

Graduate Program Handbook

M.S. and Ph.D. Degrees

Department of Computer Science
University of New Hampshire

updated: Summer 2012; February 2016; June 2017; June 2018; February 2019; May 2019

1 Overview

The department offers both an M.S. in Computer Science and a Ph.D. in Computer Science.

The M.S. program is designed to help students increase the breadth and depth of their computer science knowledge, strengthen their software development skills, and build their research skills. Professionally-oriented students often complete industry internships and the program has an outstanding job placement record for its graduates. Research-oriented students complete an M.S. thesis under the guidance of a faculty mentor, which usually leads to publication and provides clear evidence of the developed research skills useful for obtaining a leadership position in industry or to go on to do a Ph.D. Applications are welcomed from students whose undergraduate degree is not in computer science. In this case a well-defined set of undergraduate prerequisites must be completed as part of the M.S. program of study.

The Ph.D. program is designed to develop students' ability to carry out advanced research, as well as ensure that they possess the breadth and depth of computer science knowledge required to obtain a faculty position in academia, or a research position in industry or at a national laboratory. Students obtain breadth knowledge through classwork and research seminars. Working with a faculty research mentor, they also carry out advanced work that results in original research publications and a doctoral dissertation.

2 Administration

The M.S. and Ph.D. programs are overseen by a committee of faculty, the Graduate Studies Committee. This committee is chaired by the Director of Graduate Studies. The Committee assists the Director in promoting the programs, making admission decisions, awarding financial aid, and managing the curricula of the two degrees.

Modifications to the curricula need the approval of the full-time graduate faculty of the department.

The department's industry advisory board meets twice a year and regularly reviews the curricula and student outcomes for the department's undergraduate and graduate programs. The advisory board is comprised of representatives from the leading technology companies in the region, as well as UNH Information Technology and the UNH InterOperability Laboratory.

3 Admissions

All applicants must submit official college transcripts, GRE General Test results, three letters of recommendation and a personal statement. (In some cases the requirement for the GRE is waived, if the student has already completed Computer Science courses at the University of New Hampshire.) Following university policy, international students are also asked to demonstrate proficiency in the English language, typically by taking the TOEFL exam. (Having completed a bachelor's or advanced degree at a school where English is the primary language of instruction is also sufficient to demonstrate proficiency.)

We take a holistic approach to making admission decisions. We look at all components of the application to identify if there is clear evidence that the applicant will be capable of successfully completing their chosen program. For Ph.D. applicants it is important that the student's research interests align with the existing research programs in the department.

Our M.S. program is designed for students with a B.S. in computer science. However, we welcome applications from students whose undergraduate degree is not in computer science. In this case a set of undergraduate prerequisites must be completed as part of the M.S. program of study. The prerequisites include an introduction to computer science, object-oriented programming, data structures, machine organization, operating systems, and computer science theory. These prerequisites can be satisfied at UNH by the following undergraduate courses:

- CS 415, Introduction to Computer Science I
- CS 415, Introduction to Computer Science II
- CS 515, Data Structures
- CS 520, Assembly Language Programming and Machine Organization
- CS 620, Operating System Fundamentals
- CS 659, Introduction to the Theory of Computation

Some students may need to take additional mathematics classes as well.

When students are admitted to the M.S. program who do not have an undergraduate degree in computer science, the admission letter will explicitly state which undergraduate courses must be completed as part of the student's program of study. Students without a B.S. or M.S. in computer science are not normally admitted directly into the Ph.D. program, but it is possible to transfer from the M.S. to the Ph.D. program.

4 Academic Advising

The Director of Graduate Studies acts as the academic advisor for all M.S. students.

Ph.D. students will be assigned a faculty advisor when they enter the program. For Ph.D. students, this advisor will also be their initial research mentor, but a switch in the advisor/mentor is possible. However, Ph.D. students must be affiliated with an advisor/mentor at all times.

Advisors help students create and maintain a plan of study that maps out how the student will complete the requirements of their program and also tracks academic progress. The plan of study is included in an academic progress report that must be submitted by the first week of January each year. The academic progress reports will be reviewed by the Graduate Studies Committee, and will

be an important component of decisions concerning the awarding or continuing of assistantships and scholarships.

Students doing M.S. theses and M.S. projects will need to obtain a research mentor. An important part of the plan of study is to develop a strategy for obtaining the research mentor, and to eventually document which faculty member has agreed to be the mentor.

All Ph.D. students, and M.S. students with research mentors, should regularly review their plan of study with their mentor. The academic progress report submitted during the first week of January must first be approved by the research mentor.

More information about the academic progress report is available in Section 9.

5 Common Degree Requirements

The following requirements are common to the M.S. and Ph.D. programs:

- All students must take CS900, Graduate Seminar, usually during their first or second semester. The primary goal of the seminar is to introduce the new students to ongoing research projects in the department. All research-active faculty present at the seminar each year, as well as selected students. Speakers from outside UNH will also be recruited to report on recent research in the field. In addition, talks may be given to introduce services or opportunities available at UNH (e.g. the Career Center, the InterOperability Laboratory, etc.).
- All students must complete two programming-intensive courses chosen from this list: CS 812, CS 830, CS 835, CS 870 and CS 953.
- All students must satisfy a breadth requirement. This breadth requirement was modified in Spring 2019, effective for students entering in Fall 2019 or later.

Students entering Fall 2019 or later. All students must take at least two courses from each of either two or three breadth areas, depending on which program and option they pursue. The list below identifies the four breadth areas.

1. AI: CS 830, CS 833, CS 850, CS 857, CS 931, CS 950, CS 953.
2. Systems: CS 823, CS 825, CS 827, CS 853, CS 920, CS 925, CS 927.
3. Software: CS 812, CS 835, CS 845, CS 858, CS 871, CS 875, MCBS 913.
4. Users: CS 860, CS 867, CS 870, CS933.

Students entering prior to Fall 2019. All students must take courses from either three or four breadth areas, depending on which program and option they pursue. The list below identifies the seven breadth areas and the introductory graduate courses in each area. It is also acceptable to satisfy a group requirement by taking an advanced course in the specified area. Note that there are courses in the curriculum that are not in any of the identified areas.

1. Theory: CS 845, CS 858
2. Operating Systems: CS 823, CS 827
3. Compilers and Languages: CS 812, CS 835, CS 871
4. Database: CS 853, CS 875

5. Artificial Intelligence: CS 830, CS 850, CS 857
6. Interactive Systems: CS 833, CS 860, CS 870
7. Computer Networks: CS 825

6 M.S. Degree Requirements

The M.S. program has three options: thesis, project and exam. As described in Section 5, students in all three options must complete CS900 and two programming-intensive courses. The Graduate School requires that “all graduate work for any master’s degree must be completed within six years from the date of matriculation (enrollment following admission) in the program.”

6.1 M.S. Thesis Option Requirements

1. CS 900.
2. Eight Computer Science graduate courses of at least three credits each.
 - (a) Two courses must be implementation-intensive.
 - (b) At least two courses must be taken from each of two different breadth areas. (Students who entered the program prior to Fall 2019 must take one course from each of three different breadth areas.)
 - (c) At least two courses must be numbered above 900.
 - (d) At most one course can be CS 998, Independent Study.
3. Thesis (six credits). The student must complete a thesis under the supervision of a thesis advisor and a thesis committee of at least three members, with at least two of the committee members being members of the department’s graduate faculty. The committee is nominated by the Department Faculty (acting through the Director of Graduate Studies) and appointed by the Dean of the Graduate School. The committee is nominated by using the Masters Committee form. The student and mentor complete the form and give it to the Director of Graduate Studies for approval and transmission to the Graduate School. The form is available from the Graduate School website.

A public presentation of the thesis proposal must first be performed, at which time the committee will be asked to approve the proposal. A document containing the thesis proposal should be circulated to the committee at least one week before the proposal presentation. The committee indicates approval of the proposal by signing the proposal document. Once the thesis document is ready, a public thesis defense is performed. The draft thesis document should be circulated to the committee at least one week before the defense. The committee indicates approval of the thesis by signing the thesis document. Students must follow the university’s requirements for formatting and submitting the thesis document, including having the formatting inspected and approved in advance by the Graduate School.

The department requires that students purchase one bound copy of the thesis to be placed in the department collection of thesis and dissertation documents.

6.2 M.S. Project Option Requirements

1. CS 900.
2. Ten Computer Science graduate courses of at least three credits each.
 - (a) Two courses must be implementation-intensive.
 - (b) At least two courses must be taken from each of three different breadth areas. (Students who entered the program prior to Fall 2019 must take one course from each of four different breadth areas.)
 - (c) At least three courses must be numbered above 900.
 - (d) At most one course can be CS 998, Independent Study.
3. Project (three credits). The student must complete a project under the supervision of a faculty advisor. The student should submit to the department a short paper describing the project, and there should be a public viewing of the project, typically as a poster presentation at the annual UNH Graduate Research Conference or at a seminar in the department.

MS project courses can only be continued for at most one additional Fall or Spring semester. To be allowed to continue the project into a third Fall or Spring semester requires the approval of the graduate studies committee.

6.3 M.S. Exam Option Requirements

1. CS 900.
2. Ten Computer Science graduate courses of at least three credits each.
 - (a) Two courses must be implementation-intensive.
 - (b) At least two courses must be taken from each of three different breadth areas. (Students who entered the program prior to Fall 2019 must take one course from each of four different breadth areas.)
 - (c) At least three courses must be numbered above 900.
 - (d) At most one course can be CS 998, Independent Study.
3. Comprehensive exam that includes four different topics, with at least one topic from the Theory area and the other three topics being selected from three different topic areas (which can include a second theory topic). The topic areas are:
 - (a) Theory: Formal Specification and Verification; Algorithms
 - (b) Operating Systems: Advanced Operating Systems
 - (c) Compilers and Languages: Compiler Design
 - (d) Artificial Intelligence: Artificial Intelligence
 - (e) Interactive Systems: Computer Graphics
 - (f) Computer Networks: Computer Networks

The department maintains a syllabus for each exam topic. Students should contact the Director of Graduate Studies to obtain access to the syllabi. To pass the exam a student must pass each of the selected topics. Normally, a student is allowed to sit for the exam twice—the first time attempting all four topics; the second time taking only those topics that were failed the first time.

7 Ph.D. Degree Requirements

1. CS 900.
2. Six Computer Science graduate courses of at least three credits each beyond the M.S. or twelve Computer Science graduate courses of at least three credits each beyond the B.S.
 - (a) Two courses must be implementation-intensive.
 - (b) All students must take CS 845.
 - (c) At most two courses can be CS 998, Independent Study. If two CS 998 courses are taken, they must be taught by different instructors.
 - (d) All students must take a research-oriented course before the end of their second year. This might be either a research seminar or an independent-study course. (This course might also be CS898 (M.S. Project) or CS899 (M.S. Thesis), if the student wishes to complete an M.S. degree while pursuing the Ph.D.) Courses from other universities can be used only with the approval of their advisor and the Graduate Studies Committee.
 - (e) Students who arrive with an M.S. degree may have a course requirement waived with the approval of the faculty member who normally teaches the course. Note that this does not reduce the number of courses required to complete the degree.
 - (f) Students may count non-CS courses towards their degree requirements with the approval of their advisor and the Graduate Studies Committee.
3. Breadth requirement. At least two courses must be taken from three different breadth areas. Students must attain an average GPA of at least 3.4 in the six breadth courses. (For students who entered the program prior to Fall 2019, courses must be taken from four breadth areas, with one of the areas being the Theory area, and students must attain an average GPA of at least 3.4 in the four breadth courses.) The student designates which courses are used to compute the GPA. These courses must be completed by the end of the student's third year. Up to two courses to be counted can have been taken at most twice.
4. Interdisciplinary breadth requirement. The requirement must be satisfied by taking a non-CS 8xx/9xx course. The course must be approved by the student's research mentor.
5. Depth requirement.
 - (a) A student must be affiliated with a research mentor at all times. A switch is possible.
 - (b) The student and his or her mentor must nominate a Guidance Committee, which consists of at least four members, with at least three being from the department's graduate faculty. The Guidance Committee is appointed by the Dean of the Graduate School upon recommendation of the Department Faculty (acting through the Director of Graduate Studies). The student and mentor complete the Doctoral Guidance Committee form and give it to the Director of Graduate Studies for approval and transmission to the Graduate School. The form is available from the Graduate School website.
 - (c) The mentor directs the student in writing a depth proposal that defines the student's area of specialization and specifies:
 - i. the scope of a review of literature;
 - ii. the format of a research report;

- iii. a detailed syllabus, including a bibliography, of the topics for which the candidate will be held responsible in the oral exam; and

The Guidance Committee should approve the depth proposal, and the approved proposal should be distributed to all faculty members at least two months prior to the oral examination.

- (d) The components of the depth requirement are a Survey, a Research Report, and an Oral Examination. These three requirements must be approved by the guidance committee in the above order, only after approval of the depth proposal.
 - i. Survey. A written survey that records the candidate's review of the literature in the area of specialization as defined in the depth proposal. The format of the written survey, which may be combined with the research report, if appropriate, is to be proposed by the depth supervisor and approved by the Guidance Committee.
 - ii. Research Report. A research report covering some specific topic in the area of specialization. The format of the report is proposed by the depth supervisor and approved by the Guidance Committee. Examples of appropriate formats include the following:
 - A. Conference or journal article. (Note that the acceptance of such a paper by the conference or journal is neither a necessary nor sufficient condition for satisfying this part of the depth requirement.)
 - B. In-depth analysis of a set of research papers (4-5) within a specified time (3-4 months).
 - C. Report that identifies research problem(s) in the area of specialization and preliminary results that support pursuing further investigation.
 - iii. Oral Examination. An oral examination is conducted by the student's Guidance Committee. All faculty may attend, but only the committee members vote to determine if a student passes. The oral examination consists of an oral presentation followed by a question and answer period aimed at testing the student's understanding and depth of knowledge in the area of specialization as defined by the depth proposal. The oral examination cannot be taken until after the student has satisfied the breadth requirement, as well as the Guidance Committee's approval of the written depth proposal, survey, and research components. The oral presentation is open to the public and should be scheduled and announced at least one week in advance.

The satisfactory completion of the depth requirement is decided by the Guidance Committee on the basis of the depth proposal, written survey, the research report, and the oral examination. For each of the components, the outcome of the evaluation can be pass, fail, or a recommendation to submit revised written document(s), or take the exam again.

The depth requirement should be completed by the end of the student's third year.

6. Dissertation.

After the student has successfully completed the depth examination and has satisfied the interdisciplinary breadth requirement, the student is advanced to candidacy. This is recorded with the Graduate School by filing the Doctoral Candidacy Form, which should be initiated by the student and approved by the Director of Graduate Studies. The form is available from the Graduate School website.

A doctoral committee is appointed for the purpose of supervising and approving the dissertation work and administering the final defense. This committee can be the same as the Guidance Committee, but does not need to be. It shall consist of a minimum of five members. The candidate's research mentor is the chairperson of the Doctoral Committee. Normally, two members of the committee are members of departments other than computer science or qualified professionals from other universities, industry or government. The other members of the committee must be members of the department's graduate faculty. The Dean of the Graduate School is an ex-officio member of all Doctoral Committees.

The Doctoral Committee is appointed by the Dean of the Graduate School upon recommendation of the Department Faculty (acting through the Director of Graduate Studies). The committee can be nominated on the Doctoral Candidacy Form or by using the Doctoral Dissertation Committee form. The form is available from the Graduate School website. The student and mentor complete the form and give it to the Director of Graduate Studies for approval and transmission to the Graduate School. The Director of Graduate Studies informs the Department Faculty of the members of each Doctoral Committee before sending the nomination of the committee to the Graduate School.

The candidate must make a formal presentation of the proposed dissertation research, at least six months prior to the awarding of the degree. A written proposal must be distributed to all committee members at least two weeks before the oral presentation and should be made available to other faculty members upon request. The oral presentation is open to the public and should be scheduled and announced at least two weeks in advance. Following the oral presentation, the committee meets privately and with the candidate to determine if, and under what conditions, the proposal is acceptable. Other faculty may attend, but only members of the committee may participate in the decision. The committee decision, including any conditions, must be stated in writing, signed by all committee members, and filed with the written proposal in the student's file.

A minimum of two semesters of registration in CS 999, Doctoral Research, is required. However, doctoral students at candidacy must register for CS 999 each semester during the academic year, even if the minimum requirement has been met.

The candidate must make a formal oral presentation of the completed dissertation research in accordance with the requirements of the Graduate School. The written version of the thesis to be defended should be distributed to all committee members at least three weeks before the defense and should be made available to other faculty members upon request. The oral presentation is open to the public and should be scheduled and announced at least two weeks in advance. Following the oral presentation, the committee meets privately and with the candidate to determine if, and under what conditions, the thesis is acceptable. Other faculty may attend, but only members of the committee may participate in the decision. Following the Graduate school policy, the majority of the committee members must approve the final dissertation. Students must follow the university's requirements for formatting and submitting the dissertation document, including having the formatting inspected and approved in advance by the Graduate School.

The department requires that students purchase one bound copy of the dissertation to be placed in the department collection of thesis and dissertation documents.

7. Time Limits.

The Graduate School requires that "the student must be advanced to candidacy within five

years after matriculation or within four years if the student entered with a master's in the same field." In addition, "all graduate work for the doctorate must be completed within eight years of matriculation (enrollment after admission) or within seven years if the student entered with a master's degree in the same field."

8 Financial Aid

The department has assistantships and scholarships that are awarded on merit. Students must remain in good academic standing to keep these awards.

1. The department has a number of teaching assistantship positions, primarily to support the beginning programming courses and the department's offerings in the university's Discovery program (undergraduate general education curriculum). The teaching assistantship provides a stipend, a full-tuition waiver, health insurance and the waiver of some fees (but not all fees).

The appointments of all teaching assistants must be approved by the Department Chair, after recommendation by the Director of Graduate Studies with the assistance of the Graduate Studies Committee. The department considers many factors when making decisions concerning the appointment of teaching assistants, including the academic progress of the candidates, their potential performance in the role, the need to continually recruit highly qualified students, and the balance of the number of M.S. and Ph.D. students.

The Department Chair determines the work assignments for the teaching assistants. Teaching assistants are expected to work 20 hours per week. All teaching assistants are expected to work in the Programming Assistance Center as part of their duties. (An exception is made for students teaching a class.) Teaching assistants are provided office space and a computer to support them in their duties.

The department will attempt, when possible, to give senior Ph.D. students the opportunity to teach courses on their own, with appropriate supervision and support. The department is also fully supportive of Ph.D. students who wish to add the twelve-credit Cognate in College Teaching to their graduate degree.

M.S. students can hold a teaching assistantship at most two years. Ph.D. students can hold a teaching assistantship at most four years. In both cases the student must be making satisfactory progress in completing their degree and they must be effective in performing their T.A. duties.

One grade below B- may result in the student losing the assistantship.

2. The department has one full-tuition scholarship. The scholarship provides a full-tuition waiver. The student must pay the full fees.

The full-tuition scholarship is awarded for a fixed term.

One grade below B- may result in the student losing the scholarship.

3. The department has a number of partial-tuition scholarships. These scholarships provide a discount on the amount of tuition that must be paid by the student. The student must pay the full fees.

Normally a student holds the partial-tuition scholarship for the duration of their studies.

9 Academic Progress

If students are not making satisfactory progress toward their degree, they may be dismissed from their program.

The department will primarily evaluate M.S. students by their performance in coursework. All M.S. students should maintain a GPA of 3.0 or above.

The department will evaluate Ph.D. students according to criteria including (but not necessarily limited to): having a research mentor, progress in research, and performance in coursework.

In addition to the department evaluation of student academic progress, the Graduate School has the following policy: *Graduate students receiving grades below B- in 9 or more credits, including undergraduate courses taken while a graduate student, will be dismissed from the Graduate School.*

All graduate students should submit to the department an academic progress report each year by the first week of January. Faculty mentors of Ph.D. students will submit an evaluation of their students' research progress at the same time.

All progress reports will be reviewed by the graduate program coordinator with the assistance of the faculty on the graduate studies committee, and will be an important component of decisions concerning the awarding or continuing of assistantships and scholarships.

The goal of asking students to prepare the academic progress report is to help students think carefully about their goals and their progress toward achieving them. The motivation for requiring the submission of a report to the graduate program coordinator and the graduate studies committee is so that they can better advise students on how to accomplish their goals. Academic progress is also used as one element in decisions concerning renewals of teaching assistantships.

The academic progress report should include a plan for how the student will fulfill the requirements of their degree. A plan is simply that, a plan. It can be modified as circumstances in the department change or the student's goals evolve.

The report should also document steps already completed. In the text below, whenever it asks when the student plans to complete a step, and the step has already been completed, students should simply state the date when it was completed.

Here are directions for writing an academic progress report:

- The report should have the following sections:
 1. State the degree (M.S. or Ph.D.) being pursued. If you are an M.S. student then also state the degree option (thesis, project or exam) that you plan to follow.
 2. List any undergraduate prerequisites you are required to complete and when you plan to complete them.
 3. List all graduate courses you plan to take to complete your degree. For each course, indicate the semester and year when you plan to take it. Please group the courses by breadth area. (Put courses not assigned to any breadth area in their own group.) Please mark the implementation-intensive courses with an asterisk. (All students should, of course, include CS900 in their plan. PhD students should also include CS845.) Ph.D. students who already have an M.S. should indicate that here, because it impacts how many courses you need to take.
 4. If you are transferring in courses taken at UNH prior to being admitted to our graduate program, or courses taken at another university, list those courses and when you took them, and indicate whether the necessary forms have been filed with the Graduate School to complete the transfer. For courses taken at another university, list the equivalent UNH

course. Please indicate the breadth area for each course and mark the implementation-intensive courses with an asterisk.

5. State the number of implementation-intensive courses, breadth areas, and 900-level courses your degree and option require. Confirm that your plan satisfies these requirements.
6. If you plan to do an M.S. thesis, an M.S. project, or a Ph.D. dissertation, then indicate if a faculty member has agreed to be your research mentor and provide the name of that person. If you do not have a research mentor, then indicate what actions you plan to take to obtain an advisor, such as taking research seminar courses or independent study courses. Provide dates for your planned actions. **If you have a research mentor, then review this research progress report with your mentor every year prior to submitting it to the graduate program coordinator.** Please specify the date on which you reviewed your academic progress report with your research mentor.
7. M.S. exam students should indicate when they will take the exams. M.S. project students should indicate when they plan to start and finish their project. M.S. thesis students should indicate when they plan to propose their thesis and defend their thesis. Ph.D. students should indicate when they plan to complete the depth exam, propose their dissertation, and defend their dissertation. Please be aware that the dissertation proposal must be done at least six months prior to being awarded the Ph.D. In addition, a minimum of two semesters of registration in CS999, Doctoral Research, is required.
8. Ph.D. students must describe the progress towards their doctoral research. This includes research accomplishments during the past year (publications and projects), and how they relate to the student's dissertation topic. Furthermore, the students must provide a list of planned activities to further research progress.
9. Give the date you plan to graduate.

Students should e-mail their academic progress report in PDF format to the graduate program coordinator during the first week of January and cc their research mentor if they have one. (An exact deadline for submitting the report will be announced in advance each year.)

If students have questions about their academic progress report, they should make an appointment with the graduate program coordinator to discuss them.

10 Academic Honesty

All members of the university are expected to conduct themselves with integrity. The university Academic Honesty policy can be found in the Student Rights, Rules, and Responsibilities handbook: <http://www.unh.edu/student/rights/>.

Claiming other people's work as your own is a violation of the Academic Honesty policy. This is true in all situations, including examination responses, homework assignments, programming assignments and other out-of-class work. Students should be aware that department faculty use automated tools to detect the plagiarism of programming assignments.

Violation of the Academic Honesty policy in a course normally results in the student receiving a failing grade in the course. Students who violate the Academic Honesty policy may lose their department financial aid. Repeated violations will result in the student being dismissed from the program.

11 Acceptable Use of Information Technology Resources

Students need to understand the importance of the shared use of public resources such as the department computer clusters, printers, and the network uplink between the department subnet and the campus network. These resources are provided to help students complete their course assignments and thesis or project work. Student should not use these resources for recreation, such as music file sharing, streaming media, and games. The bandwidth consumed by a streaming media session often comes at the expense of other primary uses.

The department subscribes to the University System of New Hampshire policy for Acceptable Use of Information Technology Resources. This policy is viewable at <http://www.usnh.edu/olpm/UNH/VI.Prop/F.htm#5>. All students should read this document.