

Graduate Student Handbook for the University of Vermont

Electrical Engineering (EE) Graduate Degree Programs

Applicable to all graduate students
who have not passed their comprehensive exam by December 31, 2011.

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1 Introduction

The Electrical Engineering (a.k.a. Electrical and Computer Engineering) program at the University of Vermont (UVM) offers programs of study leading to the M.Sc. and Ph.D. degrees in Electrical Engineering. In addition the EE program partners with other academic units to offer M.Sc. and Ph.D. degrees in materials science, as well as a M.Sc. degree in Biomedical Engineering. Areas of research expertise in electrical engineering include digital signal processing, control systems, electromagnetics & optics, electric energy systems, solid-state physical electronics, semiconductor materials and devices, wireless communications, VLSI design & testing, and biomedical engineering.

Candidates normally have obtained the Bachelor of Science degree in electrical engineering prior to application for admission, but other applicants are encouraged to consider the program if they have an extensive background in both mathematics and the physical sciences. The general requirements for admission must be met in all cases. A master's degree in electrical engineering or the equivalent is required for admission to graduate studies for the Ph.D. degree. Successful completion of the Ph.D. comprehensive examination is required for advancement to candidacy for the Ph.D. degree.

This guide to the graduate program in Electrical Engineering at the University of Vermont is designed to help each student plan a program of graduate study leading to either, or both, the M.Sc. or Ph.D. degrees in electrical engineering. As such, it is devoted to the policies, rules, and procedures of our graduate program in electrical engineering with the intention of providing a general framework for your graduate studies. Any unanswered questions should be addressed to your faculty advisor, the EE graduate program coordinator, or the Graduate College. Notice that the program requirements for both the M.Sc. and Ph.D. degrees subsume the Graduate College requirements that are described in the Graduate Catalogue. It is the Graduate College that awards each graduate degree so that their rules must either be satisfied or subsumed by program rules. For general information regarding graduate studies at the University of Vermont, see the Graduate College webpage (<http://www.uvm.edu/~gradcoll/>).

2 Electrical Engineering Graduate Program Faculty

The following full-time faculty members advise students pursuing M.Sc. and Ph.D. degrees in Electrical Engineering:

- Professor *Gagan Mirchandani* (*Ph.D., Cornell, 1968*). Signal processing, multiresolution analysis and coding.
- Professor *Kurt Oughstun* (*Ph.D., Rochester, 1978*). Electromagnetic and optical field theory, wave propagation phenomena, and applied mathematics.
- Professor *Walter J. Varhue* (*Ph.D., Virginia, 1984*). Deposition of electronic thin film materials by plasma enhanced chemical vapor deposition (PECVD) and their characterization for microelectronic applications.

- Associate Professor *Stephen Titcomb (Ph.D., Lehigh, 1983)*. Characteristics of low-voltage, low-power solid-state electronic devices and circuits.
- Associate Professor *Jeff Frolik (Ph.D., Michigan, 1995)*. Sensor networks and wireless communications.
- Associate Professor *Tian Xia (Ph.D., Rhode Island, 2003)*. Mixed-signal VLSI design and testing.
- Assistant Professor *Paul Hines (Ph.D. Carnegie Mellon, 2007)*. Electrical energy systems and policy. Complex networks.
- Assistant Professor *Mary Dunlop (Ph.D. California Institute of Technology, 2008)*. Feedback and dynamics in microorganisms with the goal of building programmable gene circuits using biological sensors and devices.

3 Graduate Student Classifications and Admission Requirements

Graduate students in electrical engineering are classified as either Master of Science (M.Sc.) Program Students, Master of Science (M.Sc.) Candidates, Ph.D. Program Students, or Ph.D. Candidates, defined as follows:

- *M.Sc. Program Admission:* Requires an accredited bachelors' degree in engineering, physics, mathematics, computer science, or other appropriate field. Admission into the M.Sc. Program requires that the applicant have an undergraduate grade point average above 3.0 (based on a 4.0 scale), that their EE course grades are strong (B average or better), and that their letters of recommendation are all positive. In borderline cases, specific scholastic requirements may need to be set by the EE Graduate Program Committee.
- *M.Sc. Candidacy:* Requires a bachelors' degree in electrical engineering (or its equivalent) from an accredited institution.
 - A student with a bachelors' degree in either physics, mathematics, computer science, or other engineering area will be considered for candidacy after successful completion of the following undergraduate electrical engineering courses (or their equivalent at either the undergraduate or graduate level): two (2) courses in electronics at the level of EE120-121, two (2) courses in signals and systems at the level of EE171 & EE174, one (1) course in electromagnetic field theory at the level of either EE141 or EE241, one (1) course in computer hardware at the level of either EE231 or EE134, one (1) course in solid state devices at the level of either EE163 or EE261, and the junior laboratory sequence EE183–184.
 - A student with a bachelors' degree in a field other than those stated above will be considered on an individual basis by the EE Graduate Program Committee.

- *Ph.D. Program Admission:* Requires a M.Sc. degree in Electrical Engineering or its equivalent. A graduate student who meets the requirements for candidacy for the M.Sc. degree in Electrical Engineering and has completed twenty-four (24) credit hours of appropriate graduate course work with a B average (3.0 on a 4.0 scale) or better qualifies to apply to the Ph.D. program. An applicant to the Ph.D. program may be admitted provisionally based on a B average or better in twenty-four (24) hours of appropriate graduate coursework toward the M.Sc. in Electrical Engineering.
- *Ph.D. Candidacy:* Requires a M.Sc. degree in Electrical Engineering or the equivalent and the successful completion of the Ph.D. Comprehensive Examination.

4 Requirements for the M.Sc. Degree in Electrical Engineering

The M.Sc. degree in electrical engineering requires, at a minimum, 30 credit hours at the 200 level or higher, including 3 credits to satisfy the EE M.Sc. core requirement consisting of either EE 201 (Linear & Nonlinear System Theory) or EE 270 (Random Variables & Stochastic Processes), and the completion of a comprehensive examination. All courses should be selected in consultation with the student's graduate advisor in order to best prepare the student for their research and/or career objectives.

Students can choose, in consultation with their graduate advisor, between a thesis option, a project option, and a coursework option. Students who are funded with a GTA or a GRA are required to choose between the thesis or project options.

Students are highly encouraged to check frequently with the graduate college for general UVM M.Sc. degree requirements and deadlines.

4.1 M.Sc. Thesis Option

Total credits	≥ 30 credits, selected with guidance from advisor
EE coursework	≥ 15 credits, selected with guidance from advisor, including either EE 201 or EE 270
Thesis research credits	≥ 6 credits under supervision of an EE graduate program faculty member
Thesis committee	The student should work with their graduate advisor to choose a thesis committee consisting of three regular faculty members, with not less than two from the EE graduate program faculty.
Comprehensive exam	The student must orally present a proposal for their thesis research at least 3 months prior to graduation. The student's thesis committee will orally examine the student based on the student's coursework and research focus.
Thesis	A thesis must be completed, under the supervision of an EE graduate program faculty member. The written thesis must meet Graduate College requirements and be defended orally in public forum. See the Graduate College requirements.

4.2 M.Sc. Project Option

Total credits	≥ 30 credits, selected with guidance from advisor
EE coursework	≥ 18 credits, selected with guidance from advisor, including either EE 201 or EE 270
Project research credits	≥ 3 credits under supervision of an EE graduate program faculty member
Project committee	The student should work with their graduate advisor to choose a project committee by their second semester consisting of three regular faculty members, with not less than two from the EE graduate program faculty who approve the project.
Comprehensive exam	The student must orally present a proposal for their project research approximately 6 months prior to graduation. The student's project committee will orally examine the student based on the student's coursework and research focus.
Project	A written project report must be completed under the supervision of an EE graduate faculty member. The project should be orally presented in a public forum and approved by a committee of at least three faculty members, with not less than 2 from the EE graduate program faculty.

4.3 M.Sc. Coursework Option

The coursework option is available only to students with prior substantial engineering experience in industry. Students interested in the coursework option should discuss the details with the EE graduate program coordinator.

Total credits	≥ 30 credits, selected with guidance from advisor
EE coursework	≥ 21 credits, selected with guidance from advisor, including either EE 201 or EE 270
Exam committee	The student should work with their graduate advisor to choose a comprehensive exam committee consisting of three regular faculty members, with not less than two from the EE graduate faculty.
Comprehensive exam	The student must complete a written comprehensive exam during the final semester of residence at UVM. The student's written solutions are then defended orally before the exam committee.

4.4 M.Sc. - Accelerated Masters Program

Qualified undergraduate students who plan to earn a thesis-based master's degree in Electrical Engineering may enroll in the program's Accelerated M.Sc. Degree Program (AMP). This program enables the student to begin working on a master's degree while still an undergraduate. The basic requirements for admission to and completion of this program are as follows:

- Interested students must apply to the Accelerated M.Sc. Program in the second semester of their junior year.
- In order to be admitted to the Accelerated M.Sc. Program, the student must have a cumulative grade point average of at least 3.2 at the time of application, and they must submit a letter of application to the EE Graduate Program Coordinator naming an EE graduate program faculty member who has agreed to serve as their graduate advisor.
- Upon being admitted into the Accelerated M.Sc. Program, the student may take up to 9 credit hours of courses for graduate credit while still an undergraduate. Of these, up to 6 credit hours of 200-level or higher courses can be counted toward both the B.Sc. and M.Sc. degrees, subject to the approval of the student's graduate advisor.
- Students in the AMP typically begin work toward their master's thesis starting in the summer following their junior year.
- All other requirements for the thesis option M.Sc. degree apply.

5 Requirements for the Ph.D. Degree in Electrical Engineering

The Ph.D. degree in electrical engineering is designed to prepare students for advanced careers in engineering research, development and education.

Students seeking admission to the Ph.D. degree program are required to have completed the M.Sc. degree in Electrical Engineering or its equivalent. A graduate student who meets the requirements for candidacy for the M.Sc. degree in Electrical Engineering and has completed twenty-four (24) credit hours of appropriate graduate coursework with a B average (3.0 on a 4.0 scale) or better qualifies to apply to the Ph.D. program. An applicant to the Ph.D. program may be admitted provisionally based on a B average or better in twenty-four (24) hours of appropriate graduate coursework toward the M.Sc. in Electrical Engineering.

To be a candidate for the Ph.D. degree one must complete the M.Sc. degree in Electrical Engineering or the equivalent and successfully complete the Ph.D. Comprehensive Examination. The following sections describe the Ph.D. degree requirements in detail. Table 1 provides a timeline for completing the Ph.D. degree in four years.

Table 1: Timeline for completing the Ph.D. degree in 4 years

Year 1, Fall	EE 201 or EE 270
Year 1, Spring	Submit coursework plan to the studies committee
Year 2, Fall	EE 201 or EE 270
Year 2, Dec./Jan.	Comprehensive exam, part I
Year 2, Spring	Complete coursework requirements.
Year 2, May/June	Comprehensive exam, part II
Year 3, Fall	Select dissertation committee
Year 3, Spring	Present dissertation proposal
Year 4, March	Submit complete dissertation to committee
Year 4, April	Dissertation defense
Year 4, May	Submit final, edited dissertation. Graduation.

5.1 Coursework

A total of seventy-five (75) credit hours of graduate work are required for the Ph.D. degree, with at least 51 credits taken in residence at UVM. These courses should be selected to meet the following requirements:

- 6 credits to satisfy the EE Ph.D. core requirement, which consists of EE 201 (Linear & Nonlinear System Theory) and EE 270 (Random Variables & Stochastic Processes). These courses are typically offered in alternate years in the fall semester.
- At least 9 additional credits (3 courses) of advanced coursework in electrical engineering (200 or higher) specifically selected with your graduate advisor to facilitate your research goals.
- A student with a M.Sc. degree in Electrical Engineering can apply up to twenty-four (24) credit hours from this M.Sc. degree toward the Ph.D. coursework requirements, subject to the approval of the EE graduate studies committee.
- At least 20 credits of Ph.D. dissertation research credits, supervised by the student's Ph.D. advisor.
- Students must enroll in GRAD 497: Doctoral Comprehensive Examination prior to taking the comprehensive examination
- Students must enroll in GRAD 499: Dissertation Defense prior to defending their thesis

Students should complete a coursework plan in their first year of Ph.D. studies, and submit this plan to the graduate studies committee for review.

5.2 Comprehensive Examination

In order to be advanced to candidacy for the Doctor of Philosophy in Electrical Engineering, a Ph.D. Program Student is required to pass a Comprehensive Examination. Part I of this examination is

generally taken after three semesters of Ph.D. study, and after completing the EE core requirement (EE 201 and EE 270). Part II is generally taken near the end of four semesters of Ph.D. study. Students should register for GRAD 497 (Doctoral Comprehensive Examination) during the semester in which Part II is to be completed.

Part I of the Comprehensive Examination is administered by the EE Graduate Program Committee, is written, and normally takes six to eight hours for completion. Part I of the Comprehensive Examination is based on core material from the EE core courses (EE 201 and EE 270), and is generally offered annually in December or January.

Part II of the Comprehensive Examination is focused on the student's research area. It consists of an oral presentation and defense of the student's research literature review and results to date. This presentation should be scheduled near the end of the student's fourth semester, and is open to all members of the EE graduate program faculty.

A passing grade is required for each of the two parts individually. A passing grade consists of an average score of 70% or higher. A score of lower than 65% is a failing grade. An intermediate score is considered passing if approved by a two-thirds majority of the EE graduate program faculty.

5.3 Dissertation Proposal

After completion of the comprehensive examination, Ph.D. students should select a dissertation committee, in consultation with the student's research advisor. This committee should be composed of 4-5 members of the UVM Graduate College, with at least one member from outside of the EE faculty and at least two members from within the EE graduate program faculty.

The dissertation proposal is given to the selected dissertation committee only after the Comprehensive Examination has been passed. The thesis proposal, which is comprised of a written proposal with an oral presentation (open to the public), requires a comprehensive journal search and is typically given within one year of the successful completion of the comprehensive examination and at least six months prior to the final thesis defense.

5.4 Dissertation Defense

The dissertation defense is given to the selected dissertation committee only after the dissertation proposal has been successfully completed and approved by the dissertation committee.

The written dissertation should comprehensively describe the methodology and results from the student's research. The general standard for the dissertation is the completion of two manuscripts appropriate for publication in a high quality, peer-reviewed venue, such as an IEEE transactions journal or a leading international peer-reviewed conference, such as ICASP.

The dissertation defense is open to the public, and should include a comprehensive oral presentation of the student's research results, as well as questioning from the public and the student's dissertation committee.

6 General information for Graduate Students

6.1 Graduate Student Funding

A limited number of funded Graduate Teaching Assistantships (GTAs) and Graduate Research Assistantships (GRAs) are available for highly qualified applicants.

General information about billing, payroll, and taxation procedures for Fellowships and Assistantships may be obtained from the Graduate College Office (332 Waterman Building). In general, GTA and GRA awards may carry either a 9 or 12 month appointment. In both cases, payment checks are distributed on the 15th and 30th of each month. Generally, GTA appointments include a tuition scholarship (usually a maximum of 20 credit hours per academic year) which accompanies the stipend. Tuition scholarships are paid at the time of registration or pre-billing and do not involve distribution of funds directly to the students.

6.1.1 Funding Policies

In order to maintain a healthy level of activity in our graduate program, a proper balance must be maintained between the University supported GTA positions and externally supported Research Assistantships (GRA positions). In recruiting students, special attention must be given to diversity and excellence and capability of performing well as Graduate Teaching Fellows in the operation of our teaching laboratories and courses.

University supported GTA funding is typically awarded only to Ph.D. and M. Sc. thesis option students with a priority given to EE graduate students.

In order to assist in the effort to locate qualified individuals and to help maintain a healthy stream of potential GRAs to our research programs, each faculty member will be encouraged to recruit one new potential graduate student. It will be the responsibility of each faculty member to both seek an individual that meets the goals stated above, and to initially welcome and advise that student once arriving at UVM. Once at UVM the student may elect to take any member of the EE Graduate Program Faculty as their advisor (with that faculty member's concurrence) without effecting their original graduate teaching assistantship.

The EE Graduate Program Faculty will discuss the awards of GTA positions in a formal meeting chaired by the EE Graduate Program Coordinator. All the operational duties of the Graduate Program, such as organizing applications and assisting committees in administering comprehensive examinations, will be performed by the EE Graduate Program Coordinator. Awards made during the summer will be coordinated with two members of the Graduate Program Faculty, if possible.

The potential faculty advisor may select a student who has originally stated an interest in pursuing a degree in either the Materials Science or Biomedical Engineering Programs with their advisor in Electrical Engineering. If the student wishes to change to an advisor who is not a member of the EE Graduate Program Faculty, they will forfeit their GTA position.

Any remaining GTA positions will be used to provide bridge-funding for students that have temporarily lost their external funding support.

6.1.2 Duration of GTA Funding

A M.Sc. thesis option student may only receive GTA funding for no more than two years. If the student then continues on to the Ph.D. program, this two years of funding is then counted in the same manner as any other Ph.D. student (i.e., flexibility in funding is allowed).

Maintaining GTA funding requires that a student maintain good academic standing as evidenced by an overall GPA of 3.0 or higher, the completion of appropriate coursework, acceptance as a thesis student by one of the EE Graduate Program Faculty, and adequately meeting all GTA responsibilities.

6.1.3 Annual Reports

All Ph.D. students must prepare, in coordination with their faculty advisor, and submit an Annual Report to the EE Graduate Program Coordinator. This annual report is due on the last weekday of March and is to be used by the EE Graduate Program Faculty to assess the progress of each student toward the successful completion of their Ph.D. at UVM as well as to aide the faculty in determining both GTA and GRA funding offers for the next academic year.

This annual report should include the student's study/thesis committee members, coursework plan and completed course grades, comprehensive exam status, teaching duties, research description, research progress, and research presentations and publications.

6.1.4 Graduate Student Grants and Travel Funds

UVM's Graduate College provides information available to graduate students seeking specific funding for academic, research, and travel endeavors. The Funding Manual for Graduate Students, a list of graduate student fellowship competitions sponsored by such organizations as the National Science Foundation, the American Association of University Women, and the Ford Foundation, is updated each year and published in the Spring. This manual is available in the Graduate College and each of the UVM Libraries. In order to assist graduate students in attending national meetings to present papers or poster, the Graduate College, through the Graduate Student Advisory Committee (GSAC), can provide some funds on a department matching-fund basis. Application forms are available in the Graduate College Office.

6.2 Information Available Online

The best place for updated information about graduate studies at UVM is the graduate college web site: <http://www.uvm.edu/~gradcoll>. The following links may also be helpful:

6.2.1 Graduate Student Costs at UVM

- Tuition and fees: <http://www.uvm.edu/~stdfinsv>
- Living and housing: <http://www.uvm.edu/studentlife> and <http://reslife.uvm.edu>

6.2.2 Application Procedures

- Admissions web site with application deadlines: <http://www.uvm.edu/~gradcoll/?Page=admissions.html>

6.2.3 General Information

- UVM catalog: <http://www.uvm.edu/academics/catalogue>
- Graduate college: <http://www.uvm.edu/~gradcoll>