Electrical Engineering (EE)
MS and Ph.D. Policies and Procedures

1 Introduction

Electrical Engineering is the study and application of electricity, and started with the design of commercial electrical power systems. It now covers a range of topics, including telecommunications, chip design, control systems, and signal processing.

Our Electrical Engineering (EE) education program is very specialized. Our mission is to train electrical engineers in the area of speech and language processing, machine learning, and biomedical applications. We offer a Ph.D. and Masters degrees. The Masters degree is thesis-based, which combines some course work with research on some topic under the supervision of one of the professors in the program.

2 EE versus CSE

The EE education program is tightly integrated with the CSE education program. This is because our areas of focus span these two disciplines. Some of our work falls entirely within one of the domains. For example, our work on language processing, using symbolic reasoning, falls within the domain of CSE, while our work on signal processing falls within EE. But some of our work, such as machine learning, speech signal processing, and using statistical techniques for language processing, falls within the intersection of CSE and EE. Similarly, some of the courses we offer are listed as CSE, some as EE, and some count for both disciplines.

Students who are interested in the Ph.D. or Masters thesis option will need to select either EE or CSE on applying to the program. (The Masters non-thesis option is only available for CSE.) Students should select the program that is most closely aligned with their research interests and their education background. For students whose interest is at the intersection of the two disciplines, this choice will be somewhat arbitrary.

3 About this Document

This document supplements the rules and guidelines of Graduate Studies in the School of Medicine. Most of these rules and guidelines are in the *By-Laws of Graduate Council*. In particular, these rules and regulations specify:

- general admission requirements: TOEFL, GRE scores

- degree requirements: number of credits to graduate, course grade requirements, overall GPA requirement, number of full-time in-residence terms, etc.

- time-line: maximum time to advancement to candidacy, maximum time to complete degree

- good standing: reasons for dismissal from program, procedures for dismissal

- stipends

This document also supplements the degree checklists, which list course requirements and number of credits to graduate.

4 Course work

4.1 Masters Non-Thesis Option

Students will not be admitted directly into the EE Masters non-thesis option. This option is only available for students who are admitted into the Masters Thesis Option or the Ph.D. program, but do not make satisfactory progress on their research, while making satisfactory progress in their courses.

Masters students in the non-thesis option must take 45 credits of courses.

They must take the 6 courses listed below. Students who have taken an equivalent course elsewhere can request to be waived out of this requirement by the course owner.

- MATH530 Probability & Statistics for Scientists and Engineers,
- EE555 Analyzing Sequences,
- EE658 Speech Signal Processing,
- CS562 Natural Language Processing,
- EE552 Automatic Speech Recognition,
- EE559 Machine Learning

Students must have 18 credits of courses in EE, including the courses from the above list. This can include up to six credits of research in EE.

Students must have at least 33 credits of course in EE or CS, including the courses counted above. MATH530 can also be used to fulfill this requirement.

The remaining 12 credits can be from EE and CS, or can be electives from outside of EE and CS. Students must fulfill the ethics requirements, for which they can use CONJ 650, which will be counted as an elective. If students take Scholarship Skills, this will also be counted as an elective. Any other courses outside of EE and CS require the permission of the student's advisory committee.

Students will determine what courses they take in consultation with their advisory committee. Courses will be chosen so as to give the student a solid understanding of EE, as well as specialized knowledge in speech and language processing, machine learning, and/or applying this to biomedical problems.

4.2 Masters Thesis Option

The course requirements for the Masters Thesis Option is similar to the Non-Thesis Option. The difference is students must include exactly 12 credits of research in EE. These 12 credits will count as part of the 18 credits in EE. It is expected that some students will take additional research credits, giving them more than 45 credits in total.

4.3 Ph.D. Students

Applicants to the Ph.D. program do not need to have a Masters degree. Students who have a Masters degree in a related field[1] will have fewer required courses, allowing them to spend more time on research upon matriculation into the program. They must complete at least three EE courses, as well as Scholarship skills, which satisfies the ethics requirement of Graduate Studies. The student's Advisory Committee will determine which three courses the student should take, both to increase the breadth of knowledge of the student, and so the student has the appropriate knowledge for their research topic. The advisory committee can also specify additional courses. For students who graduated with their Masters in EE or CSE from this program, their advisory committee can decide to waive the three course requirement. If the student took Scholarship Skills as part of their Masters, this requirement can also be waived.

Ph.D. students without a Masters in a related field must do the course work requirements of the Masters thesis option, as described above.

4.4 Available Courses

The education program will offer at least 9 courses per year, typically three courses in fall, winter and spring. Table 4.4 lists the courses that will be offered on a regular basis. Special topic courses will also be offered, which will count as core courses.

Students can also take independent study or research credits with a professor. With approval of their Advisory Committee, students can also take courses from other departments in the School of Medicine, including conjoined courses. These will count as electives.[2] Also with approval of their Advisory Committee, students can take courses at PSU to increase their breadth in EE (and CSE). The Advisory Committee will recommend whether the course will count as a core course or an elective.

5 Roles

5.1 Program Faculty

The program faculty are members of the Graduate Faculty of the School of Medicine who teach EE or CSE courses or advise students in the EE or CSE education program. They will typically have a degree in EE or CSE, or a closely

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[1]The Education Program Committee will decide whether a student's Masters degree is in a *related field* at time of admission.

[2]The BME course on Signals and Linear Systems can be counted as an EE course.

Machine Learning			
MATH530/630	**Probability & Statistics**	Every year	
EE555/655	**Analyzing Sequences**†	Every year	
EE559/659	**Machine Learning**†	Every year	
CS560/CS660	Artificial Intelligence	Every two years	
Speech Processing			
EE658	**Speech Signal Processing**‡	Every year	
EE552/652	**Automatic Speech Recognition**†	Every year	
EE553/653	Speech Synthesis	Every four years	
EE584/684	Introduction to Image Processing	Every four years	
Language Processing			
CS562/662	**Natural Language Processing**	**Every year**	
CS550/650	Dialogue	Every two years	
CS506/606	Information Retrieval	Every four years	
CS506/606	Linguistic Analysis	Every four years	
Computer Science			
CS533/633	Automata and Formal Languages	Every two years	
CS506/606	Problem Solving with Large Clusters	Every two years	
Research			
GEN569/669	Scholarship Skills	Every two years	
CS506/606	Research Programming	Every year	1 credit
EE606/606	Faculty Research	Every year	1 credit
CS568/668	Empirical Research Methods	Every four years	

Notes:

†Analyzing Sequences,, Machine Learning, Automatic Speech Recognition, and Speech Synthesis, are cross-listed as CS courses.

‡The course requirements for Speech Signal Processing for MS and Ph.D. student is the same, so only a 600 level course is being offered.

Courses in bold are required for the MS students and for Ph.D. students who do not have a relevant Master's.

Unless otherwise noted, each course is worth 3 credits.

Table 1: Regular Course Offerings

related field. The duties of the Program Faculty include:

- Teach courses

- Advise Ph.D. stduents

- Serve on advisory committees (Section 6)

- Evaluate students during the Qualifying Exam (Section 9)

- Evaluate students during the annual review of Ph.D. students (Section 7).

- Attend the CSE/EE seminar series

5.2   Education Program Committee

The Education Program Committee will consist of the Program Director, plus two additional program faculty members. The committee is responsible for:

- Education Program. The committee will ensure that our educational program best meets the needs of our students; decide which courses will be taught each year; review instructor performance; and setting forth a plan to rectify any deficiencies.

- Advising. Ensuring that each student is treated in a fair and unbiased way. This will include approving student advisory committees, qualifying exam committees, and oral examination committees.

- Recruitment. The committee will oversee recruitment and admission of the students.

5.3   Program Director

The Program Director will do the following:

- Chair the Education Program Committee.

- Chair the annual meeting to review Ph.D. student progress (Section 7).

- Work with the academic coordinator in overseeing the program. For the Ph.D. program, this includes ensuring that advisory committees are formed and meet twice yearly, annual review of students is held, qualifying exams are held, students advance to candidacy, and oral examinations are held. For Masters students, this includes formation of Advisory Committees and ensuring that they meet twice yearly.

- Monitor each student's progress to help ensure that they will finish in a timely fashion.

- Serve on advisory committees of masters students, first year Ph.D. students, and other Ph.D. students who are having difficulty.

- Schedules courses, both determining what should be offer, and when. This will be done so as to give students the best possible sequencing of courses.

- Ensure that the program meets all requirements of education programs in the School of Medicine.

5.4   Academic Coordinator

The academic coordinator will do the following:

- Assist the Program Director with running the education program.

- Collect information for evaluation of the program, and evaluation of courses.

- Assist students in understanding the program requirements.

- Coordinate with registrar and Graduate Studies about individual students.

6   Advisory Committee

All students are assigned an Advisory Committee when they matriculate in the program.[3] The Advisory Committee will meet at least twice a year, at the beginning of Fall and Spring terms. The role of the Advisory Committee is three-fold:

- Ensure that students get advice from graduate faculty other than their advisor.

- Ensure that several faculty have detailed information about the student's progress for evaluating the student, especially during the annual review of students.

- Overseeing the student-advisor relationship.

A student's Advisory Committee may change over their studies, such as to reflect changes in the student's research interests, or to balance the workload of the Program Faculty. These changes will be minimized so as to ensure continuity. The makeup of the Advisory Committee must be approved by the Education Program Committee, with input from the Program Director and the student's advisor.

Ph.D.and Masters thesis students will prepare a self-report, listing any publications, public talks, awards, and public service, as well as a summary of their research activities.

6.1   Ph.D. Students

The Advisory Committee will initially consist of at least three members, all members of the Graduate Faculty. One member will typically be outside of the student's research area. It is expected that the Program Director will be on the Advisory Committee of all first year Ph.D. students, as well as added to the Advisory Committee of any student who is having difficulties (such as a delay in their Qualifying Exam, are in their 7th year of study, or has switched advisors).

Within 1 year of advancement to candidacy, the composition of the Advisory Committee must conform to the By-laws of the Graduate Council, at which point it is formally referred to as a Dissertation Advisory Committee. At this time, a fourth member must be added, and one member must be outside of the education program. The composition of the committee must also be approved by Graduate Studies.

6.2   Masters Thesis Students

For Masters Thesis students, the Advisory Committee will consist of 2 members of the Program Faculty, one of which will be the Program Director. After the student has identified a research topic (typically after doing one term of research), the composition of the Advisory Committee must conform to the By-laws of the Graduate Council, at which point it is formally referred to as a Thesis Advisory Committee. At this time, a third member will be added. The composition of the committee must also be approved by Graduate Studies.

7   Annual Ph.D. Student Review

At least once a year, the Program Faculty will review the progress of each Ph.D. student. This meeting will be chaired by the Program Director. The purpose of the meeting is to provide oversight over student progress, as well as to give the Program Faculty an opportunity to share best practices in advising students.

For each student, the faculty will decide one of the following:

- The student is making good progress.

- The student is not making adequate progress and is to be recommended for dismissal from the program.

- The student is not making adequate progress and needs to undertake remediative measures within a certain time frame (for example 6 months). At the end of the time frame, the student's Advisory Committee will convene to determine whether these measures have been met, and will notify the Program Director. If the the student fails to meet these measures, the Program Director will convene the Program Faculty to determine what will be done.

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[3]We formerly referred to the Advisory Committee was as the Student Proficiency Committee (SPC).

8 Presentations

All Ph.D. and Masters-thesis students are required to give one public talk on their research in their first year, and at least two presentations all subsequent years while matriculated in the program. The purpose of this is threefold:

- Ensure that students get practice in giving oral presentations of their research.

- Create an opportunity for Program Faculty to give students feedback on their presentation style, as well as on their research.

- Allow all Program Faculty to be aware of each student's progress for evaluating the student, especially for the annual review of students (see Section 7).

The presentations will be given at the CSE/EE seminar series (held weekly). Students must also attend this seminar series. As part of the student's self-report for their Advisory Committee, they will list their CSE/EE seminar talks.

9 Qualifying Examination

The Qualifying Examination is one of the requirements that a Ph.D. student must meet in order to advance to Candidacy.[4] The goal of the Qualifying Exam is to determine whether a student is able to perform independent research, by assessing the quality of research that they have conducted so far. It also ensures that the student has a good understanding of the field, is able to communicate research results in written and oral form, and has a good working relationship with his/her advisor. Although the student is expected to demonstrate that they know how to do research; unlike their final dissertation, the results obtained so far might not be substantial. Students should take Scholarship Skills before taking the Qualifying Exam, as this course will help prepare them.

9.1 Format

The Qualifying Exam consists of a written paper, an oral presentation, and an oral examination. The written paper should be based on research that the student has recently conducted with their advisor, suitable for publication in a peer-reviewed conference. The paper should be approximately 20 double-spaced pages, excluding figures and references. At least 5 pages should be a critical review of related work.

The oral presentation will be a public 30 minute talk of the material in the written paper. The presentation should be geared towards a general CSE and EE audience.

The oral examination will also be public and will immediately follow the oral presentation. It will be at least 30 minutes in length.

9.2 Role of Advisor

It is expected that the advisor has read one version of the written paper, and given the student high-level feedback. In fact, the paper can be based on a conference paper that the student, as first author, has published or submitted to a conference. In this case, the written paper should be an expanded version of the conference paper, including an expanded related work section.

It is also expected that the advisor has seen the slides for the oral presentation, and given the student feedback.

9.3 When

The Qualifying Exam should be completed in the Spring term of the student's second year. A student's Advisory Committee can recommend to the Program Faculty that a student be allowed to delay this; the Program Faculty will decide whether to allow the student to delay by consensus. Note that Graduate Studies requires a student to advance to candidacy within three years. The academic coordinator will choose a time and date for the presentations, around the 7th week of the spring term. The paper is due two weeks beforehand.

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[4]We formerly referred to the Qualifying Exam as the *Research Proficiency Exam*.

9.4   Evaluation

The research paper will be read and evaluated by the student's Advisory Committee as well as a fourth person, who is on the Program Faculty. The fourth member will be chosen by the Education Program Committee. Other Program Faculty may elect to read and evaluate the paper.

All Program Faculty are expected to attend the oral presentation and participate in the oral examination, including the advisor. At a minimum, four faculty members must be present. The Program Faculty will ask questions to the student about the content of the presentation and related science.

The Program Director will moderate the oral presentation and examination. The Program Director will ensure that (a) only clarification questions are asked during the presentation, (b) questions are directed to and answered by the student, and (c) every member of the Program Faculty and Advisory Committee (including the advisor) has a chance to ask questions.

After the oral presentation and examination, the Program Faculty and Advisory Committee will meet in a closed session to decide the outcome based on the written paper, oral presentation, and oral examination.

9.5   Outcomes

The outcome will be decided by consensus of the Program Faculty. The student will be notified of the outcome by the Program Director within one week. Possible outcomes include the following:

Pass: The student passes the qualifying exam.

Conditional Pass: If the student had some deficits in their performance, the Program Faculty may issue a conditional pass. The student will be provided with specific requirements that must be met within a prescribed time frame. A variety of requirements may be assigned by the faculty, including additional coursework, revision of the paper, and/or additional presentations.

The student's advisor will be responsible for notifying the student, the Advisory Committee, and Program Director when the student has successfully completed the requirements on the conditional pass. Failure on the part of the student to complete the requirements within the prescribed time frame will be considered unsatisfactory progress, and the student may be subject to dismissal from the program.

Retake: If the student's performance was not satisfactory, the faculty may allow the student to retake the exam. The student will be provided with a list of deficits in their performance. The faculty will decide when the exam must be retaken, which should be within 6 months. The student must report on new research results. Students will only be allowed to retake the qualifying exam once.

Fail: The student will be failed if the faculty feels that the student is not capable of Ph.D. quality research work. The Program Director will recommend to Graduate Studies that the student be dismissed.

10   Ph.D. Oral Examination

For the Oral Examination, the student will give a public oral presentation of their dissertation work, typically lasting 45 minutes to one hour. This is followed by a public question and answer period. This is then followed by a question-and-answer period, with just the student's Oral Examination Committee. This is then followed by a closed session of just the Oral Examination Committee, in which they determine the outcome.

10.1   Oral Examination Committee

The Oral Examination Committee will be formed according to the rules of Graduate Studies. This will typically consist of adding a member of the Program Faculty to the Thesis Advisory Committee who has *not* been involved with the student's research, such as serving on their Advisory Committee or being on the same research project. The Thesis Advisory Committee will recommend who will serve on the Oral Examination Committee to the Associate Dean of Graduate Studies who will have final approval. Approval from Graduate Studies should be obtained two months prior to the expected Oral Examination.

10.2 Defensible

The Oral Examination committee must be given a final copy of the dissertation. This should occur at least six weeks before the expected oral examination. The committee will have three weeks to read the dissertation and decide whether the dissertation is *defensible*. As stated in the by-laws of Graduate Council, 'The doctoral dissertation ... must show evidence of originality on the part of the candidate in the planning and execution of independent experimental work, and the results must represent a meaningful contribution to knowledge. Doctoral candidates must be the primary contributor to the design of the experiment(s), in the collection, analysis and interpretation of the data, and in the writing of the ... dissertation document.'

It is the responsibility of the advisor to inform the committee members that they need to decide that the dissertation is defensible, and ensure that they comply with the three week time limit.

If all members agree that it is defensible, the committee will notify the academic coordinator, and the student will be allowed to proceed to the oral examination. The members should agree that only minor revisions to the dissertation are required.

If the Oral Examination Committee decides that the dissertation is not defensible, they will provide the student and Program Director a written description of the deficiencies in the dissertation. After the student has rectified these deficits, the Oral Examination Committee will then reconsider whether the dissertation is defensible.

10.3 Oral Examination

It is the responsibility of the advisor to determine a date that all members of the committee and the student can attend that does not conflict with other department events, and that is convenient for most Program Faculty members to attend.

10.4 Outcomes

As specified by Graduate Studies, the Oral Examination Committee will decide whether the oral examination (and dissertation) is satisfactory by a majority vote (with a tie as unsatisfactory). If the committee finds the oral presentation satisfactory, they might still have minor revisions for the student to complete. In this case, the student's advisor will typically be given the task of ensuring these revisions are done, and will withhold his/her signature from the dissertation document until such time. However, these revisions must be completed within 6 months of the defense, along with other administrative requirements from Graduate Studies and the Registrar's office.

The committee can decide that the oral examination was not satisfactory. As required by Graduate Studies, the committee will provide the student, Program Director, and Graduate Studies with a written description of the deficiencies in the examination performance within two weeks of the examination. The Program Director will convene the Program Faculty to determine what will be done, such as allowing the student to retake the Oral Examination.

11 Masters Oral Examination

For the Oral Examination, the student will give an public oral presentation of their thesis work, typically lasting 30 to 45 minutes. This is then followed by a public question and answer period. This is then followed by a question-and-answer period, with just the student's Oral Examination Committee. This is then followed by a closed session of just the Oral Examination Committee, in which they determine the outcome.

11.1 Oral Examination Committee

The Oral Examination Committee will be formed according to the rules of Graduate Studies. It must include three members of the Graduate Faculty. The Thesis Advisory Committee will recommend who will serve on the Oral Examination Committee to the Associate Dean of Graduate Studies who final approval. It is expected that the student's Thesis Advisory Committee will be the Oral Examination Committee. Approval from Graduate Studies should be obtained one month prior to the expected Oral Examination.

11.2 Oral Examination

It is the responsibility of the advisor to determine a date that all members of the committee and the student can attend that does not conflict with other department events, and that is convenient for most Program Faculty members to attend.

11.3 Outcomes

As specified by Graduate Studies, the Oral Examination Committee will decide whether the oral examination (and thesis) is satisfactory by a majority vote (with a tie as unsatisfactory). They will take into account both the oral presentation and the written thesis.

As stated in the by-laws of Graduate Council, 'the Master's thesis ... should be a report written of original scientific work conducted by the student under close supervision of a faculty mentor.' The report must be written by the student, with the literature review and data analyses and interpretation the primary work of the student.

The committee can find the oral examination satisfactory or unsatisfactory by majority vote.

If the committee finds the oral exam satisfactory, they may require minor revisions for the student to complete. In this case, the student's advisor will typically be given the task of ensuring that these revisions are done, and will withhold his/her signature from the dissertation document until such time.

The committee can decide that the oral examination was not satisfactory. As required by Graduate Studies, the committee will provide the student, Program Director, and Graduate Studies with a written description of the deficiencies in the examination performance within one week of the examination. The Program Director will convene the Program Faculty to determine what will be done, such as allowing the student to retake the Oral Examination.

12 Time-Line

In the following sections, typical time-lines for the four types of students are outlined.

12.1 Masters Thesis Student

1st Year	Assigned an advisor and an Advisory Committee on matriculation into the program.
	Take three courses in Fall, Winter, and Spring terms. The courses to be taken will be approved by the Advisory Committee.
	Take Faculty Research in Winter term.
	Attend CSE/EE talks starting in Spring term.
	Decide on a thesis advisor by end of Spring term.
	Do a paid internship during the Summer term.
2nd Year	Fall term: take CONJ650 (Ethics), two 3-credit courses, and 3 credits of research.
	Winter term: take Scholarship Skills, one 3-credit course, and 6 credits of research.
	Take 9 credits of research in Spring term.
	Write thesis and have Oral Examination by end of Spring term.
	Attend CSE/EE talks.

12.2 Ph.D. Student with Relevant Masters

1st Year	Assigned an advisor and an Advisory Committee on matriculation into the program.
	Engage in research work with their advisor starting in their first term.
	Complete at least 3 courses during the first 2 years. The courses to be taken will be decided by the Advisory Committee. The Advisory Committee will also decide whether additional courses must be taken. All required courses must be completed within the student's first 3 years.
	Present one talk about their research work.
	Attend CSE/EE talks.
2nd Year	Engage in research work for their qualifying examination.
	Present one talk about their research work in Fall term.
	Take Scholarship Skills in their second year.
	Take their qualifying examination in the Spring term.
	Attend CSE/EE talks.
3rd Year	Engage in research work towards their dissertation.
	Present two talks about their research work.
	Advance to candidacy by end of third year.
	Attend CSE/EE talks.
Later Years	Engage in research work towards their dissertation.
	Present two talks about their research work.
	Attend CSE/EE talks.

12.3 Ph.D. Students without Relevant Masters

1st Year	Assigned an advisor and an Advisory Committee on matriculation into the program.
	Engage in 6 credits of research work in Fall, Winter and Spring with their advisor, and 12 credits in Summer.
	Complete 2 courses in Fall, Winter and Spring terms. The courses to be taken will be decided by the Advisory Committee.
	Present one talk about their research work.
	Attend CSE/EE talks.
2nd Year	Engage in 6 credits of research work in Fall, Winter and Spring with their advisor, and 12 credits in Summer.
	Complete 2 courses in Fall, Winter and Spring terms. The courses to be taken will be decided by the Advisory Committee. This includes taking Scholarship Skills, typically in year 2.
	Present one talk about their research work in Fall term.
	Take their qualifying examination in the Spring term.
	Attend CSE/EE talks.
3rd Year	Engage in research work towards their dissertation.
	Present two talks about their research work.
	Advance to candidacy by end of third year.
	Attend CSE/EE talks.
Later Years	Engage in research work towards their dissertation.
	Present two talks about their research work.
	Attend CSE/EE talks.