A Guide to the CSE Doctoral Programs

Department of Computer Science and Engineering
Washington University

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Foreword from the Department Chair

Welcome to the Computer Science and Engineering (CSE) department at Washington University in Saint Louis.

You have picked both a great place and a great field to pursue your doctorate. As a field, CSE has experienced a phenomenal growth since its inception a few decades ago (the first computer science program began in 1953 at the University of Cambridge, and the first department of Computer Science in the US was established in 1962 at Purdue University), and there is nowadays hardly a discipline that does not rely on computing. Computer Science and Engineering is, however, far from having reached its full potential, and your are stepping into a vibrant and growing field and joining a department engaged in a wide range of exciting, high-impact research activities to which you will have the opportunity to contribute as you develop into independent researchers. You will face challenges in realizing your own potential, but will have the benefit of a supportive community of fellow students, faculty, and staff who will help you and want you to succeed.

You are about to embark into what is possibly the most exciting phase of your education, and we are all looking forward to seeing you become successful researchers who will contribute to the continued growth and success of CSE. The road ahead may not always be easy, but it is often enjoyable and ultimately rewarding.

Roch Guerin, department chair

Foreword from the Doctoral Program Director

Greetings! You, our Ph.D. students, are critical to our success as a department. You contribute a huge fraction of the research output of the department and you are also the legacy each of leaves for the future. I look forward to helping facilitate your progress through our program. While you will primarily work with your research advisor in your doctoral studies, you are welcome to contact Cheryl or me at any time if you have concerns or questions.

Michael Brent, program director

Contents

List of Tables

1 Introduction to the CSE Doctoral Programs

This guide describes in detail the PhD program's procedures and requirements for a Ph.D. in either Computer Science or Computer Engineering. The Department implements, and in some cases extends, the requirements imposed by the Graduate School on all students seeking Ph.D. degrees. The requirements imposed by the graduate school are listed in the general requirements section of the Graduate School Bulletin: http://graduateschool.wustl.edu/current_students/degree-requirements.

We assume that current and prospective students will be the primary users of this guide. The guide often uses "you" and "your," which are always addressed to the student.

1.1 Overview of Program Requirements

A Ph.D. is primarily a *research degree*, certifying that the recipient is able to conceive and carry out a program of original research. A Ph.D. recipient must also be able to effectively communicate new research findings, both orally and in writing. Finally, the degree certifies a high level of competence and background knowledge in the recipient's subject area.

Ph.D. students learn to formulate and execute a research program with the mentorship and guidance of a *research advisor*, a faculty member who provides intensive mentoring and guidance throughout a student's doctoral career. The student's *dissertation*, a substantial original research contribution required to obtain the Ph.D., is typically carried out as part of this research program. Students enter our program without a predetermined research advisor and must find an advisor among the CSE faculty during their first year in the program.

At various points during a student's doctoral career, she must pass *milestones* that demonstrate mastery of certain research skills and progress toward the dissertation. Our programs include four major milestones: an oral qualifying examination; admission to candidacy based on a portfolio of written research work; a formal dissertation proposal; and, finally, completion and defense of the dissertation. In addition to these major milestones, students are expected to present their research regularly, both in external venues such as competitive academic conferences and internally through annual talks in our *Doctoral Student Seminar*.

In addition to performing research leading to a dissertation, CSE Ph.D. students must complete certain coursework requirements, including both graded courses and participation in research seminars. Courses include a set of *breadth requirements* designed to ensure that the student has a broad knowledge of CSE. All Ph.D. students must also satisfy a teaching experience requirement, typically by serving as a teaching assitant (TA) for a course, under the mentorship of a faculty member, for one semester.

1.2 Paths to a CSE Doctoral Degree

The CSE Department offers two doctoral degrees: Computer Science, which spans a broad range of subject areas unified by the study and use of computational methods, and Computer Engineering, which focuses on the design and implementation of physical computing systems

such as processors, custom computing logic, and communication fabrics. A student's choice of degree program depends on her specific interests within CSE and the interests of the faculty member who serves as the student's advisor. Most program requirements are similar for Computer Science and Computer Engineering students, with the notable exception of different lists of breadth course requirements.

Innovative research in computer science is increasingly happening at the interface between CSE and other disciplines such as biology, physics, art, and various kinds of engineering. As a department we support interdisciplinary research agendas and the current requirements reflect our efforts to be flexible, especially with regard to which courses are most appropriate and useful for each student.

2 Getting Started: the First Year

During your first year in the CSE Doctoral Program, your most important task is to integrate yourself into the department's research activities by finding a home in one of our research groups. You will also take a full load of courses, including CSE 591, designed to orient you to graduate research in general and the current research opportunities in this department.

2.1 CSE 591: Introduction to Graduate Study

Every new doctoral student must sign up for CSE 591, "Introduction to Graduate Study," as soon as possible after entering the program (generally in the first semester). This 3-unit course, offered every fall, has two aims. First, it orients students to the breadth of research in the CSE Department. You will hear presentations from a number of faculty members about the work they do. Second, the course includes discussions and assignments to help develop critical research skills, such as selecting good problems, writing a research proposal, and time management.

An important function of CSE 591 is to help you narrow your choice of potential research areas, and to show potential advisors what kind of work you can do. To promote these ends, 591 includes two required one-month *rotations*, one each in October and November. During each rotation, you will work with a particular faculty member, your "host," on a short project that is representative of the kind of work done in that person's group. You will attend your host's group meetings and get to know the students in the group. At the end of each rotation, you will present the results of your project to the class.

2.2 The Role of the Research Advisor

Every doctoral student must be mentored by a *research advisor*, a faculty member who is responsible for directing their research and academic program. It is difficult to overstate your research advisor's influence on your doctoral career. You will meet with this person more often than anyone else in the department, long after you have satisfied all course requirements. You will work closely with your advisor on research and will likely publish many joint papers. Your advisor will represent your interests to the department. Finally, your advisor will chair your dissertation committee and will ultimately certify your readiness to graduate. For all these reasons, finding your advisor is a momentous task.

2.3 Finding a Research Advisor: Rules, Procedures, and Strategies

Incoming first year students are *unaffiliated*, meaning that they do not have a research advisor, and they remain unaffiliated until they and a faculty member file an advisor affiliation form with the department. The main mechanism by which students become affiliated with faculty members is the two one-month rotations they undertake as part of 591 in the fall. Students and faculty are strongly discouraged from committing to an advising relationship

before the completion of the second rotation. Prospective faculty advisors may not require students to do research work before rotations begin, although they may provide extra research opportunities before formal rotations if asked to by a student. The rotations are expected to fill all of the time a student has available for research, so a faculty member may not ask a student to carry out research while the student is rotating with another faculty member. If a student receives such a request, he or she must decline.

You must find a research advisor no later than the end of your second semester to continue in the doctoral program. However, students are strongly encouraged to acquire a research advisor as soon as possible after completing the second formal rotation. That is the natural time to discuss committing to a mentoring relationship with a faculty member. That committment requires filing a form with the department. *If you and your prospective advisor have not filed that form, you do not have a research advisor.* Students who do not have an advisor by the end of classes in their first semester may arrange with prospective advisors additional rotation-like trials, however the faculty member must notify the department by filling out this Google Form.

While CSE591 and your initial coursework give you many opportunities to interact with the faculty, you are ultimately responsible for seeking out a faculty member and persuading that person to take you on as an advisee. Faculty usually have limited space in their groups for new advisees, and not every faculty member takes on students every year, so you should talk to several potential advisors to increase the likelihood of a successful placement. To maximize your chances of success, it is critical to do your homework in advance by learning about each faculty member's research from their web pages and publications, and to talk to faculty and older graduate students to find out whether a potential advisor is a good match to your skills, interests, and personality.

Temporary Academic Advisor

Since you arrive without a research advisor, you may receive a letter naming a faculty member as your *academic advisor*. This person is *temporarily* assigned to help you select your courses but is *not* your research advisor.

Changing Advisors

The advising relationship is established and continued only by the mutual consent of student and faculty member. You have the option at any time to seek a new research advisor. If you feel that switching research advisors is in your best interest, the faculty will do what we can to try to make the transition possible, beneficial, and amicable for all involved. Similarly, if the faculty member chooses to end the advising relationship, and you are making adequate progress toward a Ph.D., we will help you find a new advisor if possible.

3 Course and Credit Requirements

3.1 Overall Credit Requirements

You need a total of **72** credits to obtain a Ph.D. from the CSE Department. Credits come from three kinds of work: regular courses, seminars, and research credit.

Regular Courses

At least **33** of your credits must be from regular (i.e. non-seminar) courses eligible for graduate credit. At least **18** of these credits must be from CSE courses, either taken at Washington University or approved by us for transfer credit. At least **nine** of these credits must be from regular CSE courses taken at Washington University.

At most **nine** of your 33 course credits may be from 400-level CSE courses, and at most **nine** may be from graduate-level independent study (CSE 500 or 600). Any other credits for CSE courses must be from graded courses at 500 level or above.

Courses taken at Washington University outside the CSE department may be counted for degree credit with your advisor's approval. Generally, such courses must be relevant to your research area and must be 500-level or above.

Seminars

At least **three** of your credits must come from *CSE research seminars*. These seminars, whose course numbers are of the form CSE 7xxx, entail both discussion and oral presentation by students of cutting-edge research. CSE doctoral students may receive only *one credit per semester* for any one research seminar, and that seminar grades should be one of "satisfactory" or "unsatisfactory," rather than a letter grade. You may, however, take multiple seminars per semester and may take a given seminar for as many semesters as you like, since the topics change each semester.

Research Credits

At least **24** of your credits must be *research credit*, taken in the form of CSE 699 "Doctoral Research." Research credit must be arranged with your research advisor each semester. Prior to being admitted to candidacy, you may take up to **three** research credits per semester. After admission to candidacy, you may take up to **12** research credits per semester. **This means that you must take 6 credits of graded courses to maintain full time status every semester until your portfolio review is successfully completed. This rule is enforced.**

Transferring Credits from Outside Washington University

Credits counted toward your Ph.D. requirements may include no more than **24** credits transferred from another institution. Transfer credit is granted only for regular courses (not sem-

inars or research) that are appropriate substitutes for work that would have otherwise been done as part of our Ph.D. program. More specifically, a course taken at another institution must meet all of the following requirements to be eligible for transfer credit:

1. The course must be considered "graduate" where it was taught. Essentially, it must be 500-level or above. Exceptions to this rule are possible but rare.

2. The course must not have been used to satisfy an undergraduate degree requirement. Because this determination is often difficult for us to make, our usual rule is that you must have had graduate standing when you took the course. Courses taken as part of a master's or doctoral program, a graduate certification program, or as an SNCD (student not candidate for degree) are all eligible.

3. The CSE Department must approve the transfer after reviewing the course's content and your grade for the course. Generally, the decision to approve is made by a faculty member with expertise in the subject area of the course to be transferred.

Applying Credit from another Washington University Degree

If you complete a Washington University master's degree in CS or CoE, you may apply all 30 credits completed for these degrees toward the credits needed for the Ph.D. Note that all MS credits, *including* those for CSE 599 "Masters Research" (typically taken as part of a thesis or project), are considered *course credits* relative to our doctoral programs; they *cannot* be counted as research credit.

Applying credits taken to satisfy any other Washington University graduate degree toward a CSE Doctoral program requires CSE Departmental approval.

3.2 Breadth Requirements

An important component of your required course credits is a set of *breadth requirements*, which you must fulfill to ensure that you have a sufficiently broad base of general knowledge in the area of your doctoral program. Each of the CSE doctoral programs has its own breadth requirements:

- For the Computer Science Doctoral program, students must take CSE 511A, CSE 541T and CSE 560M.

- For the Computer Engineering program, students must take CSE 560M, CSE 541T and CSE 561A.

Students that entered the program before 2014 may be able to satisfy the breadth requirements based on the rules in place when they entered; these rules remain available in the Appendix (Section 10).

In all cases, courses counted toward the breadth requirements must be passed with a grade of B or above. All breadth requirements must be satisfied before you may be considered for

the portfolio review. To avoid trouble at your portfolio review, you should maintain a GPA of better than 3.5 for your breadth courses. Although you may be allowed to continue in the program with a lower breadth GPA, the faculty may require you to prove yourself through additional coursework.

Note that grades below B are considered *unsatisfactory* by the Engineering School. If you receive such a grade, it is probably wise to talk to the course instructor before trying to pass your portfolio review.

Planning your coursework for your first two years

Milestones and timelines are discussed separately below, but this is a place to point out how the various requirements interact. Namely,

1. You **must** complete your 3-course breadth requirements before submitting your portfolio, and

2. until your portfolio review is successfully completed, you **must** take two actual graded courses per semester to maintain full time status, and

3. you need 11 graded courses in total.

Therefore, you should try to complete your breadth requirements in your first 2, or at most 3 semesters. Plan this in advance as they are not offered every semester. Also, it would be a big mistake to load up on courses in your first three semesters, preventing you from making research progress and turning in a portfolio. If you do that, you will find yourself taking more than the 11 courses that are actually required (which is already a lot!), delaying your research progress, and likely irritating your research advisor. Most students will progress better if they take no more than two courses in their 2nd, 3rd, and 4th, semesters, leaving significant time for research progress and successful portfolio review. With that approach, even if your portfolio is delayed by a semester, you will still have courses you need to take, so taking two courses will help to satisfy your requirements.

Breadth Transfers

If you have taken a CSE course at another university and would like to have that course counted toward your breadth requirements, you may do so with the approval of your advisor (which must be documented via a memo to the Doctoral Program Director and the department secretary in charge of graduate student records). Courses used to satisfy breadth must have been taught as graduate courses and should be equivalent to a Washington University course that you would otherwise use to satisfy a breadth requirement. Note that your advisor will ask you to get approval from the person who teaches the equivalent course.

Important notes: using a course from another institution to satisfy a breadth requirement does not by itself cause the course's unit to transfer. You must also ask for a unit transfer, subject to the stricter rules of the previous section.

3.3 Enrollment and Residency Requirements

All Ph.D. students must be either enrolled full-time or registered as a *nonresident candidate* every semester until graduation. Prior to completing 72 units, full-time enrollment is achieved by registering for at least 9 units per a semester, or by registering for fewer than 9 units along with a 0-unit course (LGS 9000 Full-time Graduate Research/Study or LGS 9001 Full-time Graduate Study in Absentia) that indicates the student's full-time engagement in research or academic writing. Enrollment in LGS 9000 requires departmental approval, which is contingent on the student continuing to make satisfactory progress towards their degree.

During a student's period of regular registration, they may have a need or opportunity to study away from Washington University. Recommendations from departments for students' registration in absentia will be considered by the Graduate School on a case-by-case basis. If approved by the Graduate School, these will be registered for LGS 9001 Full-time Graduate Study in Absentia. Students may be allowed to register for LGS 9001 for up to four consecutive or non-consecutive fall/spring semesters. Semesters in which a student is registered in absentia are counted as part of the student's program length.

Full details of the graduate schools enrollment and residency requirements can be found here.

Residency

All students must fulfill a one-year *residency requirement*. Residency is satisfied by registering for at least 9 units in each of two consecutive academic semesters at some time in your doctoral career. *A full 9 units must be taken in each semester of residency; it is not sufficient to register for LGS 9000 for those semesters.* If you transferred to Ph.D. status from a WU CSE Master's Program, consecutive semesters spent enrolled full-time in that program may be used to satisfy your residency requirement.

Residency requires full participation in the life of the Department. For part-time students who work full time, the Department requires that you reduce the amount of time you spend at work by at least 50% during the residency period. You will have a desk and all the responsibilities of a full-time doctoral student (e.g. attending colloquia) during your residency.

4 Teaching Requirements

The skills required to obtain a Ph.D. include not only mastery of core and specialized CSE knowledge but also the ability to communicate this knowledge to others. Teaching skills are especially important if you choose to pursue an academic career, but similar abilities are required in industrial research and many areas of public life. Our Ph.D. programs therefore require you to satisfy teaching requirements as part of obtaining your degree.

There are three aspects of the Teaching Requirement that must be completed prior to graduation:

- *scholarly communication*, by participating in the Doctoral Student Research Seminar;
- *pedagogy training*, by completing certain pedagogy workhops;
- *mentored teaching*, by acting as a teacher or course TA.

4.1 Scholarly Communication Requirement

All doctoral students are expected to gain proficiency in oral communication of research results to an audience of scholars, who may be either your peers or the research community at large. Various parts of your doctoral training, such as your research seminars, your oral qualifying exam, and communication of your own doctoral research will help you build skills in this area.

Any doctoral student who is active in research should have ample opportunity to communicate their research to both internal and external audiences. At a minimum, *all doctoral students are required to complete at least two presentations of their work in Doctoral Student Research Seminar*, or appropriate substitute activities, prior to graduation. See Section 7.1 for a description of this seminar.

If for any reason you are not able to complete two DSRS presentations prior to graduation, you must complete one substitute activity for each such presentation not completed. Substitute activities include external conference or workshop talks, seminar talks, or other presentations of research (yours or someone else's) at least twenty minutes in length. Other types of activity may be counted with approval of the Doctoral Program Director. Any substitute activities must be carried out while you are enrolled as a graduate student in CSE.

Oral examinations required by a student's academic program — such as the oral qualifying exam, dissertation proposal, or dissertation defense — and talks delivered as part of a student's three required research seminar units may *not* be counted as substitute activities.

Please note that substitute activities do not exempt you from participation in Doctoral Student Research Seminar.

New rules for Doctoral Student Research Seminar (Fall 2015):

In order to promote a high quality Doctoral Student Research Seminar Series, the above rules are modified for students starting in Fall 2015 or later as follows: Prior to completing the

PhD, every student must complete at least one DSRS talk that is rated to be 'outstanding' by the faculty evaluating that talk. It is expected that almost students will take several tries to achieve this ranking. To support informed critique, talks will be shortened to allow discussion of the talk strengths and weaknesses immediately following each talk.

Documentation

No special documentation is required if you fulfill the Scholarly Communication Requirement by giving two Doctoral Student Research Seminars. If you need to claim substitute activities, please send an email to the CSE Department administrator in charge of graduate affairs describing these activities and when they were performed.

4.2 Pedagogy training (students matriculating in or after Fall 2017)

Students who have not yet completed their teaching as of August 15, 2015, are encouraged to follow the current procedures outlined above. However, the teaching section from the previous version of this handbook is reproduced verbatim below, in case a student wishes to follow the procedures in effect at the time she or he matriculated.

Prior to beginning the mentored teaching experience (MTE), students must participate in two preparation workshops.

1. The University-Wide, Graduate Student Teaching Orientation held at the beginning of the fall semester. Students are strongly encouraged to do this the fall of the year in which they plan to complete the MTE but may on occasion do it earlier.

2. The teaching workshop offered by the CSE Department in collaboration with other SEAS departments. Students are strongly encouraged to do this as close to the beginning of the semester in which they enroll in the MTE as is feasible.

4.3 Mentored Teaching Experience (students matriculating in or after Fall 2017)

The Mentored Teaching Experience (MTE) consists of a minimum of 14 hours of contact with students and will also typically require about 10 hours per week of participation in course administration such as grading assignments, answering students questions online, and other such duties as assigned by the course instructor. The 14 contact hours are organized into two levels.

1. Level 1. At least 4 hours of lecture, traditional recitation section, lab section, or structured studio. The defining features are that (a) the MTE student must prepare and plan the session in advance, and (b) the MTE student must be in charge of a group of 3 or more students engaged in some form of planned, structured learning experience. The MTE student should record the names of the students in attendance. Office hours

or 1-on-1 help do not satisfy this requirement. If the student engages in more than 4 hours of this activity, the additional hours can count toward the Level 2 requirement.

2. Level 2. At least 10 hours of some combination of (a) and (b) below:

   (a) Helping students 1-on-1, in person. These can be in scheduled office hours or ad hoc meetings. The MTE student should record the names of the students he or she helped and the approximate time spent. Or,

   (b) Designing and grading significant new assignments and writing a one-page reflection on how they went, including strengths and weaknesses. The reflection should be turned in to and discussed with the mentor in charge of the course.

   Hours devoted to either of these two options can be combined to satisfy the requirement.

The total time commitment for the MTE should be similar to that of a 3-unit course, i.e. not more than about 12-14 hours per week, on average. However, the time required may vary significantly from week to week.

The mentor should sign an MTE committment form before the beginning of the semester and an MTE completion form at the end. The student should enroll in LGS 600, Mentored Teaching Experience, section 25 for the semester(s) in which they plan to satisfy the teaching requirement.

Transferring Teaching

If you believe you have satisfied some or all of the fundamental teaching requirement before joining our program, you may apply to transfer your outside teaching experience. Transfers must be approved as a special exception by the Department Chair and the Dean of the Graduate School. You must both document the activity as described above *and* supply an official memo, signed by the faculty member who supervised you at the time of the outside teaching activity, to verify that you did the work described. Please check with the Doctoral Program Director if you want to pursue such a transfer.

Optional teaching training

Doctoral students interested in academic careers have the option to undertake additional training to better prepare them to the challenges of teaching. Specifically, in cooperation with the department's Associate Chair and with the approval of their advisor, students can opt to teach a one semester course in the CSE department. This option cannot be exercised more than twice during a student's Ph.D. program, and requires that the student enroll in CSE 801 in the semester(s) during which she/he is teaching such a course.

Teaching a course does not translate in additional compensation, and will result in a reduction in the amount of time the student is able to devote to research by 40% to 60% depending on the course. A student must, therefore, ensure that the approval of her/his advisor is officially conveyed to the Director of Graduate Studies before enrolling in CSE

801. Selection of a suitable course will then be performed in collaboration with the Associate Chair, who will also coordinate supervision of the student's teaching during the semester.

5 Pedagogy training and teaching requirements for students who matriculated before Fall (2017)

The following implementations of the pedogogy training and mentored teaching experiences apply to students matriculating matriculating between fall 2011 and spring 2017.

5.1 Pedagogy Training (students matriculating in Fall 2011 to Spring 2017)

The pedagogy training requirement entails completion of workshops and seminars dealing with teaching and course management. These seminars are organized by the Washington University Teaching Center, either alone or in conjunction with the CSE Department.

To fulfill this requirement, you must complete all of the following:

- the school-wide TA Orientation: "Teaching Symposium for First-Time TAs and IAs", held immediately prior to the beginning of fall semester;
- a teaching orientation offered to all new CSE Ph.D. students as part of CSE 591;
- at least **three** additional pedagogy workshops offered by the Teaching Center (either the TA Training introductory workshops, or the Advanced Level workshops).

The Department organizes occasional workshops specifically for Ph.D. students, which may be used to count toward this requirement. The Teaching Center also offers a regular rotation of workshops on general pedagogical topics; you can find a complete list on their web site at *teachingcenter.wustl.edu*. Any workshop in the "Introductory-Level Workshops for Graduate Students" or "Advanced-Level Workshops and Seminars" categories may be counted toward the required three workshops. Workshops generally last one to two hours.

Documentation

As you complete your teaching orientation and each required workshop, you will receive *completion certificates* from the Teaching Center. Please give a copy of each such certificate to the CSE Department administrator in charge of graduate affairs.

5.2 Fundamental Teaching Requirement (equivalent to "Mentored Teaching Experience" for students matriculating before Fall 2017)

The fundamental teaching requirement entails at least one semester's worth of experience as a teacher, co-teacher, or teaching assistant (TA) in a for-credit, non-seminar CSE class,

or in CSE 501 or 502, our non-credit "immigration courses" offered to incoming graduate students with a non-CSE background. To count toward the requirement, the TA or teaching position must include a certain amount of *group contact activity*, during which you lead an oral communication with a group of students in the context of the class.

Group contact activity may take the form of, e.g., classroom lectures, supervised laboratory exercises, recitation sections, or group review or help sessions. **Activities not involving group contact with students, such as grading, creating assignments, tutoring, responding to email, and one-on-one office hours, may be entailed by the teaching or TA position but do not by themselves satisfy the requirement.**

The fundamental teaching requirement must be met either by one semester of teaching that entails group contact activity averaging at least one hour per week, or by two semesters of teaching, each of which entails group contact activity averaging at least one hour every other week. Activities that normally satisfy the full requirement include:

- teaching or co-teaching a 3-unit graded course, or CSE 501 or 502;
- serving as a TA for one semester in a position that entails recitation sections, supervised labs, and/or group help sessions averaging at least one hour per week.

Activities that normally satisfy half the requirement include:

- teaching a 1- or 2-unit CSE course (which typically meets once a week for half a semester);
- serving as a TA for one semester in a position that entails recitation sections, supervised labs, and/or group help sessions averaging at least one hour every two weeks.

The course instructor and the CSE Department will determine whether any particular TA activity of the types described above is suitable for the fundamental teaching requirement; if in doubt, ask the Graduate Program Director. Other types of teaching activity may also be counted with the Program Director's prior approval.

Documentation

At the end of a semester in which you taught or TA'd a course in complete or partial fulfillment of the fundamental teaching requirement, you should fill out a Fundamental Teaching Requirement Completion Form, which must be signed by the instructor or other faculty member who supervised your teaching. On the form, you should briefly summarize your teaching activity and should specifically identify the type and frequency of group contact activity that fulfilled the requirement. Please return the signed form to the CSE Department administrator in charge of graduate affairs.

Table 1: Suggested Timing of Program Milestones

Milestone	Guideline Time (years)	Time Limit
Oral Qualifying Examination	1.5-2.0	
Admission to Candidacy (portfolio review)	2.0	[2.5]
Dissertation Proposal	2.5-3.5	[4.0]
Dissertation Defense	4.5-5.5	[7.0]

6 Program Milestones

Your graduate career is marked by a series of milestones achieved on the way to your doctorate. At each milestone, you will demonstrate certain skills and abilities critical to success in CSE research. The CSE faculty have defined these milestones both to give you intermediate targets at which to aim and to give us ways to assess your progress toward the doctorate.

Table 1 lists the milestones of the doctoral program and indicates roughly how long it should take you to reach each one ("Guideline time"). Times are given in years relative to the beginning of your first semester as a graduate student (M.S. or Ph.D.) at Washington University. The guideline times are only approximate, and some variation is natural. For example, a student who enters the program with a CS or CoE master's degree from another university is likely to proceed faster, while a student without an undergraduate CS or CoE degree is likely to proceed more slowly. While the guidelinse are flexible, **the time limits should be taken seriously.**

The following sections describe the procedures of each milestone in more detail.

6.1 Milestone 1: Oral Qualifying Examination

The oral qualifying examination tests your ability to read deeply the literature in your research area, to synthesize and to critically evaluate existing research results, to present these results in a scholarly and professional oral presentation, and to answer orally questions from the faculty about the literature you've read. All of these skills are essential for being able to pursue research at the doctoral level.

To the extent that the research area for your oral exam is related to your doctoral research area, the time you spend preparing for the exam should help you make progress toward your degree. The exam will also be one of (we hope) many opportunities for you to build confidence in your research and oral presentation skills.

Important Note: if you have completed and orally defended a master's thesis in this department, you may waive the oral qualifying examination.

Procedure of the Exam

When you are ready to proceed with the oral qualifying examination, you should meet with your advisor to identify a topic for the exam. You and your advisor will then assemble an oral examination committee.

Your committee must include at least three regular (i.e. tenured or tenure-track) CSE faculty members. Your advisor may *not* serve on this committee and will not be present at the exam. We recommend that the chair of the committee be someone in your research area who can act as advocate for you at the exam, and that at least one committee member be from outside your research area.

To provide a starting point in preparing for the exam, you and your advisor, in collaboration with the examining committee, will select three research papers covering different aspects of the area to be examined. As part of your preparation, you are expected to read each assigned paper in depth to understand both the significance of its results and the details of how these results were achieved. However, your preparation should cover the whole area of the exam, *not just the selected papers*. You will likely need to do significant background reading to understand current work in the area and to place it in its historical context. You should have well-informed opinions about the quality of the work in the selected papers and how their approaches relate to each other and to other work in the area. You should also formulate well-reasoned opinions about the future of the research area and the role, if any, that each of the reviewed papers is likely to play in it.

Your advisor may *not* work closely with you on exam preparation after the initial choice of papers and committee are complete. Your interactions regarding the exam should be limited to occasional questions and at most one practice talk attended by the advisor. These limits do not preclude giving additional practice talks for other students, including those in your research group. Indeed, we *strongly recommend* practicing your presentation for other students prior to the exam. A clear, polished, practiced presentation heads off much confusion and makes it easier and much more pleasant for you and the committee to engage in a dialog about the area of your presentation.

When you are ready to proceed (in at most about two months), you should prepare a polished, professional, conference-style oral presentation of around 35 minutes that presents an overall view of and direction for work in the area of the exam.

ImportantYour presentation should include a summary of important ideas from the selected papers, their significance, and how they relate to each other and to other relevant work. However, **it is not sufficient to give a talk focused on these papers alone**. **Let me repeat this: A talk that merely summarizes the three papers is a failing talk.** Rather, you must demonstrate that, having read both the selected papers and other literature, you have synthesized a clear understanding of the current state of research in the area and can propose and defend reasonable directions for further, novel research in it.

During and after your presentation, the committee will ask you questions about the substance of the papers and their implications for your research area and your own planned work. Please schedule two hours for your exam to allow sufficient time for questions. At the end, the committee will confer in private to determine whether you have passed the exam.

Outcomes

There are three possible outcomes to an oral exam:

- Pass, allowing the student to continue to the next milestone.

- Fail, asking the student to retake the exam. This is the most common type of fail.
- Fail without the option to retake, effectively asking the student to leave the program.

In the event that you fail the oral examination and are asked to retake it, you should immediately confer with your examining committee to determine the areas in which your performance fell short of the committee's expectations. You should then arrange to retake the exam, using the *same research area and starting papers*, within one month. Your committee for an exam retake must include at least one member who was present at the previous exam and at least one new member who was *not* present.

6.2 Milestone 2: Admission to Candidacy

The second milestone, the portfolio review for admission to doctoral candidacy, assesses whether you have (or will soon achieve) both sufficient breadth in CSE and sufficient ability to carry out independent research to proceed with a research-based dissertation in your area.

Prerequisites

Before you can be considered for candidacy, you must:

1. pass the oral qualifying examination;
2. satisfy all breadth requirements, whether by taking courses or by transfers;
3. complete at least **nine** graded units of course work while a graduate student at Washington University. At least **six** of these units must be from CSE courses.

The last, most important prerequisite for admission to candidacy is to prepare a written *portfolio* demonstrating that you can contribute significantly to original research. A student's portfolio may contain any desired written materials, including selected homework, exams, or publications. However, the centerpiece of the portfolio *must* be a written product of research performed as part of a relationship with your research advisor at Washington University. You must make a substantial contribution both to the research itself and to the composition of this written material.

The centerpiece of your portfolio may be a research paper (submitted or accepted) or a technical report. You need not be the primary author of this work, but your contribution must be substantial enough that the work can be used as a demonstration of your ability to carry out research and to write clearly about your results.

Important Note: if you have completed a master's thesis in the Washington University CSE Department, this thesis may serve as your portfolio's centerpiece.

The Faculty Portfolio Review

When you and your advisor determine that you should be reviewed for admission to candidacy, you will assemble your portfolio and submit it to the Doctoral Program Director. The portfolio must be submitted by the beginning of the student's fifth semester, though it can (and hopefully will) occur earlier. **Unless there are extenuating circumstances, a students who has not been admitted to candidacy by the end of her fifth semester will be placed on academic probation.**

Your portfolio submission should include a cover letter listing the portfolio's contents, certifying that you have passed or waived your oral qualifying exam, and explaining how you have met the coursework and breadth requirements for candidacy. Besides the information listed in this letter, you should also provide a copy of your portfolio centerpiece and an (unofficial) copy of your Washington University transcript. A printout from WEBSTAC, the university's on-line student information system, is fine for the latter.

If you are submitting several papers or other written works with your portfolio, please indicate which paper you would like to designate as the centerpiece. In general, the centerpiece should be the document on which you contributed most to the writing.

The Director will assign your portfolio to a faculty reviewer (not your advisor). After the reviewer has assessed the portfolio, the Director will bring up your case at a meeting of the CSE faculty. At that time, the faculty will review your total package (portfolio, oral qualifier, and grades in breadth courses) and will then vote on whether to admit you to candidacy. The vote is based on whether, in the faculty's opinion, you have demonstrated the knowledge, ability, and creativity needed to conduct high-quality research.

Outcomes

There are three possible outcomes to the vote on admission to candidacy:

- Admit to candidacy (possibly with conditions) for the Ph.D. degree;
- Delay any decision and conduct a second review at some later time (usually within six months);
- Do not admit to candidacy, effectively asking the student to leave the program.

Admission to candidacy may be unconditional or may be conditional on your completing specified additional work. Typically, this work would be intended to remedy a weakness in breadth and would entail demonstrating sufficient mastery in one or more specific courses. Alternatively, the faculty may reject the portfolio centerpiece and ask for additional work showing evidence of your ability to carry out research.

If you are conditionally admitted to candidacy, your admission will be conditional on satisfactory completion of these conditions, including any remaining breadth requirements, *prior to your dissertation proposal*.

6.3 Milestone 3: Dissertation Proposal

The next milestone for the Ph.D. program is proposal of a topic for dissertation research. You should choose your dissertation topic and formulate a plan of research on this topic in consultation with your research advisor. The planned research must be original, novel, and significant enough to warrant publication (typically at least three journal-quality papers' worth of work).

When you have selected a research topic, you must describe your research plan in a written *dissertation proposal*. The proposal, which typically ranges from 10 to 15 single-spaced pages in length, not counting the bibliography / references section. This length guideline is not abitrary – learning how to condense your ideas to a proposal of limited length is a very important research skill in industry as well as in academia. The proposal should include the following information:

- motivation for the planned research;
- one or more goals that you will achieve through your research program;
- background sufficient for someone educated in CSE (but not necessarily in your area) to understand your goals and their significance;
- a review of existing work related to your research plan, indicating how your planned research is novel;
- high-level details of the planned research, including challenges, methods, and deliverables, sufficient for an expert in your area to evaluate its technical feasibility;
- a timeline indicating when you plan to achieve your goals and when you plan to complete the dissertation.

A good model for the dissertation proposal is an NSF or NIH grant proposal. Your advisor or another faculty member can provide examples of such proposals.

Forming a Committee

Your dissertation work, starting with the proposal, will be supervised by an *advisory committee*, which is typically also the committee before whom you present your final dissertation defense. Your committee is typically chaired by your advisor, and must include a total of at least **five** members, who collectively must meet two independent criteria:

1. Four of the five must be tenured or tenure-track Washington University faculty; one of these four may be a member of the Emeritus faculty. The fifth member must have a doctoral degree and an active research program, whether at Washington University, at another university, in government, or in industry.
2. Three of the five must come from the student's degree program; at least one of the five must not.

Your committee may be as large as you wish, so long as some subset of five members satisfies the above requirements. The Dean of the Graduate School is the final arbiter of what constitutes an acceptable committee.

Notes on Outside Members. Washington University faculty whose primary appointment is wholly or partially in the CSE Department are never considered "outside" the department, even if they have appointments in other departments as well. Faculty with primary appointments in another department and courtesy appointments in CSE may be considered "inside" or "outside" at the student's discretion.

Your required non-CSE faculty may be a person who is not tenured, tenure-track, or emeritus Washington University faculty. This person may be at Washington University, at another university, or in a non-academic position (e.g. government or industry). The only requirements are that the person have a doctoral degree and an active research program.

Procedure of the Proposal

You must defend your written dissertation proposal in a public oral examination before your committee. You should supply each committee member with a copy of the proposal at least seven days prior to the examination.

Attendance by a minimum of four members of the dissertation defense committee, including the committee chair and an outside member, is required for the proposal to take place. This provision is designed to permit your defense to proceed in case of a situation that unexpectedly prevents one of the five members from attending. Do not plan in advance to have only four members in attendance; if one of those four cannot attend, your proposal must be rescheduled. Note that the absence of all outside members or of the committee chair would necessitate rescheduling the defense.

Members of the dissertation defense committee normally attend in person, but one of the five (or, in case of an emergency, one of the four) members may attend virtually instead.

The proposal defense consists of two parts. First, you must give an oral presentation of about 45 minutes describing the content of your proposal, including its background and motivation, its aims, related work, the research plan itself, and the timeline for completion. This presentation is open to all, so it should be comprehensible to those outside your area of research. Following this presentation and questions from the audience, the research advisory committee examines you privately about details of the research plan and any questions raised by their reading of the proposal. At the end, the committee deliberates privately to determine whether to accept the dissertation proposal. You should schedule at least two hours of time for this examination.

Outcomes

The committee may either accept or reject the dissertation proposal. Even if the proposal is accepted, the committee may still recommend changes to the research plan and may require you to provide regular oral and/or written updates on your progress toward the proposal's specific aims.

The Title, Scope, and Procedure Form

Once you pass your proposal defense, you should submit a Title, Scope, and Procedure Form to the Graduate School as soon as possible. This form briefly describes the planned work of the dissertation. The "scope" of your dissertation indicates the specific area of study and the questions to be answered, while the "procedure" briefly describes how you will carry out the work. You should have the form filled out and ready for signatures prior to the proposal defense.

At least three CSE faculty from your committee, including your advisor, must sign the form, though ideally the entire committee should sign.

6.4 Milestone 4: Dissertation Defense

At the conclusion of your doctoral research, you will produce a written dissertation describing the results of your doctoral research, along with sufficient context to make the importance of the question you addressed and the implications of your findings clear to a general computer science audience. It should also provide sufficient details for a specialist in your field to verify your findings. This dissertation must be produced according to the Graduate School's Dissertation Guide. Please see this guide for detailed instructions about formatting and which materials and forms must be submitted to the Graduate School before and after the examination. Note that you must file an *intent to graduate* through the University's on-line WebSTAC system in the semester in which you defend your dissertation

Important Note: you may not schedule the final dissertation defense less than *six months* from the time a signed Title, Scope, and Procedure Form is received by the Graduate School.

Procedure of the Dissertation Defense

The written dissertation must be defended in a final, public oral examination (the *defense*), which uses a procedure similar to that of the proposal examination. The defense is conducted by a five-member *examining committee*, whose composition and attendance requirements are the same as those described in Section 6.3.

Per Graduate School rules, you must deliver your written dissertation to your examining committee at least **seven days** prior to your examination. However, the CSE Department strongly recommends that the dissertation be delivered at least *fourteen days* in advance. You should offer to provide each committee member a printed copy of the dissertation as well as an electronic copy.

Outcomes

The examining committee may separately accept or reject the written dissertation and the oral defense. A committee that accepts the written dissertation may still request changes to the document that you should complete before submitting it to the Graduate School.

6.5 Time Limits, Consequences and Appeals Process

Some students, for a variety of reasons, are not able to complete the entire process of attaining a Ph.D. degree. You should do your best to understand, at the earliest possible stage in your doctoral program, which steps may be troublesome for you and to work to meet these challenges. At any step in the process, the faculty may raise concerns about your ability to continue and may even ask you to leave the program. This does *not* mean that you are a failure, only that the faculty strongly believes that continuing with doctoral research is not in your best interest. We have seen, over and over again, that making this determination earlier rather than later is in the best interest of both students and faculty.

If a student has a healthy relationship with her research advisor, concerns from the faculty about the student's ability to continue in the program should *never* come as a surprise. Moreover, the Doctoral Program Committee tracks the progress of doctoral students and alerts both student and advisor to any substantive concerns while there is still time to take corrective action. Part of this tracking is to evaluate your progress relative to the milestones listed in Table 1. To remain in good standing, it is vital that you become integrated within a research group in the first year, and accomplish the milestones in a timely fashion. In particular, you must:

1. become integrated with a research group by April 1. Because the PhD is a research degree, failure to become integrated within a research group is a serious problem. This will lead to a probation period until August 31 during which the student must continue to seek a research advisor. Failure to become integrated with a research program will lead to dismissal from the PhD program and termination of funding.

2. complete the oral exam by the end of the fourth semester.

3. complete the portfolio review by the end of the fifth semester.

4. complete the thesis proposal by the beginning of the ninth semester.

5. complete the degree by the end of the seventh year. All Ph.D. students, whether full-time or part-time, must complete all the requirements of their program and graduate within seven years of admission. For Washington University students transferring from M.S. to Ph.D. status, the seven-year clock starts at the beginning of *M.S. admission*, not when the student switches to a Ph.D.

   Students who do not complete their degree within their program length may apply for a one-year extension if circumstances warrant. To obtain an extension, the student must apply to the department. If the department supports the extension, that decision must still be approved by the Graduate School.

6.6 Procedures for Progress Evaluation, Probation and Dismissal

The Graduate School has rules governing the procedures to follow for students that are failing to make progress towards the milestones above or failing to make sufficient progress

towards your research goals. These guidelines can be found here.

Failure to meet the timelines for the oral exam, the portfolio, and/or the thesis proposal will trigger an evaluation by the Doctoral Program Director about whether progress in the PhD program is satisfactory. That evaluation may lead to a probation with a period of not less than 3 months which would be lifted when the student successfully completes the milestone. The probabationary period is expected to last less than one semester, unless there are extenuating circumstances such as requiring the student to pass a class that is not offered until a later semester.

Aside from the milestones, student progress towards research goals is also necessary to complete the PhD program. Concerns about student productivity can be brought to the attention of the Doctoral Program Director at any time, including but not limited to the Annual Review described in Section 7.3. This may lead to a probationary period not less than 3 months, accompanied by a specific plan, shared with you and the Doctoral Program Director detailing specific achievements necessary for a return to appropriate research productivity and good standing.

Extreme underperformance, such as consistently missing research group meetings, failing to discharge basic laboratory responsibilities, or actions that negatively affect the safety and productivity of the workplace for others may result in a recommendation for dismissal from the program without a probationary period.

Decisions regarding placement on probation, removal from probation, recommendations for dismissal after a probationary period and recommendations for immediate dismissal are managed collectively by a committee comprising, as ex-officio members, the Doctoral Program Director and the Doctoral Admissions Director and one additional faculty member appointed by the Department Chairperson. If one of these faculty member is the advisor of the student, they will be replaced by an additional faculty member appointed by the Department chairperson for decisions regarding that student. Decisions to put a student on probation, to remove them from probation or to recommend dismissal all require a two-thirds vote from this committee.

7 Other Student Responsibilities

Besides the major milestones, you have some continuing responsibilities as part of your participation in the doctoral program. These responsibilities are partly to help the faculty assess your progress and partly to help you better prepare for a career in CSE research.

7.1 Doctoral Student Research Seminar

The Department's Graduate Student Association organizes a regular non-credit seminar in which doctoral students present their ongoing research. This seminar provides a forum for you to show off your accomplishments to your peers, an opportunity to practice the skills of talk preparation and presentation, and an occasion for interested faculty to assess your progress in the program.

Each student who takes CSE 699 or LGS 9000 for at least one semester of a given year must present a talk in the seminar and must attend other seminars in the series. Students who take research credits in the fall semester typically present in spring, while those who take research credits only in spring present the following fall. The talk requirement is waived if the student is presenting a dissertation proposal or defending a dissertation or M.S. thesis in the same year that she becomes eligible to talk in the seminar.

The format of the seminar is two half-hour slots. Each slot is devoted to a conference-style presentation by one student, followed by time for questions. Presentations are typically fairly polished (practicing is strongly recommended). Listeners in the seminar provide anonymous feedback to speakers in the form of comment sheets filled out during the seminar. Talks are announced in advance by posted abstract, which should be sent to the seminar organizer(s) about a week in advance of a presentation.

Students who are not required to present in a given year may still choose to do so. Participation by M.S. students and advanced undergraduates is also possible, given sufficient space in the schedule.

7.2 Colloquium Series

Throughout the year, faculty members invite speakers from other universities and from industry to give public colloquia in the department. These talks are extremely important in helping us to stay abreast of developments in our field and in encouraging productive relationships with researchers outside the Department. Some talks also serve as job interviews by applicants for CSE faculty positions.

Doctoral students are expected to attend all talks in the colloquium series. You will have the opportunity to hear about exciting research in your field and to find out about areas in which you might want to work. You will also have the opportunity to critically assess presentations, which will help you learn how to present well yourself. Seeing what works and does not work in job talks is especially useful as you yourself begin to think about applying for jobs.

The obligation to attend colloquia applies less stringently to part-time students, who may not be in the Department during our usual colloquium times. However, during the residency period, part-timers have the full opportunity and obligation to attend.

7.3 Annual Review of Progress

At the end of each year's spring semester, the Doctoral Program Committee reviews the progress of all students in the CS and CoE doctoral programs. The purpose of this review is to ensure that students are making adequate progress toward their degrees, to identify potential trouble spots early enough to respond, and to maintain a uniform expectation from the faculty as a whole about how quickly students should be moving through the program milestones.

All doctoral students are asked to fill out a survey form documenting their progress over the last year and their plans for next year to aid in the annual review. Your submission to the committee must be discussed with and approved by your advisor. In addition to the survey form, you should feel free to include papers, technical reports, or other documentation of your work.

You may also use the annual assessment as an opportunity to raise concerns about your relationship with your advisor or other progress-related issues. You may, if you prefer, raise these issues separately (and, if need be, confidentially) from your advisor-approved submission.

Important note: advisors are strongly urged to let the Doctoral Program Director know as soon as possible if a doctoral student is in danger of being left unadvised and unfunded or is otherwise having difficulty making progress. Please **do not wait for the annual review**, since losing an advisor can have not only academic but also financial and immigration implications for the student.

7.4 Academic Integrity and Ethics

We expect doctoral students to maintain a high standard of academic integrity. This standard includes integrity in both your coursework and your research activities. **Failure to abide by the department's standards of academic integrity can result in your dismissal from the Ph.D. program.**

For details on expectations, policies, and procedures associated with academic integrity, please see the school's academic integrity policy here. If you have any questions or uncertainties, please do not hestitate to ask your instructor (for courses), your advisor (for research), or the program director for rare circumstances in which you do not feel comfortable with these other options.

separate Departmental Policy on Academic Integrity.

7.5 Outside Employment and Internships

Full-time CSE doctoral students receiving research assistantships are restricted as to what kinds of work they may do outside of their doctoral research. Students receiving research assistantships are expected to dedicate all their energy to making progress toward their degrees and to contribute to related research activities. As such, only limited effort may be directed to income-generating activities within or outside the university, and only if such activities do not interfere with the student's academic pursuits or general university policies on conflict of interest and conflict of commitment.

The scope of outside income-generating activities for full-time students is limited to one day per calendar week. The student has an obligation both to keep her advisor and the Department informed about all such extra activities, and to secure the advisor's explicit approval. Special exceptions may be made for certain kinds of teaching, such as covering a summer course for the Department; please consult your advisor for more information.

Internships

Doctoral students in some areas of computer science often pursue research internship opportunities during their graduate career. An internship experience generally involves doing CSE research in an industrial or other non-academic setting. The work, which typically lasts several months, is done under the supervision of the company or lab supporting the internship. Students do not receive graduate assistantship support during their internships; rather, they are paid by their employer.

Any student contemplating an internship must first obtain her advisor's permission. Verify in particular that your advisor approves of your planned absence from your research group! Moreover, you should carefully consider whether the work you will perform for your internship could overlap with work you plan to do for your dissertation. In most cases, your employer holds intellectual property rights in the work you do while on an internship; hence, you should be careful to avoid unintentionally encumbering your dissertation research.

International students on F-1 visas need a work permit to take an outside internship. These permits can be obtained through the University's Office of International Students and Scholars (OISS). OISS will treat your internship as co-op experience, which is eligible for Curricular Practical Training but does not count for academic credit. Please note the following rules that apply to F-1 visa holders seeking an internship:

- You must obtain written approval for the internship from both your advisor and the department chair.
- You must register for one of the following non-credit co-op courses:
  - E60 ENGR 500S for summer internship
  - E60 ENGR 500A for academic-year internships

Academic-year internships must be one full semester, full-time. Please contact OISS or the Career Center to learn more about how to arrange an internship and the procedures associated with co-op experience.

8 Switching from Master's to Doctoral Status

If you are a current M.S. student in our department and are interested in joining one of our doctoral programs, you may follow either the normal application procedure or the following, expedited procedure:

1. You must find a faculty research advisor willing to both advise and, if required, to support your doctoral study. Typically, you should already have a strong working relationship with the advisor, based on, e.g., research done for a master's thesis.

2. You must fill out the on-line graduate application for the Engineering School, including the parts specific to CSE. You do not have to submit transcripts or test scores. You must, however, complete all requested essays and submit three letters of recommendation.

3. Your advisor must write a letter to the Department Chair recommending you for doctoral admission, stating that she is willing to advise you, and indicating the source of your doctoral funding.

Approval of the status change is at the discretion of the Department Chair. You will still need to complete the necessary Ph.D. enrollment paperwork with the Graduate School, and your enrollment must be approved by the Dean of the Graduate School.

9 Index of Links to Forms

- Rotation or temporary research affiliation
- Cover letter and breadth certification for portfolio review
- Mentored Teaching Experience Forms
  - Committment form (for faculty to complete before the beginning of the MTE)
  - Completion form (for faculty to complete after the MTE)
- Title, Scope, and Procedure Form

10 Appendix

10.1 Historical Breadth Requirements

Each of the CSE doctoral programs has its own breadth requirements, and these have changed over time. All students may choose to use the breadth requirements currently in main section of this document. Additionally, students may choose to use the breadth requirements that were in effect when they entered the program. Those requirements are listed here.

For each program, these requirements divided into several areas. You must take the specified number of courses from each area, choosing from among the list shown. Where two courses are listed as "X or Y," only one of these two courses may be counted toward the breadth requirement.

Some courses that satisfy breadth requirements are 400-level (i.e., part of our undergraduate curriculum). You may count **at most three** 400-level courses toward your breadth requirements.

In all cases, courses counted toward the breadth requirements must be passed with a grade of B or above. To avoid trouble at your portfolio review, you should maintain a GPA of better than 3.6 for your breadth courses. Although you may be allowed to continue in the program with a lower breadth GPA, the faculty may require you to prove yourself through additional coursework.

Under these rules, all of the breadth requirements must be satisfied before you present your dissertation proposal. Additionally, at least four of the six requirements must be satisfied, either by taking courses or by transfers, before you may be considered for the portfolio review.

10.2 Historical Computer Science Breadth Requirements

Students who started in the program before Fall 2012 may satisfy their breadth requirements under the former rules for Computer Science degree which are shown in table 2.

Table 2: Computer Science Breadth Requirements, **pre Fall 2012**

Theory (take 2)	Systems (take 2)	Machines (take 1)	Applications (take 1)
CSE 541T or CSE 441T CSE 542T CSE 547T	CSE 522S or CSE 422S CSE 531S or CSE 431S CSE 425S CSE 467S	CSE 560M	CSE 511A CSE 552A or CSE 452A CSE 573S or CSE 473S CSE 587A CSE 530A CSE 405A

10.3 Historical Computer Engineering Breadth Requirements

Students that arrived before 2014 may satisfy the Computer Engineering breadth requirments shown in Table 3.

Table 3: Computer Engineering Breadth Requirements, **pre 2014**

Theory (take 1)	Systems (take 2)	Architecture (take 1)
CSE 541T or CSE 441T CSE 542T CSE 547T CSE 460T	CSE 522S or CSE 422S CSE 531S or CSE 431S CSE 573S or CSE 473S CSE 467S	CSE 560M
Hardware Design (take 1)	**Performance Evaluation (take 1)**	
CSE 462M CSE 463M CSE 464M CSE 465M CSE 563M CSE 565M	CSE 567M CSE 577M	