



Graduate Degree Programs in Electrical Engineering



**The Pennsylvania State University
Department of Electrical Engineering
121 Electrical Engineering East
University Park, PA 16802**

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TABLE OF CONTENTS

I.	General Information	1
	A. University Policies	1
	B. Safety and Compliance	1
	C. Ethics, Patents, Copyrights.....	1
	D. Graduate Student Association and Other Graduate Organizations	2
II.	Admission, Advising, Scholarship and Research Integrity Requirement and Electrical Engineering Minors	3
	A. Admission to Graduate Programs	3
	B. Advising.....	3
	C. Scholarship and Research Integrity Requirement	4
	D. Electrical Engineering Minors for Students in Other Fields	4
	E. Area Table	5
III.	M. S. Program in Electrical Engineering	6
	A. Supervision and Advising.....	7
	B. M. S. Committee Specifications	7
	C. Thesis Option	8
	D. Paper Option.....	9
	E. M. S. Time Limits	10
IV.	Ph.D. Program in Electrical Engineering	10
	A. Advisor and Committee.....	11
	B. Admission to Candidacy	12
	C. Communication and Language Competence	14
	D. Comprehensive Exam.....	15
	E. Final Oral Exam	17
	F. Other Constraints	18
	G. Ph.D. Time Limits	18
V.	Policies for Graduate Assistants	20
	A. General Policies	20
	B. Teaching Assistant Policies	22
	C. Research Assistant Policies	24
VI.	Electrical Engineering Graduate Faculty	26
VII.	Graduate Program Contact Information.....	28
VIII.	Graduation Checklist for M.S.E.E. Students.....	29

Department OF Electrical Engineering

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I. GENERAL INFORMATION

A. University Policies

This handbook includes a few of the general University policies that have special relevance to The Department of Electrical Engineering (E E). It does not include all of the policies that can affect your stay at Penn State (for example, see <http://www.gradsch.psu.edu/policies/student.html>). This handbook does not supersede any general policy of the University.

The Graduate Degree Programs Bulletin is often a useful reference, especially with regard to academic issues. Special procedures related to registration, thesis approval, health insurance, housing, and visas are not included in this handbook but they are well documented elsewhere.

The World Wide Web provides an extensive listing of student policies that can be located under the Penn State home page at <http://www.psu.edu>. You can access the Electrical Engineering Department home page directly at <http://www.ee.psu.edu>. Anyone unable to locate needed information may inquire in 121 Electrical Engineering East for referrals to the appropriate source.

B. Safety and Compliance

Any questions regarding safety should be directed to your research supervisor, the department head, and to Environmental Health and Safety at 865-6391.

EMERGENCIES --- 911

UNIVERSITY POLICE --- 863-1111

Beyond the safety issues are federally mandated compliance issues. Filing applications and obtaining approvals for the proposed work must precede any activities involving human subjects, vertebrate subjects, bio-hazardous material, and radioactive materials. Details are available at <http://www.research.psu.edu/policies/index.html>.

C. Ethics, Patents, and Copyrights

Students are expected to commit themselves to the highest level of ethical conduct in their academic and research activities. Information on ethical guidelines and discussions of these issues can be found at the following web site:
<http://www.engr.psu.edu/ethics/codes.asp>

The following web sites contain information on the University policies regarding intellectual property and publication:

<http://www.research.psu.edu/ipo/faq.html>

<http://www.cede.psu.edu/ip/faq.html>

D. Graduate Student Association and Other Graduate Organizations

The Graduate Student Association (*GSA*) provides numerous services and information to graduate students. The *GSA* invites graduate students to participate in its meetings and functions. More information about the *GSA* is at <http://www.clubs.psu.edu/up/gsa/>.

There are many other student organizations, including the Engineering Graduate Student Council, the student branch of IEEE, hobby and sports clubs, etc. The *GSA* is a good source of information.

The EE Graduate Student Advisory Committee provides representation of the graduate student body to the Graduate Program Coordinator and the Department Head, who appoint this committee. The members also organize several events throughout the year to encourage interaction between graduate students in different research groups. The current members of the EE Graduate Student Advisory Committee are:

Caitano Da Silva	cld295@psu.edu
Perry Edwards	pse104 @psu.edu
Amanda Mills	acm210@psu.edu
Israel Ramirez.....	jir121 @psu.edu
Clinton Scarborough	cps168@psu.edu
Sonny Smith	sus309@psu.edu
Kaya Tutuncuoglu	kxt234@psu.edu

II. ADMISSION, ADVISING, SARI REQUIREMENT AND ELECTRICAL ENGINEERING MINORS

A. Admission to Graduate Programs

Students may be admitted to the M.S. program, to the Ph.D. program after completing an M.S. program, or directly to the Ph.D. program, bypassing the M.S. program. Applicants are expected to have a B.S. degree in electrical engineering. Exceptional candidates from related fields are also welcome to apply. Only well prepared and highly competitive candidates should apply to enter the Ph.D. program directly from the B.S. program because they will be required to take the candidacy examinations within one year of entry into the program.

Applicants are required to complete the University's application form and the Department of Electrical Engineering supplemental application form. They must provide formal transcripts, general GRE scores, letters of reference, a resume, and a personal statement of technical interests, goals, and experience. An international student whose first language is not English must submit a TOEFL score. It should be noted that students admitted to the graduate program who do not demonstrate satisfactory proficiency in English will be required to alleviate this deficiency by taking additional English and/or speech communications courses.

Students who intend to continue from the M.S. to the Ph.D. program should apply to resume study at least three months prior to the transition. An updated personal statement, and a letter from the Department of Electrical Engineering faculty member who will serve as the student's Ph.D. advisor should accompany that request. Standards for entry to the Ph.D. program are generally more rigorous than for the M.S. program. Satisfactory completion of the M.S. program does not guarantee admission to the Ph.D. program.

B. Advising

Academic advising usually comes from the faculty member who supervises the student's research. Other members of the student's thesis committee may also serve as advisors. A newly arriving student will be assigned a temporary faculty advisor who will provide initial advising at the beginning of the first semester. The graduate program coordinator is available to consult and assist with difficult decisions. Students are encouraged to meet with faculty members in their area of interest and strive to complete a

Graduate Student/Faculty Advisor Agreement Form by the end of the first semester.

C. Scholarship and Research Integrity (SARI) Requirement

Within the first year all EE graduate students must complete the following activities:

- Responsible Conduct of Research (RCR) training provided by the Collaborative Institutional Training Initiative (CITI) on-line (www.research.psu.edu/orp)
- 3 hours of discussion-based training available through special EE colloquia
- 2 hours of discussion-based training facilitated at the University and/or College of Engineering level

for detailed information please see the following web site
<http://www.ee.psu.edu/Graduate/SARIProgram.pdf>

D. Electrical Engineering Minors for Students in Other Fields

The general requirements for a minor in electrical engineering shall be consistent with those of The Graduate School as stated in the Graduate Degree Programs Bulletin.

All graduate students desiring minors in Electrical Engineering shall formally register such minors with the graduate program coordinator as soon as the decision to enter upon such a minor has been made. At the time of registration, a program of study shall be formulated and any departures from these courses must have the approval of the graduate program coordinator and The Graduate School. The electrical engineering M.S. minor requires 6 credits of 500-level electrical engineering courses. The Ph.D. minor requires 15 credits of electrical engineering courses with at least 12 of the 15 credits at the 500 level.

E. Area Table

Specialization Area¹	EE Core Course²
Communications	560
Computer Vision and Pattern Recognition	560
Networking	560
Signal and Image Processing	560
Control Systems	580
Power Systems	580
Electro-Optics and Non-Linear Optics	524
Microwaves, Antennas, and Propagation	531
Remote Sensing and Space Systems	531
Circuits and Networks	510
Materials and Devices	542
VLSI	542

1. A student's primary and secondary **specialization areas** may not have the same core course for the Ph.D. candidacy exam.
2. The **specialization area** core courses are intended to establish the fundamentals of the technical area.

III. M.S. PROGRAM IN ELECTRICAL ENGINEERING

The M.S. degree may fill several different objectives. It can be a terminal degree or it can focus toward preparing for the Ph.D. The M.S. degree can be research oriented or it can emphasize graduate level course work. These various objectives are possible because of a choice between preparing an M.S. thesis or an M.S. paper. Course requirements are different for the two options.

One other option available is that a student who is admitted to one program may concurrently pursue a second master's degree. Instructions and application forms are available from the graduate program staff assistant, 121 EE East. Both programs and the dean of The Graduate School must approve concurrent degree program requests.

Regardless of what options are chosen, several general requirements must be met. At least 50% of the total course credits required (excluding colloquium and research credits) must be electrical engineering courses. The student's program shall include no more than 3 credits of individual studies (596) and only members of the Department of Electrical Engineering graduate faculty may instruct electrical engineering individual studies courses. The undergraduate independent studies course (EE 496) will not count toward the program credit requirements. At most, 9 credits taken at the 400 level may be counted toward the degree requirements, though students can and often do take credits beyond degree requirements. Students may take relevant 400-level technical courses from other graduate programs as long as they do not duplicate other course work they have taken. All students are expected to complete one credit of colloquium (EE 500) for two semesters. Degree requirements should be completed during a 6-year period.

Students who have deficiencies in the use of spoken or written English may be required to take courses in these topics in addition to the usual degree requirements.

Courses have been grouped into areas for the purpose of incorporating a breadth requirement into the M.S. program. These areas are:

Communications, Computers, Networking, and Signal Processing
Control and Power Systems
Electromagnetics and Optics
Electronics and Photonics

The most recent listing of 500-level courses by area can be found inside the back cover of this booklet. It should be noted that some CSE courses are included in

one of the areas. Not all courses are included in the listings. Only these listed courses are acceptable for the breadth requirement. If a student wishes to satisfy the breadth requirement by taking an electrical engineering special topics course (EE 597), he/she must request approval from the graduate coordinator **before** the beginning of the semester in which the course is scheduled. Special topics courses from the Department of Computer Science and Engineering (CSE 597_) may not be counted toward the total credit requirement.

A. Supervision and Advising

Students will be assigned temporary academic advisors at the beginning of their first semesters, unless they were offered a research assistantship at the time of their admission. The new M.S. student will consult with possible research supervisors to identify a research advisor with whom they will formulate plans, including courses to be taken and the choice between thesis and paper option. The research advisor may suggest and approve relevant technical courses from other closely related departments to be included in the M.S. program. The student and advisor will also identify other faculty members who will serve on the student's committee. By the end of the second semester, the student should complete the "Option and Committee Membership Approval Form" requesting the approval of the student's committee, tentatively identifying the research topic, and choosing the thesis or paper option. The committee members and the graduate program coordinator ultimately sign the student's thesis or paper approval form.

B. M.S. Committee Specifications

A student's M.S. committee must have at least two members who are Department of Electrical Engineering graduate faculty and at least one member who is tenured or tenure-track in the Department of Electrical Engineering. The chair or one of the co-chairs must be a Department of Electrical Engineering graduate faculty member and have a tenured/tenure-track appointment or a joint appointment in the Department of Electrical Engineering. All persons serving as chair or co-chair of a committee must be members of the Penn State graduate faculty. The committee may have additional members who are Penn State graduate faculty or who have professorial appointments in the Department of Electrical Engineering or in a department related to the research topic. The committee may also have special members who have expertise in the MS candidate's research area and who would normally carry significant supervisory responsibilities. The special members should hold a PhD degree and must be approved by the EE Graduate Program Coordinator. Members of the Penn State graduate

faculty or persons not affiliated with Penn State who have particular expertise in the student's research area may serve as signatories who will read and approve the thesis or paper but are not required to attend the defense or presentation. The committee must be appointed by the end of the second semester in the program.

C. Thesis Option

The degree requires 32 credits including 24 technical course credits (50% or more must have an EE designation) with at least 15 credits at the 500 level, 2 colloquium credits, and 6 thesis credits identified as E E 600 (thesis research). At least one course must be taken at the 500 level in two of the previously mentioned four areas to complete the **breadth requirement**. (A list of 500-level courses by area is on the inside back cover of this booklet.) EE 597(X) courses must be approved by the Graduate Program Committee (by petition to the Committee) **prior to scheduling**, to be used to satisfy the breadth requirement.

Original research, usually requiring at least two semesters of work (nominal 6 credits), is expected for a thesis. The work should be an in-depth investigation intended to extend the state of the art in some specialty area. Mere application of some existing engineering technology is generally not sufficient.

At the beginning of the research, each student should obtain a "Thesis Guide" from the Thesis Office web page at <http://forms.gradsch.psu.edu/thesis/thesisguide.pdf>. Thus, the written or graphical materials generated from time to time can be in the format acceptable to The Graduate School. Thesis deadlines, which are available at <http://forms.gradsch.psu.edu/thesis/Calendar.pdf>, or from the Academic Affairs Office should be carefully noted as well. Committee members may request periodic progress reports that may contain materials that will appear in the thesis. As work is satisfactorily completed, the grade of 'R' is assigned to 600-level credits.

Two weeks prior to the thesis defense, the completed thesis should be delivered to the committee members. The student shall provide a copy of their thesis to committee members as each member prefers, either as pdf attachment to email or as a hard copy. Also at this time, a defense date must be scheduled with the department's graduate program staff assistant who will provide assistance with the room reservation and publicity for the public presentation. All committee members must attend the defense. After the defense, all members of the committee and the

department head will sign the signature page (<http://forms.gradsch.psu.edu/thesis/mastersApprovalPage.pdf>) of the approved thesis. If the thesis needs modifications, then members may sign after they see the revised version. (When the department head is appointed as a committee member, the committee must have at least three members or two members and an approved signatory to satisfy the Thesis Office requirement for three signatures on the thesis.) These individuals will also sign a thesis completion report to be placed in the student's file. As soon as the thesis is in its final form the student must complete the following:

1. Provide copies of the approved thesis to all committee members.
2. Upload thesis on the Grad School Thesis Office website as indicated in the Thesis Guide.
3. Pay thesis fee on-line.
4. Submit the thesis approval page with the signatures of all the committee members and the Department Head.

D. Paper Option

The degree requires 34 credits including 30 technical course credits (50% or more must have an EE designation) with at least 21 at the 500 level, 2 colloquium credits, and 2 credits of E E 594 (paper research). At least one course must be taken at the 500 level in two of the previously mentioned four areas to complete the **breadth requirement**. (A list of 500-level courses by area is on the inside of the back cover of this booklet.) EE 597(X) courses must be approved by the Graduate Program Committee (by petition to the Committee) **before** scheduling, to be used to satisfy the breadth requirement.

The paper is intended to be a relatively short document compared to the thesis. Typically, it is the length of a manuscript prepared for submission to a journal. The work should be done while a student is enrolled in the M.S. program at Penn State. The paper should be written according to the standards set for an IEEE publication and should represent a contribution to a specific engineering activity. It should depict application at the state of the art. Interdisciplinary activity is encouraged.

In conjunction with the paper, the student is required to make a presentation on the work. The student **must** schedule the paper presentation through the graduate program staff assistant who will arrange the proper publicity and reservations. All committee members must attend the presentation. **The paper should be delivered to the committee members and the presentation scheduled at least two weeks prior to the**

event. The student shall provide a copy of the thesis to committee members as each member prefers:; either as pdf attachment to email or as a hard copy.

The student must fulfill the 2-credit paper research requirement by registering for E E 594. A grade of 'R' is submitted if the work is satisfactory. When the paper is successfully completed, all committee members and the department head will sign a paper completion report that will be kept with a copy of the paper in the student's file.

E. M.S. Time Limits

The Department of Electrical Engineering has established a six-year time limit for completion of the M.S. degree.

The M.S. committee must be appointed by the end of the second semester.

The thesis defense or paper presentation must be scheduled and a copy of the thesis or paper provided to all committee members **at least two weeks** prior to the scheduled date.

IV. Ph.D. PROGRAM IN ELECTRICAL ENGINEERING

The doctoral student's goal will be to establish his/her reputation as a researcher with a broad supporting base in laboratory and/or analytical techniques, and with experience in presenting original research results at conferences and in refereed journals. The Department of Electrical Engineering welcomes highly qualified students with B.S. or M.S. degrees in electrical engineering, as well as in related engineering and science disciplines. The Ph.D. candidacy requirements, while centered in electrical engineering, are also intended to allow students with diverse backgrounds to efficiently move toward attaining their Ph.D. degrees. To these ends, the student will complete admission to candidacy procedures (Section IV-B-2 of this booklet) to verify a sufficient base of study, be evaluated for English proficiency and presentation skills during a 15-20 minute technical presentation, develop a dissertation proposal to be presented at an oral comprehensive exam (thesis proposal exam), conduct the proposed research, and disseminate the results through the dissertation and related publications. As part of the program, the student will complete 39 technical course credits and 2 colloquium credits beyond the B.S. degree, with at least 30 of these course credits at the 500 level (i.e., at most 9 credits may be 400 level). No more than 3 of these credits may be individual studies (E E 596) and only members of the Department of Electrical Engineering graduate faculty may instruct electrical engineering individual studies courses. Courses not in electrical engineering require approval of the research supervisor. Special topics courses from the Department of Computer Science and

Engineering (CSE 597_) and the undergraduate individual study course (EE 496) will not count toward program credit requirements. A Ph.D. student with graduate credits from other institutions may request the approval of the graduate program coordinator to count related technical course credits toward the Ph.D. credit requirement. A maximum of 24 such credits may be counted. Students with MS Degrees entering the Ph.D. program will be required to take a minimum of 15 course credits, with no 596 credits counting toward this total, with at most 3 credits at the 400 level, and with at most 6 credits outside of EE. EE 596 taken as entrance to PhD candidacy cannot be counted toward the PhD course requirements.

A. Advisor and Committee

The chairperson of the student's general area committee will select an interim (temporary) academic advisor at the beginning of the first semester. Each student is encouraged to visit members of the graduate faculty during the first semester and strive to complete a Graduate Student/Faculty Advisor Agreement Form by the end of the first semester. These visits will assist in the selection of the research advisor and help identify potential committee members. The advisor is expected to be the research supervisor when the student is supported as a research assistant. The student should select his/her research advisor no later than the end of the second semester after admission as a Ph.D. student and should form a doctoral committee no later than the end of the semester after the student has completed admission to candidacy procedures. The committee will consist of at least three members of the Department of Electrical Engineering graduate faculty and one non-electrical engineering graduate faculty member. At least two members must be tenured/tenure-track in the Department of Electrical Engineering. The chairperson or one co-chairperson of the committee must be a Department of Electrical Engineering graduate faculty member and have a tenured/tenure-track appointment or joint appointment in the Department of Electrical Engineering. Either the chairperson or one of the co-chairpersons will normally be the primary research supervisor. In addition to the chairperson, at least two members of the doctoral committee should have a specific interest in the dissertation or in a closely related area. Additional graduate faculty and/or special members (as defined in the Graduate Degree Programs Bulletin and approved by the Dean of The Graduate School) may be appointed to the committee. The committee must be recommended by the Department and appointed by the Dean of The Graduate School. The student must request the appointment of the committee through the graduate program staff assistant. If a student wishes to change his/her advisor to a new advisor, a written notification must be submitted to the

department head. This petition must be reviewed and approved by the new advisor.

B. Admission to Candidacy

Admission as a Ph.D. student does not imply admission to candidacy, which is granted only by the Graduate Committee after the student completes all the admission to candidacy procedures. The decision for or against candidacy is reported to The Graduate School. Positive recommendations are entered on the transcript but failures are not recorded.

1. Eligibility

Only registered Ph.D. students with a GPA of at least 3.0 are eligible for admission to candidacy. A student must complete all admission to candidacy procedures **no later than the beginning of the fourth semester** (excluding summer) after entry to the Ph.D. program.

2. Procedures

Each student in the Ph.D. program is required to complete the following components of the EE entrance to candidacy process:

- Successful completion of the designated core courses in their primary and secondary areas of specialization (a grade of B or better is expected) - the area table is in Section II-D of this booklet.
- Successful completion of 3 credits of EE 596 research immersion course (a grade of B or better is expected).
- Written or oral candidacy exam in the primary area of specialization.

Please note: the majority of core courses are offered fall semester only.

Each student in the Ph.D. program is required to complete a candidacy exam in his/her primary specialization area. The purpose of the candidacy examination is to assess whether the student is capable of conducting doctoral research based on evidence of critical thinking or other measures that the Electrical Engineering Graduate Faculty view as important to a successful doctoral student. The format of the exam is determined by faculty members responsible for the primary core course in the

specialization area chosen by the student. This may be a written exam, an oral exam, or a combination of the two. Each student must submit a candidacy exam registration form to the EE graduate program staff assistant at least two months prior to the scheduled date of the exam, and no later than the end of the second semester in the Ph.D. program.

A written candidacy exam will be composed of 6 questions from the student's primary specialization area (Area Table, First Column). Students will be required to answer 5 of 6 questions. The questions will be based on fundamental material found in the core course and the respective prerequisite courses for the student's primary specialization area (Area Table, Column 2). The exam duration will be four hours. No books or notes will be allowed unless indicated otherwise. Students should bring pens or pencils, erasers, and calculators, but no paper. Each problem will be scored from 0 to 10 with 7 being the minimum passing grade.

An oral candidacy exam will be administered by a committee of at least three tenured or tenure-track faculty members in the department, including the student's adviser. The student will be informed about the specifics of the oral exam format no later than one month prior to the exam. The questions during the exam will be based on fundamental material found in the core course and the respective prerequisite courses for the student's primary specialization area (Area Table, Column 2). At the completion of the exam each committee member will submit a score from 0 to 10, with 7 being the minimum passing grade, reflecting the student's performance during the exam.

A student may review his/her written test or discuss his/her performance during the oral exam with the candidacy exam coordinator. No student is permitted to personally contact the faculty members who graded the exam questions or served on the oral exam committee. If a student wishes to dispute the outcome of an exam, he/she must submit a written petition to the candidacy exam coordinator, who will then contact the student after the re-evaluation is completed.

The written and/or oral examinations will be scheduled for the 2nd week of classes during the Fall and Spring semesters.

The graduate committee will consider the two core course grades, the EE 596 research immersion course grade and the candidacy exam score in making the decision regarding admission to Ph.D. candidacy.

Students who do not pass the written or the oral candidacy exam may take it again the next time it is offered. Students who are unsuccessful in their second attempt will be disqualified from the Ph.D. program in EE.

3. Appeals

The graduate committee will consider student petitions giving special attention to inputs from the student's area faculty and research adviser. The primary criteria that the graduate committee will consider will be based on evidence of quality of accomplished research and potential for future research. This evidence should include statements by at least one and preferably two EE professors commenting on past and expected research, as well as a list of papers published or accepted for publication in refereed journals or conferences. The primary evidence can be strengthened by a statement of willingness of a faculty member to provide supervision and financial support for the candidate's research. The graduate committee will also consider GPA, EE research immersion and core course grades, written and oral exam scores and improvement in performance from the previous exam. Proximity to the pass threshold is not by itself sufficient grounds for reversing a decision.

C. Communication and Language Competence

The Ph.D. student shall demonstrate competence in the use of the English language for purposes of both written and oral communication. He/she should be able to communicate technical material in a clear, concise, and well-organized manner. The research advisor or the doctoral committee may require that the student take formal courses in technical writing, speech, etc., if it is determined that the communication skills are inadequate. There will be various communication experiences throughout the program, starting at the beginning of the first semester at Penn State.

1. Writing Requirements

PhD students who have been admitted to PhD candidacy must take a test of written English. This test is given during the last month of the spring semester every year and is scheduled by the EE Department. Non-native English speakers who have successfully completed ESL 116G or native English speakers who have successfully completed a technical writing course (e.g., ENGL 202C at Penn State) will be exempt from this test. Students who fail the test will be required to take ESL 116G.

Students are expected to gain further writing experience by preparing research reports, conference papers and refereed journal articles as they report on their original findings before their final defense. The doctoral committee is expected to review and critically evaluate any of the student's written work, including the dissertation proposal, interim reports and manuscripts.

The dissertation is to meet the standards set forth by The Graduate School and is to be evaluated by the doctoral committee for the quality of the writing as well as technical content. At the beginning of the research, each student should obtain a "Thesis Guide" from the Thesis Office web page at <http://forms.gradsch.psu.edu/thesis/thesisguide.pdf>. Thus, the written or graphical materials generated from time to time can be in the format acceptable to The Graduate School.

2. Oral and Presentation Requirements

All international PhD students will be interviewed at the beginning of their study for evaluation of oral English skills. Those who have deficiencies will be required to take ESL (English as a second language) courses during their first year (preferably their first semester). Those who score at least 220/300 on the Penn State American English Oral Proficiency Test will not be required to take ESL courses for oral English. However, students who would like to be considered for teaching assistantship positions must score at least 250/300 in the test or successfully complete ESL 118G.. During the first year, students whose first language is not English must demonstrate speaking and listening skills.

Presentation skills of all PhD students will be evaluated after formal completion of all procedures required for admission to PhD candidacy. Each student will make a 15 to 20 minute presentation on a technical topic to a group of students and faculty including their research advisor. This presentation will be coordinated by the research advisor and should take place no later than the first semester after passing the candidacy exam. Students found to have deficiencies in presentation skills will be required to take a course to develop these skills.

The student will make an oral presentation of approximately 30-minutes in length to the doctoral committee on the dissertation problem and the approach to its solution. This thesis proposal presentation is a part of the comprehensive exam.

The student is encouraged to travel to conferences to make oral presentations of his/her work.

In addition, an oral presentation on the results of the dissertation research is required. This presentation will be a part of the final dissertation defense.

D. Comprehensive Exam

The Ph.D. candidate will take the comprehensive exam following completion of a major portion of the course work and submission of the Ph.D. proposal to his/her committee members. The student will be responsible for determining a time for the exam that is acceptable to the committee. The student will then notify the graduate program staff assistant. The graduate program coordinator will request that the dean of The Graduate School schedule the exam. The exam must be scheduled **at least three weeks prior to the exam date**. The dissertation proposal must also be submitted to the doctoral committee at that time (as each committee member prefers, either as pdf attachment to email or as a hard copy). **The exam may be canceled if documents are not delivered to committee members at least three weeks prior to the exam date.**

A **thesis proposal** is required for the **comprehensive exam**. Though the nature of this proposal is under the jurisdiction of the doctoral committee, it is recommended that it should be prepared by adhering to the guidelines provided for research proposals submitted to such agencies as the National Science Foundation. That would require **limiting the size of the main body of the proposal to the equivalent of fifteen single-spaced pages of text**. This proposal should contain, as a minimum, the background and motivation for the research being undertaken, the specific problems to be tackled, and the approach as well as methods to be adopted for attempting the solution together with a summary of any preliminary results. Any additional material that does not belong to the core of the proposal, but provides either justification of the proposed scheme or documentation of preliminary efforts, could be included in an appendix.

All members of the committee must participate in the comprehensive exam. One committee member may participate by telephone in special circumstances. Permission for telephone participation must be obtained from The Graduate School prior to the exam date. The student and at least three members (including the chair) must be physically present at the exam.

The graduate program coordinator will submit this request for scheduling the comprehensive exam when:

- the committee has been appointed;
- the committee members have approved the date;
- all conditions stipulated after the candidacy exam have been met;
- any required English courses have been completed.

The comprehensive exam will consist of three parts:

- the oral presentation of the thesis proposal (including a discussion of the importance of the problem and the current state-of-the-art in related areas);
- the oral examination by the doctoral committee which will seek to determine the student's qualifications to pursue the proposed dissertation research, i.e., the preparation in the appropriate specialized and related areas, and the student's general background and knowledge;
- the committee's verbal evaluation of the student's progress and recommendations for any additional course work and research.

Upon completion of the comprehensive examination, the chairperson of the student's doctoral committee will report the result to the graduate program coordinator who will forward it to the dean of The Graduate School. The Graduate School requires a favorable vote of at least two-thirds of the committee for passing this examination.

Students who have passed the comprehensive exam and who have met the residency requirement may register for EE 601 in subsequent semesters. This is an inexpensive way to register as a full time student. Such a student may take 3 additional credits with reduced tuition or 3 additional credits for audit with no extra charge.

E. Final Oral Exam

The final oral exam must be completed within 8 years of admission to candidacy and within 6 years of passing the comprehensive exam. A minimum

of five months must have elapsed since the comprehensive exam. **The student's advisor must sign the thesis approval form before the thesis may be distributed to the other committee members. At least three weeks before the exam date,** the student will distribute copies of the thesis (either as a pdf email attachment or a hard copy, depending on committee member's preference) to the committee members and submit the request to schedule the final oral exam to the graduate program staff assistant. **The exam may be canceled if documents are not delivered to committee members at least three weeks prior to the exam date.** Before forwarding this request to the dean of The Graduate School, the graduate program coordinator will require that the student has either completed or registered for all necessary course work.

The dean of The Graduate School then notifies the members of the doctoral committee and the student by letter regarding the time and place of the examination. This examination, open to the public, relates in large measure to the dissertation but may cover the entire field of study. The doctoral committee determines the exact examination procedure. **All members of the committee must participate in the final oral exam.** One committee member may participate by telephone in special circumstances. Permission for telephone participation must be obtained from The Graduate School prior to the exam date. The student and at least three members (including the chair) must be physically present at the exam. The results of the examination are reported to the graduate program coordinator and the dean of The Graduate School. A favorable vote of at least two-thirds of the members of the committee is required for passing. If the student fails, it is the responsibility of the doctoral committee to determine whether or not another examination may be taken. The approval of the dissertation rests entirely with the doctoral committee and the department head.

Final oral exams and dissertation submissions must meet The Graduate School's published deadlines for graduation at the end of that semester or summer session.

F. Other Constraints

To be eligible for the candidacy, comprehensive, and final oral exams, a student must have a minimum grade point average of 3.0, must be registered, must have no missing or deferred grades, and must have satisfied any provisional requirements for admission.

Over some twelve-month period, while enrolled in the Ph.D. program, the student must be registered for **full-time** academic work at the University Park campus for at least two consecutive semesters (excluding summer).

After passing the comprehensive exam, a student must maintain continuous registration for each fall and spring semester until the Ph.D. dissertation is accepted. Students who fail to register are subject to retroactive tuition assessments.

G. Ph.D. Time Limits

Area Selection

The primary and secondary specialization areas for the Ph.D. candidacy exam must be declared in writing by submitting the Candidacy Exam Registration Form to the Graduate Program Office no later than the end of the second semester after admission into the Ph.D. program. The specialization areas may not have the same core course.

Admission to Candidacy

A student must complete all admission to candidacy procedures **no later than the beginning of the fourth semester** (excluding summer) after entry to the Ph.D. program. Each student must submit a candidacy exam registration form to the EE graduate program office at least two months prior to the scheduled date of the exam, and no later than the end of the second semester in the Ph.D. program.

Committee Appointment

After admission to candidacy, a student's Ph.D. committee must be appointed no later than the end of the following semester (excluding summer).

Comprehensive Exam

The comprehensive exam may be scheduled only after the student has completed most of the required course work (i.e. 3 credits remaining), received English proficiency certification, and satisfied all conditions stipulated during the test of English proficiency and presentation skills. (The dissertation proposal must be provided to the members of the Ph.D. committee and the comprehensive exam must be scheduled with the graduate program staff assistant **at least three weeks** prior to the exam date.)

E E 601

Registration for E E 601 is permitted only for semesters following the semester in which the student has passed the comprehensive exam **and** met

the residency requirement. A student may register for E E 601 (full time dissertation research, zero credits) to maintain the required continuous registration between the comprehensive and final oral exams at reduced tuition.

Final Oral Exam

The final oral exam must be scheduled no less than 5 months or no more than 6 years after passing the comprehensive exam. (The thesis must be provided to the members of the Ph.D. committee and the final exam must be scheduled with the graduate program staff assistant **at least three weeks** prior to the exam date.)

Program Time Limit

A doctoral student must complete the program and submit an accepted thesis **within eight years** of passing the candidacy exam.

V. POLICIES FOR GRADUATE ASSISTANTS

Graduate assistant policies from several sources are summarized here for easy reference. Some of the relevant sources that will take precedence if this summary is found to be unclear are the Graduate Degree Programs Bulletin and University Policy PR-6.

A. General Policies

1. Types of Appointments

Appointments may be for 1/4 time, 1/2 time, or 3/4 time on a full-time basis of 40 hours per week. Thus, the typical half-time appointment requires 20 hours per week. The pay rates may vary depending on the nature of the job and the student's experience. Students with half-time appointments pay no tuition and must take from 9 to 12 credits per semester or 4 to 6 credits in the summer during the period of employment. All appointments automatically terminate at the end of the spring semester, if not before, and appointments carry no guarantee of renewal. Students who have had appointments for both the preceding fall and spring semesters are eligible to apply for summer tuition assistance if the assistantship is not renewed for the summer.

Appointments may be for a variety of duties generally classified as research (RA) or teaching (TA). Teaching appointments will be supported by internal funds. Research appointments may be supported by either internal funds or externally funded research. The latter is more common. Some appointments may be supported by two sources of funds in which case the service is to be split in proportion to the funds from each source.

A graduate assistant is not eligible for other forms of employment such as part-time hourly wage payroll, either within or outside of Penn State, unless approval is obtained from those supplying the assistantship, the graduate program coordinator, and the college dean. However, a graduate assistant is allowed to receive fellowship funds in addition to the assistantship.

A graduate assistant may deviate from the prescribed course loads (if given permission from the source of funds, the graduate program coordinator, and the dean of The Graduate School) only to the extent that one heavy semester is balanced by another that is light.

2. Periods of Service

Unless specified otherwise, a semester appointment requires 18 weeks of service and a summer appointment requires 12 weeks. A full year's appointment will then be 48 weeks. It is notable that class is in session for a total of only 44 weeks including exam periods. Research assistants work independently of the academic calendar, more or less, while the responsibilities of teaching assistants are concentrated during the weeks when class is in session. Teaching assistants may have pre-class preparation as well.

3. Health Insurance

All graduate assistants must have health insurance. A person may choose to purchase insurance separately and provide timely evidence that the policy meets Penn State standards. Otherwise a student is automatically enrolled in a group health insurance policy and in a vision care policy and dental insurance plan for graduate assistants and pays 20% of the premium. When requested, health insurance and dental and vision care insurance for the student's eligible dependents may be included and the student pays 30% of the premium for dependent coverage. Because the details are too numerous to be repeated here,

the student should go to 302 Student Health Center Building or call 814-865-7467 for information.

4. Pay Periods

Stipends are delivered electronically near the end of the month to the student's local bank account five times each semester and twice during the summer. A new arrival will not receive the first paycheck on time unless prior processing of the appointment has occurred.

5. Applicability of Assistantship to Degree Requirements

No student is required to have an assistantship as a part of degree requirements, but the official who appoints the assistant may direct that all or a portion of the work will be devoted toward meeting degree requirements. For example, a teaching assistant seldom devotes 18 weeks at 20 hours per week to assigned teaching responsibilities, but usually more than that amount of time to assigned teaching plus degree-related research. In part, most assistantships can be considered to support study as well as to require service.

6. Supervision and Evaluation

Each graduate assistant is assigned to a supervisor, usually a faculty member, who has the responsibility to specify the requirements of the position, to oversee the assistant's work on some regular schedule, and to evaluate the assistant's work, dependability, and readiness to move to higher levels of responsibility.

7. State and Local Tax Deductions

The University will not withhold state and local tax from assistantship stipends when a student is only performing services that are required of all degree candidates in his or her program.

B. Teaching Assistant Policies

1. Preparation and Training

Electrical Engineering has a positive history of teaching assistant performance in various capacities including classroom instruction.

Student complaints about teaching assistants are not frequent and some have achieved unusually high student ratings for their services. We are careful in our selection of persons to serve and we strongly advocate preparation and training for specific jobs. Both supervisors and teaching assistants are responsible for ensuring that teaching assistants are properly prepared for their assignments.

During the first semester, a new teaching assistant should enroll in ENGR 888. This is a one-credit course that provides teaching assistants with the opportunity to learn some pedagogy and to discuss problems that arise in the classroom. In this course, teaching assistants can present talks relevant to their assignments and receive feedback from other assistants who are in similar situations.

Teaching assistants should expect to have meetings with their immediate supervisors prior to the start of the semester, and often during the semester. At the beginning, the teaching assistants should receive a course syllabus, a text, any information to be distributed to students, and specific details about their assignments. Teaching assistants and supervisors are to discuss the instructional goals and objectives of the course and the means to accomplish them. Periodically, meetings should be held to emphasize the purposes of a particular lab or project and how it should be evaluated. Teaching assistants should expect to attend course lectures, especially the first time assigned to a course, to be aware of the instructor's emphasis and expectations of the students.

State law requires teaching assistants whose native language is not English to pass a test of their ability to converse in English (AEOCPT). This department appoints only those who have already passed the test that is administered by Penn State's Department of Applied Linguistics.

2. Responsibilities

Teaching assistants may expect a wide variety of assignments including the following: grading homework, projects, and exams; preparing assignments; preparing solutions for posting or distribution; maintaining office hours and holding help sessions; substituting as lecturers when faculty members are out of town; helping to administer exams including evening exams and exams in courses other than the primary assigned course; preparing and setting up

demonstrations; processing grade data and, in some cases, assigning grades. Teaching assistants are advised to keep a daily log of time devoted to the job and how it divides among various tasks.

Teaching assistants should not be asked to do the following: choose textbooks; prepare a syllabus; lecture regularly; teach a new course; help with a professor's work that is unrelated to the course; or meet with a supervisor outside of the hours from 8:00 a.m. - 5:30 p.m. except for formally scheduled exams.

3. Absences

From time to time, teaching assistants must be absent from an assigned job, yet clearly an unmet class represents a major lapse in responsibility and it creates a very poor image of the Department among the student clientele. In case of illness or planned absences such as professional trips, teaching assistants should notify the supervisor at the first knowledge of such absence and work with the supervisor to have the responsibilities covered. It is common for two individuals, students or faculty, to arrange mutual exchanges of responsibilities from time to time to allow for such personal needs. Any emergencies or extended changes should come to the attention of the department head who may need to reassign jobs.

4. Evaluations

During the first week of the semester, the teaching assistant and supervisor should meet to assure that start-up details have been completed. Late in the semester, any teaching assistant who has had contact with students will have an SRTE (Student Rating of Teaching Effectiveness) evaluation. Additional information and evaluation guidelines are available from the Schreyer Institute for Teaching Excellence or on their web page at www.schreyerinstitute.psu.edu.

C. Research Assistant Policies

1. The Research Assistant Appointment and Thesis Preparation

Because a research assistant appointment is normally accompanied by the preparation of a graduate thesis, the research supervisor is usually the thesis supervisor and will have much to say about related course work and other aspects of the research assistant's

preparation. The dual aspects of the appointment cannot be separated. Likewise, the evaluation of the research assistant cannot be separated from the evaluation of the thesis preparation. All that can be asked is that the combination of research appointment and the registration for thesis credits represents a realistic workload, especially in light of other course work the research assistant may be carrying.

2. Work Hours

The nature of the work may well require that hours be spent outside of the normal 8:00 a.m. - 5:30 p.m., Monday-Friday schedule. An obvious example is lidar work that must be conducted at night. Lab tests or experiments may require continuous supervision for an extended period of time. Those who accept research assistant positions do so understanding that unusual hours may be expected. No graduate student, research assistant or otherwise, should expect to be placed in a situation of personal danger by being asked to work alone in a laboratory with a hazardous environment or by being asked to work in an environment where that person might be exposed to harassment or assault from fellow workers or strangers. Supervisors are to be sensitive to such issues and to arrange work schedules to provide necessary safeguards for all individuals involved in the work. Concerns should be brought to the supervisor's attention immediately and to the department head if not promptly resolved.

3. Responsibilities

Research assistants may be expected to do any of the following: maintain hardware or software; clean equipment and work-spaces (but not provide janitorial services); follow prescribed lab and safety procedures; prepare proposals; prepare reports and related graphics; collect and process data; interact with sponsors and vendors; and attend meetings and seminars. Research assistants should not be expected to travel without advances and reimbursement for expenses, to lecture for the supervisor, except for occasional substitutions, or to provide services unrelated to University business, such as consulting or moving household furniture.

VI. Electrical Engineering Department Graduate Faculty

Graduate Faculty who are Tenured or Tenure Track in the Department of Electrical Engineering

Aydin, Kultegin	129 E E East	863-2788
Breakall, James K	225 E E East	865-2228
Datta, Suman	N231 MSC Bldg	865-0519
Doherty, John F	227B E E West	863-8102
Giebink, N. Christopher	209H E E West	865-2229
Gupta, Sumeet	111K E E West	867-4776
Higgins, William E	209F E E West	865-0186
Jackson, Thomas N	216 E E West	863-8570
Jenkins, W. Kenneth	209C E E West	863-1263
Kane, Timothy J	212 E E East	863-8727
Kavehrad, Mohsen	229 E E West	865-7179
Khoo, lam-Choon	216 E E East	863-2299
Lagoa, Constantino	205 E E West	865-0244
Liu, Zhiwen	N211 MSC Bldg	865-2362
Mathews, John D	323A E E East	865-2354
Mayer, Jeffrey S	209G E E West	865-0242
Mayer, Theresa S	N229 MSC	863-8458
Miller, David J	227C E E West	865-6510
Mirzaei, Ahmad	230 E E West	867-4774
Mitchell, John D	330 E E East	865-2359
Mitra, Raj	319 E E East	865-1298
Monga, Vishal	111J E E West	863-1267
Narayanan, Ram	202 E E East	863-2602
Pasko, Victor	211B E E East	865-3467
Ruzyllo, Jerzy	214 E E West	865-5193
Schiano, Jeffrey L	227D E E West	865-5422
Tadigadapa, Srinivas	N237 MSC Bldg	865-2730
Uchino, Kenji	134 MRL	863-8035
Urbina, Julio	315 E E East	865-5326
Werner, Douglas H	211A E E East	863-2946
Yener, Aylin	228A E E West	865-4337
Yin, Shizhuo	217 E E East	863-4256
Zhang, Qiming	N219 MSC	863-8994
Zhu, Minghui	227E E E West	865-5315

Electrical Engineering Graduate Faculty with Joint Appointments

Bilén, Sven	213N Hammond /313 E E East	863-1526/8684
Kesidis, George	338J IST Bldg.	865-9190
Liu, Yanxi	338B IST Bldg.	865-7495
Metzner, John J	346J IST Bldg.	863-1264

Electrical Engineering Graduate Faculty from other Departments and Colleges

Awadelkarim, Osama O	212 Earth & Eng. Sciences	863-1773
Coraor, Lee D	360G IST Bldg.	865-1265
Das, Chitaranjan	354F IST Bldg.	865-0194
Hall, David L.	316B IST Bldg.	867-2154
Irwin, Mary Jane	348C IST Bldg.	865-1802
LaPorta, Thomas	360B IST Bldg.	865-6725
Mohney, Suzanne	202A Steidle	863-0744
Narayanan, Vijaykrishnan	354D IST Bldg.	863-0392
Phoha, Shashi	228 ARL	863-8005
Piovosio, Michael J.	Great Valley Campus	610-648-3200
Ray, Asok	329 Reber Bldg.	865-6377
Redwing, Joan	108 Steidle	865-8665
Russell, David W.	Great Valley Campus	610-648-3233
Tutwiler, Richard L	165 ARL	863-2188
Werner, Pingjuan L	2 Hiller Bldg. DuBois Campus	375-4785
Young, Randy K	165 ARL Bldg.	865-1493

Adjunct Electrical Engineering Graduate Faculty

Goldberg, Richard	Meisel, David	Nickel, Robert
Xu, Jian		

Retired Electrical Engineering Graduate Faculty

Adams, William S	Carpenter, Lynn A.	Croskey, Charles
L.Cross, Leslie E	Burton, Larry C.	Das, Mukunda
Ferraro, Anthony J	Grimes, Dale	Kurtz, Stewart
Leubbers, Raymond	Nisbet, John	Philbrick, C. Russell
Robinson, James	Ross, Willam J	Wronski, Christopher
Yu, Francis T S		

VII.

Graduate Program Contact Information

SherryDawn Jackson, Graduate Program Staff Assistant, 118 E E East, 863 - 7294

Lisa Timko, Graduate Admissions Staff Assistant, 121 E E East, 863 - 7295

VIII. GRADUATION CHECKLIST FOR M.S.E.E. STUDENTS (BEGINNING FALL 2007or LATER)

_____ THESIS - 6 CREDITS OF E E 600 OR _____ PAPER - 2 CREDITS OF 594 _____ COLLOQUIUM - 2 CREDITS

NAME _____		ID. NUMBER _____	
COMMUNICATIONS, COMPUTERS, NETWORKING, AND SIGNAL PROCESSING	CONTROL AND POWER SYSTEMS	ELECTROMAGNETICS AND OPTICS	ELECTRONICS AND PHOTONICS
CSE 514	E E 580	E E 520	E E 510
CSE 543	E E 581	E E 521	E E 526
CSE 572	E E 582	E E 522	E E 541
CSE 577	E E 584/M E 558	E E 524	E E 542
CSE 578	E E 587/M E 559	E E 531	E E 543
E E 550/M E 550	E E 588	E E 534	E E 544
E E 551		E E 535	E E 545/MATSE 545
E E 552/CSE 583		E E 537	E E 546
E E 553		E E 538	E E 547
E E 554/CSE 586		E E 573	E E 549
E E 555/CSE 585		E E 574	
E E 556		E E 576	
E E 557		E E 579	
E E 560			
E E 561			
E E 562			
E E 564/CSE 554			
E E 565/CSE 515			
E E 567			
E E 568			
E E 569			
Courses listed above may be used for the breadth area requirement.			
EE 597(X) courses must approved by the Graduate Program Committee (by petition to the Committee) prior to scheduling to be used to satisfy the breadth requirement.			
List EE 597 courses:			
list 400 level EE courses (maximum 9 credits, 496 not counted)	list EE 596 course(s) (maximum 3 credits)	List external university transferred credits	related 400 & 500-level (no 496 or 596) non-EE courses (advisor approval required)
M.S. THESIS OPTION	32 credits (24 course credits, 6 thesis research credits, and 2 colloquium credits)	500-level minimum 15 course credits	Thesis Defense
M.S. PAPER OPTION	34 credits (30 course credits, 2 paper research credits, and 2 colloquium credits)	500-level minimum 21 course credits	Paper Presentation
ALL M.S. STUDENTS	50% of the required course credits must be <u>Electrical Engineering Department</u> courses (excluding colloquium and research)	For the breadth requirement, a 500-level course from at least two of the four areas listed above must be successfully completed.	Time Limit M.S. 6 years