the questions posed by the committee member. The exam should focus on the paper, and relevant background and extensions.

Timing / Logistics: For students entering the PhD program in August, oral exams will be given in a fixed, two-week period in October of the candidate's second year of graduate school. Students who do not pass on the first attempt must take a second (and final) exam given in a fixed two-week period in April. Students failing the exam twice will be dismissed from the program. There are no exceptions to the schedule without DGS and Dept. Chair approval. Exceptions will only be granted in extraordinary circumstances. Spring and summer admits may take the exam in either the first or second year of their residency. Three gateway courses must be completed with a grade of at least B- prior to the exam.

Scoring: Grades in each of three gateway courses count as follows: A- and above: 1.33; B+: 0.67; B: 0.33; below B: 0. The score on the written document is 0-4 points (average of committee members' scores). For students who take more than one gateway course in a particular area, the highest grade is used. The score on the oral exam is 0-4 points (average of committee members' scores). Scores are by independent secret ballot of the committee members and are tallied by the graduate program coordinator, and rounded to the nearest tenth. The maximum possible score is 12. The DGS reviews, approves, and

announces the result to the student and the committee.

Pass/Fail: A passing score is 8.10 or higher. If the student fails during the first exam period, (s)he must retake the exam in next semester. If the student fails the exam a second time, (s)he will be removed from the program.

b. Procedures for students admitted prior to Fall Semester of 2014

Students admitted prior to the Fall Semester of 2014 may choose between the preliminary examination procedures detailed in section 8.a. and those detailed in this section. Once a path is chosen by the student, (s)he must successfully complete all requirements of that path in order to pass the examination.

To be eligible for the preliminary examination, students must have passed with a grade of B or better one of the gateway courses in each of the three following areas: electronics, computers, and signals and systems. Gateway courses are graduate level courses with senior-level prerequisites, the list of which will be maintained by the DGS. The preliminary exam consists in an oral examination administered by three faculty members, one from each of the aforementioned areas. The examination committee is selected by an oversight committee composed of the DGS and representatives of the various specialties in the Department. Its members are chosen such that the expertise of its members covers the stated area of interest of the student as well as his/her academic background. The student's main research advisor will not serve on the exam committee although (s)he can participate to the exam as an observer. Exceptions can be made to this requirement if it results in the inability of the DGS to constitute a committee. Specific topics to be covered during the exam will be agreed upon between the student and the examiners no later than four weeks before the exam. Assigned material can range from papers published recently in the literature to a book or book chapter but the scope of the material should be such that a student with the appropriate background can cover it within four weeks.

After the exam, the exam committee, the DGS, and the student's main research advisor will meet and deliberate. The committee will review the complete student's record including GPA, research performance, and performance during the preliminary exam and make one of the following determinations:

- i) the student has passed the preliminary examination requirements.
- ii) the student must retake the preliminary examination the next time it is offered. If the student fails the reexamination, it will be recommended to the Graduate School that the student be dropped from the program.
- iii) the student has failed the preliminary examination and the committee recommends to the department's graduate faculty and the department's DGS office that

the student be dropped from the program.

9. Ph.D. Qualifying Examination and Major Area Paper

The qualifying examination will consist of a written or oral examination together with the preparation and oral defense of a major area paper. The qualifying examination requirements are normally to be completed after 36 hours of course work, but no later than one semester after the candidate has completed 48 hours of course work. (*The qualifying examination requirements are normally to be completed no later than one semester after the candidate has completed 36 hours of course work*).

The student is to schedule, at the convenience of his or her committee, individual conferences with each member at least two weeks before the qualifying examination to establish the scope and nature of the written or oral examination. The student then must register to take this exam with the DGS office at least ten days prior to the exam.

The written and (or) oral exam is to demonstrate the student's competence in his or her area of specialty. The nature of this exam is at the discretion of the student's committee. The oral defense of the major area paper is not limited to the topic of the paper, but may also include knowledge relevant to the student's research. The area paper will be judged by the following criteria. It will

- i) identify and explore a significant research area.
- ii) contain a comprehensive review of the research literature relevant to the area.
- iii) demonstrate the student's thorough familiarity with the literature and with the concepts and methods pertinent to conducting research in the area.
- iv) have the scope, length and critical perception of issues of major review articles in leading journals.

At completion of the oral defense of the major paper, the student's committee will judge the student's performance on the qualifying examination. One of the following determinations will be made and transmitted to the student and the DGS office.

- i) the student has passed the qualifying examination requirements.
- ii) the student must retake all or part of the qualifying examination. If the student fails the reexamination, it will be recommended to the Graduate School that the student be dropped from the program.
- iii) the student has failed the qualifying examination and the committee recommends to the department's graduate faculty and the department's DGS office that the student be dropped from the program.

10. Dissertation Requirements

- a. At the time of the qualifying examination, the candidate is required to provide his or her Ph.D. committee with a proposal for the dissertation research. The proposal should state the research problem and specify the methods and procedures to be used. If the candidate has performed preliminary work, the results should be included. The committee may administer a formal oral examination on the proposal or may elect to have each individual member of the committee pass on the merits of the proposal separately. The DGS office is to be notified of the committee's acceptance of the Ph.D. proposal. The proposal may be modified as research proceeds and new directions are indicated.
- b. After completing the work proposed, the candidate will prepare a draft of the dissertation. The Ph.D. committee chairman will determine when the draft has progressed sufficiently for it to be given to the committee and for an oral examination to be scheduled with the DGS and the Graduate School.
- c. The candidate must distribute a final draft, including all figures, tables, appendices and references, to the candidate's Ph.D. committee members two weeks before the scheduled oral examination.
- d. At the oral examination, the candidate will be required to defend the dissertation and the work presented by it. The candidate should, in the course of the defense, be able to demonstrate a thorough knowledge of the literature relevant to the area and competence in justifying procedures and interpretations in the work. The results of the examination shall be reported to the graduate school and the DGS office.
- e. If the defense is not satisfactory, the student's Ph.D. committee may require revisions of the draft and a re-examination. In extreme cases, it may require more extensive work.
- f. After approval by the committee, the student will produce a final typed manuscript. This manuscript can either be a monograph or a collection of papers submitted or ready for submission to leading peer-reviewed journals in the student's area of research. If the latter option is taken, the final document should include the manuscript(s) plus a general introduction, a summary, recommendations for future work, and possibly appendices presenting material not included in the manuscripts.
- g. Before the final acceptance of the dissertation, the candidate must present the work at a Department seminar and at least one manuscript must have been submitted to a leading peer-reviewed journal in the student's area of research.

11. Time Limit

Full-time Ph.D. students are normally expected to have completed all work credited for the doctoral degree within a three-year period from the date of qualification. In all cases, the doctoral degree shall be completed within four years after the candidate passes the qualifying examination. Candidates not meeting this requirement will be dropped from the Program or may be required to retake the qualifying examination.

12. Waiver of Requirement

In rare situations, a requirement or requirements for the Ph.D. may be waived. This requires that a faculty advocate present the reasons for waiver to the department's Graduate Policy and Program Committee. This committee shall accept or reject the proposed waiver or recommend to the student's chairman further action.