DEPARTMENT OF
ELECTRICAL & COMPUTER ENGINEERING

2017-18 Graduate Handbook

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Messages from the Department

Message from the Department Chair

Welcome to the Department of Electrical and Computer Engineering at the University of Maryland.

Our Department offers one of the strongest education and research programs in the nation. We recently celebrated the 100th Anniversary of the ECE Department (1908-2008) here on the College Park campus. For over a century, our vibrant department has established a tradition of excellence in research and education innovation, and I see a future that is even brighter. Led by over 65 faculty members and many more research staff, the research programs of the department cover a wide spectrum of activities in the areas of:

- Communications and Networking
- Signal Processing
- Control, Robotics, and Dynamical Systems
- Computer Engineering
- Optics and Photonics
- Circuits and Systems
- Electronic Materials and Devices
- Bioelectronics and Systems
- Applied Electromagnetics

Our location near Washington, D.C. offers unique opportunities for students to engage in research at national and government laboratories, including NASA's Goddard Space Flight Center, the National Institute of Standards and Technology, the National Institutes of Health, and the Army and Navy Research Laboratories.

We place particular emphasis on enriching the student experience. Our Department is strongly committed to undergraduate education, and offers students the opportunity to participate in programs like our Research Experiences for Undergraduates (REU), such as MERIT-BIEN, as well as the GEMSTONE program.

At the graduate level, our students can participate in our ECE Graduate Student Association, an award winning student organization that fosters a supportive and vibrant community for graduate students.

Our faculty research is supported by annual expenditures of over $30 million. Our level of research expenditures places the department among the very top electrical and computer engineering departments in the nation, a reputation that is supported by national rankings.

Our close affiliation with a number of research institutes such as the Institute for Systems Research, the Institute for Advanced Computer Studies, the Institute for Research in Electronics and Applied Physics, the Institute for Physical Science and Technology, the Maryland Energy Research Center, the Maryland Cybersecurity Center, and the Maryland NanoCenter provides our students and researchers the opportunity for team-oriented, cross-disciplinary research and access to state-of-the-art laboratories.

With approximately 650 undergraduates and more than 500 graduate students, we are the largest and most prestigious academic department within the A. James Clark School of Engineering, the fastest rising engineering school in the country. Our alumni find themselves in high demand for positions in some of the top corporate, government and education institutions and continue to make significant contributions to the field.

I invite you to learn more about our department and the exciting experiences that await you here at Maryland.

Rama Chellappa
Professor and Chair

Message from the Graduate Studies Office (GSO)

Greetings and welcome to the University of Maryland and the Department of Electrical and Computer Engineering! We are excited for another successful year and look forward to assisting you in your academic career at one of the fastest rising ECE graduate program in the country.

The Graduate Studies Office (GSO) serves approximately 325 diverse full- and part-time graduate students and handles approximately 1,500 applications for admission each year. We have many constituents including campus administrators, faculty, staff, and prospective students from all over the United States and abroad. Come visit our office, and let us know how we can better serve you.

The GSO would like to emphasize several things that will help you progress through your graduate studies. First, you should subscribe to the ece-gradstudents listserv. To sign-up, send an email to listserv@listserv.umd.edu with the message "subscribe ece-gradstudents <Your Name>" in the body of the email.

Next, you should read emails that you will regularly receive from us and talk one-on-one with our dedicated staff. We are always looking for the most effective ways to communicate information, policies, and deadlines to you. And, if at any point you have any questions, email us at ecegradstudies@umd.edu

Also, for students who are seeking a well-rounded experience, we are happy to talk with you about various aspects of graduate student life. We can direct you to resources that may help you achieve a work-life balance. We want you to know that you are a part of a community here in ECE that is both close-knit and connected to broader areas such as the university and metropolitan D.C.

Lastly, the GSO encourages you to take responsibility for your own success. One way to do this is to consult this handbook as well as the *Graduate Catalog* for information on policies, procedures, and requirements. Another way is for you to access and keep your student record updated through the Office of the Registrar. Visit all of these resources today on-line at:

https://www.testudo.umd.edu (Office of the Registrar)
http://www.gradschool.umd.edu/catalog (The Graduate School's *Graduate Catalog*)
http://www.ece.umd.edu/handbook (ECE Graduate Handbook)

Good luck this year, and go Terps!

Melanie Prange, Director of Graduate Academic and Student Affairs
Emily Irwin, Program Manager, Graduate Studies
Maria Hoo, Program Management Specialist
Vivian Lu, Payroll Coordinator, Graduate Assistant

Graduate Studies Office
2434 A.V. Williams Building
301-405-3681 / 301-405-8728 fax
ecegradstudies@umd.edu

Departmental Information

Department Overview

The chief administrative officer in the Department of Electrical and Computer Engineering is the chair. This position is currently held by Professor Rama Chellappa. Several associate chairs assist in the administration of the department: Professors Gilmer Blankenship (external affairs), R.D. Gomez (undergraduate studies), and Ankur Srivastava (raduate studies and research).

Many academic and administrative functions of the department are organized around the following five technical areas:

- Communications and signal processing (CSP)
- Computer engineering (COMP)
- Controls (CONT)
- Microelectronics (MICR)
- Electrophysics (ELEC)

An important role in the administrative operation of the department is also played by the Department Council and several standing departmental committees: General Academic Affairs, Graduate Studies and Research, Human Relations and Welfare, Facilities and Services, Undergraduate Affairs, Salary, and Promotion and Tenure. Graduate students have representatives on the council and on the first four committees. Elections for graduate student representatives are coordinated by the ECE Graduate Student Association (ECEGSA). Also, the Graduate Studies and Research Committee (GSRC) is supported by area advisors, who are non-voting members of the committee. Area advisors are faculty members, one from each of the department's five technical areas and appointed by the associate chair for graduate studies and research, who can advise the committee as well as graduate students.

Important Contact Information

Resource	**Contact person**	**Telephone**	**Email or Website**	**Office**
Chair's Office	Dr. Rama Chellappa Ms. Edna Walker	405-3683 405-3683	rama@umiacs.umd.edu ednaw@ece.umd.edu	AVW 2415
Graduate Studies Office ecegradstudies@umd.edu	Dr. Ankur Srivastava Ms. Melanie Prange Ms. Emily Irwin Ms. Mario Hoo Ms. Vivian Lu	405-0434 405-3686 405-0680 405-3681 405-3388	ankurs@umd.edu mprange@umd.edu eirwin@umd.edu mch@umd.edu vivianlu@umd.edu	AVW 2317 AVW 2437 AVW 2435 AVW 2434 AVW 2423
Conference Room Reservations	ECE Helpdesk	405-3689	ecehelp@umd.edu ece.umd.edu/ece-helpdesk	AVW 1449
Office assignments (GRA ONLY)	Tech Ops	405-1036	techops.ece.umd.edu/	AVW 1338
Payroll and health insurance (ECE GRA/GTA ONLY)	Ms. Vivian Lu	405-3388	vivianlu@umd.edu	AVW 2423

Payroll and health insurance (ISR RA ONLY)	Ms. Alexis Jenkins	405-6612	ajenkin4@umd.edu	AVW 2165
Payroll and health insurance (UMIACS RA ONLY)	Ms. Arlene Schenk	405-6726	aschenk@umd.edu	AVW 2131
Payroll and health insurance (IREAP RA ONLY)	Ms. Nancy Boone	405-5039	nboone@umd.edu	1203B Energy Research
Photocopying accounts and supplies (RA/TA ONLY)	ECE Business Office	405-1240	ece-businessoffice@umd.edu	AVW 2410
ECE computing issues	ECE Computer Help Desk	405-3689	ecehelp@umd.edu ece.umd.edu/ece-helpdesk	AVW 1449
Campus-wide computing issues	Division of Information Technology	405-1500	itsc@umd.edu helpdesk.umd.edu	CSS
Campus-wide graduate issues	The Graduate School	405-3644	gradschool@umd.edu gradschool.umd.edu	2123 Lee
International student issues	International Student and Scholar Services	314-7740	isss.umd.edu	3109 Susquehanna Hall
Registration and ID cards	Registrar	314-8240	registrar-help@umd.edu testudo.umd.edu	Mitchell Bldg.

Faculty

The Department of Electrical and Computer Engineering at the University of Maryland has 70 full-time professors, 11 affiliate faculty members, 50 research faculty and post-docs, and 11 professors emeriti who perform research in the following areas:

- Communications and networking
- Signal processing
- Control, robotics, and dynamical systems
- Computer engineering
- Optics and photonics
- Circuits and systems
- Electronic materials and devices
- Bioelectronics and systems
- Applied electromagnetics

For more information about our faculty and their research areas, please see http://www.ece.umd.edu/facultyresearch

Among faculty members, there are 10 NSF presidential young investigators, 14 recipients of NSF CAREER awards, 32 IEEE fellows, two NAE members, two ACM fellows, 10 APS fellows, three OSA fellows and two ASA fellows.

A large number of faculty members hold joint appointments with different research institutes. Currently, there are 19 joint appointments with the Institute for Systems Research (ISR), nine with the University of Maryland Institute for Advanced Computer Studies (UMIACS), four with the Institute for Research in Electronics and Applied Physics (IREAP), three with Physics, and one with the Institute for Physical Science and Technology, and one with the School of Medicine.

For more information about our faculty, including adjunct and research faculty, please see http://www.ece.umd.edu/faculty

Financial Aid

Financial Aid

Packages include graduate research and teaching assistantships and prestigious fellowships. Details are given below. Applicants for admission are automatically considered for these packages provided they mark "yes" for graduate funding on the application for admission and submit their materials by the deadline.

Fellowships

Applicants with exceptionally strong academic records may be offered prestigious fellowship packages. Fellowships may include tuition remission, subsidized health benefits, and a generous stipend.

Graduate Teaching Assistantships (GTA)

GTA duties typically involve conducting lab or recitations for lecture courses, providing one-on-one assistance to students (office hours), and grading of homework assignments or examinations. A full GTA is a nine-month appointment and requires an average time commitment of 20 hours per week during the fall and spring semesters. The assistantship includes a salary, tuition remission for 10 credit hours per semester, and subsidized health benefits. Graduate teaching assistantships are awarded competitively either upon recruitment or after a student has enrolled for at least one semester. International students must demonstrate proficiency in English by passing the Maryland English Institute's International Teaching Assistant (ITA) evaluation in order to serve as a GTA.

Graduate Research Assistantships (GRA)

Students supported on GRAs participate in research projects funded by grants. They perform their duties under the supervision of a faculty member. Graduate research assistants often work on material that is directly related to their theses or dissertations. A full GRA is a 12-month appointment, and the typical work load is 20 hours per week during the academic year and 40 hours per week during the summer. The assistantship includes a salary, subsidized health benefits, and tuition remission for 10 credit hours per semester, as well as eight credit hours for summer.

GRAs are awarded through the department by individual faculty members. Subject to satisfactory performance and the availability of funds, GRAs are renewable each semester.

Health Benefits

Students supported by graduate assistantships (full or half) and fellowships may enroll in the state employee health plans. The state pays a percentage of the health insurance premiums, and students are covered for the entire year when on a 12-month appointment. Students on nine-month appointments may have health coverage over the summer provided that their assistantships will be renewed in the following fall. Medical, dental, and prescription coverage are among the benefits available.

Graduate Teaching Assistant (GTA) Employment Agreement

In accepting a graduate teaching assistant appointment, students agree to fulfill the following responsibilities. Failure to do so may jeopardize students' current or future GTA appointment.

1. Register as a full-time student as defined by the Graduate School;
2. Beginning on the appointment start date, be available to assist the course instructor, which may require meeting on campus;
3. Report to the ECE GSO for TA Check-in and Orientation;
4. Contact the course instructor immediately upon receiving the TA course assignment;
5. If assigned as a TA for lab sections(s), complete the requisite training before the first lab;
6. If an international student, satisfy all requirements related to the Maryland English Institute International Teaching Assistant Evaluation (MEI ITA);
7. Attend lectures, if required by the course instructor of the assigned course(s) throughout the semester;
8. Meet with the course instructor at least three times during the semester to discuss progress as a TA;
9. Conduct mid-semester evaluations, meet with TA Training and Development mentor to discuss evaluations (new TAs only), and submit a self-evaluation;
10. Remind students of end-of-semester online evaluations (CourseEvalUM);
11. Prepare and appear for all scheduled recitations/labs for the entire semester;
12. Request permission for emergency absences in advance or as soon as possible and notify all pertinent parties;
13. Fulfill end-of-semester TA duties related to the course after the final exam is given;
14. Return all loaned books/materials in excellent condition upon completion of the term;
15. Read and adhere to emails from the GSO and announcements posted to ece-tas@umd.edu;
16. Comply with the Family Educational Rights and Privacy Act (FERPA). See https://www.sis.umd.edu/ferpa/ for an explanation and tutorial.
17. Complete the ECE TA Training and Development Program:
    a. Attend CTE Campus-wide TA Orientation if never attended before;
    b. New TAs must attend three TA Training and Development Program sessions per semester, which must include TA Orientation and two workshops;
    c. Returning TAs must attend two TA Training and Development Program workshops per semester.

Travel Grants

The **International Conference Student Support Award** will cover a graduate student's conference registration fee up to $500. To be eligible, a graduate student must be presenting a paper, poster, or other research or creative material at a major, international scholarly, scientific, or professional conference that is held outside of the US. The graduate student must be enrolled at the University of Maryland at the time of travel to the international conference.

The **Jacob K. Goldhaber Travel Grants** are intended to help defray the expenses incurred by graduate students who are traveling to scholarly, scientific, and professional conferences to present papers, posters, or other scholarly material.

For details, please visit http://www.gradschool.umd.edu/current_students/travel_awards.html

M.S. Degree Requirements

M.S. Degree Requirements

Please also check Graduate School requirements for master's degrees in the Graduate Catalog *at http://www.gradschool.umd.edu/catalog*

The department offers two options for the M.S. degree: thesis and non-thesis. Students must select one of these options before the end of their first semester but may subsequently change options.

Under the M.S. with thesis option, the student must:

1. satisfy a course requirement (24 credits of course work plus six credits of thesis research)
2. write a master's thesis and pass the oral master's thesis examination

Under the non-thesis option, the student must:

1. satisfy a course requirement (30 credits of course work)
2. write and submit an approved scholarly paper

In addition, for both options, once enrolled, all students must register for courses and pay associated tuition and fees each semester, not including summer and winter sessions, until the degree is awarded.

Course Requirement

To satisfy the course requirement for the M.S. degree, the student must successfully complete at least 30 credits. A grade of C- or better must be earned in each course, and an overall minimum GPA of 3.0 must be maintained. The main conditions for approval are:

1. in the opinion of the student's advisor and of the graduate director, the program must be coherent;
2. the program must satisfy the thesis or non-thesis option's rules listed below;
3. non-ENEE courses that are not pre-approved (see **Course Information** section) must receive special approval by the student's advisor and the graduate director in the context of the proposed plan of study; such approval must be obtained before the start of the semester in which the student plans to take the course.

Modifications to the plan of study can be filed subsequently, again subject to approval by the student's advisor and the graduate director.

Transfer of Credit

A maximum of six credits can be transferred. The criteria set forth by the Graduate School listed below must be met. In addition, the following departmental criteria must also be met:

- Any course to be transferred must be equivalent to a graduate-level (numbered 600 or above) lecture course offered at the University of Maryland, College Park.

- If a course is transferred, the equivalent UMCP course cannot be included in the plan of study.

Graduate School Regulations for Transfer of Credit for the M.S. Degree

Please see the *Graduate Catalog* (http://www.gradschool.umd.edu/catalog/) for additional information on transfer of credit.

- The courses must be graduate level and have been taken for graduate credit at the original institution.

- The student must have earned a grade of "B-" or better in the course.

- The credit must not have been used to satisfy the requirements for any other degree.

- The student must furnish an official transcript to the Graduate School.

- Transfer work satisfies only the 400-level requirements for the master's degree and does not apply to the upper-level requirements.

- The transfer course work must have been taken within seven years of the award of a University of Maryland master's degree for which the student is currently enrolled. (All other course work must be taken within five years of the award of master's degree.)

Credit transfer is approved only in the context of a specific proposed plan of study. When applying for credit transfer, the student must produce an official transcript, as well as evidence that the course is indeed equivalent to a course offered at UMCP. Documented evidence should include a course description, as well as a syllabus showing what material was covered in the specific offering the student took and what text(s) were used. Additionally the **MS REQUEST FOR TRANSFER OF GRADUATE CREDIT** departmental form and the **MS REQUEST FOR TRANSFER OR INCLUSION OF CREDIT** Graduate School form must be submitted. Transfer requests must be submitted within the first semester of enrollment.

M.S. with Thesis Option

Under the thesis option, a valid plan of study must include a total of 30 credits: 24 credits of approved course work at the 400-level and above and six credits of ENEE799: Master's Thesis Research. The plan of study must satisfy the following rules:

1. No more than nine credits at the 400-level may be included. ENEE499 may not be included.
2. Three core courses must be included.
3. Prerequisites must be fulfilled before taking courses that require them.
4. No more than one credit of ENEE698: Graduate Seminar may be included.
5. Combined total number of credits of ENEE698 and ENEE699 may not exceed three.
6. No more than 12 credits earned while holding the advanced special student status may be included.
7. At least six credits of ENEE799: Master's Thesis Research must be included.

A minimum overall GPA of 3.0 must be maintained. For the purposes of meeting the plan of study rules, all transferred courses will count as B (3.0 grade point value). However, grades obtained on transfer courses do not affect the GPA as recorded on the official UMCP transcript.

If two or more attempts are taken at a course, only the grade obtained at the latest attempt will count towards the GPA.

Master's Thesis and Oral Examination

Directions for the preparation and submission of theses can be found in the *Thesis and Dissertation Style Guide* on-line at: http://www.gradschool.umd.edu/current_students/etd_style_guide.html

Membership on thesis examining committees must adhere to Graduate School policy. From the *Graduate Catalog* on the Thesis Examining Committee (http://www.gradschool.umd.edu/catalog):

> **Thesis Examining Committee Membership**. The Committee will include a minimum of three members of the Graduate Faculty, at least two of whom will be Full Members. The Chair of the Committee normally will be the student's advisor, who will be a Full or Adjunct Member of the Graduate Faculty, or who has been granted an exception to the policy by the Dean of the Graduate School.
>
> **Membership on a Thesis Examining Committee** requires nomination by the student's advisor and Graduate Director in the student's graduate program, and approval by the Dean of the Graduate School. The nomination of a Thesis Examining Committee should be provided to the Graduate School at least six weeks before the date of the expected thesis examination. The thesis examination cannot be held until the Graduate School approves the composition of the Thesis Examining Committee. Furthermore, if the

Graduate Faculty status of any member of an approved Thesis Examining Committee changes, the approval of the Thesis Examining Committee may be voided, and a new Committee nomination form will be required for approval by the Graduate School.

Chair. The Thesis Examining Committee will have as chair the student's advisor, who must be a Full or Adjunct Member of the Graduate Faculty or, by special permission, has been otherwise appointed by the Dean of the Graduate School. Thesis Examining Committees may have co-chairs upon the written recommendation of the Graduate Director and with the approval of the Dean of the Graduate School.

The student is responsible for scheduling the defense with the committee and reserving a conference room for the thesis defense. The members of the committee must receive the thesis (PDF) at least seven working days before the defense.

The student must provide the Graduate Studies Office with the date, time, location, and abstract at least two weeks before the defense so that it may be announced to the department. Information about the proper announcement format can be obtained from the Graduate Studies Office.

M.S. Non-Thesis Option

Under the non-thesis option, a valid plan of study must include a total of 30 credits of approved course work at the 400-level and above. The plan may not include ENEE799: Master's Thesis Research. The plan of study must satisfy the following rules:

1. No more than nine credits at the 400-level may be included. ENEE499 may not be included.
2. Four core courses must be included.
3. Prerequisites must be fulfilled before taking courses that require them.
4. No more than one credit of ENEE698: Graduate Seminar may be included.
5. Combined total number of credits of ENEE698 and ENEE699 included in the plan of study may not exceed three.
6. No more than 12 credits earned while holding the advanced special student status may be included.

A minimum overall GPA of 3.0 must be maintained. For the purposes of meeting the plan of study rules, all transferred courses will count as B (3.0 grade point value). However, grades obtained on transfer courses do not affect the GPA as recorded on the official UMCP transcript.

If two or more attempts are taken at a course, only the grade obtained at the latest attempt counts towards the GPA.

Scholarly Paper

For the M.S. non-thesis, a scholarly paper is to be prepared by the student in consultation with his/her academic advisor, who serves as the first reader. (Students who wish to change advisors should submit such request before the start of the semester during which they plan to graduate.) The second reader may be any full member of the Graduate Faculty. A completed **M.S. SCHOLARLY PAPER READER SELECTION** form, with a tentative title and signed by the student's advisor and the second reader, must be submitted to the Graduate Studies Office by the posted deadline (which is generally the same date as the **APPROVED PROGRAM FORM** deadline).

The scholarly paper should consist of a concise summary of a few research papers published in the open literature. Its length should be approximately 10 to 15 pages, not counting possible appendices. The scholarly paper must be submitted to both readers at least two weeks prior to the filing deadline published by the Graduate Studies Office.

Each reader rates the paper as either "satisfactory" or "unsatisfactory." The scholarly paper requirement is satisfied once both ratings are "satisfactory."

M.S. "along the way" for Ph.D. Students

Ph.D. students who do not already hold an M.S. degree from this department may earn an M.S. non-thesis "along the way" upon admission to doctoral candidacy. Ph.D. students who choose to earn the M.S. non-thesis "along the way" must satisfy the M.S. non-thesis course requirement and may substitute the Ph.D. research proposal for the scholarly paper. Ph.D. students do not have the opportunity to obtain an M.S. non-thesis before admission to candidacy. The M.S. degree cannot be conferred in the same semester as the Ph.D.

Ph.D. Degree Requirements

Ph.D. Degree Requirements

Please also check Graduate School requirements for doctoral degrees in the Graduate Catalog *at* *http://www.gradschool.umd.edu/catalog*

To fulfill all requirements for the Ph.D. degree, students must:

1. satisfy a course requirement (36 credits)
2. satisfy a qualifying requirement
3. prepare a written research proposal and pass the oral research proposal exam
4. complete 12 credits of ENEE899: Doctoral Dissertation Research
5. write the dissertation and pass the oral defense

Students must demonstrate the ability to do independent research by producing an original dissertation on an approved topic. After successful completion of the second and third items above, students are eligible for doctoral candidacy. Students must be admitted to candidacy within five years of enrollment in the Ph.D. program. Once admitted to candidacy, students have four years to complete the remaining degree requirements. Admission to candidacy must take place at least six months before the date on which the degree is to be conferred.

It is the responsibility of the student to submit the **APPLICATION FOR ADMISSION TO CANDIDACY** form when all the requirements for candidacy have been fulfilled. This form must be submitted at least three business days prior to the 25th of the month in order for the candidacy to be effective on the first day of the following month. When applying for candidacy, the student must have a valid Ph.D. plan of study on file that has been approved by the student's advisor and the graduate director. See the **Course Requirement** section below for more information about the plan of study.

M.S. "along the way" for Ph.D. Students

Ph.D. students who do not already hold an M.S. degree from this department may earn an M.S. non-thesis "along the way" upon admission to doctoral candidacy. Ph.D. students who choose to earn the M.S. non-thesis "along the way" must satisfy the M.S. non-thesis course requirement and may substitute the Ph.D. research proposal for the scholarly paper. Please see M.S. non-thesis option above. Ph.D. students do not have the opportunity to obtain an M.S. non-thesis before admission to candidacy. The M.S. degree cannot be conferred in the same semester as the Ph.D.

Definition of Satisfactory Academic Progress

The department uses the following guidelines to determine satisfactory academic progress for doctoral students. Satisfactory progress is one of the major factors used to determine financial support (GTA, GRA, fellowship appointments).

Students who meet the guidelines listed below will be considered to be making satisfactory progress. Students who do not meet these guidelines may still continue in the Ph.D. program but may not receive priority consideration for financial support.

The following is expected in the first year:

- The student must be enrolled in the Ph.D. program and register as a full-time student in graduate-level technical courses. The courses should be selected in consultation with and approved of by the student's advisor.
- The student must maintain a GPA of 3.5, both cumulatively and in graduate-level technical courses, every semester.
- Students who are initially assigned to academic advisors must make verifiable efforts towards finding and selecting a research advisor.
- The student must achieve a borderline pass or better in the written portion of the Ph.D. qualifying exam in their first attempt at the written exam.
- The student should be in good standing with the University and follow the Code of Student Conduct set by the Office of Student Conduct.

The following is expected in subsequent years:

- The student must continue to be enrolled in the Ph.D. program.
- The student must fulfill the qualifying requirement by the end of the second year.
- The student must continue to perform well in courses, maintaining a 3.5 GPA each semester.
- The student must demonstrate progress in research by meeting degree milestones in a timely manner (including passing the PhD proposal exam, advancing to candidacy, etc.).
- The student is expected to have a conference or journal publication by the end of the second year in the Ph.D. program.
- The student must have satisfactory teaching evaluations if serving as a teaching assistant.
- The student will compete for merit-based departmental, college, Graduate School, and/or external fellowships that may supplement or replace research assistantship funding (for example, the Graduate School Summer Research Fellowship, the Future Faculty Program, the Dean's Research Award, the ECE Distinguished Dissertation Fellowship the Graduate School Wylie Dissertation Fellowship).

Additional Financial Information:

- Typically, students who maintain satisfactory academic performance are continually supported as research or teaching assistants subject to the availability of resources. These guidelines are used in determining the renewal of funding.
- Students may receive fellowship or teaching assistantship support or any combination of the two for no more than two years.

Course Requirement

To satisfy the course requirement for the Ph.D. degree, the student must successfully complete 36 credits of course work and 12 credits of ENEE899: Doctoral Dissertation Research. A grade of C- or better must be earned in each course, and an overall minimum GPA of 3.0 must be maintained.

All Ph.D. students must complete and gain approval for a proposed plan of study within the first semester of enrollment. The main conditions for approval are:

1. in the opinion of the student's advisor and graduate director, the program must be coherent;
2. the program must satisfy the rules listed below;
3. non-ENEE courses that are not pre-approved (see **Course Information**) must receive special approval by the student's advisor and the graduate director, in the context of the proposed plan of study; such approval must be obtained before the start of the semester in which the student plans to take the course.

Modifications to the plan of study can be filed subsequently, again subject to approval by the student's advisor and the graduate director.

For the purposes of meeting the plan of study rules, all transferred courses (see below) will count as B (3.0 grade point value). However, grades obtained on transfer courses do not affect the GPA as recorded on the official UMCP transcript.

If two or more attempts are taken at a course, only the grade obtained at the latest attempt counts towards the GPA.

For all doctoral students (*except those with a previous M.S. degree in Electrical Engineering or Electrical and Computer Engineering from a U.S. institution — see below*), a valid plan of study must include at least 36 credits of approved course work. Moreover, the plan of study must satisfy the following rules:

1. Prerequisites must be fulfilled before taking courses that require them;
2. All credits must be at the 600-level or above, excluding ENEE899: Doctoral Dissertation Research;
3. At least 18 credits of ENEE lecture courses must be included;
4. At least six credits of approved non-ENEE courses at the 600-level or above must be included (see **Course Information** section).

5. Three credits of ENEE698: Graduate Seminar must be included, but no more than three may be included;
6. Combined total number of credits of ENEE699: Independent Study and ENEE799: Master's Thesis Research included in the plan of study may not exceed six;
7. No credits of ENEE898: Pre-candidacy Research or ENEE889: Teaching Workshop may be included.

Previous UMCP Credits

Approved courses taken at the University of Maryland, College Park before the student enters the Ph.D. program may generally be counted towards the Ph.D. plan of study. Also, courses taken while the student is enrolled in the Ph.D. program but that were used towards the M.S. degree can be counted for the Ph.D., provided that the credits have not been used for another Ph.D. degree and that all the rules specified above are satisfied.

Credit Reduction Option: Previous M.S. Degree from U.S. Institution

Optionally, for students who have obtained an M.S. degree in Electrical or Electrical and Computer Engineering from a U.S. institution, the course work requirement is reduced to 21 credits. When this option is selected, all other rules above apply except for item 3 – only 12 credits of ENEE lecture courses need be included.

Students selecting this option, however, are not allowed any additional credit transfer.

Transfer of credit

A maximum of 15 credits can be transferred. The following conditions must be met:

1. Any course to be transferred must be equivalent to a graduate-level (600-level or above) lecture course available at the University of Maryland, College Park. Also, if a course is transferred, the equivalent UMCP course may not be included in the plan of study;
2. At least a B (or equivalent) must have been obtained in each course transferred; and
3. The courses must have been taken for graduate credit at the original institution, but may not have been used towards another Ph.D. degree.

Credit transfer is approved only in the context of a specific proposed plan of study. When applying for credit transfer, the student must produce an official transcript, as well as evidence that the course is indeed equivalent to a course offered at the University of Maryland, College Park. Documented evidence should include a course description, as well as a syllabus showing what material was covered in the specific offering the student took, and what text was used. Additionally, the **PhD REQUEST FOR TRANSFER OF GRADUATE CREDIT** form should be submitted. Transfer requests must be submitted within the first semester of enrollment.

Ph.D. Qualifying Requirement

The Ph.D. qualifying requirement consists of two components: a written examination and an oral examination. The purpose of the written examination is to test basic knowledge, understanding, and problem solving at an undergraduate level. The purpose of the oral examination is to test the student's ability to integrate material in a field chosen by the student, to think creatively, and, to a lesser extent, to demonstrate proficiency in the chosen field.

Students will be exempt from the oral exam if they both a) earn a clear passing score as determined by the PhD Qualifying Committee on the written exam; and b) fulfill a course-based component within their first year. The raw score threshold for clear passing scores will be determined after the administration of each written exam. The course-based component will require a minimum GPA of 3.5 in any four core courses, as declared by the student, taken during the student's first two semesters. Only one attempt is allowed at each core course that the student declares towards the course-based component. Students should submit the **PHD QUALIFYING REQUIREMENT COURSE-BASED DECLARATION** form upon satisfying the course-based requirement.

Flowchart of ECE PhD Qualifying System

Written Examination

Administration of the Written Exam

The written examination is given two times per year, usually a few days before classes begin each semester. Students must pass the written examination within one year of entry into the graduate program. They are given two chances to pass and three opportunities to take the exam. For instance, students entering in the fall semester may attempt the exam in August just before the start of the student's first fall semester, in the end of January just before the start of spring semester, and the following August. Students must inform the ECE Graduate Studies Office of their intention to take the written examination at least one week before the exam is scheduled to be given unless an earlier registration deadline has been stated otherwise.

Format of Exam

The Ph.D. written qualifying exam is comprised of 10 sections, each covering a different topic related to Electrical and Computer Engineering. Students must answer five out of the 10 sections. Each section is graded out of 20 points, such that the maximum attainable cumulative score on the exam is 100 points. Calculators, cell phones and all other hand-held electronic devices are not permitted in the exam. The exam is closed-book and closed-notes. The questions shall be composed and graded with these constraints in mind. The total time allowed for the exam is 3 hours and 45 minutes (i.e., 45 minutes on average per section.)

Exam Sections and Topics

The questions are chosen to test understanding of standard undergraduate material at or below the junior level. The list provided below describes the 10 sections of the exam and the topics covered under each section. **Basic Mathematics**

1. Calculus
    a. Derivatives and integrals
    b. Taylor series
    c. Limits and convergence
2. Elementary Linear Algebra
    a. Matrices and vectors – linear independence and orthogonality
    b. Eigenvalues and eigenvectors
3. Differential Equations
    a. First order linear and nonlinear differential equations
    b. Second-order linear ordinary differential equations
    c. Systems of first order linear ordinary differential equations
4. Vector Calculus
    a. Partial derivatives, curl, gradient, vector fields
    b. Line, surface, and volume integrals

Probability

1. Basic probability
    a. Random experiments, axioms of probability
    b. Conditional probability, Bayes' theorem, independence
    c. Permutations and combinations, counting methods
    d. Discrete, independent, identically distributed trials: binomial, multinomial, and geometric distributions
    e. Poisson distribution and its applications
2. Random Variables
    a. Probability density (PDF), probability mass (PMF) and cumulative distribution (CDF) functions
    b. Common continuous distributions: uniform, exponential, Gaussian, Laplace
    c. Expectation and variance; fundamental theorem of expectation
    d. Simple transformations of random variables
3. Multiple Random Variables
    a. Joint and marginal distributions
    b. Conditional PDFs and PMFs; iterated (total) expectation
    c. Basic properties of independent random variables
    d. Correlation and covariance

Electromagnetism

1. Electrostatics and Magnetostatics
    a. Gauss’s, Ampere’s, Biot-Savart’s, and Coulomb’s laws
    b. Boundary conditions at dielectric and conducting interfaces
    c. Scalar and vector potential

    d. Calculating capacitance and inductance
2. Electrodynamics and Waves
    a. Maxwell's equations
    b. Wave equation and Helmholtz equation
    c. Plane wave solutions in lossy and lossless materials
    d. Poynting vector and power density
3. Reflection and Transmission of Plane Waves
    a. Normal incidence at dielectric and conducting interfaces
    b. Reflection from multiple layers (normal incidence)
    c. Oblique incidence at dielectric and conducting interfaces
    d. Snell's law, Brewster's angle and total internal reflection
4. Transmission Lines
    a. Transmission line equations for V and I (Telegraphist's equations)
    b. Characteristic inductance, capacitance, and impedance of transmission lines
    c. Input impedance of terminated transmission lines
5. Waveguides
    a. TE and TM modes of metallic waveguides
    b. Dispersion relations and cutoff frequencies
    c. Parallel plate and rectangular waveguide

Circuits

1. Linear Circuit Analysis
    a. Series and parallel combinations, voltage and current dividers
    b. Node-voltage and mesh-current methods
    c. Norton and Thevenin equivalent sources
2. AC Circuits Analysis
    a. Phasor representation of sinusoidally varying signals
    b. Complex impedance
    c. Time averaged power
    d. Transfer functions and frequency response
3. Transient Analysis
    a. 1st order RC and RL circuits
    b. 2nd order RLC circuits
4. Ideal Operational Amplifier Circuits
    a. Common op-amp circuits: buffer, inverting, non-inverting, summing, integrating, differentiating amplifier circuits
    b. Analyzing ideal op-amp circuits
5. Diode Circuits
    a. Ideal and non-ideal idiode operation
    b. Rectifers
    c. Load lines and biasing
6. BJT and CMOS Transistors
    a. DC analysis and biasing
    b. Small signal equivalent models
7. Transistor circuits

a. CMOS digital gate circuits and inverters
b. Amplifiers and small signal equivalent circuits
c. Current sources, mirrors, differential pairs

Linear Systems and Signals

1. Linear Time-Invariant (LTI) Systems
    a. Basic concepts: linearity, time invariance, causality
    b. Convolution (discrete and continuous)
    c. Impulse and step response (discrete and continuous)
2. Fourier Analysis in Continuous Time
    a. Fourier series of a periodic signal; determination of coefficients
    b. Fourier transform; basic properties and pairs
3. Fourier Analysis in Discrete Time
    a. Discrete-time Fourier transform (DTFT) of a sequence; basic properties and pairs
4. Continuous-Time LTI Systems in the s-Domain
    a. Laplace transform and its properties; regions of convergence
    b. Systems described by differential equations
    c. Transfer function: poles, zeros; causality and stability
    d. Determination of system output using the Laplace transform
    e. Relationship between Laplace and Fourier transforms; response of stable LTI systems to exponential and sinusoidal inputs; input-output relationship in the frequency domain

Devices

1. Elementary Properties of Materials
    a. Semiconductors
    b. Conductors
    c. Insulators
2. Basic Solid State Devices: PN Junctions, Bipolar Transistors, MOS Capacitors, MOSFETs
    a. Fundamental structure of these device
    b. Their internal operation in terms of electrons and holes, drift and diffusion currents, and electromagnetic principles
    c. Operation of these devices as circuit elements

Computer Architecture and Systems

1. Pipelines and their analysis
2. Caches and their analysis
3. Assembly code and program analysis
4. Virtual memory
5. Multitasking and process management

Digital Logic

1. Boolean Algebra and Boolean Simplification (K-Maps and Quinn McCluskey methods)
2. Complex Logic Design With Simple Boolean Functions (Adders, Subtractors etc.)
3. Flip Flops
4. Synchronous Sequential Systems

Basic Physics

1. Newtonian Mechanics
    a. Kinematics
    b. Newtons laws of motion
    c. Work, energy and power
    d. Momentum and center of mass
    e. Circular motion and rotation
    f. Harmonic oscillation
2. Waves and Optics
    a. Wave equations
    b. Traveling waves and standing waves
    c. Interference, superposition and diffraction
3. Thermodynamics and Heat
    a. Ideal gas law
    b. Pressure, work, and heat
    c. Laws of thermodynamics
4. Modern Physics and Quantum Mechanics
    a. Schrodinger wave equation
    b. Operators, eigenfunctions and eigenvalues
    c. One dimensional potentials - bound and unbound solutions
    d. Angular momentum and spin

Software

1. Data types, Variables and Operators
2. Program Control and Structure
    a. Expressions, declarations, and statements
    b. Functions, arguments, return values, and recursion
    c. Storage classes and variable scope
    d. Loop structures (for, while, do)
    e. Conditional execution (if-then-else, switch)
3. Input and Output
    a. Formatted input and output (printf, scanf)
    b. Basic file I/O (fopen, fclose, fprintf, fscanf)
4. Arrays
    a. Strings
    b. Arrays
    c. Pointers
5. Dynamic Memory Allocation (malloc, calloc, free, realloc)

6. Structures
7. Linked lists
8. The C pre-processor
    a. #include, #define, #ifdef
    b. Standard library header files

The software section covers undergraduate programming at a level treated in most Electrical and Computer Engineering curricula. In this exam, ANSI C is used consistently as the specific language for programs. It is insufficient for students to convey the "general idea" of a solution through pseudocode or code in some other programming language; syntactically and logically correct ANSI C code must be provided to receive full credit.

Previous semesters' exam questions are posted at

http://www.ece.umd.edu/qual-exam

Oral Examination

Students who earn a clear pass in the written examination are eligible to take the oral examination. Students who earn a borderline pass and have a 3.25 GPA or greater in core courses taken during their first two semesters—one attempt only—are eligible to take the oral examination. The raw score thresholds for borderline passing (and passing) scores will be determined after each administration of the written exam by the PhD Qualifying Committee. The student will choose any two core courses for the oral exam:

- Communications & signal processing: ENEE 620, 621, 627, 630
- Computer engineering: ENEE 640, 641, 645, 646
- Controls: ENEE 620, 660, 661, 664
- Electrophysics: ENEE 680, 681, 690, 691
- Microelectronics: ENEE 600, 601, 610, 611

Technical material covered in the oral exam involves undergraduate material in the chosen area and graduate material as represented in the two chosen 600-level courses.

Students must pass the oral exam within two years of entering the graduate program. They are given two chances to pass the exam. The number of opportunities depends upon when the student passes the written exam and meets the course-based eligibility requirement.

Administration of the Oral Examination

The oral exam is given twice a year, once each semester. It is typically held in November and in April.

The oral examination normally is given by a panel of three appointed ECE faculty members, one of whom is designated as the panel chair. The exam lasts approximately one hour but shall not exceed 90 minutes. Panel members are expected to confer briefly before the examination begins.

After the examination ends, the student is expected to leave the room, and the panel will again confer privately to reach a pass or fail decision. A majority vote will suffice if the decision is not unanimous. After the decision is reported to the GSO, the student will be notified.

Appeals

A student may make a written appeal of a fail or borderline pass to the Ph.D. Qualifying Committee. The Ph.D. Qualifying Committee may elect to make a decision based on the written appeal or to interview the student, or to obtain input from the oral examination committee if an oral exam is being appealed before coming to a decision.

Research Proposal Examination

Students may register for their first attempt only after having satisfied the Ph.D. qualifying requirement but must register by the end of their **fourth year**. For example, a student who entered in fall 2014 must register by August 2018, before the start of classes. Students who fail to register by the end of their fourth year will forego one attempt. Please see the second item below regarding repeat attempts.

Students register by submitting a completed Ph.D. Research Proposal Examination Committee Selection form and abstract of their research proposal to the Graduate Studies Office no later than two weeks prior than the tentative date of the examination.

Three attempts may be taken at the examination. A repeat attempt must take place at least three months after the previous attempt. The proposal exam must be passed before the end of the student's fifth year. For example, a student who entered in fall 2014 must pass the proposal exam by July 25, 2019. (As per Graduate School regulation, students must advance to candidacy within five years of entry; the proposal is a candidacy requirement.)

Each examination is conducted by an ad hoc Ph.D. Research Proposal Examination Committee consisting of three full members of the Graduate Faculty. The candidate's advisor chairs the committee. The second member of the committee is selected by the student (with the advisor's approval). The second member must be a regular ECE faculty member or affiliate member; however, if the candidate's advisor is an affiliate member of the department's faculty, the second member of the committee must be a regular ECE member. The third member of the committee is selected by the Graduate Studies and Research Committee (GSRC) once the student has registered for the attempt. The advisor/student may suggest potential members for GSRC consideration. The third member will be a regular ECE faculty member. For a repeat attempt, the committee consists of the same faculty members who served for the first attempt.

The examination must be scheduled for a two-hour period. It must take place no later than four weeks after the candidate has been notified of the identity of the third committee member. The student is responsible for scheduling and room reservation. The student is also responsible for announcing the time and place to the committee and providing a PDF copy of the proposal to all committee members at least one week before the examination. The proposal should contain:

- motivation for the research,
- a concise statement of the proposed problem,
- an outline of the methodology, and
- a careful survey of relevant literature.

All Electrical and Computer Engineering regular faculty members are allowed to attend the examination, but only committee members may address questions to the examinee. Upon invitation by the chair of the committee, other faculty may be allowed to attend the entire

examination. Other members of the department or interested visitors may attend the presentation portion (first 30 minutes) at the discretion of the committee in consultation with the student.

At the examination the student is requested to:

- give a presentation on the main lines of the proposed Ph.D. research
- answer questions from the committee

Not counting the time devoted to the research proposal presentation, a significant portion of the examination may be devoted to questions assessing the soundness of the proposed research. The remainder of the examination may be given to questions probing the student's mastery of the fundamentals in his/her proposed field of specialization, taken in a broad sense.

At the end of the examination, all but the committee members must leave the room for the committee's deliberations. In order for the student to pass, the committee's decision must be unanimous.

Upon passing the examination, a finalized copy of the research proposal must be emailed to the Graduate Studies Office for the student's file.

Doctoral Research Credits (ENEE 898 and 899)

Every Ph.D. student must successfully complete 12 credit hours of ENEE899: Doctoral Dissertation Research. Students are eligible to take ENEE899 only after they have advanced to candidacy. Doctoral candidates are automatically registered by the Registrar for each fall and spring semester until they graduate for six-credit blocks of ENEE899 and are billed at a flat tuition rate.

Students who have not yet reached candidacy may register for ENEE898: Pre-candidacy Research. ENEE898 does not fulfill any course requirements and is not equivalent to ENEE899 in satisfying the dissertation research credit requirement.

Doctoral Dissertation and Oral Defense

Directions for the preparation and submission of dissertations can be found in the *Thesis and Dissertation Style Guide*, on-line at:
http://www.gradschool.umd.edu/current_students/etd_style_guide.html

As per departmental regulation, the dissertation committee must include all three members of the student's Research Proposal Examination Committee. (Department rules for proposal examination committees are detailed above.) Dissertation committees may have co-chairs upon recommendation of the department's graduate director and with the approval of the dean of the graduate school. In addition, membership on dissertation examining committees must adhere to Graduate School policy.

From the *Graduate Catalog* on the Dissertation Examining Committee (www.gradschool.umd.edu/catalog):

- **Dissertation Examining Committee Membership.** The Committee must include a minimum of five members of the Graduate Faculty, at least three of whom must be Full Members. The Chair of the Committee normally will be the student's advisor, who will be a Full Member of the Graduate Faculty, or who has been granted an exception to the policy by the Dean of the Graduate School. Each Committee will have appointed to it a representative of the Dean of the Graduate School. The Dean's Representative may be one of the five voting members. Alternatively, the Dean's Representative may not be a voting member of the Committee. Whether the Dean's Representative votes or not is a decision made by the student, primary advisor and the Dean's Representative before the Dean's Representative is nominated for approval by the Dean of The Graduate School. In addition, the Dean will ensure that there are five voting members on the Committee. Therefore, Committees that have a non-voting Dean's Representative must have at least six members (five voting members and the non-voting Dean's Representative).

- **Nomination of the Dissertation Examining Committee.** Membership on a Dissertation Examining Committee requires nomination by the student's advisor and the Graduate Director of the student's graduate program and approval by the Dean of the Graduate School . The nomination of a Dissertation Examining Committee should be provided to the Graduate School at least six weeks before the date of the expected dissertation examination. The dissertation examination cannot be held until the Graduate School approves the composition of the Dissertation Examining Committee. Furthermore, if the Graduate Faculty status of any member of an approved Dissertation Examining Committee changes, the approval of the Dissertation Examining Committee may be void, and a new Dissertation Examining Committee nomination form may be required to be approved by the Graduate School.

- **Chair.** Each Dissertation Examining Committee will have a chair, who must be a Full Member of the Graduate Faculty or, by special permission, has been otherwise appointed by the Dean of the Graduate School. Dissertation Examining Committees may be co-chaired upon written recommendation of the program's Graduate Director and with the approval of the Dean of the Graduate School; at least one of the co-chairs must be a Full Member of the University of Maryland Graduate Faculty.

- **Representative of the Dean of the Graduate School.** Each Dissertation Examining Committee will have appointed to it a representative of the Dean of the Graduate School. The Dean's Representative should have some background or interest related to the student's research. The Dean's Representative must be a tenured member of the Graduate Faculty at the University of Maryland. The Dean's Representative must be from another tenure home than the student's primary advisor, or co-advisor(s). In the case of multi-disciplinary programs, the Dean's Representative can be a member of the program, as long as they have a different tenure home from the primary advisor, co-advisor(s), or Doctoral Committee Chair (if the Doctoral Committee Chair is not a primary advisor).

The person nominated to become the Dean's Representative may serve as a regular

member of the student's Doctoral Graduate Committee from the time it is first convened. Alternatively, the person nominated to be the Dean's Representative may be added to the Doctoral Graduate Committee at a later date and either take part in some Committee meetings including the qualifying examination, or only join as a Doctoral Dissertation Committee member for the final dissertation defense. In all cases, the Dean's Representative must be present for the full dissertation defense and serve to adjudicate the defense.

- **Special Members.** Individuals from outside the University of Maryland who have been approved for Special Membership in the Graduate Faculty may serve on Dissertation Examining Committees. These Special Members must be in addition to the required three Full Members of the University of Maryland Graduate Faculty. For procedures to nominate an individual for Special Membership, please refer to the section below on Graduate Faculty....

The student is responsible for scheduling the defense with the committee and reserving a conference room for the dissertation defense. The student must also provide a PDF copy of his/her dissertation to all committee members at least 10 working days before the defense.

The student must provide the Graduate Studies Office with the date, time, and location, and abstract at least two weeks before the defense so that it may be announced to the department. Information about the proper announcement format can be obtained from the Graduate Studies Office.

For more details, and for the rules governing the dissertation oral examination, see the *Graduate Catalog* at: http://www.gradschool.umd.edu/catalog

Graduation Forms

Graduation Forms

A number of forms must be submitted during the semester in which you plan to graduate. Please be sure to follow departmental deadlines — those set forth by the Graduate Studies Office. (The Graduate School deadlines may be later, but you should adhere to GSO deadlines in order to ensure timely processing.) Please consult the **GRADUATION DEADLINES CHECKLIST** available at http://www.ece.umd.edu/grad/forms/graduation and from the Graduate Studies Office.

M.S. Students — Graduation

M.S. students must apply online for graduation and be enrolled at the beginning of the semester in which they plan to graduate:

1. http://www.testudo.umd.edu (Graduate School)

M.S. with thesis students must submit the following to the Graduate Studies Office:

1. **APPROVED PROGRAM FOR MASTER'S DEGREE** form

2. **NOMINATION OF THESIS OR DISSERTATION COMMITTEE** form

3. **REPORT OF THE ORAL EXAMINING COMMITTEE** form (with original signatures). This form is given to the advisor at the time of the defense and should be submitted by the advisor.

The final, approved electronic version of your thesis must be submitted to the Graduate School. Instructions for electronic submission and the Graduate School's *Thesis and Dissertation Style Guide* can be found at http://www.gradschool.umd.edu/current_students/etd_style_guide.html

M.S. non-thesis students must submit the following to the Graduate Studies Office:

1. **APPROVED PROGRAM FOR MASTER'S DEGREE** form

2. **M.S. SCHOLARLY PAPER READER SELECTION** form

3. **CERTIFICATION OF MASTER'S DEGREE WITHOUT THESIS** form

4. **APPROVAL OF M.S. SCHOLARLY PAPER** form

5. Final copy of scholarly paper

All forms can be obtained at http://www.ece.umd.edu/grad/forms/graduation and from the Graduate Studies Office. All Graduate School forms are also available online at http://www.gradschool.umd.edu/current_students/general_forms_for_graduate_students.html

Ph.D. Students — Advancement to Candidacy & Graduation

Ph.D. students must apply online for graduation and be enrolled at the beginning of the semester in which they plan to graduate:

2. http://www.testudo.umd.edu (Graduate School)

Ph.D. students must submit the following to the Graduate Studies Office:

1. **APPLICATION FOR ADMISSION TO CANDIDACY** form

2. **NOMINATION OF THESIS OR DISSERTATION COMMITTEE** form

3. **REPORT OF THE ORAL EXAMINING COMMITTEE** form (with original signatures). This form is given to the advisor at the time of the defense and should be submitted by the advisor.

The final, approved electronic version of your dissertation must be submitted to the Graduate School. Instructions for electronic submission and the Graduate School's *Thesis and Dissertation Style Guide* can be found at http://www.gradschool.umd.edu/current_students/etd_style_guide.html

All forms can be obtained at http://www.ece.umd.edu/grad/forms/graduation and from the Graduate Studies Office. All Graduate School forms are also available online at http://www.gradschool.umd.edu/current_students/general_forms_for_graduate_students.html

Regulations

Petition for Waiver of Regulation

Student petitions for exceptions to the policies and requirements listed in the ECE Graduate Handbook will be considered by the Graduate Studies and Research Committee (GSRC). Petitions should be submitted directly to the Graduate Studies Office (GSO). Student petitioners may seek advice from GSRC faculty/student members on generic issues related to their petitions but are advised not to discuss specific details. Student petitioners should note that GSRC faculty/student members cannot act as advocates on their behalf. The petitioners should not give out any written documents to support their case to the faculty/student representatives but should supply all the relevant documents directly to the GSO. The student's own explanation as listed on the petition form shall be provided to the GSRC. (Limit: one page explanation by student). In the case that a GSRC member is unable to form an unbiased opinion, the member should abstain from voting.

Students should submit the departmental **PETITON FOR WAIVER OF REGULATION** for exceptions to departmental policy. Students should submit the Graduate School's **PETITION FOR WAIVER OF REGULATION** for exceptions to Graduate School policy.

Advisor (Academic, Research, or Area Advisors)

Upon admission, students will be initially assigned an academic advisor based on the technical interests indicated in the application. The academic advisor will serve in this capacity for the first year and is a regular or affiliate faculty member in ECE from whom students should seek general advice, such as in selecting courses for the plan of study. For students who are offered a graduate research assistantship, the research advisor should serve as the academic advisor, unless he/she is not a regular or affiliate faculty member in ECE. All students are expected to meet with their academic advisors at least once per semester.

During the first semester in the program, students may wish to contact other faculty members who share their technical interests. Students may consult with one of the department's area advisors for guidance in locating a research advisor. The Graduate Studies Office can help put students in touch with an area advisor.

Regardless of funding, by the second year, all students are expected to establish a relationship with an advisor who will both provide academic advising and direct their research. This advisor is referred to as the student's research advisor. Students are expected to submit the **CHANGE OF ACADEMIC ADVISOR** form whenever a new advising relationship is established. This form must be signed by the faculty member who will serve as the new advisor. The change of advisor is subject to the associate chair's approval, and the former advisor will also be contacted.

For M.S. non-thesis students, the research advisor serves as the first reader of the scholarly paper. For M.S. with thesis students, the research advisor chairs the Thesis Examining Committee. For Ph.D. students, the research advisor chairs the research proposal exam and the Dissertation Examining Committee.

Full-Time Status

From the *Graduate Catalog* (http://www.gradschool.umd.edu/catalog):

> The Graduate School uses a unit system in making calculations to determine full-time or part-time student status. Please note that graduate units are different from credit hours. The number of graduate units per credit hour is calculated in the following manner:
>
> - Courses in the series: 000-399 carry 2 units per credit hour.
> - Courses in the series: 400-499 carry 4 units per credit hour.
> - Courses in the series: 500-599 carry 5 units per credit hour.
> - Courses in the series: 600-897 carry 6 units per credit hour.
> - Master's Research course: 799 carries 12 units per credit hour.
> - Pre-candidacy Doctoral Research courses: 898 carries 18 units per credit hour.
> - Doctoral Dissertation Research: 899 carries 18 units per credit hour. All doctoral candidates must pay candidacy tuition for which they will be registered for six (6) credit hours of 899; this defines all currently registered doctoral candidates as full-time.
>
> To be certified as full-time, a graduate student must be officially registered for a combination of courses equivalent to 48 units per semester. Graduate assistants holding regular appointments have full-time status if they are registered for at least 24 units in addition to the assistantship; holders of half-time assistantships are considered full-time if registered for 36 units. Audited courses do not generate graduate units and cannot be used in calculating full-time or part-time status.

Full-time registration throughout the fall and spring semesters is required for international students on F-1 or J-1 visa. Please check with the Office of International Student and Scholar Services for exceptions to this policy.

Continuous Registration Requirement

From the *Graduate Catalog* (http://www.gradschool.umd.edu/catalog):

> All graduate students must register for courses and pay associated tuition and fees each semester, not including summer and winter sessions, until the degree is awarded.
>
> A student who fails to register and who has not requested and received a waiver of registration or "Leave of Absence for Childbearing, Adoption, Illness or Dependent Care" will be notified by the Graduate School after the first day of classes that the student must register for the current semester. The Graduate School will also inform the Graduate Director of the graduate program that the student is in jeopardy of termination. If the student does not register, he or she will be dismissed from the Graduate School at the end of the semester for failure to comply with the continuous registration requirement.

> A student who is dismissed for non-registration may appeal dismissal during a 30-day period following the end of the semester of non-registration. If the student does not appeal, or if the appeal is denied, and the student wishes to continue in the Graduate School, the student must apply for readmission. In this case, readmission does not alter the initial requirements for time to complete the degree or advance to candidacy.
>
> Certificate, Master's, and pre-candidacy Doctoral students who will be away from the University for a semester or a year may request a waiver of continuous registration and its associated tuition for the semester or year. Waivers of registration will be granted only if the student is making satisfactory progress toward the degree and can complete the degree requirements within the required time limits. Interruption of registration cannot be used to justify a time extension….
>
> Doctoral Candidates are not eligible for Waivers of Continuous Registration. Each doctoral Candidate must maintain continuous registration in 899 (Doctoral Dissertation Research) until the degree is awarded. Waivers of Registration may be granted only under the University's policy for Leave of Absence for Graduate Students for Childbearing, Adoption, Illness or Dependent Care (see below).

Please see the Graduate Catalog or visit the ECE Graduate Studies Office for more detailed information about submitting the **PETITION FOR WAIVER OF CONTINUOUS REGISTRATION**.

Leave of Absence

From the *Graduate Catalog* (http://www.gradschool.umd.edu/catalog):

> In recognition of the effects that childbirth, adoption, illness, and caring for incapacitated dependents (such as children, ill or injured partners, or aging parents) may have on the time and energy that graduate students have to devote to their educational programs, the University allows students in such circumstances to apply for a leave of absence of up to two semesters during which time they do not intend to make academic progress toward the completion of their degree. The time taken on an approved leave of absence is not included in the time limitations for degree completion and advancement to candidacy. For the Graduate Student Parental Accommodation Policy, which enables students to maintain full-time enrollment status rather than take a leave of absence, see the **Parental Accommodation Policy**.

If a leave of absence is granted by the Graduate School, all ECE department deadlines are shifted accordingly. Students should submit the **REQUEST FOR LEAVE OF ABSENCE** form with supporting documents to the ECE Graduate Studies Office prior to the beginning of the academic term for which leave is being requested.

Parental Accommodation Policy

From the *Graduate Catalog* (http://www.gradschool.umd.edu/catalog):

The University of Maryland Graduate Student Parental Accommodation Policy provides a period of up to six (6) weeks during which new parents may postpone completion of academic requirements. It is intended to provide graduate students with an opportunity to integrate the challenges of new parenthood with the demands of graduate-level training, scholarship, and research. In addition to providing support to young families, this policy seeks to reduce attrition and improve time to degree for students who become parents.

The Parental Accommodation Policy is not a leave of absence. This policy allows students to maintain status as full-time, registered graduate students, and thus be eligible for the rights and privileges of registered students (e.g., access to University resources) while adjusting to their new familial obligations.

During this parental accommodation period, eligible students will continue to be enrolled as fulltime graduate students and will continue to pay tuition and fees. Students also will be expected to keep the lines of communication with their departments open and demonstrate to their advisors that they are academically engaged and making progress in coursework and research, though perhaps at a slower pace.

ELIGIBILITY: To be eligible to apply for the benefits of the Parental Accommodation Policy, a new parent must (1) have been enrolled full-time for at least one full semester in a graduate program at the University, (2) be enrolled full-time at the time of application, (3) be in good academic standing, and (4) be making satisfactory progress toward degree. Any parent (regardless of gender) is eligible to apply.

In the event that both parents are eligible, each is individually entitled to a Parental Accommodation period of up to six (6) weeks. This Parental Accommodation period may be taken concurrently with or consecutively to the Parental Accommodation period taken by the other parent, with or without some overlap. The total combined Parental Accommodation period for both parents, however, may not exceed 12 weeks and must conclude 12 weeks following the child's birth or adoption.

ACCOMMODATION: Approval of a student's application for a period of Parental Accommodation allows the student, assuming the prior agreement of instructors, advisor, and academic program, to modify deadlines and academic expectations to accommodate the student's new parental responsibilities. Students may be able to postpone completion of course assignments, examinations, and other academic requirements for a period of up to six (6) weeks. Students who will be enrolled in courses during the accommodation period must meet with their instructors to develop a written plan as to how they will satisfactorily complete the course(s). These plans must be approved and signed by the instructor(s) and submitted as part of the Parental Accommodation Application form. At the end of the accommodation period, students are expected to return to graduate study and resume progress toward completion of their degree. Deadlines with regard to time to degree, time to candidacy, time to comprehensive or qualifying exams, etc. will be extended one semester per childbirth or adoption, upon the request of the student. The total additional time granted for the extension of any deadlines as a result of the student's use of the Parental Accommodation Policy, however, cannot exceed a maximum period

of one (1) year, regardless of the number of births or adoptions, or the number of times the student invokes the Parental Accommodation Policy.

The period of Parental Accommodation begins immediately upon the birth or adoption; must be taken in a consecutive block of time; and cannot extend beyond six (6) weeks. The student may not divide the accommodation period into separate periods or defer the accommodation period beyond this time limit. In the event of simultaneous multiple births or adoptions, the maximum Parental Accommodation period for which a student is eligible with respect to that event remains six (6) weeks.

APPLICATION: At least eight (8) weeks prior to the anticipated birth or adoption, students must submit a written application for Parental Accommodation signed by the Faculty Advisor, Director of Graduate Studies, and the Chair of their academic department, to the Graduate School. (In unusual or extraordinary circumstances, the Graduate School may accept applications with less than eight week's notice.)

Written plans to complete coursework, signed by the student and the instructor, must be provided for each course in which the student will be enrolled during the accommodation period. The discretion to provide an accommodation that allows a student to be away from the classroom for six weeks rests with the individual course instructor. Faculty are strongly encouraged to work with students to develop an accommodation that permits the student to fulfill academic coursework requirements while benefitting from a period of parental accommodation, and that also maintains fairness with regard to other students. In some cases such an accommodation may not be feasible. In such cases, faculty should provide a written explanation to the department's Director of Graduate Studies as to why the accommodation is not possible, and students should adjust their class schedules accordingly.

The Dean of the Graduate School will review the request and notify the student and the student's academic program if the request for a period of Parental Accommodation has been approved. The Graduate School will coordinate with academic programs to make appropriate adjustments to the student's deadlines and records. Retroactive requests will not be considered. A copy of the application form is attached.

International students should discuss plans with the Office of International Services as soon as possible in order to identify and address proactively any individual or unique visa issues and/or to consider the latest applicable regulations. The intent of this policy is to permit all students to maintain their status as full-time, enrolled students during this period of accommodation. Medical complications, prior to or following the birth, are not covered by this policy. If a student is not able to return at the end of the period of accommodation, s/he should consider applying for a Leave of Absence…

Academic Integrity

From the *Graduate Catalog* (http://www.gradschool.umd.edu/catalog):

> The University is an intellectual community. Its fundamental purpose is the creation and dissemination of knowledge. Like all other communities, the University can function properly only if its members adhere to clearly established goals and values. Essential to the fundamental purpose of the University is the commitment to the principles of truth and academic honesty. The Code of Academic Integrity is designed to ensure that the principle of academic honesty is upheld. While all members of the University community share this responsibility, The Code of Academic Integrity is designed so that special responsibility for upholding the principle of academic honesty lies with students.

Penalties for Violations of Academic Integrity

From the *Graduate Catalog* (http://www.gradschool.umd.edu/catalog):

> Students who are found to have falsified, fabricated, or plagiarized in any context, such as course work, laboratory research, archival research, or thesis / dissertation writing, will be referred to the Office of Student Conduct. The Office of Student Conduct has some discretion in determining penalties for violations of the University's standards of academic integrity, but the normal sanction for a graduate student found responsible for a violation of academic integrity will be dismissal (suspension or expulsion) from the University.

To review the official UM policy on academic integrity, see the University of Maryland Code of Academic Integrity at http://www.president.umd.edu/policies/iii100a.html

Academic Probation and Dismissal

From the *Graduate Catalog* (http://www.gradschool.umd.edu/catalog):

> A student whose cumulative grade point average falls below 3.0 will be placed on academic probation by the Graduate School. When a student is placed on probation, the Graduate School will notify both the student and the Graduate Director of the student's program. Permission of the academic advisor and the Graduate Director will be required for a student on probation to register for courses. Probation will be lifted when the student achieves a cumulative GPA of 3.0.
>
> A student on probation who has completed fewer than 15 credits must raise the GPA to 3.0 or above by the end of the semester in which the student completes 15 credit hours or be dismissed from the Graduate School. A student who has completed 16 or more hours of course work and whose cumulative GPA falls below 3.0 will be placed on probation

and will have one semester in which to raise his or her GPA to a 3.0 or be dismissed from the Graduate School.

Time Limitations for Doctoral Degrees

From the *Graduate Catalog* (http://www.gradschool.umd.edu/catalog):

> Students must complete the entire program for the doctoral degree, including the dissertation and final examination, during a four-year period after admission to candidacy, but no later than nine years after admission to the doctoral program. Students must be advanced to candidacy within five years of admission to the doctoral program. Under certain circumstances, time extensions may be granted by the Graduate School as outlined below. Admission to the degree program terminates if the requirements are not completed in the time specified. Time taken for an approved Leave of Absence for Childbearing, Adoption, Illness or Dependent Care is not counted in these time limitations.

Time Extensions for Doctoral Students

From the *Graduate Catalog* (http://www.gradschool.umd.edu/catalog):

> Extensions of time for doctoral students must be requested from the Graduate School by the doctoral program. The first request for an extension of the deadline for admission to candidacy or completion of the doctoral dissertation requires a letter of support from the Graduate Director. The letter must include a timetable listing specific goals to be accomplished at various points during the extension period. Normally, the extension will be for a maximum of one year.
>
> The request for a second extension requires a letter of support from the Graduate Director that includes a statement that the graduate program has approved the request. Departmental approval may be either a vote of the department as a whole or of a committee designated to deal with such matters, such as the Graduate Committee. The letter must include a timetable that lists specific goals to be accomplished at various points during the extension period. Typically this extension will be for a maximum of one year.
>
> Requests for a third extension will be honored only in rare instances when serious and unforeseen circumstances that are not covered under the Leave of Absence for Childbearing, Adoption, Illness or Dependent Care policy have interfered with the student's normal progress toward the degree. The request for a third extension requires a letter of support from the Graduate Director that includes a statement that the program has approved the request. The letter must include a timetable listing specific goals to be accomplished at various times during the extension period. Typically, this extension will be for a maximum of one year. The third extension is the final extension. Additional extensions will not be approved by the Graduate School.

Students should submit the **REQUEST FOR TIME EXTENSION FOR COMPLETION OF GRADUATE DEGREE** form with supporting documentation to the ECE Graduate Studies Office at least a month before their termination date.

Incomplete Grades

From the *Graduate Catalog* (http://www.gradschool.umd.edu/catalog):

> An incomplete is a mark that an instructor may award to a student whose work in a course has been qualitatively satisfactory, but who is unable to complete some portion of the work required because of illness or other circumstance beyond the student's control. In awarding the mark of "I" for graduate courses other than 799 and 899, instructors must fill out an "Incomplete Contract for Graduate Students." The contract will specify the work remaining to be completed. It must be signed by the instructor and the student and maintained by the department offering the course. The student is responsible for providing a copy of the contract to the director of graduate studies in his or her program.
>
> The mark of incomplete in 500-, 600-, 700-, and 800-level courses will not automatically roll-over to letter grades. Normally, students are expected to complete courses in which they have received an "I" by a date no more than twelve months from the beginning of the semester in which the course was taken. The mark of incomplete in 400-level courses will be governed by the rules for awarding incompletes to undergraduate students, including the provision of automatically converting an "I" to a letter grade.
>
> Advisors should stay current with their students in urging completion of incomplete grades, and programs should review the status of incompletes in their annual reviews of students' progress toward their degrees. Students will remain in good standing despite marks of incomplete if the courses are not required for their degrees. For courses required for graduation, students will be considered to be making satisfactory progress only if they fulfill the conditions of any outstanding incomplete contracts in a timely manner. An "I" can remain in place on a student's transcript for a maximum of one year.
>
> Departments and programs may specify the maximum number of incomplete credits students may carry, exclusive of credits in 799 and 899.

Students are strongly encouraged to obtain the **INCOMPLETE CONTRACT FOR GRADUATE STUDENTS** form and to initiate the paperwork process with the instructor. Students should ensure that the terms of the incomplete contract (work to be completed and completion date) are clear and specific. Students are responsible for providing a copy of the contract to the Graduate Studies Office. The form can be found online at http://www.gradschool.umd.edu/images/uploads/Incomplete_Contract.pdf

Registration

Registering for ENEE 699/799/898

To register for ENEE 699: Independent Study, ENEE799: Master's Thesis Research and/or ENEE898: Pre-candidacy Doctoral Research you must submit the appropriate paperwork for the particular course at least two weeks before the start of the semester in which you wish to register.

For ENEE699, you must complete the **APPROVAL FORM FOR INDEPENDENT STUDY (ENEE 699).** For ENEE 799/898, you must complete the **APPROVAL FORM FOR RESEARCH REGISTRATION (ENEE 799/889/898)**. In all cases, the signature of the faculty member who is to supervise the studies or research must be obtained. The faculty member's "section number" must be entered on the form. Section numbers can be obtained from the Graduate Studies Office. Once the completed forms have been submitted to the ECE Graduate Studies Office, permission will be granted so that you may register for these courses on http://www.testudo.umd.edu/

Registering for ENEE 400-level courses

To register for ENEE undergraduate courses, please request permission from the ECE Undergraduate Studies Office by filling out the form for graduate students at the bottom of this webpage: http://www.ece.umd.edu/undergrad/courses Priority will be given to ECE undergraduate students, and permission may not be given before the start of classes. Permission will not be granted for graduate students to enroll on ENEE408 Capstone Courses.

Grading Methods

Course	Grade (A-F)	Satisfactory or Failure	Audit
ENEE 698	Yes	Yes	Yes
ENEE 699	Yes	Yes	NO
ENEE 799	NO	Yes	NO
ENEE 898	NO	Yes	NO
ENEE 899	NO	Yes	NO
All Other	Yes	NO	Yes

From the *Graduate Catalog* (http://www.gradschool.umd.edu/catalog):

Grading Systems: The conventional A through F grading system is used in graduate level courses. A "satisfactory or failure" (S-F) grading system may be used for certain types of graduate study at the discretion of the graduate program. These include courses that require independent fieldwork, special projects, or independent study. Graduate program seminars, workshops, and graduate program courses in instructional methods may also be appropriate for the S-F grading system. The "pass-fail" grading system is not available for graduate students. However, a graduate program may allow, in certain cases, a graduate student to use the pass-fail option for 100-300 level courses. Graduate credit may not be earned for these courses. Either the A-F or the S-F grading system may be used for Master's Thesis (799), and Pre-candidacy (898) and Doctoral Dissertation (899) Research, as well as for courses labeled "Independent Study" or "Special Problems." Only one grading system may be used per course in a particular semester

except for thesis and dissertation credits. The grading system will be designated by the student's graduate program or the graduate program offering the course.

Student Affairs

Engineering Co-op & Career Services

The Engineering Co-op & Career Services assists students in finding cooperative education, summer internships, and part-time engineering positions. Students participating in these programs earn a salary, gain professional experience, integrate theory into practice, and confirm career choices. For further information, please visit the Engineering Co-op & Career Services at http://www.coop.engr.umd.edu/

Graduate Student Life

The Office of Graduate Student Life (GSL) was established to provide programming and advocacy for graduate student needs on campus as well as to promote interdisciplinary interaction and campus community for all graduate students. The office conducts research on graduate students' quality of life and advocates for graduate students' needs. Other services include social programming, involvement in organizations and committees, and much more.

For more information, visit the GSL web site at http://www.thestamp.umd.edu/student_involvement/graduate_student_life. The GSL office maintains the *Graduate Student Life Handbook* online at http://thestamp.umd.edu/GH

Office of International Student and Scholar Services

The Office of International Student and Scholar Services (ISSS) provides a wide range of information and services to international students and scholars including:

- Assistance with the process of applying to Maryland.
- Orientation services for international students.
- Counseling for students on immigration concerns, financial problems, and cross-cultural issues.
- Assistance to departments in obtaining appropriate visas for visiting scholars and faculty members.
- Assistance to American and international students interested in studying outside the U.S.

For more information, visit the ISSS web site at http://globalmaryland.umd.edu/offices/international-students-scholar-services

Maryland English Institute

The Maryland English Institute (MEI) provides programs and courses for non-native speakers of English. MEI also offers a variety of part-time non-credit courses, customized programs for special purposes, and evaluation of the English language proficiency for international students and international teaching assistants. For more information, visit the MEI web site at http://www.mei.umd.edu/

Course Information

Regularly Offered Department Courses

The department's General Academic Affairs Committee (GAAC) coordinates and establishes the list of courses for each term well in advance. Below is a list of regularly offered CORE courses and other frequently offered courses that can help students develop their plans of study.

Communications and Signal Processing (CSP)			**Fall, Odd Year**	**Spring. Even Year**	**Fall, Even Year**	**Spring. Odd Year**
CORE	ENEE 620	Random Processes in Communication & Control	**X**	**X**	**X**	**X**
CORE	ENEE 621	Estimation and Detection Theory		**X**		**X**
CORE	ENEE 627	Information Theory		**X**		**X**
CORE	ENEE 630	Advanced Digital Signal Processing	**X**		**X**	
—	ENEE 623	Digital Communications	**X**		**X**	
—	ENEE 625	Multi-User Communications				**X**
—	ENEE 626	Error Correcting Codes	**X**			
—	ENEE 631	Digital Image and Video Processing		**X**		**X**
—	ENEE 632	Speech and Audio Processing				**X**
—	ENEE 633	Statistical Pattern Recognition	**X**			
—	ENEE 634	Space-Time Signal Processing				**X**
—	ENEE 720	Wireless Communication Theory			**X**	
—	ENEE 731	Image Understanding			**X**	

Computer Engineering (COMP)			**Fall, Odd Year**	**Spring. Even Year**	**Fall, Even Year**	**Spring. Odd Year**
CORE	ENEE 640	Digital CMOS VLSI Design		**X**		**X**
CORE	ENEE 641	Mathematical Foundations for Computer Systems	**X**		**X**	
CORE	ENEE 645	Compiler Optimizations		**X**		**X**
CORE	ENEE 646	Digital Computer Design	**X**		**X**	
__	ENEE 651	Parallel Algorithms		**X**		

Controls (CONT)			Fall, Odd Year	Spring. Even Year	Fall, Even Year	Spring. Odd Year
CORE	ENEE 620	Random Processes Communication & Control	X	X	X	X
CORE	ENEE 660	System Theory	X		X	
CORE	ENEE 661	Nonlinear Control Systems		X		X
CORE	ENEE 664	Optimal Control		X		X
—	ENEE 662	Convex Optimization	X		X	
—	ENEE 762	Stochastic Control			X	
—	ENEE 765	Adaptive Control	X			

Electrophysics (ELEC)			Fall, Odd Year	Spring. Even Year	Fall, Even Year	Spring. Odd Year
CORE	ENEE 680	Electromagnetic Theory I	X		X	
CORE	ENEE 681	Electromagnetic Theory II		X		X
CORE	ENEE 690	Quantum & Wave Phenomena with Electrical Application	X		X	
CORE	ENEE 691	Optical Communication Systems		X		X
—	ENEE 790	Quantum Electronics I		X		X
—	ENEE 791	Quantum Electronics II			X	

Microelectronics (MICR)			Fall, Odd Year	Spring. Even Year	Fall, Even Year	Spring. Odd Year
CORE	ENEE 600	Solid State Electronics	X		X	
CORE	ENEE 601	Semiconductor Devices & Technology		X		X
CORE	ENEE 610	Electrical Network Theory	X		X	
CORE	ENEE 611	Integrated Circuit Design and Analysis		X		X
—	ENEE 605	Design & Fabrication of Micro-Electro-Mechanical Systems (MEMS)			X	
—	ENEE 614	Radio Frequency VLSI Circuit Design	X			
—	ENEE 704	Physics and Simulation of Semiconductor Devices			X	

Occasionally Offered Courses

	Description	Contact	Semester
	Communications and Signal Processing (CSP)		
ENEE 723	Wireless Communication Networks	Staff	F2010 F2008
ENEE 725	Advanced Networking	Ephremides	F2006 F2008
ENEE729D	Muti-user Information Theory	Narayan	F2005 F2009
ENEE 729E	Information-Theoretic Security for Wireless Communications	Ulukus	F2010
ENEE 739B	Neural Signal Processing	Babadi	S2014
ENEE 739C	Coding Theory	Barg	F2003 S2007
ENEE 739D	Auditory Scene Analysis	Shamma	F2009
ENEE 739E	Sparse Statistical Signal Processing & Learning	Pal	S2015
	Computer Engineering (COMP)		
ENEE 644	Computer-Aided Design of Digital Systems	Nakajima	S2012 S2013 S2014
ENEE 750	VLSI Design Automation	Nakajima	F2006 F2008 S2014
ENEE 756	Computer Networks	Silio	F2006 F2008
ENEE 757	Security in Distributed Systems and Networks	Dumitras	F2007 F2014 F2015
ENEE 759A	Parallel Processing Computer Architecture	Yeung	F2003
ENEE 759B	Advances in Low-Power Design Methodologies	Qu	S2005 F2009 S2015
ENEE 759D	CyberSecurity Data Science	Dumitras	F2013
ENEE 759E	Synthesis of Embedded Software	Bhattacharyya	F2004 F2006
ENEE 759G	Advanced Topics in Computer Engineering: Unsupervised Learning	JaJa	F2014 F2015
ENEE 759H	Highspeed Memory Systems	Jacob	S2003 S2005
ENEE 759J	Interconnection Networks	Oruc	F2004 F2007
ENEE 759L	Cloud Computing Security	Papamanthou	S2014
ENEE 759M	Microarchitecture	Franklin	S2005 S2006 S2008

ENEE 759O	Cryptography Against Physical Attacks	Dachman-Soled	F2013
ENEE 759T	Challenges in Automated System Design Methodologies	Srivastava	S2003 F2011 S2013
	Controls (CONT)		
ENEE 769A	Quantum Communication, Computing and Control	Baras	F2005
ENEE 769B	Geometric Methods in Control and Information	Krishnaprasad	S2006
ENEE 769C	Analysis and Design of Remote Feedback Systems	Martins	F2006
ENEE 769E	Game Theory: Dynamic and Evolutionary	Krishnaprasad	F2008
ENEE 769G	Networked Control Systems	Baras	F2009
ENEE 769R	Principles for Algorithms for Collectives	Krishnaprasad	F2012
	Electrophysics (ELEC)		
ENEE 780	Microwave Engineering	(Staff)	F2004 F2006 F2008
ENEE 789C	Solar Energy and Conversion	Munday	F2013 F2014 F2015
ENEE 789G	Magnetism and Magnetic Technology	Gomez	F2011
ENEE 789O	Chaotic Dynamics	Ott	F2012 F2013 F2014
ENEE 789Q	Quantum Optics & Communication	Goldhar	S2010
	Microelectronics (MICR)		
ENEE 702	Advanced Materials and Devices	Iliadis/Goldsman	S2002
ENEE 719A	Nanostructure Fabrication Technology	Iliadis/Ghodssi	S2005 S2009
ENEE 719B	Advanced Power Electronics	Khaligh	S2012
ENEE 719C	Advanced Mixed Signal VLSI Design	Abshire/Horiuchi	F2002

Seminars

Seminar offerings are subject to cancellation. However, each seminar is guaranteed to be offered in a semester following a semester when it was not offered.

Area	Number	Description
CSP	ENEE 698A	Communications and Signal Processing
COMP	ENEE 698B	Computer Engineering
CONT	ENEE 698C	Controls
ELEC	ENEE 698D	Electrophysics
MICR	ENEE 698E	Microelectronics
all	ENEE 698T	Intellectual Property
all	ENEE 698Q	Colloquium Seminar

Non-ENEE Pre-Approved Courses for the ECE Graduate Program

All ENEE courses at the 400-level and above (except ENEE 499) are automatically pre-approved for inclusion in the plan of study. **Non-ENEE courses not listed here require approval by the Graduate Studies and Research Committee or graduate director. Please submit the departmental PETITION FOR WAIVER OF REGULATION to obtain approval.**

Note for Ph.D. students: Graduate courses (600-level or above) in this list can be counted towards the required six credits of non-ENEE courses (item 4 under **Ph.D. Course Requirement**) only if they are not equivalent to an ENEE course. Also, courses that are cross-listed as ENEE courses do not count towards the non-ENEE course requirement.

Applied Mathematics and Scientific Computation (AMSC)	
AMSC 600	Advanced Linear Numerical Analysis
AMSC 607/CMSC 764	Advanced Numerical Optimization
AMSC 612	Numerical Methods in Partial Differential Equations
AMSC 614	Mathematics of the Finite Element Method
AMSC 660/CMSC 660	Scientific Computing I
AMSC 661/CMSC 661	Scientific Computing II
AMSC 662	Computer Organization and Programming for Scientific Computing
AMSC 666/CMSC 666	Numerical Analysis I
AMSC 667	Numerical Analysis II
AMSC 673/MATH 673	Partial Differential Equations I
AMSC 674/MATH 674	Partial Differential Equations II

Business and Management (BMGT)	
BMGT 830	Operations Research: Linear Programming
BMGT 831	Operations Research: Extension of Linear Programming and Network Analysis
BMGT 832	Operations Research: Optimization and Nonlinear Programming
BMGT 834/STAT 650	Applied Stochastic Processes/Operations Research: Probabilistic Models
BMGT 835	Simulation of Discrete-Event Systems

Computer Science (CMSC)	
CMSC 417/ENEE 426	Computer Networks
CMSC 420	Data Structures
CMSC 421	Introduction to Artificial Intelligence
CMSC 424	Database Design
CMSC 430	Introduction to Complier
CMSC 434	Introduction to Human-Computer Interaction

CMSC 435/ENEE 642	Software Engineering
CMSC 451	Design and Analysis of Computer Algorithms
CMSC 452/ENEE 459D	Elementary Theory of Computation
CMSC 456/MATH 456	Cryptology
CMSC 475	Combinatronics and Graph Theory
CMSC 630	Foundations of Software Verification
CMSC 651	Analysis of Algorithms
CMSC 660/AMSC 660	Scientific Computing I
CMSC 661/AMSC 661	Scientific Computing II
CMSC 662	Computer Organization & Programming for Scientific Computing
CMSC 664	Advanced Scientific Computing II
CMSC 666/AMSC 666	Numerical Analysis I
CMSC 667	Numerical Analysis II
CMSC 702	Computational Systems Biology
CMSC 711	Computer Networks
CMSC 712	Distributed Algorithms and Verification
CMSC 714	High Performance Computing Systems
CMSC 723	Computational Linguists
CMSC 724	Database Management Systems
CMSC 726	Machine Learning
CMSC 733	Computer Processing of Pictorial Information
CMSC 740	Advanced Computer Graphics
CMSC 751/ENEE 759K	Parallel Algorithms
CMSC 760/AMSC 600	Advanced Linear Numerical Analysis
CMSC 764/AMSC 607	Advanced Numerical Optimization
CMSC 838	Advanced Topics in Programming Languages
CMSC 858	Advanced Topics in Theory of Computing
Economics (ECON)	
ECON 703	Advanced Microeconomics I
Engineering, Aerospace (ENAE)	
ENAE 692	Introduction to Space Robotics
Engineering, Civil (ENCE)	
ENCE 725	Probabilistic Optimization in Project Management
Engineering, Materials (ENMA)	

ENMA 620	Polymer Physics
ENMA 650	Nanometer Structure of Materials
ENMA 659	Special Topics in Electronic Materials
ENMA 660	Thermodynamics in Materials Science
ENMA 671	Defects in Materials
ENMA 680	Experimental Methods in Materials Science
ENMA 682	Electron Microscopy for Research
Engineering, Mechanical (ENME)	
ENME 665	Advanced Topics in Vibrations
ENME 674	Finite Element Methods
ENME 680	Experimental Mechanics
ENME 690	Mechanical Fundamentals of Electronic Systems
ENME 693	High Density Electronic Assemblies and Interconnects
ENME 780	Mechanical Design of High Temperature & High Power Electronics
Engineering, Reliability (ENRE)	
ENRE 682	Software Reliability & Integrity
ENRE 684	Information Security
Mathematics (MATH)	
MATH 401	Applications of Linear Algebra
MATH 402	Algebraic Structures
MATH 403	Introduction to Abstract Algebra
MATH 404	Field Theory
MATH 405	Linear Algebra
MATH 406	Introduction to Number Theory
MATH 410	Advanced Calculus I
MATH 411	Advanced Calculus II
MATH 414	Differential Equations
MATH 420	Mathematical Modeling
MATH 430	Euclidean and Non-Euclidean Geometries
MATH 432	Introduction to Point Set Topology
MATH 436	Differential Geometry of Curves and Surfaces
MATH 437	Differential Forms
MATH 442	Partial Differential Equations
MATH 445	Elementary Mathematical Logic

MATH 446	Axiomatic Set Theory
MATH 452/PHYS 715	Introduction to Dynamics and Chaos
MATH 456/CMSC 456	Cryptology
MATH 461	Linear Algebra for Scientists and Engineers
MATH 462	Partial Differential Equations for Scientists and Engineers
MATH 463	Complex Variables for Scientists and Engineers
MATH 464	Transform Methods for Scientists and Engineers
MATH 475	Combinatorics and Graph Theory
MATH 600	Abstract Algebra I
MATH 601	Abstract Algebra II
MATH 602	Homological Algebra
MATH 603	Commutative Algebra
MATH 606	Algebraic Geometry I
MATH 607	Algebraic Geometry II
MATH 620	Algebraic Number Theory I
MATH 621	Algebraic Number Theory II
MATH 630	Real Analysis I
MATH 631	Real Analysis II
MATH 632	Functional Analysis I
MATH 634	Harmonic Analysis
MATH 636	Representational Theory
MATH 642	Dynamical Systems I
MATH 643	Dynamical Systems II
MATH 660	Complex Analysis I
MATH 661	Complex Analysis II
MATH 668	Selected Topics in Complex Analysis
MATH 670	Ordinary Differential Equations I
MATH 671	Ordinary Differential Equations II
MATH 673/AMSC 673	Partial Differential Equations I
MATH 674/AMSC 674	Partial Differential Equations II
MATH 712	Mathematical Logic I
MATH 713	Mathematical Logic II
MATH 718	Selected Topics in Mathematical Logic
MATH 730	Fundamental Concepts of Topology

MATH 734	Algebraic Topology I
MATH 740	Fundamental Concepts of Differential Geometry
MATH 742	Geometric Analysis
MATH 744	Lie Groups I
MATH 745	Lie Groups II
Neuroscience and Cognitive Science (NACS)	
NACS 642	Cognitive Neuroscience
NACS 643	Computational Neuroscience
Physics (PHYS)	
PHYS 404	Introduction to Statistical Thermodynamics
PHYS 410	Classical Mechanics
PHYS 411	Intermediate Electricity and Magnetism
PHYS 414	Introduction to Thermodynamics and Statistical Mechanics
PHYS 420	Principles of Modern Physics
PHYS 429	Atomic and Nuclear Physics Laboratory
PHYS 431	Properties of Matter
PHYS 441	Topics in Nuclear and Particle Physics
PHYS 601	Theoretical Dynamics
PHYS 603	Methods of Statistical Physics
PHYS 604	Methods of Mathematical Physics
PHYS 606	Electrodynamics
PHYS 621	Graduate Laboratory
PHYS 622	Introduction to Quantum Mechanics I
PHYS 623	Introduction to Quantum Mechanics II
PHYS 624	Advanced Quantum Mechanics
PHYS 625	Non-relativistic Quantum Mechanics
PHYS 704	Statistical Mechanics
PHYS 711	Symmetry Problems in Physics
PHYS 715/MATH 452	Chaotic Dynamics
PHYS 721	Atomic and Optical Physics I
PHYS 731	Solid State Physics: Survey
PHYS 741	Nuclear Physics: Survey
PHYS 751	Elementary Particle Physics I: Survey
PHYS 752	Elementary Particle Physics II: Theory

PHYS 761	Plasma Physics I: Survey
PHYS 762	Plasma Physics II
PHYS 771	Cosmic Ray Physics: Survey
PHYS 832	Theory of Solids I
PHYS 849	Special Topics in Theoretical Nuclear Physics
PHYS 851	Advanced Quantum Field Theory
PHYS 862	Controlled Fusion Physics and Technology
PHYS 879	Special Topics in General Relativity
Statistics (STAT)	
STAT 410	Introduction to Probability Theory
STAT 420	Introduction to Statistics
STAT 440	Sampling Theory
STAT 600	Probability Theory I
STAT 601	Probability Theory II
STAT 650/BMGT 834	Applied Stochastic Processes/Operations Research: Probabilistic Models
STAT 658	Advanced Applied Stochastic Processes II
STAT 700	Mathematical Statistics I
STAT 701	Mathematical Statistics II
STAT 710	Advanced Statistics I
STAT 740	Linear Statistical Models
STAT 750	Multivariate Analysis
STAT 770	Analysis of Categorical Data

Sample Course Sequences for Ph.D. Students

Students must put together their plan of study in consultation with their advisor, based on their specific interests and needs in connection with their intended research area. Some guidelines and sample programs are given below that may help students in putting together their plan of study.

The guidelines listed below apply to full-time Ph.D. students entering the graduate program in a fall semester. They are organized into sample "tracks." *The list given below is not meant to be exhaustive.* For each track, major and minor areas are suggested from the department's five technical areas: Communications and Signal Processing (CSP), Computer Engineering (COMP), Controls (CONT), Electrophysics (ELEC) and Microelectronics (MICR). Note: 400-level courses may not be counted toward the Ph.D. course requirement.

Sample tracks list three courses per semester. This is a reasonable load for most full-time students, but some may find it heavy in their first semester of enrollment. Also, graduate teaching or research assistants may take fewer than three courses per semester (see **Full-Time Status** section above.)

Sample Tracks:
Controls
Signal and Image Processing
Communications and Networking
Computer Engineering: Architecture
Computer Engineering: CAD/VLSI
Microelectronics: Circuits
Microelectronics: Devices
Micro Electro-Mechanical Systems (MEMS)
Lasers and Optics
Magnetics and Devices
Particle Beams and Microwaves

CONTROLS
Major: CONT, Minor: CSP or COMP

	Fall	**Spring**
Year 1	620; 660; 630 or 646 or non-ENEE	661; 664; 621 or 627 or 644 or non-ENEE
Year 2	762 or 765; 646 or Adv. Topics/non-ENEE	627/645 Adv. Topics/non-ENEE
Year 3	762 or 765; Adv. Topics/non-ENEE	

Possible Non-ENEE Courses: AMSC 600, AMSC 607, AMSC 612, AMSC 666/667, AMSC 673/674, BMGT 835, CMSC 666/667, CMSC 760, CMSC 764, MATH 630/631/632, MATH 642/643, MATH 673/674, STAT 600/601

SIGNAL and IMAGE PROCESSING
Major: CSP, Minor: CONT or COMP

	Fall	**Spring**
Year 1	620; 630; 660 or 646 or non-ENEE	621; 631; 632 or 634 or non-ENEE
Year 2	623; 633 or Adv. Topics or non-ENEE	627; 632 or 634; 661 or 664 or 644 or Adv. Topics or non-ENEE

Possible Non-ENEE Courses: AMSC 600, AMSC 607, AMSC 612, AMSC 666/667, AMSC 673/674, CMSC 666/667, CMSC 760, CMSC 764, MATH 630/631/632, MATH 642/643, MATH 673/674, STAT 600/601

COMMUNICATIONS and NETWORKING Major: CSP, Minor: CONT or COMP		
	Fall	**Spring**
Year 1	620; 630; 660 or 646 or non-ENEE	621; 625; 627
Year 2	623; 626; 720 or 723 or 731 or Adv. Topics or non-ENEE	661 or 664 or 644 or Adv. Topics or non-ENEE
Possible Non-ENEE Courses: AMSC 600, AMSC 607, AMSC 612, AMSC 666/667, BMGT 835, CMSC 666/667, CMSC 760, CMSC 764, MATH 630/631/632, MATH 642/643, MATH 673/674, STAT 600/601		

COMPUTER ARCHITECTURE Major: COMP, Minor: MICR		
	Fall	**Spring**
Year 1	641; 646; 610; or non-ENEE	645; 759A or 759C or 759M; 601 or 611; Adv. Topics or non-ENEE
Year 2	750 or 651; Adv. Topics or non-ENEE	640; Adv. Topics or non-ENEE
Possible Non-ENEE Courses: Most CMSC courses		

CAD/VLSI Major: COMP, Minor: CSP		
	Fall	**Spring**
Year 1	641; 646; 610; or non-ENEE	644; 640; Adv. Topics or non-ENEE
Year 2	750; 600; Adv. Topics or non-ENEE	759E or 759Q or 759T; Adv. Topics or non-ENEE
Possible Non-ENEE Courses: CMSC 651, CMSC 712, CMSC 751		

MICROELECTRONICS: CIRCUITS Major: MICR, Minor: COMP or CSP		
	Fall	**Spring**
Year 1	610; 480/600/704/646/620/425/400-level/non-ENEE	611; 601/644/645/621/non-ENEE
Year 2	600/704/646/630/Adv. Topics/non-ENEE	644/645/621/Adv. Topics/ non-ENEE
Possible Non-ENEE Courses: Most MATH courses		

MICROELECTRONICS: DEVICES Major: MICR, Minor: ELEC or COMP		
	Fall	**Spring**
Year 1	600; 610/704/714/680/690/646/400-level/non-ENEE	611; 601; 681/644/645/non-ENEE
Year 2	600/704/714/680/690/646/Adv. Topics/non-ENEE	681/644/645/Adv. Topics/non-ENEE
Possible Non-ENEE Courses: Most PHYS courses		

MICRO ELECTRO-MECHANICAL SYSTEMS (MEMS) Major: MICR, Minor: ELEC, CONT or CSP		
	Fall	**Spring**
Year 1	605; 416/472/480/680/690/600/non-ENEE	601; 416/611/Adv. Topics/non-ENEE
Year 2	680/690/600/Adv. Topics/non-ENEE	601; 611/Adv. Topics/non-ENEE
Possible Non-ENEE Courses: AMSC 666/667, CMSC 666/667, ENMA 650/651/660/680, PHYS 623, PHYS 731, PHYS 761/762		

LASERS and OPTICS Major: ELEC, Minor: MICR or CSP		
	Fall	**Spring**
Year 1	480; 680; 690	681; 496; 790
Year 2	789C or 791; 600 or 620; non-ENEE	789C; 630/Adv. Topics/non-ENEE
Possible Non-ENEE Courses: Most PHYS courses		

MAGNETICS and DEVICES Major: ELEC, Minor: MICR or COMP		
	Fall	**Spring**
Year 1	416; 680; 690	681; 790; 601 or 644 or 645
Year 2	480 or 489M; 789C/ Adv. Topics/non-ENEE	691; 611; 644/645/Adv. Topics/non-ENEE
Year 3	600 or 646; 789C/Adv. Topics/non-ENEE	
Possible Non-ENEE Courses: ENMA 680, most PHYS courses		

PARTICLE BEAMS and MICROWAVES Major: ELEC, Minor: MICR or CSP		
	Fall	**Spring**
Year 1	480; 498B; 690	686; 681; 790
Year 2	789C or 791; 780/Adv. Topics/non-ENEE	611/ 601/ 620/ 621; Adv. Topics/non-ENEE

Year 3	789C or 791; 780/620/ 630/ Adv. Topics/non-ENEE	
Possible Non-ENEE Courses: Most PHYS courses		