



This document details the degree requirements and procedures for the Computer Engineering (CpE) Graduate Program, jointly administered by the Departments of Computer Science (CS) and Electrical and Computer Engineering (ECE) at the University of Virginia.

# **Computer Engineering Graduate Handbook**

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## Table of Contents

### Masters Degree

Requirements & Procedures.....	1
Course Requirements.....	2
Assessment Requirements.....	6

### Doctor of Philosophy

Requirements & Procedures.....	8
Coursework.....	8
PH.D. Qualifying Examination.....	10
Advancement to candidacy.....	14
Publication Requirements.....	16
The Dissertation.....	17
Other requirements.....	18

## Masters Degree

### Requirements & Procedures

The CpE Program offers two Masters degrees: a Master of Science (MS), which requires a thesis, and a Master of Engineering (ME). Although most students finish within two years, the time limit for degree completion after entering the Masters program is five years for the MS and seven years for the ME. Degree requirements set by the School of Engineering and Applied Science (SEAS) are given in the SEAS Graduate Record and are additional to the following CpE Graduate Program requirements.

Upon admission to the graduate program, students will be assigned an advisor by mutual consent. The advisor normally is a faculty member in the student's primary area of interest.

### Course Requirements

MS degrees require at least 24 regular course credits plus 6 credits of CS/ECE 8999 Masters Thesis Research) for a total of 30 credits.

ME degrees require 30 course credits, 3 credits of which are strongly recommended to be CS/ECE 7995.

## Plan of Study

Every Masters student, in consultation with his/her advisor or advisory committee, must develop and submit a course Plan of Study to the CpE Graduate Committee by the end of his/her first semester in the Program. When properly completed and approved, the Plan of Study represents the course curriculum for that student's degree. A revised Plan of Study must be submitted should the course curriculum change.

## Required Courses

Every student in the Program must successfully complete all of the following:

1. Architecture/Design requirement – one of the following:
  - CS 6354 Computer Architecture
  - ECE 6434 Computer Organization and Design
2. Analysis requirement - one of the following. Must include engineering analysis assessment (form G101A) (see Note 1):
  - ECE 7438 Computer System Reliability Engineering
  - CS 7456 Models of Computing Systems
  - ECE 6415 Performance and Analysis of Communication Networks
  - CS 6161 Design and Analysis of Algorithms

3. Professional Preparation – both are required in the first year and are generally offered in the Fall only.

- CS 6190 Computer Science Perspectives (a one credit course)
- ECE 6505 Electrical and Computer Engineering Seminar (a one credit course)

## Area Requirement

Plans of Study must include at least one course from each of these three different subject areas. Ask the program director about new or special topics courses. Subject areas and their associated courses are:

### Area 1: Hardware

ECE 6332 Introduction to VLSI  
ECE 5150 Integrated Circuit Fabrication Process  
ECE 6331 Advanced Switching Theory  
ECE 6660 Analog ICs  
ECE 7332 Advanced VLSI Systems Design

### Area 2: Software

CS 6250 Building Complex Software Systems  
CS 6456 Operating Systems  
CS 6161 Design and Analysis of Algorithms  
CS 6240 Software Engineering  
CS 7620 Advanced Compilers  
CS 6610 Programming Languages  
CS 6750 Databases  
CS 8545 Topics in Operating Systems

### **Area 3: Computer Systems and Networks**

CS 5487 RealTime Systems  
ECE 6434 Dependable Computing Systems  
CS 6435 Introduction to Parallel Computing  
CS/ECE 6415 Performance Analysis Comm. Networks  
ECE 7438 Computer System Reliability Engineering  
CS 7456 Models of Computing Systems  
CS/ECE 7457 Computer Networks  
CS 8535 Topics in Computer Architecture

Note 1: The analysis requirement course may also be used to meet an Area Requirement. An engineering analysis assessment form must be completed.

### **Mathematics Requirement**

At least one course (three credits) in the Plan of Study must be a graduate-level (5000 level or above) mathematics course (APMA, MATH, ECE 6711, SYS 6005) that complements the Plan of Study and is approved by the advisor or advisory committee. Any exceptions must be approved by the CpE Graduate Committee.

### **Electives and courses outside the CS and ECE Departments**

Electives can be graduate-level CS courses, ECE courses, or courses from other departments. A maximum of two courses (not including the Mathematics requirement) may be taken outside of the CS and ECE Departments. Any exceptions must be approved by the CpE Graduate Committee.

### **Advanced Topics and Special Topics Courses**

The Program regularly offers variable content "Advanced Topics" or "Special Topics" courses that address new or emerging aspects in the field. They will be announced as far in advance as possible, including the area(s) that are covered by the course, and can be used to meet the area requirement in that area with approval of your advisor. Students are encouraged to explore such courses and file the necessary Plan of Study change accordingly.

### **500-Level and Independent Study Courses**

A Plan of Study may not contain more than six credits of 5000-level courses. Also, no more than one Independent Study course (three credits) may be applied towards an MS or ME degree.

## Transfer Credit

Subject to approval from the CpE Graduate Committee, MS candidates may transfer a maximum of six credits of approved graduate courses into the program. ME candidates may transfer a maximum of 12 credits of approved graduate courses into the program. Students may only transfer courses in which they earned a grade of B or better. Requests for transfer credit should be accompanied by a Plan of Study (G-101 or 102) and a List of Courses Completed (available on CpE Graduate Website).

## Assessment Requirements

Students enrolled in the CpE ME program are expected to achieve competence in Engineering Analysis, Technical Writing and Oral Presentations. Each student will be evaluated for these outcomes, using the appropriate SEAS assessment forms, available from the SEAS graduate web page. It is the responsibility of the student to ensure that each of the required assessments are performed and that the required forms are filed. If a student completes a project with a written or oral presentation, the appropriate forms can be completed at that time. The entire set of required assessment forms must be completed for each ME student before graduation.

Outcome assessment for Master of Science degree programs in SEAS is based on the thesis and its oral defense. The assessment form for the MS thesis must be submitted with the G-110 (report on Master Thesis and

Final Examination) form. The assessment form is to be completed by the examining committee at the conclusion of the examination and defense

## Thesis Requirements

A thesis describing research of publishable quality is required of all MS students. In this spirit, at least one paper submission to a refereed conference/journal is required of all MS candidates. The research and development of the thesis will be directed by the student's advisor or advisory committee. Once the thesis has been written and approved by the advisor, a public oral defense is required. The format of the oral defense is a presentation by the student (maximum 30 minutes) followed by a question and answer period. This presentation is open to the public.

The examination committee for the MS oral defense consists of a minimum of three faculty members. The Chair of the committee cannot be the advisor and must be from either the CS or ECE Department. This examining committee is selected by the student and the advisor and approved by the CpE Graduate Committee Chair.

# Doctor of Philosophy Degree

## Requirements & Procedures

The CpE Program offers a Ph.D. degree, the primary focus of which is a dissertation describing publishable quality research (directed by a faculty advisor) of significant depth. The time limit for completion of the Ph.D. is seven years after admission to the doctoral program. Degree requirements set by the School of Engineering and Applied Science (SEAS) are given in the SEAS Graduate Record and are additional to the following CpE Graduate Program requirements.

## Coursework

The student should put together a Plan of Study before the end of the first semester. The Plan of Study should be approved by the Computer Engineering Graduate Committee (shortened to "CpE Graduate Committee" in the rest of this document), which serves as the de facto advisory committee for all entering PhD students. The Plan of Study must include at least 24 hours of CS 9999 or ECE 9999 – Dissertation, and at least 9 hours of graduate-level coursework beyond the master's degree. Although an MS degree in CpE is not required, the Plan of Study must meet a set of "pre-requisite coursework requirements," defined to include the architecture/design course requirement, analysis course requirement, mathematics course

requirement and the three area requirements of the MS degree program (see the CpE Masters programs section for details). For the courses meeting the three area requirements, the student must receive a minimum grade of A-. Petitions for substitution of the required courses by courses taken outside the university will be considered by the CpE Graduate Committee. While submitting a petition, the student is required to submit transcripts, detailed course syllabus, and may be asked to provide sample homework assignments and examinations. If such a petition is not approved, the CpE Graduate Committee may recommend that the student register for courses needed to fulfill their missing requirements. Alternatively, the student may be given the option to demonstrate core competency in the subject matter by taking the final examination of an appropriate course with the approval of the course instructor.

## Transfer Credit

Subject to approval from the CpE Graduate Committee, PhD candidates may transfer PhD-level course and dissertation credit hours from other schools of recognized standing. Students may only transfer courses in which they earned a grade of B or better. Requests for transfer credit should be accompanied by a Plan of Study. Students should discuss courses acceptable for transfer of credit with their advisor, at the same time the plan of study is developed.

## Ph.D. Qualifying Examination

Student desiring a PhD should take the qualifying examination as soon as possible. Students entering with a master's degree should take the exam no later than the beginning of their third semester. Students entering with a bachelor's degree should ideally take the exam by the beginning of their third semester, but no later than the beginning of the fourth semester. (The exam should not be postponed in order to finish a master's degree first.)

The objective of the qualifying examination is to assess the student's potential to begin doctoral-level research. The latter requires the student to demonstrate the following in their primary research area and two secondary research areas:

1. an ability to state a problem clearly, provide its motivation, and the requirements for a solution.
2. an ability to determine if a solution is correct.
3. an ability to assess to what extent a (presumably correct) solution meets the requirements (solves the problem).
4. an ability to describe how a problem and its solution fits into the big picture (and to understand the big picture).
5. an ability to communicate effectively (both in writing and speaking) and to answer questions relating to the problem and its solution and the broader research context.

The qualifying exams are administered at least twice a year, typically in January and August. Students must pass the qualifying examination before beginning their fourth academic semester after admission to the doctoral program, unless otherwise approved by the CpE graduate Committee.

## Exam Format

We have identified a set of six research areas from which each candidate will be required to select a primary research area and two secondary areas for the examination. The CpE qualifiers committee will announce one paper for each area about three months prior to the date set for an examination. One month before the examination date, students will provide the CpE administrative coordinator their selections for the primary and secondary areas. The paper for the primary area is expected to be studied in depth. Students will be required to read and understand papers cited by the paper in the primary area as well as follow-on work. The committee will ask questions to gauge the students' detailed understanding of the primary paper and related work. For the secondary areas, students should study the selected papers and be prepared to answer general questions on these papers. Our goal for testing the student on these secondary areas is to determine the students' multi-disciplinary abilities, a key factor that is becoming increasingly important in today's research environment.

Two weeks before the oral exam date, the student will submit a written report (maximum of 3 pages in IEEE standard format at <http://www.ieee.org/portal/pages/pubs/transactions/stylesheets.html>) on the paper in the primary area to the head of the CpE qualifiers committee. This report should demonstrate the five abilities listed at the start of this section. The report is expected to cover relevant work: both too little and too much will be considered negatively. The student should also prepare a 20-minute (max) presentation on the primary paper, and a 10-minute (max) presentation on each secondary paper summarizing their salient points, for delivery at the oral examination.

The oral examination will be in two parts:

#### Part I: Primary area test

This is a 1-hour examination, which will start with the student's 20-minute presentation on the paper selected by the student in the primary research area. The committee will then ask in-depth questions on the presentation, the assigned paper, related papers, and other topics in the selected primary area.

#### Part II: Secondary area test

This is a 1-hour examination, each half of which starts with the student's 10-minute presentation on the two secondary papers selected by the student. The committee will then ask broad questions on the presentation, the assigned papers and other topics in the selected secondary areas.

Students will be evaluated on the combined written submission and oral examination. The result will be a

clear-cut pass or fail for the entire exam; no remedial work will be allowed to alter the outcome. A student who fails the qualifying exam on the first try must retake it at the next offering. A student who fails the examination twice will lose financial support and must leave the program at the end of that semester.

The areas are:

- Computer Architecture
- VLSI, Switching Theory
- Operating Systems, Real-Time and Embedded Systems
- Compiler, Software Systems and Software Engineering
- Fault-tolerant Computing and Reliability Engineering
- Networks, Distributed Systems & Security

## **Advancement to candidacy and Dissertation Proposal**

After a student has successfully passed the qualifying examination, the student is now formally admitted to the PhD program. The student should put together a Proposal Examining Committee of at least five faculty members, including the research advisor and one member outside the student's department. The student should prepare an acceptable dissertation proposal done under the guidance of the student's advisor. This proposal should be presented before any extensive research is undertaken, in order to receive early faculty approval of the suitability of the proposed research. The written proposal document should be prepared according to the following guidelines:

The proposal must be limited to 20 single-spaced pages including figures exclusive of bibliography. The document should succinctly describe:

1. the problem;
2. relationship to other work in the field;
3. the research plan including specific research activities;
4. expected contributions.

An example of an organization that meets these four requirements is:

- What is the problem?
- Why is it important?
- What is the "shape" of a solution?
- What is the research agenda?
- Why will the agenda work (produce a solution)?

A comprehensive literature review (not subject to page limitations) may be included as an appendix.

Any departure from these guidelines must be approved in advance by the student's proposal examining committee.

The student should prepare a public oral presentation of the proposal, which should be made within two semesters after successfully completing the Ph.D. qualifying examination. The student should provide the proposal examining committee the written proposal document at least two weeks prior to the oral presentation. The presentation should be limited to 30 minutes and will be followed by questions from the audience and the proposal examining committee.

Successful completion of the dissertation proposal examination will result in your being admitted to candidacy for the degree. The student must complete at least one full semester as a candidate before the degree is awarded.

In the event that a suitable proposal is not presented but the faculty believes the student has sufficient research potential, another research presentation will be scheduled within 6 months. If a suitable proposal is still not presented, the student is subject to dismissal from the program.

## **Publication requirements**

At a minimum, all Ph.D. candidates are required to submit an advisor-approved article related to their research to a refereed journal or conference, prior to completing their dissertation defense. If the student's advisor is not a co-author of the paper, the advisor must provide the CpE graduate committee with a note indicating the advisor's approval of the paper.

## **The Dissertation**

The culmination of the PhD program is the defense of the dissertation. This dissertation will be the result of the final research outlined in the dissertation proposal. It is expected that the work be of sufficient quality to warrant journal publication. The dissertation defense, which is announced publicly, is an oral defense before the student's Ph.D. final examining committee as well as any other interested faculty, students or other persons. The student presentation portion should not exceed 45 minutes. Follow the SEAS rules with regards to the format of the dissertation and the number of copies required for distribution.

## **Other requirements**

### **Assessment Requirements**

Outcome assessment for the PhD degree occurs at three different points in the program: the qualifying exam, the proposal and the dissertation defense. The assessment of the qualifying exam performance is recorded on the program specific G107 CPE form. The G-107 CPE form must be submitted with the G107 form that records the result of the examination. The committee administering the exam completes the G-107 CPE form.

The assessment of the dissertation proposal is performed by the advisory committee at the time of the defense of the proposal. The examining committee completes the dissertation proposal assessment form at the time of the proposal defense and it is submitted with the G-108 form.

The assessment form for dissertation work is completed at the time of the defense and is submitted with the G-111 form. Also required is a list of publications. The assessment form is to be completed by the examining committee at the conclusion of the examination and defense. The assessment form is the same for both MS theses and PhD dissertations.

## English Language Proficiency

All new graduate students whose native language is not English are tested for English proficiency near the beginning of their first semester at UVa. All non-native speakers of English must pass the Virginia Language Proficiency Exam (administered by the Center for American English Language and Culture) at this time. Students, who are non-native speakers of English, must also pass the SPEAK Test administered at UVa by CAELC. Students must pass this test before:

- Taking the Qualifying Examination.
- Being appointed to a Graduate Teaching Assistant position (CS 8897, CS 9897, ECE 8897, ECE 9897) or commencing a doctoral-program Graduate Teaching Experience.
- Applying for a graduate degree.

If a pass grade is not achieved on the SPEAK test, CAELC offers a program of courses of instruction in preparation for a repeat test at a later date. If a student takes the SPEAK Test in the fall, portions of the Virginia Language Proficiency Exam and the SPEAK Test are merged into a single composite exam.

## Graduate Teaching Requirement

Students are strongly encouraged to complete one semester of guided undergraduate teaching experience with the approval and supervision of a faculty member. The faculty supervisor may or may not be the student's advisor.

Mnemonic	Old #	New #
CS	586	5487
CS	644	6444
CS	650	6250
CS	654	6354
CS	655	6610
CS	656	6456
CS	661	6161
CS	662	6750
CS	685	6240
CS	696	6190
CS	756	7456
CS	771	7620
CS	854	8535
CS	856	8545
CS	895	7995
CS	897	8897
CS	997	9897
CS	999	9999

Mnemonic	Old #	New #
CS/ECE	715	6415
CS/ECE	898	8999
ECE	564	5150
ECE	611	6711
ECE	631	6331
ECE	632	6332
ECE	634	6434
ECE	635	6435
ECE	673	6660
ECE	696	6505
ECE	715	6415
ECE	736	7332
ECE	738	7438
ECE	895	7995
ECE	897	8897
ECE	997	9897
ECE	999	9999
SYS	605	6005