Graduate Handbook

Department of Computer Science
Virginia Tech, Blacksburg, VA 24061
Last updated: December 15, 2011

Table of Contents

1 About this Handbook

The purpose of this handbook is to present the policies and procedures of the graduate program in the Department of Computer Science at Virginia Tech. The currency of the handbook is noted on the cover page.

2 Graduate Program Contacts

The graduate coordinator (GC), initial academic advisor (IAA), and the associate head for graduate studies (AGS) are the key contacts for all aspects of the graduate program. The GC oversees all day-to-day aspects of the graduate program and serves as an important focal point of contact for all graduate students. The IAA serves as the initial academic advisor to all incoming students till they find a research advisor. The AGS addresses program administration related issues, such as design, implementation, and evolution of graduate degrees and approvals of programs of study. The AGS also works closely with the department head to make decisions pertaining to course registrations and financial assistance administered by the department (such as teaching assistantships and fellowships). The GC, IAA, and AGS work closely to cover all aspects pertaining to the successful functioning of the graduate program. The GC, IAA, and AGS also serve on the graduate program committee (GPC), a body of faculty members along with a graduate student representative, that meets regularly and deliberates about all graduate program related matters. The AGS also serves as the de-facto chair of GPC.

The current GC is Ms. Sharon Kinder-Potter (540-231-6932, KWII 1105, skpotter@vt.edu). The current IAA is Dr. Manuel Perez (540-231-2646, KWII 1125, perez@cs.vt.edu). The current AGS is Dr. Naren Ramakrishnan (540-231-8451, Torgersen Hall 2050B, naren@cs.vt.edu).

3 The Department

The Department of Computer Science at Virginia Tech is poised to become one of the top programs in the country. The number of Ph.D. degrees awarded places us in the top 30 programs in the United States. The resources and facilities for research areas such as human-computer Interaction, bioinformatics, and high-end computing are state-of-the-art, and the growing list of specialized courses provides opportunities for students to concentrate their research and study on the specific aspects of computer science in which they are most interested. See http://www.cs.vt.edu for more information about the department.

4 Courses

Courses at the 4000 (senior), 5000 (beginning graduate), and 6000 (advanced graduate) are available for registration by graduate students. See Appendix A for a list of courses available for graduate students. In special cases, when students have been admitted with deficiencies in their computing background, they may be required to take courses at the 2000 (sophomore) or 3000 (junior) level, beyond their regular graduate program requirements. See Section 12.2 for further details.

5 Degree Programs

The department offers M.S. (Master of Science) and Ph.D. (Doctor of Philosophy) degrees in computer science and applications (CSA). In addition, by satisfying additional requirements, either of these degrees can be awarded with a "Bioinformatics option" annotation in the student's transcript. A "HCI Certificate" is also available and can be received with either graduate degree..

5.1 M.S.

The Master of Science degree provides a solid foundation in computer science while still offering flexibility to meet the needs and interests of individual students.

The M.S degree is completed through either the thesis or the coursework option. The thesis option requires 30 credits of course work of which typically 21 credits must derive from courses. The coursework option requires 33 credits derived from courses. Students in good standing typically complete either degree option in at most two years. The thesis option is strongly encouraged since it provides students with an in-depth research experience, and requires fewer courses.

To fulfill requirements for these degrees, students must satisfy breadth, credit distribution, seminar, and final exam requirements. These are detailed next.

5.1.1 Breadth requirements

To encourage Masters graduates to exhibit sufficient breadth of computer science areas, M.S. thesis students must take CS courses spanning four (4) different areas and M.S. coursework students must take CS courses spanning five (5) different areas. Only CS courses at the 5000 or 6000 level are considered when evaluating the breadth requirement. See Appendix B for a list of departmental topical areas and courses in each of these areas.

5.1.2 Credit distribution requirements

The credit distribution table for the M.S. thesis option can be summarized as follows:

Category of courses	**Credits**		**Notes**
	Min	**Max**	
CS courses at 4000 level and above	30		Cannot include CS 5894, CS 5904, CS 5944, CS 5974, or CS 7994. All courses must be in CS except that at most one course outside CS may be used if it appears in the list of approved cognate courses in Appendix C.
CS courses at 4000 level		3	See Appendix A for list of approved 4000 level courses.
CS 5994	6	9	
CS courses at 6000 level	3		
Total credits required	30		

Note: Each of the lines above must be interpreted as an individual, distinct, constraint so that all constraints have to be simultaneously satisfied. The columns are not meant to "add up", i.e., 30+6+3 is obviously not equal to 30.

Additional credit hours may be taken in any category, but do not count toward degree requirements. Substitutions for degree requirements are allowed only under rare or exceptional circumstances. Requests for substitutions must be made to the AGS.

Observe that all courses must be at the 5000 level or above with possibly at most one 4000 level included. If a CS 4000 level course is included, it must be from the list of CS 4000 level courses approved for graduate credit (see Appendix A). Credits from CS 5894 (Final Examination), CS 5904 (Project and Report), CS 5944 (Graduate Seminar), CS 5974 (Independent Study), and CS 7994 (Research and Dissertation) cannot be used to satisfy any M.S. thesis credit requirements. Finally, observe that at least one 6000 level course is required.

As the table shows, a student satisfying the M.S. thesis credit requirements typically uses 7 CS courses to supply 21 credits with the remaining 9 credits accrued from CS 5994 (Research and Thesis). In exceptional cases, the student can use 8 CS courses to supply 24 credits with the remaining 6 credits from CS 5994. All courses must be in CS, except that one course outside CS may be used if it appears on the cognate course list.

The credit distribution table for the M.S. coursework option can be summarized as follows:

Category of courses	**Credits**		**Notes**
	Min	**Max**	
CS courses at 4000 level and above	33		Cannot include CS 5014, CS 5894, CS 5904, CS 5944, CS 5994, or CS 7994. All courses must be in CS, except that at most one course outside CS may be used if it appears in the list of approved cognate courses in Appendix C.
CS courses at 4000 level		3	See Appendix A for list of approved 4000 level courses.
CS 5974		3	
CS courses at 6000 level	3		
Total credits	33		

Note: Each of the lines above must be interpreted as an individual, distinct, constraint so that all constraints have to be simultaneously satisfied. The columns are not meant to "add up", i.e., 33+3 is obviously not equal to 33.

Additional credit hours may be taken in any category, but do not count toward degree requirements. Substitutions for degree requirements are allowed only under rare or exceptional circumstances. Requests for substitutions must be made to the AGS.

Observe that all courses must be at the 5000 level or above with possibly at most one 4000 level included. Furthermore, if a CS 4000 level course is included, it must be from the list of CS 4000 level courses approved for graduate credit (see Appendix A). Credits from CS 5014 (Research Methods in Computer Science), CS 5894 (Final Examination), CS 5904 (Project and Report), CS 5944 (Graduate Seminar), CS 5994 (Research and Thesis), and CS 7994 (Research and Dissertation) cannot be used to satisfy any M.S. coursework credit requirements. Finally, observe that at least one 6000 level course is required.

Although the credit distribution table indicates that CS 5974 is optional, the final report from CS 5974 effectively serves to fulfill the final exam requirement and hence registering for CS 5974 is the most common way to obtain a coursework Masters degree. See more discussion below on how to satisfy the final exam requirements if CS 5974 is not included in the student's plan of study.

5.1.3 Seminar Requirement

All full-time M.S. students are required to register for CS 5944 in their first three semesters of graduate study and to earn a passing grade in these semesters. CS 5944 cannot be used to satisfy course credit requirements toward either the M.S. thesis or M.S. coursework degrees. Exceptions to the seminar requirement will be considered by GPC on a case-by-case basis - please contact the AGS if you would like to petition for an exception.

5.1.4 Final Exam Requirements

The final exam requirement for the M.S. thesis option requires that the student orally defend a written thesis before a suitably constituted advisory committee (see Section 9). The final exam requirement for the M.S. coursework option can be met in either of two ways. The first approach is for the student to attempt the Ph.D. qualifier examination (administered in specific areas; typically in Jan-Feb of every year) and pass this exam at at least the Masters level (a score of 1 out of a possible 3 on the exam). The second approach applies if CS CS5974 is part of the set of courses used to satisfy the degree requirements. In this case, the final report prepared for CS5974 can be submitted to the AGS (along with an approval from the CS5974 course instructor) and this serves to complete the final exam requirement. In either case, an advisory committee needs to be constituted (see Section 9 for more details).

5.2 Ph.D.

A student pursuing the Ph.D. degree is expected to exhibit a comprehensive knowledge of a broad cross section of the computer science discipline and to contribute significant new knowledge to the discipline through the research contribution contained in the doctoral dissertation. A PhD student must complete a minimum of 90 credits of graduate study, of which at least 33 must derive from courses. The PhD program is intended to be completed in about five years from entering the graduate program with a BS degree in Computer Science or a related field, or about four years if the student already has an MS degree in Computer Science or a related field. This is possible because students who begin the PhD program already in possession of a Masters may be able to count as many as six courses toward their course requirement (see Section 8 on Transfer Credits).

To fulfill requirements for the Ph.D. degree, students must satisfy breadth, credit distribution, seminar, and final exam requirements.

5.2.1 Breadth requirements

To encourage Ph.D. graduates to exhibit sufficient breadth of computer science areas, Ph.D. students must take CS courses spanning five (5) different areas. Only CS courses at the 5000 or 6000 level are considered when evaluating the breadth requirement. See Appendix B for a list of departmental topical areas and courses in each of these areas.

5.2.2 Credit distribution requirements

The credit distribution table for the Ph.D. degree can be summarized as follows:

Category of courses	**Credits**		**Notes**
	Min	**Max**	
CS courses at 4000 level and above	27		Cannot include CS 5894, CS 5904, CS 5944, CS 5994, or CS 7994. All courses must be in CS.

CS courses at 4000 level		3	See Appendix A for list of approved 4000 level courses.
CS 5974		3	
CS 7994	30		
CS courses at 6000 level	6		
Cognate courses	6	6	From list of approved cognate courses in Appendix C.
Total credits	90		

Note: Each of the lines above must be interpreted as an individual, distinct, constraint so that all constraints have to be simultaneously satisfied. The columns are not meant to "add up", i.e., 27+30+6+6 is obviously not equal to 90.

Additional credit hours may be taken in any category, but do not count toward degree requirements. Substitutions for degree requirements are allowed only under rare or exceptional circumstances. Requests for substitutions must be made to the AGS.

Observe that all CS courses must be at the 5000 level or above with possibly at most one 4000 level included. Furthermore, if a CS 4000 level course is included, it must be from the list of CS 4000 level courses approved for graduate credit (see Appendix A). Credits from CS 5894 (Final Examination), CS 5944 (Graduate Seminar) cannot be used to satisfy any Ph.D. credit requirements. Credits from CS 5904 (Project and Report), and CS 7994 (Research and Dissertation) cannot be used to satisfy any Ph.D. coursework credit requirements. Observe also the limits on CS5974 in the above credit distribution table. At least two CS 6000 level courses are required and exactly two cognate courses are required. See Appendix C for a list of approved cognate courses.

5.2.3 Seminar requirement

All full-time Ph.D. students are required to register for CS 5944 in their first three semesters of graduate study and to earn a passing grade in these semesters. CS 5944 cannot be used to satisfy course credit requirements toward the Ph.D. degree. Exceptions to the seminar requirement will be considered by GPC on a case-by-case basis - please contact the AGS if you would like to petition for an exception.

5.2.4 Final exam requirements

The final exam requirement for the Ph.D. degree requires that the degree candidate make an oral presentation of his or her research work and defends the significance and accuracy of this work in response to questions from the student's advisory committee. The committee, in closed session, determines whether the student has successfully completed the examination. This exam can be attempted at most twice.

5.3 5-year BS/MS Program

To enable the completion of both a bachelor's and a master's degree in five years, Virginia Tech allows students with a 3.5 or above GPA to apply for admission to the Graduate School on the completion of seventy-five hours of undergraduate study.

Computer science students in this program take four graduate courses during their senior year in place of the four required CS 4000-level courses. The graduate courses must include either CS 5104 or CS 5114 as a replacement for the required senior-level theory course. The selection of the other three courses must be worked out with, and approved by, the chair of the Undergraduate Program Committee or the Associate

Department Head. An Undergraduate Program of Study listing these four graduate courses, which count toward the requirements of both the undergraduate and graduate degrees, must be included with the application. Note that these courses must be taken for an A-F grade, e.g., CS 5974 and CS 5994 are not allowed.

No more than two graduate-level courses should be taken in one semester while an undergraduate, and no more than a total of 12 graduate credits will count toward the undergraduate degree. An average of B (3.0) must be earned over the four graduate courses on the Undergraduate Program of Study. Award of the B.S. degree occurs on completion of 120 credits, including the 12 credits of graduate work and the other departmental and university core curriculum requirements. The remaining graduate courses for the M.S. degree should be taken after conferral of the B.S. degree and follow the requirements for the M.S. degree as set forth previously.

Typically, a BS student transitions to the BS/MS program after completing 75 hours of undergraduate study and, after completing all the requirements of the undergraduate program, transitions to become a regular MS student.

5.4 Bioinformatics Option

Any CSA degree (M.S. or Ph.D.) may include an option in Bioinformatics. Students receiving the option will have that fact noted on their transcript upon successful graduation. To receive the option, students will take a minimum of seven (7) additional credits beyond those necessary for the CSA degree without the option. These and other requirements as noted next:

- Students receiving the Bioinformatics option must take PPWS 5314 Biological Paradigms for Bioinformatics (3 credits), BCHM 5024 Computational Biochemistry for Bioinformatics (3 credits), and GBCB 5004 Seminar (1 credit). PPWS 5314, BCHM 5024, and GBCB 5004 may not be used both to complete the option and to satisfy CSA degree course requirements. Students who already have background equivalent to PPWS 5314 and/or BCHM 5024 may be permitted to substitute more advanced courses to satisfy this requirement.

- Students receiving the Bioinformatics option must take ONE of STAT 5615 (Statistics in Research), STAT 5616 (Statistics in Research), MATH 5515 (Modeling and Simulation of Biological Systems), or MATH 5516 (Modeling and Simulation of Biological Systems). These courses may also be used to fulfill CSA coursework requirements.

- Students must complete the final exam requirement for their respective CSA degree using a topic suitable for the Bioinformatics option. Students completing a MS thesis or PhD dissertation must receive approval from the AGS for their thesis or dissertation topic to count toward the Bioinformatics option. MS coursework-only students must take GBCB 5874 Problem Solving in Genetics, Bioinformatics, and Computational Biology, and use the final report from this course to satisfy their final exam requirement. In rare cases, the final report from CS5974 Independent Study may be used to satisfy the final exam requirement under the Bioinformatics option if the AGS approves the topic of the report.

5.5 Graduate Certificate in HCI

A Graduate Certificate in Human-Computer Interaction Program is administered by the Center for Human-Computer Interaction and offered in conjunction with either a master's or doctoral degree in most departments (including computer science).

Master's degree students complete 9 hours and doctoral students 15 hours of coursework for the certificate; at least two of the courses taken must be outside the student's degree program requirements and home department. These courses should be relevant to HCI; those in the following list are especially recommended. If the student writes a thesis or dissertation, it must be related to human-computer interaction. Students can normally fit the requirements for the certificate into their program of graduate study so that the time needed to complete the graduate degree in their basic discipline is not extended by simultaneously pursuing the certificate. Students interested in the Graduate Certificate in Human-Computer Interaction should confer with the director of the Center for Human-Computer Interaction (http://www.hci.vt.edu) prior to submitting a program of study to the Graduate School.

CS 3724	Introduction to Human-Computer Interaction
CS/ISE 5714	Usability Engineering
CS 5724	Models and Theories of HCI
CS 5734	Computer-Supported Cooperative Work
CS 5754	Virtual Environments
CS 5764	Information Visualization
CS 5774	User Interface Software
CS 6724	Advanced Topics In Human-Computer Interaction
CE 5064	Knowledge-based expert systems
CS 4624	Multimedia, Hypertext, Information Access
EDCI 6664	Advanced Instructional Technology
ESM 4714	Visual Data Analysis and Multimedia
ISE 5604	Human Information Processing
ISE 5605	Human Factors System Design I
ISE 5694	Macroergonomics
ISE 6604	Human Factors of Visual Display Systems
ISE 6614	Human Computer Systems
PSYCH 5354	Information Processing
STS 5424	Computers in Society

6 Procedural Milestones

This section identifies the key procedural milestones for obtaining the M.S. and Ph.D. degree.

6.1 M.S.

The primary procedural milestone for the M.S. thesis degree is the final exam, i.e., the defense of the thesis, which typically happens in the fourth semester of graduate study. The final exam requirement for the M.S. coursework option is met whenever the student completes CS 5974 (and submits its report for approval to the AGS) or attempts the Ph.D. qualifying examination and passes it at (at least) the M.S. level (see Section 6.2.1).

6.2 Ph.D.

Students seeking a PhD must successfully complete four major milestones: the Ph.D. qualifying process, the Preliminary Proposal Exam, the Research Defense, and the Final Defense. The typical timeline for these milestones are:

Ph.D. qualifying process: This stage must be completed within 30 months of entering the Ph.D. program. Students who received an M.S. degree in Computer Science at Virginia Tech must complete this stage within 15 months of entering the Ph.D. program. Students entering the Ph.D. program with an M.S. degree from elsewhere can typically complete this stage within 15 months, although they have 30 months to do so. Extensions to these time limits may be negotiated, but extensions are intended to apply to students who take leave from the University, or are part-time students for some reason.

The qualifying process comprises of three components (described in detail later): classwork achievement score, research achievement score, and a qualifying exam (in the student's cognizant area of specialty). While the first two components are assessed on a running basis, the qualifying exams are offered only in Spring semesters of every year. Notice that within the 30 month limit for the (entire) qualifying process, students will have two choices for when to take the qualifying exam: namely, the Spring semester in the year after they enter the program or the Spring semester in the subsequent year. This exam can be attempted at most once.

Preliminary Proposal Exam: A recommended deadline is 12-18 months from completion of the Ph.D. qualification process or M.S. degree, whichever comes second. This and subsequent stages requires that the Ph.D. advisor and advisory committee be constituted.

Research Defense: A recommended deadline is 12-18 months from completion of the Preliminary Proposal Exam.

Final Defense: A recommended deadline is 6-9 months from completion of the Research Defense.

The following sections detail these milestones further.

6.2.1 The Ph.D. Qualifying Process

The PhD qualifying process is completed early in a student's doctoral studies and is the first of four milestones which must be completed successfully to earn the PhD degree. It is important to keep in mind that the Ph.D. qualifier is a "process" rather than just an "exam". It involves two components: excellence in breadth and excellence in depth. Breadth is assessed through classwork achievement. Depth is assessed through a combination of research achievement and the results of a qualifying exam (in the student's cognizant area of specialty). A Ph.D. student must demonstrate excellence in both breadth and depth to be considered qualified.

Excellence in Breadth: This score is assessed on a binary scale (pass/fail). To pass this requirement, a student needs to take CS courses spanning four areas and receive a GPA of at least 3.5 across these four courses. Only 5000-level and above CS courses eligible to be used on a CS graduate plan of study are considered. At least three 5000-level courses must be included. These courses must be graded on an A-F scale (therefore, CS 5974 cannot be included). Transferred courses are not considered. Note that, among all courses taken at Virginia Tech, the student can choose 4 courses of their interest to satisfy this requirement.

Excellence in Depth: This score is assessed on a points system using two components: research achievement and a qualifying exam. Each component can provide upto 3 points. Out of the total possible 6 points, a student must obtain 3 points to pass the excellence in depth requirement. Note that it is possible to pass the excellence in depth requirement using only one of the two components (i.e., either research achievement or the qualifying exam).

Research achievement score: This score is assessed by the AGS by soliciting input from the faculty regarding a student's research ability. In addition, the student may submit a written description of his or her

research achievements. This score will then be assigned based on the individual's research record and the faculty recommendations. Guidelines for scoring:

3: Student has a non-trivial publication record. Traditionally, this is publication of at least one paper in a recognized, peer-reviewed conference or journal, and typically with additional submissions or publications. While this might be for work done prior to entering our program, it is expected that some research work (Independent study, GRA, or major volunteer effort) will have been done here. Alternatively, the student has completed a MS thesis in CS at Virginia Tech, or a peer institution, and has submitted at least one paper for publication to a peer reviewed conference or journal. To gain this score, some VT CS faculty member must endorse the student, and be willing to act as PhD advisor.

2: Student has demonstrated research ability through satisfactory performance on an Independent Study project, a graduate research assistantship (GRA) assignment, or an equivalent volume of work on a volunteer basis. This might have been done at another university, and there might be minor publications. To gain this score, some VT CS faculty member must endorse the student, and be willing to act as PhD advisor.

1: Recommendations from faculty who have personal knowledge of a student's research ability, based on class projects, papers, or presentations, indicate that the student is able to do credible research.

0: No evidence of research achievement.

Qualifying exam score: A PhD qualifying examination committee may be formed in any area recognized by the Department (see Appendix G for details). There is at most one committee per area in a given year and is constituted based on student interest (hence, due to insufficient student interest, some areas might not offer qualifying exams in some years). The examination will be either written or oral (or both), with format and procedures as the examination committee sees fit. Students are normally eligible for only one attempt at the exam. See Appendix F for details on the goals of the qualifying exam.

Guidelines for assessing the qualifying exam score are as follows:

3: Excellent performance, beyond that normally expected or required for a PhD student.

2: Performance appropriate for students preparing to do PhD-level work. Prime factors for assessment include being able to distinguish good work from poor work, and explain why; being able to synthesize the body of work into an assessment of the state-of-the-art on a problem (as indicated by the collection of papers); being able to identify open problems and suggest future work.

1: While the student adequately understands the content of the work, the student is deficient in one or more of the factors listed for assessment under score value of 2. A score of 1 is the minimum necessary for an MS-level pass.

0: Student's performance is such that the committee considers the student unable to do PhD-level work in Computer Science.

Attempting or using a qualifying exam in a given area to get qualified does not “tie” a student to Ph.D. research in that area. For instance, a student might get qualified using scores from the qualifying exam in the HCI area but might opt to pursue a Ph.D. in the area of algorithms and theory. It is presumed that the student’s advisor (and advisory committee) are adequately positioned to judge the suitability of the student’s proficiency to undertake Ph.D. research in a given area and the Preliminary Proposal Exam is an opportunity to ascertain the same.

Since the Ph.D. qualifying exams are offered early in the calendar year, the AGS will attempt to assign initial valuations to all who take the exam, and give feedback via email on current standing to those students. If at

that point a student has six points, a letter to that effect will be issued automatically. At the end of Spring semester, the AGS will attempt to update those valuations based on Spring grades, again issuing a qualification letter if the student is qualified. Aside from immediately after the exam and at the end of Spring semester, evaluation will only be conducted when initiated by the student. There are two cases where a student will initiate an evaluation. (1) If the student determines that he/she can obtain six points without taking the exam, they should contact the AGS and provide appropriate documentation to support receiving the points. (2) If at some point after the Spring semester evaluation the student feels he/she has a case for six points, they can contact the AGS to do an evaluation. When the qualifier case is clear cut for a given student, the AGS will make an immediate determination. Cases that are not clear cut will be referred to the full committee.

As stated earlier, the PhD qualifying examination also serves as one of the two methods whereby an MS coursework-only option student may pass their MS degree final examination.

6.2.2 The Ph.D. Preliminary Proposal Exam

The Preliminary Proposal Exam is the second of four milestones to be completed by a PhD student. The Preliminary Proposal Exam serves as the University's required Preliminary Exam. The Preliminary Proposal Exam should occur as early as possible after completing the PhD Qualifying Process, preferably within one year to 18 months. Unlike the Ph.D. qualifier, this step requires that the student's Ph.D. advisor and advisory committee be constituted and operational.

The Preliminary Proposal Exam is an oral presentation and examination expected to last between one and three hours. The actual conduct, content, and scope of the Preliminary Proposal Exam are under the control of the student's advisory committee. However, the intent of the Preliminary Proposal exam is to assess the student's readiness to begin independent research on the proposed problem. In particular, it seeks to answer two questions:

1. **Does the work proposed appear satisfactory to qualify as completing a PhD?** This means that the proposed work is not so ambitious as to be implausible for a PhD student, yet is ambitious enough to warrant granting of a PhD if completed.
2. **Is the student adequately prepared to do the proposed work?** In particular, does the student have an adequate grasp of the current state-of-the-art in the proposed research area? This is likely to be determined in part by a literature review, which should also be useful to the student at the time of writing the dissertation.

It is expected that, to satisfy these objectives, the student will prepare a document and submit it to the committee sufficiently in advance of the exam that the committee members have adequate time to review it. This document will likely consist of (a) a literature review and discussion of relevant work, and (b) a research plan describing the work to be completed and its significance. To whatever extent is reasonable, it is advisable that the document include a timeline for completion and description of any equipment, supplies, or support necessary for successful completion.

Depending on the will of the committee, the Preliminary Proposal Exam may be limited strictly to a presentation and discussion of the document presented by the student. In addition the committee may, but certainly is not obligated to, chose to ask questions to test the student's background knowledge in the relevant areas of Computer Science. Ideally, the student and advisor will discuss and reach an agreement on the format and scope of the exam well in advance. By passing the student's research proposal, the committee is certifying that, if the student does the stated work in a satisfactory manner, it will prove adequate for a dissertation topic. Note that once the Preliminary Proposal Exam has been completed, there is no necessary requirement that the student's final dissertation adhere to the proposal. The student and committee are free to change the direction of the work as it progresses, based on mutual consent, if they deem that appropriate.

The student is considered to have failed the exam if two or more members of the examination committee give negative votes. If performance on the Preliminary Proposal Exam is unsatisfactory, one full semester must lapse (a minimum of 15 weeks) before the administration of a second examination. The Preliminary Proposal Exam cannot be attempted more than twice.

6.2.3 Research Defense

The Research Defense is the third of four milestones that must be completed for the PhD degree. It is the lesser of the two milestones preceding the Final Defense, but nonetheless is an important step in the process. The Research Defense will typically occur about one year to 18 months after the Research Proposal Exam, and approximately 3-6 months prior to the Final Defense.

The Research Defense is expected to last one or two hours. The actual conduct, content, and scope of the Research Defense are under the control of the student's advisory committee. The Research Defense should take place once the student has completed most of the work for the dissertation. It is likely that significant writing will yet remain, but no significant problems (other than perhaps mechanical data collection, routine software development, or usability testing) should remain to be solved.

The Research Defense is meant to be an opportunity for the committee to review the key results and verify that a satisfactory body of work appears to have been completed. The committee should understand what has been and what will be accomplished as part of the dissertation, and to agree within itself whether completion of the work as described by the student, or a revision as determined by the committee at the Research Defense, will result in successful completion of the dissertation.

It is expected that the student will prepare a document and submit it to the committee sufficiently in advance of the exam that the committee has sufficient time to review it. If the committee is expected to read and comment on a significant amount of material then it should be given to the committee two weeks in advance of the meeting. The document will likely consist of a review of the proposed work plan (possibly revised since the time of the Preliminary Exam) for the dissertation, and a description of the student's progress towards completing the plan. Key results and their significance should be presented clearly, but briefly. The document should clearly detail what work remains to be done, and the timeframe for its completion. It is not intended that this document be a draft of the dissertation. For some committees, the document might simply be a list of accomplishments and remaining tasks. The student might also submit to the committee copies of papers published or submitted for publication. It is up to the committee to specify how much information it needs to determine if dissertation work is on track.

The Research Defense will typically be the committee's last major opportunity to review the student's progress and work prior to the Final Defense. As such, any major objections or reservations regarding the research plan and progress should be expressed at the Research Defense. Under normal circumstances the expectation is that, if the work completed at the time of the Research Defense is deemed satisfactory, and if the dissertation is completed in the manner specified at the Research Defense, then the result will be deemed satisfactory at the Final Defense.

Note that the Research Defense plays no official role within the University. The Department requires that students pass the Research Defense in a timely manner to remain in good standing. Aside from this, it is up to the student and the committee to determine the next step should a student be considered by the committee to have failed the Research Defense.

6.2.4 The Final Defense

The last of the four stages for the PhD degree is the final defense. During this examination the candidate makes an oral presentation of his or her research work and defends the significance and accuracy of this work in response to questions from the student's committee. The committee, in closed session, determines

whether the student has successfully completed the examination. The final defense can be attempted at most twice.

7 Getting an MS on the way to the PhD/Do I need an MS before the PhD?

Successful completion of an M.S. degree in computer science is not a pre-requisite to register as a Ph.D. student at Virginia Tech. Upon entering the graduate program, students are classified as M.S. or Ph.D. based on their stated degree objective.

Students on a Ph.D. track can opt to obtain an M.S. during their course of study, i.e., "on the way". They may use either the coursework or thesis option. PhD students who have completed the PhD Qualifier Process and who have a valid Plan of Study that satisfies the PhD requirements may always use that PhD Plan of Study to satisfy their MS Coursework-only program requirements, even if that PhD Plan of Study does not technically meet all of the MS Coursework-only degree requirements. For instance, a PhD plan of study requires two cognate courses whereas an MS plan of study permits at most one cognate course. Nevertheless, if a student has cleared the PhD Qualifier Process and has a valid PhD Plan of Study on file, the courses on that PhD plan of study can be used to fulfill the MS Coursework degree requirements.

8 Transfer Credits

Courses used on a student's plan of study will normally be courses in Computer Science taken at Virginia Tech or designated cognate courses in other departments at Virginia Tech. Students entering our graduate program with credit for courses taken at other universities can apply to have a certain amount of that credit transferred to Virginia Tech and applied to their plans of study here.

In general, the procedure is to first determine an appropriate faculty member who will validate that equivalent credit has been done elsewhere. This is typically a faculty member who teaches a corresponding course here or, if such a course does not exist at Virginia Tech, a faculty member who is most knowledgeable in the cognizant area of the course. Depending on the nature of the course (CS course or cognate course), the appropriate faculty member might be within or outside the CS department. The student presents necessary documentation on the coursework to this faculty member who approves the transfer of credit.

Master's students may transfer a maximum of **nine** hours (three regular courses). Ph.D. students may transfer a maximum of **fifteen** hours (five regular courses) to be applied toward a Ph.D. plan of study. (Students who joined prior to Fall 2009 were allowed to transfer upto six regular courses but this number has since been reduced to five, to ensure that not more than 50% of the graded coursework credits for a VT degree originates from elsewhere.) Courses taken at other universities will normally be approved for use on a plan of study if the course is essentially the same as a Virginia Tech course which can appear on the student's plan of study. Credit for courses that are not essentially the same as a Virginia Tech course might be permitted as a general CS elective at the 5000- or 6000-level. Such courses might be approved within a specific CS area, in which case they would count as a regular course within that area for the purpose of fulfilling breadth requirements. Non-computer science courses that have not been designated as cognate courses will normally be approved for use on a plan of study (again, probably as general electives) if the student's advisor believes that this course is an integral and essential part of a student's plan of study.

A course may be transferred only if it was taken while the student was enrolled as a graduate student. A course may not be transferred if it was used to satisfy requirements for any undergraduate degree. To be eligible for credit, the student must have earned at least a grade of B or its equivalent, and the course must be taken at an accredited graduate institution. We must have on file an official transcript from the institution that shows the course and grade earned.

A student requesting transfer credit must follow this procedure:

Requests for transfer of credit are typically made during your first semester at Virginia Tech, but can be applied for and approved at any time. For **each** course you request to be transferred, print a copy of the credit transfer request form (see Appendix E).

Fill out the primary details of the form and attach to the form as much information about the course as possible, such as: a copy of the course syllabus as taught (as opposed to the university or college catalog description, which does not carry enough information); the title and author of the textbook used; a sample graded assignment (preferably the last one in the course, definitely not the first); a copy of the final exam--preferably both the questions and your graded answers (if you do not have the final, please supply the mid-term); URLs to the course website or other online resource. In cases where the course was taken a long time ago and little documentation is available, do the best you can. Transfer credit may be denied if insufficient information is provided to judge the content and level of the course. Take this package to the professor who teaches the course most like the one you wish to transfer and ask the professor to consider your request.

In many cases the faculty member will give the recommendation immediately on your form, and you can give it to the GC. In cases where documentation is sparse, the faculty member might choose to "interview" you to assess your knowledge in the stated course. If more time and consideration is needed, please leave the form with the faculty member with a request to forward it to the GC. Once the form is received by the GC, the AGS typically reviews it and approves it, and the transferred course(s) can then be used on a plan of study.

9 Advisors and Advising Committees

All graduate students have access to a faculty advisor who can help with both academic advising (i.e., issues related to getting a degree) and career advising. PhD students, and MS students under the thesis option, should select a faculty member to act as their research and course advisor as early as possible in their academic career and definitely by the time their plan of study is due (see Section 10 about "Plans of Study"). The advisor must be a full-time Virginia Tech faculty position with either a regular, emeritus, or courtesy appointment in the Department of Computer Science, and hold a Ph.D. or equivalent terminal degree.

In place of a single advisor, thesis students can instead choose two faculty members to serve as co-advisors. In this case, at least one of the co-advisors must be a full-time Virginia Tech faculty position with either a regular, emeritus, or courtesy appointment in the Department of Computer Science, and hold a Ph.D. or equivalent terminal degree. The advisor or co-advisors chair the student's advisory committee.

The composition of an M.S. thesis advisory committee must be designed taking into account the following considerations:

- The committee must have at least three members (including the advisor or co-advisors).
    - At least two members of the committee must hold a PhD or equivalent terminal degree. Any member without a PhD or equivalent terminal degree must have recognized expertise in their field and have research experience.
    - At least two members must hold tenure track or emeritus positions in the Department of Computer Science.
    - A person from outside the university can serve as an advisory committee member with the permission of the chair of the advisory committee.

The composition of a Ph.D. advisory committee must be designed taking into account the following considerations:

- The committee must have at least five members (including the advisor or co-advisors).
- At least four members of the committee must hold a PhD or equivalent terminal degree. Any member without a PhD or equivalent terminal degree must have nationally recognized expertise in their field and have research experience.
- At least three members must hold tenure track or emeritus positions in the Department of Computer Science.
- At least one member of the committee must be from outside the university.

Ph.D. students and MS students who plan to do a thesis but who have not yet selected a research advisor or who need additional academic advising can approach any faculty member on the graduate program committee (GPC) to serve as an interim advisor, and who can serve to provide signatures and other official approvals as required. For most such students, the AGS serves as the de-facto interim advisor.

The composition for an M.S. coursework advisory committee typically consists of three members as follows:

- The chair of the committee (advisor) is the instructor for the CS 5974 (Independent Study) course that was used to satisfy the M.S. coursework requirements. If the final exam requirement is met through the use of the qualifying exam, the chair of this exam serves as the advisor. This person must be a full-time Virginia Tech faculty position with either a regular, emeritus, or courtesy appointment in the Department of Computer Science, and hold a Ph.D. or equivalent terminal degree.
- The AGS and another faculty member serve as the second and third members.

10 Plans of Study

The Plan of Study is an official University document that serves as a "contract" between the student and the department. It details the degree program (M.S. or Ph.D.; with or without Bioinformatics option; if M.S. whether coursework or thesis), list of courses along with the semesters they have been taken/will be taken, and the advisory committee. Separate plans of study are required for M.S. and Ph.D. degrees.

The student prepares the plan of study in consultation with the advisory committee and submits it to the GC. Once the AGS approves it, the plan of study is submitted to the Virginia Tech graduate school for its approval.

A plan of study can be submitted and accepted only ONCE for a given degree. However, once a plan of study is on file, it can be changed but ONLY by filing a Request for Plan of Study Changes form. In other words, a new Plan of Study form is not initiated to make changes.

The graduate school encourages that plans of study be submitted as early as possible; As of Aug 2007, it stipulates that plans of study are due by the end of the second academic semester for all Master's students, and are due by the end of the third academic semester for doctoral students.

The department recommends that MS thesis students file a plan of study as soon as they know they will be doing a thesis. MS Coursework-only students must file their plan of study prior to the beginning of their third semester at Virginia Tech. Ph.D. students should select an advisor within 3 months of passing their Ph.D.

qualifier process and have an approved plan of study on file within 12 months of passing their Ph.D. qualifier process.

11 Funding Opportunities

There are several possible sources of funding with or near the University for qualified graduate students. Well over half of CS graduate students are typically funded through departmental fellowships, teaching, or research assistantships. Others were supported elsewhere within the University, or at the nearby Corporate Research Center. The vast majority of students seeking support will find it in one of the following ways:

* Graduate Teaching Assistantship (GTA): The number of GTAs awarded in a given year is difficult to predict and is driven by undergraduate (not graduate) enrollments. A fraction of the GTAs (approximately one-third) are offered to new students. In 2006/07, stipends were about $1600-$1800/month for nine months. Students on assistantships are exempt from tuition and a significant fraction of the costs for a University sponsored healthcare plan are covered.

* Graduate Research Assistantship (GRA): Many faculty have active research programs that include funds for research assistants. Note that GRAs are most commonly awarded to students who have been in the Department for at least one semester. GRAs receive the same stipends, tuition exemption, and healthcare benefits as GTAs.

* Computer Science Scholars and Pratt Fellowships: a limited number of exceptional applicants are admitted as CS Scholars or Pratt Fellows, which guarantees them multiple years of support. These positions may include summer support for research as well.

* University/College-level Fellowships: Our applicants are eligible to compete for University- and College-level fellowships including the Cunningham Fellowship, Dean's Fellowship, and PhD 2010 Fellowships. These fellowships typically include multiple-year support guarantees, summer research support, and possibly travel or discretionary funds. Some are only available to US citizens and permanent residents.

* Minority Scholarships: Virginia Tech provides a number of scholarships for minority students who are US citizens. Contact the CS Department at gradprog@cs.vt.edu for further information about applying to these programs.

* Other departments and local companies: Our graduate students are in demand to fill positions in other departments Graduate Research Assistants, or as programmers doing software development and system administration. Typically 10-20 of our students work as GRAs for other departments. There are also a number of software development companies in the Corporate Research Center (CRC) who have interest in hiring our students. Since such companies are located off-campus, these positions are typically not available to foreign nationals on student visas.

MS Thesis and PhD Students who received Departmental support in their first year can normally expect to recieve continued support during the remainder of their course of study (typically 2 years for MS, 4 or 5 years for PhD), so long as their job performance and degree progress is good. PhD students whose job performance is good are normally guaranteed three years of funding once they have passed their PhD Qualifier process. MS Coursework-only students will normally be given assistantships only if funding is available after all qualified Thesis and PhD students have been funded.

GTA applications are accepted twice a year, in November for spring semester and in March for the following academic year. Applications are placed in graduate student mailboxes approximately two weeks before the due date. Students entering the program in fall or spring are given GTA application forms at the departmental orientation meeting and can submit them immediately. Be aware, however, that the department will have already screened the incoming students and awarded a pool of assistantships at the time admission offers

were made. Thus, incoming students for that semester not given an assistantship from this pool generally have lower priority over continuing students for the few remaining positions.

Continuing students must have a minimum GPA of B (3.0) to be eligible for a GTA position. Decisions regarding the award of GTA positions are made by the AGS and the Graduate Program Committee. Funding decisions are largely guided by a ranking formula. Students who do not receive initial awards are placed on a waiting list and will be informed of their quartile standing on that list. The list is re-ordered at the end of the semester when new grades and GTA evaluations become available.

12 Survival Notes

12.1 A General Note about Paperwork

There are many forms that you will need to deal with as a graduate student. Often these require the signature of two sets of people: (1) your advisory committee members (including your advisor) and (ii) the AGS, the Department Head, the College Dean, or the Graduate School. The fastest way to get these forms signed is to get the signatures of people in set (1), leave them with the GC, who will see that the appropriate signatures from the set (2) are obtained. If appropriate, the GC will have you deliver them in person to the Graduate School once completed, but this is usually not necessary.

It is almost never appropriate to send a form directly to the Department Head, even if the form indicates the need for the Department Head's signature. Decisions related to plans of study, admissions, transfers, etc. are always made initially by an advisor and/or the AGS and then forwarded to the Department Head for approval. If you send a form directly to the Department Head, you can be sure that you have just slowed down the process.

On occasion you will want to discuss the contents of a form with the AGS, in which case a personal meeting or email exchange will be appropriate. If you only need a signature from the AGS, it is far more efficient to leave the form with the GC than to try to locate the AGS personally.

While the GC will make every effort to obtain the signatures as quickly as possible, sometimes one of the necessary people will be out of the office for several days. So it is important to turn in forms well in advance of any deadline you may be trying to meet.

12.2 Background Deficiencies

The department admits applicants from a variety of backgrounds, who have the potential for completing a CS graduate degree. Students with less than the equivalent of an undergraduate CS minor may have insufficient CS background to immediately undertake graduate courses. Particular background assumed as prerequisites for various graduate courses include object oriented programming, data structures, operating systems, and algorithm analysis. Incoming students might have identified deficiencies upon entering, or if they are concerned that they may have deficient background, should discuss this issue with the AGS prior to the start of classes in their first semester. Typically the AGS suggests undergraduate courses to make up for the background deficiencies.

Undergraduate courses assigned to overcome background deficiencies must be taken at the earliest possible opportunity to remain in good standing. These courses must be taken for a regular grade (A/F) and cannot be taken pass/fail. Such undergraduate deficiency courses should be listed on the plan of study, however they do not directly count toward satisfying the graduation requirements for any graduate degree in CS.

12.3 Course Registrations

Students currently enrolled in the graduate program are eligible to pre-register for courses. This normally takes place in October and March. Students are strongly encouraged to take advantage of pre-registration since (a) courses might be cancelled for lack of enrollment if not enough pre-register (especially Spring Semester classes when relatively few new students enter the program) and (b) it is your best opportunity for getting into the courses you want.

After pre-registration, Fall courses are typically locked so that students may not add them online. Courses normally stay locked until after new students entering the program for Fall semester have had a chance to be added. After this time (typically the Friday before classes begin), courses will be opened for add/drop access online.

All CS graduate courses are normally open to CS graduate students only. Non-CS graduate students will be required to supply a written request from their advisor to gain permission to enroll in a CS course.

Registration for CS5974: Independent Study involves a special procedure. You do not register online for CS5974 Independent Study, but instead fill out a request form. The form must be processed by the end of the normal drop/add period in the first week of class. The AGS will give additional time for the student and instructor to complete the project description and evaluation criteria if needed, but the registration portion of the form (the first page) needs to be submitted by the end of the drop/add week. Note that only CS faculty can serve as instructors for CS5974. Sometimes a student will wish to work with a faculty member outside the CS Department, working on a project with that outside person. A CS faculty member must still be recruited as the official instructor, and that CS faculty member assigns the actual grade (more on this below).

Recall that only the M.S. coursework and Ph.D. degree options allow credit toward the degree for CS5974 Independent Study. Although CS5974 is technically available for variable credit hours, students will nearly always take it for 3 credits. An Independent Study course requires commitment from a CS professor to sponsor the study, and a separate application form must be submitted.

A CS graduate student can do a CS5974 Independent Study under a professor outside the CS department but in a topic relevant to the CS major if the following two criteria are met:

(1) The content is appropriate for credit toward a CS degree.

(2) A CS faculty member agrees to be the formal sponsor of the course. The person who signs the course approval form as the supervisor of the work must be a CS faculty member. Even though the work is mainly done with another person, the CS faculty member must be the responsible party within our department.

12.4 Courseload Expectations and Courseload restrictions

Students on GTA or GRA support must have "full-time" enrollment status, and so must enroll for 12 credit hours. While a normal course load is 12 credits, this does not mean that students are expected to take four regular 3-credit courses during any semester. Students should take the number of courses in a given semester appropriate for making good progress toward completing their degree, and add in research hours (CS5994 or CS7994, as appropriate) to bring the total number of credits per semester to 12.

The department restricts the number of regular courses that students may take. These restrictions are motivated by two considerations: (1) What we consider to be a rational workload balancing the need to take courses versus obligations to work and/or expectations to participate in research programs. (2) Protection for

other students who might be locked out of courses by those who would hold seats while they "shop" for the subset they actually will keep.

For the purpose of these restrictions, a "regular course" is any (typically 3-credit) course that is eligible for graduate credit, whether given by the CS department or another department. This includes CS5974 Independent Study. It does not include CS5994/7994 Research Hours, 1-credit seminar courses (such as the GBCB seminar), or courses taken for personal interest that do not count for graduate credit (such as an arts or foreign language courses). The following courseload restrictions are enforced by the department:

* GTAs and GRAs are limited to at most three regular courses per semester.
* No student may enroll in more than three regular courses until the last day of the normal drop/add period (Friday of the first week of classes).
* Students in the PhD program are limited to two regular courses per semester unless they have permission from their advisor and the AGS to take a third course.

12.5 Dropping Courses

Graduate students wishing to drop a course after the official drop date must obtain the approval of the course instructor and the Associate Department Head. **Approvals for late dropping of courses are not guaranteed and are given only under extreme (e.g., life-altering) circumstances. Poor performance in the course, lack of interest in the course etc. are not valid reasons to request a late drop.** See Appendix D for information about course drop deadline dates in the context of a typical semester. To late drop a course, the student must submit a completed Drop-Add form with the Instructor's and the AGS's signatures to the GC. It will then be submitted to the graduate school for the Dean's (of the graduate school) signature. If approved, the course will be dropped from the student's schedule.

12.6 Leaves of Absence and Re-admission

Graduate students wishing to take some time off (e.g., a semester) of graduate studies must fill and submit a "Leave of Absence Request" Form. Once the leave is approved, the student can resume studies after the break. For leaves of more than one calendar year, a formal re-admission request must be submitted before rejoining VT. Such requests must be submitted in the semester prior to the semester in which studies are to be resumed. Readmission might require a small processing fee.

12.7 Maintaining Good Standing

Graduate students must remain in "good standing" throughout the period of graduate studies. This means that the student is making satisfactory progress towards the completion of a graduate degree. The milestones indicated below are designed with the intention that a Master's degree student will typically graduate two years after entering the graduate program, and a PhD student will typically graduate five years after entering the graduate program (if starting with a BS) or four years after entering the graduate program (if starting with a MS). Each student's progress is reviewed annually by the Graduate Program Committee (GPC). Only students in good standing are normally eligible for funding support administered by the department, i.e., GTAs and fellowships. In extreme cases, students not in good standing will be removed from the graduate program. The GPC will normally provide at least one warning before removing a student, however, in cases where there exists substantial failure to achieve satisfactory progress the student may be removed without prior warning.

Masters degree students retain their good standing by meeting all of the following:

- take a normal course load (12 semester credits) in each term and maintain a B (3.0) average over all courses. Note that while a normal course load is 12 credits, this does not mean that students are expected to take four regular 3-credit courses during any semester. Students should take the number of courses in a given semester appropriate for making good progress toward completing their degree, and add in research hours (CS 5994) to bring the total number of credits per semester to 12;

- take any courses assigned as a background deficiency during the earliest possible academic term;

- remove any Incomplete course grade by the end of the next semester in which the student is enrolled; and

- have an approved Plan of Study on file no later than the end of the semester when the 15th credit hour is completed (normally the second semester in the program). This means that the student will also need to have decided whether to pursue the thesis option or coursework-only option by this time, and have identified a major advisor and an advisory committee.

PhD students retain their good standing by meeting all of the following:

- take a normal course load (12 semester credits) in each term and maintain a B (3.0) average over all courses. Note that while a normal course load is 12 credits, this does not mean that students are expected to take four regular 3-credit courses during any semester. Students should take the number of courses in a given semester appropriate for making good progress toward completing their degree, and add in research hours (CS 7944) to bring the total number of credits per semester to 12;

- take any courses assigned as a background deficiency during the earliest possible academic term;

- remove any Incomplete course grade by the end of the next semester in which the student is enrolled;

- complete the PhD qualifying process within 30 months of entering the PhD program;

- have an approved Plan of Study on file within 12 months of passing the Ph.D. qualifying process; and

- pass the preliminary examination within 18 months of passing the PhD qualifying process.

Students who have any doubts about their standing should discuss this with their advisor and/or the AGS.

12.8 Periodic Assessment of Progress to Degree

Each spring, all graduate students are required to complete a Progress to Degree form. If you are graduating that semester, you need only note this on the form and not complete all the details. However, you should still get your advisor to complete the evaluation section. If you are a coursework-only student, or if it is your first semester in the Department, you typically will have little to say on the form and need not get an advisor to write an assessment. If you are a MS Thesis or PhD student, particularly one who is seeking support from the Department as a GTA or GRA, then the form is important for us to assess your progress. The assessment from your advisor is an important tool for you to be sure that you are truly on track with your work. This form will be placed in your mailbox approximately two weeks before it is due.

The Graduate School requires that all graduate students receive an annual evaluation of their progress. In the Department of Computer Science, the annual evaluation process is similar in some respects to how faculty

are given their annual review. The review process is initiated by each student filling out the Progress to Degree form by the annual deadline (typically set for late March). The form has essentially three parts:

* A listing of academic milestones passed and planned (which serves to give the student self guidance as to whether he or she is on track toward graduation)
* A listing of accomplishments for the year. This also self-guides the student regarding progress for the year.
* A written statement from the student's advisor assessing the student's progress, to be signed by both the advisor and the student.

GPC will review all Progress to Degree forms towards the end of the Spring semester. These forms serve as a major source of input for assessing rankings for GTA assignments, for graduation awards and other honors, and in rare cases for issuing warning letters or termination from the program for lack of progress.

12.9 Scheduling Exams

All graduate degree programs require the scheduling of a final exam.

Both the MS Thesis option and the PhD require an oral final exam before the advisory committee. This exam must be taken during an academic term in which the student is registered (perhaps this registration will be as a defense-only student, see Section 12.11). At least two weeks prior to the examination date, the student must submit to the graduate school a signed copy of the Request to Admit Candidate to the Final Exam form. Please have the GC make a copy of the completed form for your departmental file. Once that form is approved by the graduate school, the "exam card" is mailed to the chair of the committee. Upon successful completion of the exam, the card is signed by all members of the committee and the student typically returns it to the graduate school within 24 hours of the exam. Again, the GC makes a copy of the signed exam card before it is returned.

Coursework-only MS option students must also fulfill their final exam requirements. Recall that coursework students complete their requirements through either performance on the Ph.D. qualifier or satisfactory completion of CS 5974: Independent Study. Although they do not have an "oral" defense, they are still required to constitute a committee, as mentioned in Section 9, and schedule a nominal date for their final exam with the graduate school. They must follow the procedures exactly as noted about for thesis students, except that the exam card comes to the chair of the committee who signs it and obtains signatures of the other committee members and returns it to the graduate school (again, the GC makes a copy of the signed exam card before it is returned).

The procedure for the PhD Preliminary exam is quite similar to that of an oral final exam. First you must submit a form (Request to Admit Candidate to the Preliminary Exam) to the Graduate School at least two weeks in advance of the exam date. Please have the GC make a copy of this form for the departmental file. After the exam, have the GC copy the card before returning it to the Graduate School, which you must do within 24 hours of the exam.

12.10 Graduation Procedures

Each semester, the Graduate School publishes a list of deadlines for the necessary steps toward graduation in that semester. Besides finding that schedule at the Graduate School website, the AGS will typically send out the schedule by email at least once during the semester.

The first step in the process toward graduation is to complete an Application for Degree form, via Hokie SPA.

Typically there is a deadline by which you must have completed your final exam requirements if you want to be listed on the commencement bulletin and receive your diploma at commencement. There is a later deadline (in fact, past the end of the semester) by which you must complete all requirements to be considered a graduate in that semester. Be sure to check in advance on the appropriate deadlines so that you know what is expected. They are posted at the Graduate School website.

To graduate, you must first submit an Application for Degree card by the Graduate School's deadline for that semester. You must also complete all defense requirements by the Graduate School's deadlines. For the MS Thesis option and PhD degree, this means holding the final defense and submitting the final documents by the appropriate deadlines. All MS Theses and PhD Dissertations must be submitted to the Electronic Theses and Dissertations system (see the ETD Homepage). If you are using the report from CS5974 Independent Study as the final exam requirement for the MS Coursework-only option, you should submit a copy (electonic or hard-copy) of the report to the AGS by the deadline, and have your course instructor send an email message to the AGS advising whether to accept or reject the report. These reports are not submitted to ETD.

12.11 Defending Student Status

Sometimes a student is unable to complete (defend) their thesis or dissertation by the end-of-semester deadline, but is close to completing. The graduate school requires that all students be registered in the semester that they complete their degree. This means that if you intended to defend in a Fall semester, but couldn't, you would normally need to register for the next semester (i.e., Spring).

To keep the registration expenses to a minimum, the graduate school offers the ability to register for only a "token" credit of 1 hour, rather than normal, full-time credit hours. This type of registration is known as "defending student status" and is only available if you will defend by the 20th day from the start of the semester. To avail of this option, students must submit the Certificate of Defending Student Status form along with the Final Exam Request form. The graduate school will then add a 1-credit course to the student's schedule. If you cannot defend within this 20-day grace period, you must register for the full semester and pay regular fees.

12.12 Participation in Commencement Activities

If you are completing a MS thesis or PhD, please tell your faculty advisor well in advance if you plan to attend the graduation ceremony. Part of the ceremony involves "hooding" of the graduate by the faculty member. With the myriad different graduation ceremonies in place (at the department level, college level, and at the university level) most faculty are assigned to attend one or another ceremony, and few are able to go to all ceremonies. Further, faculty paticipating in hooding ceremonies typically must come dressed in regalia. Thus, your advisor needs to know in advance so that he or she can be prepared.

12.13 Internships and Co-ops

Graduate students can opt to pursue industrial/research internship opportunities, typically during the summer (May-July). These are usually paid opportunities and can serve to supplement a student's academic training at Virginia Tech. The decision to undertake an internship and co-op must be taken in consultation with the advisor, who will ensure that it doesn't interfere with the student's academic progress.

Foreign students are typically limited by their visa status regarding such employment opportunities. In particular, leave of absence for a "coop" or "internship" may only be permitted when it does not interfere

with the degree program. The CS Department routinely grants permission for students on student visas to pursue coops and internships during the summer. It almost never grants permission for coursework-only students on student visas to pursue coop or internship during the academic year. MS Thesis and PhD students might be given permission for pursue coop or internship during the academic year only under the extremely rare situation where such coop or internship is required to support that student's research program.

For foreign students, internships and coops are typically categorized as CPT (Curricular Practical Training) for the purpose of immigration classifications. See the graduate school's website (http://grads.vt.edu) for forms and procedures relating to CPT.

12.14 Graduate Council

The Graduate Council (http://csgrad.cs.vt.edu) is a student-run organization that pursues the interests of graduate students in the Computer Science Department. Elected members serve on committees that decide policy, curriculum, funding, research, computing resources, and work space allocations. In particular, one member of the graduate council serves on the graduate program committee (GPC). The Graduate Council also sponsors various events to promote the computer science graduate community, administers funds for student travel to conferences and meetings, and provides a mentoring program where current students serve as mentors to incoming graduate students. Students are encouraged to contact the Graduate Council with their concerns at gradcouncil@csgrad.cs.vt.edu.

13 Graduate Honor Code

The Graduate Honor Code establishes a standard of academic integrity. As such, this code demands a firm adherence to a set of values. In particular, the code is founded on the concept of honesty with respect to the intellectual efforts of oneself and others. Compliance with the Graduate Honor Code requires that all graduate students exercise honesty and ethical behavior in all their academic pursuits here at Virginia Tech, whether these undertakings pertain to study, course work, research, extension, or teaching.

It is recognized that the graduate students have very diverse cultural backgrounds. In light of this, the term ethical behavior is defined as conforming to accepted professional standards of conduct, such as codes of ethics used by professional societies in the United States to regulate the manner in which their professions are practiced. The knowledge and practice of ethical behavior shall be the full responsibility of the student. Graduate students may, however, consult with their major professors, department heads, the International Students Office, or the Graduate School for further information on what is expected of them.

More specifically, all graduate students, while being affiliated with Virginia Tech, shall abide by the standards established by Virginia Tech, as these are described in this Constitution. Graduate students, in accepting admission, indicate their willingness to subscribe to and be governed by the Graduate Honor Code and acknowledge the right of the University to establish policies and procedures and to take disciplinary action (including suspension or expulsion) when such action is warranted. Ignorance shall be no excuse for actions which violate the integrity of the academic community.

The fundamental beliefs underlying and reflected in the Graduate Honor Code are that (1) to trust in a person is a positive force in making a person worthy of trust, (2) to study, perform research, and teach in an environment that is free from the inconveniences and injustices caused by any form of intellectual dishonesty is a right of every graduate student, and (3) to live by an Honor System, which places a positive emphasis on honesty as a means of protecting this right, is consistent with, and a contribution to, the University's quest for truth.

14 Virginia Tech Equal Opportunity/Affirmative Action Statement

Virginia Tech does not discriminate against employees, students, or applicants on the basis of age, color, disability, gender, national origin, political affiliation, race, religion, sexual orientation or veteran status. Discrimination or harassment on any of these bases is prohibited by Policy 1025, "Anti-Discrimination and Harassment Prevention Policy."

The university is subject to Titles VI and VII of the Civil Rights Act of 1964, Title IX of the Education Amendments of 1972, Sections 503 and 504 of the Rehabilitation Act of 1973, the Americans with Disabilities Act of 1990, the Age Discrimination in Employment Act, the Vietnam Era Veterans' Readjustment Assistant Act of 1974, the Federal Executive Order 11246, Virginia's State Executive Order Number Two, and all other rules and regulations that are applicable.

Those having questions or concerns about Policy 1025, any of these regulations, or related issues should contact:

Office for Equal Opportunity
336 Burruss Hall (0216)
Blacksburg, VA 24061
(540) 231-7500
TTY: (540) 231-9460

Appendix A: Courses Available for CSA Graduate Credit

Unless otherwise stated, the courses listed here involve 3 credits.
Unless otherwise stated, the courses listed here must be taken for an A-F grade.
Unless otherwise stated, a course from the list below cannot be repeated on a program of study.

CS 4104: Data and Algorithm Analysis
This course emphasizes the understanding of data structures and algorithms from an analytical perspective rather than from an implementation standpoint. The concepts developed allow discussion of the efficiency of an algorithm and the comparison of two or more algorithms with respect to space and run-time requirements. Analytical methods are used to describe theoretical bounds as well as practical ones. In general, this course addresses the constraints that affect problem solvability. A grade of C or better required in CS prerequisite 2604 or 2606. Pre: (2604 or 2606), (MATH 3134 or MATH 3034).

CS 4114: Introduction to Formal Languages and Automata Theory
The course presents a study of formal languages and the correspondence between language classes and the automata that recognize them. Formal definitions of grammars and acceptors, deterministic and nondeterministic systems, grammar ambiguity, finite state and push-down automata, and normal forms will be discussed. Pre: MATH 3134 or MATH 3034.

CS 4124: Theory of Computation
Theoretical analysis of the computational process; fundamental concepts such as abstract programs, classes of computational machines and their equivalence, recursive function theory, unsolvable problems, Church's thesis, Kleene's theorem, program equivalence, and generability, acceptability, decidability will be covered. Pre: MATH 3134 or MATH 3034.

CS 4204: Computer Graphics

Hardware and software techniques for the display of graphical information. 2D and 3D geometry and transformations, clipping and windowing, software systems. Interactive graphics, shading, hidden surface elimination, perspective depth. Modeling and realism. A grade of C or better required in CS prerequisite 2604 or 2606. Pre: 2604 or 2606.

CS 4214: Simulation and Modeling
Overview of discrete-event digital computer simulation and modeling. Fundamentals of model development, Monte Carlo simulation, the life cycle of a simulation study, input and output data analysis, world views and time control, random number and variate generation, credibility assessment of simulation results, simulation languages, applications of simulation using the General Purpose Simulation System (GPSS). A grade of C or better required in CS prerequisite 1706. Pre: 1706, STAT 4714.

CS 4224: Performance Evaluation of Computer Systems
Overview of techniques for measuring, improving, and tuning the performance of computer systems. Procurement, workload characterization, measurement principles, the representation of measurement data, software and hardware monitors, capacity planning, bottleneck detection, system and program tuning, simulation and analytic models and their applications, case studies. Pre: 3204, (STAT 4714 or STAT 4105 or STAT 4705).

CS 4234: Parallel Computation
Survey of parallel computer architectures, models of parallel computation, and interconnection networks. Parallel algorithm development and analysis. Programming paradigms and languages for parallel computation. Example applications. Performance measurement and evaluation. A grade of C or better required in CS prerequisite 3204. Pre: 3204.

CS 4244: Internet Software Development
Key technology underlying the World-Wide Web. Web architecture, including server design, caching, network protocols, and related standards (e.g. http, SHTTP, TCP/IP, MIME). Programming systems (e.g. Java, Active-X, component models). Security and cryptography. Document representations (e.g. XML, HTML, PDF, VRML). Legal and social issues of the Web. A grade of C or better required in CS prerequisite 3204. Pre: 3204.

CS 4254: Computer Network Architecture and Programming
Introduction to computer network architecture, and methods for programming network services and applications (e.g. DNS, Email and MIME, http, SNMP, multimedia). Wired, wireless, and satellite network architectures. OSI protocol model, with an emphasis on upper layers. Congestion control, quality of service, routing. Internet protocol suite (e.g. IP, TCP, ARP, RARP). Server design (e.g. connectionless, concurrent). Network programming abstractions (e.g. XDR, remote procedure calls, sockets, DCOM). Case studies (e.g. TELNET). A grade of C or better required in CS prerequisite 3204. Pre: 3204.

CS 4304: Compiler Design and Implementation
This course includes the theory, the design, and the implementation of a large language translator system. Lexical analysis, syntactic analysis, code generation, and optimization are emphasized. A grade of C or better required in CS prerequisite 3204. Pre: 3204.

CS/MATH 4414: Issues in Scientific Computing
Theory and techniques of modern computational mathematics, computing environments, computational linear algebra, optimization, approximation, parameter identification, finite difference and finite element methods and symbolic computation. Project-oriented course; modeling and analysis of physical systems using state-of-the-art software and packaged subroutines. Pre: MATH 2214, MATH 3214. (2H,3L,3C)

CS/ECE 4504: Computer Organization

Information representation and transfer; instructions and data access methods; the control unit and microprogramming; memories; input/output and interrupts; secondary storage; the von Neumann SISD organization; high level language machines; the RISC concept; special purpose processors including operating system, file, text, floating point, communication, etc. Multicomputers; multiprocessors; concurrent processing support; Pipeline machines, processor arrays, database machines; the data flow/data directed approach; computer networks. A grade of C or better required in CS prerequisite 3204. Pre: 3204.

CS/ECE 4570: Wireless Networks and Mobile Systems
Multidisciplinary, project-oriented design course that considers aspects of wireless and mobile systems including wireless networks and link protocols, mobile networking including support for the Internet Protocol suite, mobile middleware, and mobile applications. Students complete multiple experiments and design projects. Pre: 4254 or ECE 4564.

CS 4604: Introduction to Database Management Systems
Emphasis on introduction of the basic data base models, corresponding logical and physical data structures, comparisons of models, logical data design, and data base usage. Terminology, historical evolution, relationships, implementation, data base personnel, future trends, applications, performance considerations, data integrity. Senior standing required. A grade of C or better required in CS prerequisite 2604 or 2606. Pre: 2604 or 2606.

CS 4624: Multimedia, Hypertext, and Information Access
Introduces the architectures, concepts, data, hardware, methods, models, software, standards, structures, technologies, and issues involved with: networked multimedia (e.g., image, audio, video) information, access and systems; hypertext and hypermedia; electronic publishing; virtual reality. Coverage includes text processing, search, retrieval, browsing, time-based performance, synchronization, quality of service, video conferencing and authoring. Senior standing required. A grade of C or better required in CS prerequisite 2604. or 2606. Pre: 2604 or 2606.

CS 4634: Design of Information
Survey of the higher-order properties that allow data to become information, that is, to inform people. The course focuses on the design of user interface layouts, and on the design of texts and hypertexts, as well as on the information development process. Senior standing required. A grade of C or better required in CS prerequisite 2604 or 2606. Pre: 2604 or 2606.

CS 4704: Software Engineering
Introduction to the basic principles of software engineering. Issues in the software life cycle. Emphasis on methods for software design and testing. Project management and quality assurance. Significant software project required. A grade of C or better required in CS prerequisite 3704. Pre: 3704.

CS 4804: Introduction to Artificial Intelligence
Overview of the areas of problem solving, game playing, and computer vision. Search trees and/or graphs, game trees, block world vision, syntactic pattern recognition, object matching, natural language, and robotics. Senior standing required. A grade of C or better required in CS prerequisite 2604 or 2606. Pre: 2604 or 2606.

CS 5014: Research Methods in Computer Science
Preparation for research in computer science. Technical communication skills. Design and evaluation of experiments. The research process.

CS 5104: Computability and Formal Languages
Formal theory of computability, the halting problem, models of computation, and Church's thesis, and formal languages.

CS 5114: Theory of Algorithms
Methods for constructing and analyzing algorithms. Measures of computational complexity, determination of efficient algorithms for a variety of problems such as searching, sorting and pattern matching. Geometric algorithms, mathematical algorithms, and theory of NP-completeness.

CS 5124: Algorithms in Bioinformatics
Algorithms to solve problems found in biology, especially molecular biology. A variety of current problems in computational molecular biology will be introduced, investigated, analyzed for computational complexity, and solved with efficient algorithms, when feasible. A number of such problems will be shown to be intractable or other evidence of their difficulty will be presented. Prerequisites or graduate standing in CSA required.

CS 5204: Operating Systems
Issues in the design and functioning of operating systems. Emphasis on synchronization of concurrent activity in both centralized and distributed systems. Deadlock, scheduling, performance analysis, operating system design, and memory systems including distributed file systems.

CS 5214: Modeling and Evaluation of Computer Systems
An overview of modeling, simulation, and performance evaluation of computer systems, i.e., operating systems, database management systems, office automation systems, etc. Fundamentals of modeling, the life cycle of a simulation study, workload characterization, random number and variate generation, procurement, measurement principles, software and hardware monitors, capacity planning, system and program tuning, and analytic modeling. Duplication of subject matter of 4214 and 4224. Maximum of 6 hours credit may be obtained from 4214, 4224, 5214.

CS 5224: Systems Simulation
An in-depth treatment of systems simulation and simulation programming languages (SPLs). Input data modeling, simulation model formulation and representation, conceptual frameworks for modeling, a comparative study of some SPLs, principles of SPL design, statistical analysis of simulation output data, credibility assessment stages, model development environments.

CS 5234: Advanced Parallel Computation
Survey of leading high-end computing systems and their programming environments. Advanced models of parallel computation. Mapping of parallel algorithms to architectures. Performance programming and tools for performance optimization on parallel systems. Execution environments and system software for large-scale parallel computing. Case studies of parallel applications. Graduate standing required.

CS 5244: Internet Software
Languages and technologies needed to develop software for the Internet and world-wide web (WWW). Commonly used protocols and standards. Advanced technologies for distributed computation, component-based systems, interoperability with legacy systems, and database access. Principles and technologies for agent-based systems and electronic commerce. Credit will not be given for both 4244 and 5244.

CS 5304: Translator Design and Construction
Fundamental theory of parsing and translation and practical applications of this theory. Lexical analysis, parsing techniques based on top-down (LL, Recursive Descent) and bottom-up (LR, Precedence), code generation, code optimization techniques, and runtime systems.

CS 5314: Programming Languages
Indepth investigation of the principles of programming systems, not necessarily restricted to programming languages, both from the point of view of the user implementor. Algorithms of

implementation, syntax and semantic specification systems, block structures and scope, data abstraction and aggregates, exception handling, concurrency, and applicative/functional/data-flow languages.

CS/GBCB/BIOL 5424: Computational Cell Biology
Use of mathematical models (nonlinear ordinary differential equations and stochastic processes) and simulation algorithms to explore the complex feedback circuits that control the behavior of living cells. Concepts and techniques from dynamical systems theory, bifurcation analysis, numerical methods, SBML (systems biology makeup language) and Matlab programming. Applications in gene regulatory networks, cell cycle control, circadian rhythms, cell signaling.

CS/MATH 5465: Numerical Analysis
A survey of the construction, analysis, and implementation of numerical algorithms in linear algebra, nonlinear equations and optimization, approximation by polynomials, quadrature, and ordinary differential equations.

CS/MATH 5466: Numerical Analysis
A survey of the construction, analysis, and implementation of numerical algorithms in linear algebra, nonlinear equations and optimization, approximation by polynomials, quadrature, and ordinary differential equations.

CS/MATH 5474: Finite Difference Methods for Partial Differential Equations
Finite difference methods for initial and boundary value problems for partial differential equations. Consistency, stability, convergence, dispersion, and dissipation. Methods for linear and nonlinear elliptic and parabolic equations, first- and second-order hyperbolic equations, and nonlinear conservation laws.

CS/MATH 5484: Finite Element Methods for Partial Differential Equations
Weak formulations of boundary-value problems for elliptic partial differential equations. Finite element spaces. Approximation theory for finite element spaces. Error estimates. Effects of numerical integration and curved boundaries. Nonconforming methods. Concrete examples of the application of the finite element method. Efficient implementation strategies. Time dependent problems.

CS/MATH 5485: Numerical Analysis and Software
Presentation and analysis of numerical methods for solving common mathematical and physical problems. Methods of solving large sparse linear systems of equations, algebraic eigenvalue problems, and linear least squares problems. Numerical algorithms for solving constrained and unconstrained optimization problems. Numerical solutions of nonlinear algebraic systems. Convergence, error analysis. Hardware and software influences. Efficiency, accuracy, and reliability of software. Robust computer codes.

CS/MATH 5486: Numerical Analysis and Software
Presentation and analysis of numerical methods for solving common mathematical and physical problems. Methods of solving large sparse linear systems of equations, algebraic eigenvalue problems, and linear least squares problems. Numerical algorithms for solving constrained and unconstrained optimization problems. Numerical solutions of nonlinear algebraic systems. Convergence, error analysis. Hardware and software influences. Efficiency, accuracy, and reliability of software. Robust computer codes.

CS/ECE 5504: Computer Architecture
Advanced computer architectures, focusing on multiprocessor systems and the principles of their design. Parallel computer models, programming and interconnection network properties, principles

of scaleable designs. Case studies and example applications of pipeline processors, interconnection networks, SIMD and MIMD processors.

CS/ECE 5510: Multiprocessor Programming
Principle and practice of multiprocessor programming. Illustration of multiprocessor programming principles through the classical mutual exclusion problem, correctness properties of concurrency (e.g., linearizability), shared memory properties (e.g. register constructions), and synchronization primitives for implementing concurrent data structures (e.g., consensus protocols). Illustration of multiprocessor programming practice through programming patterns such as spin locks, monitor locks, the work-stealing paradigm and barriers. Discussion of concurrent data structures (e.g., concurrent linked lists, queues, stacks, hash maps, skiplists) through synchronization patterns ranging from coarse-grained locking to fine-grained locking to lock-free structures, atomic synchronization primitives, elimination, and transactional memory.

CS/STAT 5525: Data Analytics I
Basic techniques in data analytics including the preparation and manipulation of data for analysis and the creation of data files from multiple and dissimilar sources. The data mining and knowledge discovery process. Overview of data mining algorithms in classification, clustering, association analysis, probabilistic modeling, and matrix decompositions. Detailed study of classification methods including tree-based methods, Bayesian methods, logistic regression, ensemble, bagging and boosting methods, neural network methods, use of support vectors and Bayesian networks. Detailed study of clustering methods including k-means, hierarchical and self-organizing map methods.

CS/STAT 5526: Data Analytics II
Techniques in supervised, unsupervised, and visualized learning in high dimensional spaces. Theoretical, probabilistic, and applied aspects of data analytics. Methods include generalized linear models in high dimensional spaces, regularization, lasso and related methods, principal component regression (pca), tree methods, and random forests. Clustering methods including k-means, hierarchical clustering, biclustering, and model-based clustering will be thoroughly examined. Distance-based learning methods include multi dimensional scaling, the self organizing map, graphical/network models, and isomap. Supervised learning will consist of discriminant analyses, supervised pca, support vector machines, and kernel methods.

CS/ECE 5560: Network and Computer Security
Introduces both fundamental security principles as well as real-world applications of network and computer security. Covers a wide range of topics including authorization and access control, basic cryptography, authentication systems, e-commerce security, sensor network security, and legal and ethical issues. Graduate standing required.

CS/ECE 5565: Network Architecture and Protocols
Principles and concepts of networking and protocols, with emphasis on data link, network, and transport protocols. Contemporary and emerging networks and protocols to illustrate concepts and to provide insight into practical networks including the Internet. Quantitative and qualitative comparisons of network architectures and protocols.

CS/ECE 5566: Network Architecture and Protocols
Performance evaluation, design, and management of networks. Use of queuing and other analytical methods, simulation, and experimental methods to evaluate and design networks and protocols. Network management architectures and protocols. Graduate standing in EE, ECE, or IT is required.

CS 5604: Information Storage and Retrieval

Analyzing, indexing, representing, storing, searching, retrieving, processing and presenting information and documents using fully automatic systems. The information may be in the form of text, hypertext, multimedia, or hypermedia. The systems are based on various models, e.g., Boolean logic, fuzzy logic, probability theory, etc., and they are implemented using inverted files, relational thesauri, special hardware, and other approaches. Evaluation of the systems' efficiency and effectiveness. Graduate standing required.

CS 5614: Database Management Systems
Emphasizes concepts, data models, mechanisms, and language aspects concerned with the definition, organization, and manipulation of data at a logical level. Concentrates on relational model, along with introduction to design of relational systems using Entity-relationship modeling. Functional dependencies and normalization of relations. Query languages, relational algebra, Datalog, and SQL. Query processing, logic and databases, physical database tuning. Concurrency control, OLTP, active and rule-based elements. Data Warehousing, OLAP.

CS 5634: Data Management in Bioinformatics
Data models, query languages, and data management systems for bioinformatics applications. Logical data organization, functional dependencies, design of schemas, querying, manipulation, information integration, and data mining. Specialized data structures, interchange formats, and designs for applications such as sequencing and microarray analysis. Partially duplicates 5614. Prerequisite or graduate standing in CSA required.

CS 5704: Software Engineering
Study of the principles and tools applicable to the methodical construction and controlled evolution of complex software systems.All phases of the life cycle are presented; particular attention focuses on the design, testing, and maintenance phases. Introduction to software project management. Attention to measurement models of the software process and product which allow quantitative assessment of cost, reliability, and complexity of software systems.

CS/ISE 5714: Usability Engineering
Design and evaluation of effective user interfaces, beginning with principles for designing the product. Development process for user interaction separate from interactive software development. Development process includes iterative life cycle management, systems analysis, design, usability specifications, design representation techniques, prototyping, formative user-based evaluation. Integrative and cross-disciplinary approach with main emphasis on usability methods and the user interaction development process.

CS 5724: Models and Theories of Human-computer Interaction
Survey of models and theories of users and their use of computer equipment; conditions of application for various approaches. Task analysis, task modeling, representations and notations.

CS 5734: Computer-supported Cooperative Work
Review and critique of state-of-the-art computing systems supporting cooperative work. Introduction to toolkits, software architectures and implementation issues relevant to development of systems for cooperative work. Analysis of group interactions and concerns in collaborative activities such as writing, design, meetings, communication, and decision-making.

CS 5744: Software Design and Quality
This course focuses on critical aspects of the software lifecycle that have significant influence on the overall quality of the software system including techniques and approaches to software design, quantitative measurement and assessment of the system during implementation, testing, and maintenance, and the role of verification and validation in assuring software quality.

CS 5754: Virtual Environments

Introduction to the theory and practice of three-dimensional virtual environments (VEs). 3D input and output devices, applications of VEs, 3D user interfaces and human-computer interaction, 3D graphics techniques for VEs, 3D modeling and level of detail, evaluation of VEs, VE software systems and standards, collaborative and distributed VEs. Includes hands-on experience with VE hardware and software.

CS 5764: Information Visualization
Examine computer-based strategies for interactive visual presentation of information that enable people to explore, discover, and learn from vast quantities of data. Learn to analyze, design, develop, and evaluate new visualizations and tools. Discuss design principles, interaction strategies, information types, and experimental results. Research-oriented course surveys current literature, and group projects contribute to the state of the art.

CS 5774: User Interface Software
Survey of software architectures to build user interfaces, particularly focused on graphical user interfaces. Includes the design and implementation of user interfaces, the use of object-oriented application frameworks, software architecture for command undo, document management, layout managers, customized components, and separation of concerns in user interface software architectures. Discussion of research and advanced topics in User Interface Software.

CS 5804: Introduction to Artificial Intelligence
A graduate level overview of the areas of search, knowledge representation,logic and deduction, learning, planning, and artificial intelligence applications.

CS 5814: Digital Picture Processing
Representation and processing of greytone images. Construction and simulation of grey scales, digitization, thresholding, local neighborhood operations, template matching and filtering, enhancement and restoration, segmentation, connected components, matching, morphology.

CS/GBCB 5854: Computational Systems Biology
Phenomenological and data-driven models of molecular interaction networks. Applications of graph theory, discrete algorithms, data mining, and machine learning to the modeling and analysis of molecular interaction networks. Biological applications. Interaction between biological and computational disciplines in systems biology. Must have GBCB pre-requisite and CS pre-requisites or graduate standing in CSA or equivalent.

CS 5894: Final Examination
Pass/Fail only.

CS 5904: Project and Report
EQ grade only. Variable credit course. 1 to 19 credit hours.

CS 5944: Graduate Seminar
Pass/Fail grade only. 1 credit hour(s).

CS 5974: Independent Study
Pass/Fail grade only. Variable credit course. 1 to 19 credit hours.

CS 5984: Special Study
Variable credit course. 1 to 19 credit hours. May be repeated with different content for a maximum of 12 credit hours.

CS 5994 - Research and Thesis
EQ grade only. Variable credit course. 1 to 19 credit hours.

CS 6104: Advanced Topics in Theory of Computation
This course treats a specific, advanced topic of current research interest in the area of theory of computation. Papers from the current literature or research monographs are likely to be used instead of a textbook. Student participation in a seminar style format may be expected. May be repeated with different content for a maximum of 12 credit hours.

CS 6204: Advanced Topics in Systems
This course treats a specific advanced topic of current research interest in the area of systems. Papers from the current literature or research monographs are likely to be used instead of a textbook. Student participation in a seminar style format may be expected. May be repeated with different content for a maximum of 12 credit hours.

CS 6304: Advanced Topics in Languages and Translation
This course treats a specific advanced topic of current research interest in the area of languages and translation. Papers from the current literature or research monographs are likely to be used instead of a textbook. Student participation in a seminar style format may be expected. May be repeated with different content for a maximum of 12 credit hours.

CS 6404: Advanced Topics in Mathematical Software
This course treats a specific advanced topic of current research interest in the area of mathematical software. Papers from the current literature or research monographs are likely to be used instead of a textbook. Student participation in a seminar style format may be expected. May be repeated with different content for a maximum of 12 credit hours.

CS 6504: Advanced Topics in Computer Architecture
This course treats a specific advanced topic of current research interest in the area of architecture. Papers from the current literature or research monographs are likely to be used instead of a textbook. Student participation in a seminar style format may be expected. May be repeated with different content for a maximum of 12 credit hours.

CS/ECE 6564: Multimedia Networking
This course examines and explores recent advances in multimedia networking technologies. Major topics include multimedia compression and standards, quality of service (QoS) support mechanisms and protocols, performance analysis, network claculus, IP multicasting, Internet multimedia applications, and multimedia transport over wireless networks.

CS/ECE 6570: Advanced Foundations of Networking
This course covers theoretical foundations that are necessary for advanced study of networking. It focuses on algorithm design and optimization techniques that are most commonly used to solve complex networking problems. Major topics include complexity analysis with applications to networking problems, design and proof of approximation algorithms, design of meta-heuristic algorithms, formulation techniques for network optimization, linear and non-linear optimization techniques with applications to networking, design of distributed algorithms with proof of convergence for networks systems.

CS 6604: Advanced Topics in Data and Information
This course treats a specific advanced topic of current research interest in the area of data and information. Papers from the current literature or research monographs are likely to be used instead of a textbook. Student participation in a seminar style format may be expected. May be repeated with different content for a maximum of 12 credit hours.

CS 6704: Advanced Topics in Software Engineering

This course treats a specific advanced topic of current research interest in the area of software engineering. Papers from the current literature or research monographs are likely to be used instead of a textbook. Student participation in a seminar style format may be expected. May be repeated with different content for a maximum of 12 credit hours.

CS 6724: Advanced Topics in Human-computer Interaction
Addresses a specific advanced topic of current research interest in the area of human-computer interaction (HCI). Research monographs and papers from the current literature will be used as a source of material too new yet to be in a textbook. Student participation in a seminar-style format. Each offering of this course will address a different subtopic area of HCI. May be repeated with different content for a maximum of 12 credit hours.

CS 6804: Advanced Topics in Intelligent Systems
This course treats a specific advanced topic of current research interest in the area of intelligent systems. Papers from the current literature or research monographs are likely to be used instead of a textbook. Student participation in a seminar style format may be expected. May be repeated with different content for a maximum of 12 credit hours.

CS 6824: Adv Topics Comp Biol & Bioinf
Addresses a specific advanced topic of current research interest in the area of computational biology and bioformatics (CBB). Research monographs and papers from the current literature used as a source of material too new to be discussed in a textbook. Student participation in a seminar-style format. Each offering of this course will address a different subtopic area of CBB. May be repeated with different content for a maximum of 12 credit hours. Pre: Graduate standing; other pre-requisites may apply.

CS 7994: Research and Dissertation
EQ grade only. Variable credit course. 1 to 19 credit hours.

Appendix B: Area wise Distribution of Courses

Historically, the second digit of the four-digit course numbers was intended to denote the cognizant area of the course, e.g., “1” denoted algorithms/theory, “3” denoted languages, and so on. As the number of areas grew, this convention became difficult and cumbersome to maintain. Hence this appendix gives the authoritative listing of all areas and the graduate courses that fall in each of them. Note that only 5000 and 6000 level CS courses are listed since these are the courses used to assess the breadth requirement for M.S. and Ph.D. degrees. Those 5000 level/above courses not discussed here (such as CS 5994, CS 7994) do not count toward the breadth requirement.

Area 1: Algorithms and Theory

CS 5104: Computability and Formal Languages
CS 5114: Theory of Algorithms
CS 6104: Advanced Topics in Theory of Computation

Area 2: Computer Systems

CS 5204: Operating Systems
CS 5214: Modeling and Evaluation of Computer Systems
CS 5224: Systems Simulation
CS 5234: Advanced Parallel Computation
CS 5244: Internet Software
CS 6204: Advanced Topics in Systems

Area 3: Programming Languages

CS 5304: Translator Design and Construction
CS 5314: Programming Languages
CS 6304: Advanced Topics in Languages and Translation

Area 4: Numerical and Scientific Computing

CS/MATH 5465: Numerical Analysis
CS/MATH 5466: Numerical Analysis
CS/MATH 5474: Finite Difference Methods for Partial Differential Equations
CS/MATH 5484: Finite Element Methods for Partial Differential Equations
CS/MATH 5485: Numerical Analysis and Software
CS/MATH 5486: Numerical Analysis and Software
CS 6404: Advanced Topics in Mathematical Software

Area 5: Computer Architecture and Networking

CS/ECE 5504: Computer Architecture
CS/ECE 5510: Multiprocessor Programming
CS/ECE 5560: Network and Computer Security
CS/ECE 5565: Network Architecture and Protocols
CS/ECE 5566: Network Architecture and Protocols
CS 6504: Advanced Topics in Computer Architecture
CS/ECE 6564: Multimedia Networking
CS/ECE 6570: Advanced Foundations of Networking

Area 6: Data and Information

CS/STAT 5525: Data Analytics I
CS/STAT 5526: Data Analytics II
CS 5604: Information Storage and Retrieval
CS 5614: Database Management Systems
CS 6604: Advanced Topics in Data and Information

Area 7: Software Engineering

CS 5704: Software Engineering
CS 5744: Software Design and Quality
CS 6704: Advanced Topics in Software Engineering

Area 8: Human-Computer Interaction

CS/ISE 5714: Usability Engineering
CS 5724: Models and Theories of Human-computer Interaction
CS 5734: Computer-supported Cooperative Work
CS 5754: Virtual Environments
CS 5764: Information Visualization
CS 5774: User Interface Software
CS 6724: Advanced Topics in Human-computer Interaction

Area 9: Intelligent Systems

CS 5804: Introduction to Artificial Intelligence
CS 5814: Digital Picture Processing
CS 6804: Advanced Topics in Intelligent Systems

Area 10: Computational Biology and Bioinformatics

CS 5124: Algorithms in Bioinformatics
CS 5424: Computational Cell Biology
CS 5634: Data Management in Bioinformatics
CS 5854: Computational Systems Biology
CS 6824: Adv Topics Comp Biol & Bioinf

Three courses are treated distinctly. CS 5014: Research Methods in Computer Science is considered to be a course in its own area for the purpose of determining the satisfaction of breadth requirements. The cognizant area of CS 5974: Independent Study depends on the description of the course and is decided by GPC in consultation with the faculty advisor for the course. Similarly, the cognizant area of CS 5984: Special Study depends on the specific offering of the course and is decided by GPC in consultation with the instructor of the course. For questions about area classifications, please contact the AGS.

Appendix C: Approved Cognate Courses

Cognate Courses are specially designated graduate-level courses from departments outside of Computer Science. This appendix identifies the list of approved cognate courses. Ph.D. students are required to take a minimum number of 6 credit hours from this list and M.S. students can (but are not required to) take at most 3 credit hours from this list. A cognate may not significantly overlap the content of any other course on a student's Plan of Study.

Students wishing to add a course to this list should submit a request to the AGS, along with documentation supporting the following criterion. The principal requirement is that the course have a strong relationship to computer science (e.g., be an application area of computing). The course must, therefore, have a strong computing component, at a level appropriate to graduate courses in CS (e.g., not just spreadsheets, programming).

Normally, students will be permitted to use as a cognate only courses from this list. However, Ph.D. students may be given permission to substitute a course not on this list; such requests should include a supporting note from the advisor. With the consent of their research advisor, an MS Thesis or Ph.D. student may petition GPC to substitute additional cognate courses in place of required 5000-level courses in CS on their plan of study.

Aerospace and Ocean Engineering (AOE)

* 5074: Computer-Aided Design of Vehicle Structures
* 6145-46: Computational Fluid Dynamics

Biochemistry (BCHM)

* 5024: Computational Biochemistry for Bioinformatics (see note below)

Civil and Environmental Engineering (CEE)

* 5064: Knowledge-Based Expert Systems

Electrical and Computer Engineering (ECE)

* 5004: Network Analysis
* 5505: Testing of Digital Systems
* 5506: Verification of Digital Systems
* 5514: Design of Systems on a Chip
* 5524: Pattern Recognition
* 5530: Configurable Computing
* 5534: Representation and Synthesis of Digital Systems
* 5554: The Theory and Design of Computer Vision Systems
* 5605: Stochastic Signals and Systems
* 5714: Robust Estimation and Filtering
* 6514: Applications of Automata Theory to Digital Design
* 6314: Microcomputer Applications in Power Systems
* 6334: Computational Methods in Power Engineering
* 6504: Advanced Topics in Computer Engineering
* 6604: Advanced Topics in Communications

Educational Research and Evaluation (EDRE)

* 5644: Questionnaire Design and Survey Research
* 6654: Multivariate Statistics

Engineering Science and Mechanics (ESM)

* 5984: ESM Special Study Class on Scientific Visual Analysis and Multimedia
* 5734: Introduction to the Finite Element Method
* 6734: Finite Element Analysis

Geography (GEOG)

* 5034: Analysis of Spatial Data
* 5314: Geographic Information Systems

Industrial Systems Engineering (ISE)

* 5104: Operations Research
* 5154: Applied Human Factors Engineering
* 5304: Digital Computers in Manufacturing Systems Controls
* 5314: Industrial Applications of Robotics Devices
* 5405-06: Optimization
* 5424: Simulation
* 5464: Queuing Theory
* 5505-06: Operations Research Models
* 5604: Human Information Processing
* 5605,5606: Human Factors System Design
* 5615-5616: Human Factors Research Design
* 6404: Graph Theory and Network Flows
* 6414: Integer Programming
* 6424: Dynamic Programming
* 6434: Scheduling and Sequence Theory
* 6464: Queuing Networks
* 6514: Advanced Topics in Mathematical Programming
* 6614: Human Computer Systems

Mathematics (MATH)

* 5125-26: Abstract Algebra
* 5135-36: Topics in Number Theory
* 5225-26: Real Analysis
* 5235-36: Complex Analysis
* 5244: Systems and Stability of Differential Equations
* 5245-46: Ordinary Differential Equations
* 5425-26: Applied Partial Differential Equations
* 5435-36: Principles and Techniques of Applied Mathematics
* 5454: Graph Theory
* 5464: Combinatorics
* 5515-16: Modeling and Simulation of Biological Systems
* 5524: Matrix Theory
* 5545-46: Calculus of Variations and Optimal Control Theory
* 5554: Approximation Theory
* 5114: Specialized Topics in Algebra
* 5214: Specialized Topics in Analysis
* 5344: Specialized Topics in Topology and Geometry
* 5415-16: Specialized Topics in Applied Mathematics

Mechanical Engineering (ME)

* 5604: Computer-Aided Design I
* 6604: Computer-Aided Design II

Philosophy (PHIL)

* 5505, 5506: Symbolic Logic
* 6504: Advanced Logic

Plant Pathology, Physiology, & Weed Science (PPWS)

* 5314 Biological Paradigms for Bioinformatics (see note below)

Psychology (PSYC)

* 5125, 5126: Organizational Psychology

Statistics (STAT)

* 5104: Probability and Distribution Theory
* 5204: Experimental Design and Analysis
* 5114: Statistical Inference
* 5124: Linear Models Theory
* 5314: Statistical Simulation
* 5344: Linear and Nonlinear Programming
* 5414: Time Series Analysis I
* 5434: Markov Chains and Renewal Theory
* 5454: Reliability Theory
* 5464: Queuing Theory
* 5504: Multivariate Statistical Methods
* 5615-5616: Statistical Research

* 6105-06: Measure and Probability

PPWS 5314 and BCHM 5024 may not be used as cognates by students who are taking the CSA degree option in Bioinformatics.

Appendix D: Typical schedule of semester

The deadlines in a typical semester are structured as follows using two parameters: x (the date when classes start) and y (the date when final grades are due). These are approximate guidelines only. The ordinal sequence of events will be maintained although the specific "gaps" may not. To get the authoritative answer, consult the academic calendar available on the main VT website: www.vt.edu.

Classes start:	x	
Add deadline:	x + 4 days	
Drop deadline:	x + 4 days + 1 month	(see Note 1 below)
Course withdrawal date:	y – 2 weeks	(see Note 2 below)
Last day of classes:	y – 9 days	
Final grades due:	y	

Note 1: This is the deadline to drop the course without grade penalty or it appearing on the student's transcript.
Note 2: Withdrawal at this late stage is granted only under extreme circumstances. Poor performance in the course is not a valid reason to request a withdrawal. The course will appear on the transcript with a "W" grade. See Section 12.5.

Appendix E: Forms

Over the course of your graduate study, you might need to complete several forms. The important ones are listed here for your reference. Those marked with a superscript (*) are not required for all students. Unless otherwise stated, all completed forms must be turned in to the GC. Always make sure to use the latest/authoritative forms which can had either from the department site, from the graduate school's website (http://www.grads.vt.edu) or the registrar's website (http://www.registrar.vt.edu).

Confidentiality Waiver Form*
Purpose: Federal and Virginia Tech policies require that students be made aware of their rights with respect to privacy of student records. See http://www.registrar.vt.edu/records/ferpa.php for more details. CS department administrative personnel automatically have access to graduate student records. These include: department head, AGS, and the GC. In addition, graduate students may choose to grant access to their files to any CS faculty member, or they may choose to grant access only to specific faculty members. This is the form that authorizes who, besides the administrative personnel, can have access to a student's records.
Applies to: M.S. thesis, M.S. coursework, and Ph.D. students.
When to submit: Can be submitted at any time prior to graduation. Not required.
Web: http://www.cs.vt.edu/graduate/current_students/forms/

Independent Study Request Form*

Purpose: To allow a student to register for CS 5974: Independent Study in a given semester. See Section 12.3 for more information.
Applies to: M.S. thesis, M.S. coursework, and Ph.D. students.
When to submit: Prior to last day of the first week of classes.
Web: http://www.cs.vt.edu/graduate/current_students/forms/

Late Drop Form*
Purpose: To withdraw from a course after the drop deadline (see Appendix D: Typical schedule of semester).
Applies to: M.S. thesis, M.S. coursework, and Ph.D. students.
When to submit: Prior to the end of that semester after the drop deadline. Requires the instructor's signature, the AGS's signature, and the Dean of the Graduate School's signature. Forms can be obtained from the main office of 2050 Torgersen Hall or 1102 Knowledgeworks II. Obtain the instructor's signature, then leave the form with the GC, who will obtain the consent of the AGS and forward it to the graduate school.

Student Resignation/Withdrawal Form*
Purpose: To withdraw from all courses for a given semester.
Applies to: M.S. thesis, M.S. coursework, and Ph.D. students.
When to submit: Prior to the end of the given semester. The number of required signatures increases after the first week of classes.
Web: http://www.registrar.vt.edu/forms/documents/resign_withdrawal.pdf

Credit Transfer Request Form*
Purpose: To allow courses taken elsewhere to count toward a Virginia Tech plan of study (see Section 8).
Applies to: M.S. thesis, M.S. coursework, and Ph.D. students.
When to submit: Prior to the submission of the plan of study and typically in the first semester of graduate studies.
Web: http://www.cs.vt.edu/graduate/current_students/forms/

Non-Virginia Tech Committee Member Registration Form*
Purpose: To allow a professor/researcher outside of VT to serve on an advisory committee.
Applies to: M.S. thesis, M.S. coursework, and Ph.D. students.
When to submit: Prior to end of second semester in the program, prior to the submission of the plan of study (see below). Requires submission of a current curriculum vitae of faculty member.
Web: http://www.grads.vt.edu/forms/index.html

Course Justification Form*
Purpose: To allow coursework 5 years or older to be revalidated so that they can be used on a plan of study.
Applies to: M.S. thesis, M.S. coursework, and Ph.D. students.
When to submit: Prior to end of second semester in the program along with the plan of study (see above).
Web: http://www.grads.vt.edu/forms/index.html

MS Plan of Study
Purpose: Identifies the list of courses to be taken to fulfill MS degree requirements and the advisory committee.
Applies to: M.S. thesis, M.S. coursework students.

When to submit: Prior to end of second semester in the program
Web: http://www.cs.vt.edu/graduate/current_students/forms/

Request for Plan of Study Changes*
Purpose: To make changes to the courses listed on a plan of study.
Applies to: M.S. thesis, M.S. coursework, and Ph.D. students.
When to submit: After an approved plan of study is on file and prior to submitting an Application for Degree (see below).
Web: http://www.grads.vt.edu/forms/index.html.

Change of Committee/Advisor Form*
Purpose: To make changes to committee members, advisor(s), or composition of advisory committee.
Applies to: M.S. thesis, M.S. coursework, and Ph.D. students.
When to submit: Prior to submission of the Request to Admit Candidate to the Final Exam (see below).
Web: http://www.grads.vt.edu/forms/index.html.

Request for Thesis Option Change*
Purpose: To switch between thesis and non-thesis options.
Applies to: M.S. thesis, M.S. coursework students.
When to submit: Along with Change of Plan of Study Form (see above) if plan of study has already been submitted.
Web: http://www.grads.vt.edu/forms/index.html.

Ph.D. Plan of Study
Purpose: Identifies the list of courses to be taken to fulfill Ph.D. degree requirements and the advisory committee.
Applies to: Ph.D. students.
When to submit: Prior to end of second semester in the program.
Web: http://www.cs.vt.edu/graduate/current_students/forms/

Request to Admit Candidate to the Preliminary Exam
Purpose: Allows a Ph.D. preliminary exam to be scheduled.
Applies to: Ph.D. students.
When to submit: Two weeks prior to the desired exam date.
Web: http://www.grads.vt.edu/forms/academics/Sched_Prelim.pdf

Request to Admit Candidate to the Final Exam
Purpose: Allows a final exam to be scheduled. Can be submitted anytime during a semester but for Ph.D. students desiring to participate in commencement exercises (i.e., “to walk”), there is a decalred last day to have the final exam. This date is typically one month before the last day of classes. Final exams can indeed be scheduled after this date but this doesn’t guarantee ability to participate in commencement exercises. If a student desires “to walk” and requires an extension, the advisor could make a request to the graduate school on the student’s behalf and such requests are considered on an individual basis. If participation in commencement is not a consideration, the last day to have the final exam is typically the day before commencement.
Applies to: M.S. thesis, M.S. coursework, and Ph.D. students.
When to submit: At least two weeks prior to the desired exam date.
Web: http://www.grads.vt.edu/forms/index.html.

Certificate of Defending Student Status Form*

Purpose: To allow a student to register as a defense-only student in a given semester. This is typically used by students who expected to graduate the previous semester but were unable to do so. They might have hence completed all requirements save for the final exam or defense. Using this form, students register as a defense-only student in the current semester, which involves only one (1) credit and, hence, incur substantially lower tuition fees. But they must defend by a stipulated deadline into the current semester (typically within 2 weeks from the beginning of the semester), beyond which they are required to register for more credits like other students.
Applies to: M.S. thesis, M.S. coursework, and Ph.D. students.
When to submit: At least two weeks prior to the desired exam date. Submit along with the "Request to Admit Candidate to the Final Exam" form (see above).
Web: http://www.grads.vt.edu/forms/index.html.

Thesis and Dissertation (ETD) Approval Form
Purpose: Registers the thesis with the ETD repository, a pre-requisite for graduation. Similar to the "Request to Admit Candidate to the Final Exam" form, for (only) Ph.D. students, there is an absolute deadline to submit it if the student desires to participate in commencement, which is usually 2 weeks before the last day of classes.
Applies to: M.S. thesis and Ph.D. students.
When to submit: Within two weeks after successfully completing the final exam.
Web: http://www.grads.vt.edu/forms/index.html.

Application for Degree
Purpose: To declare intent to graduate in a given semester. Deadline is typically 1 month after the first day of classes (in order for the student's name to appear in the commencement bulletins). While this form can be usually submitted online, it MUST be submitted in paper form for the case of a PhD student earning a MS coursework degree "on the way."
Applies to: M.S. thesis, M.S. coursework, and Ph.D. students.
When to submit: As early as possible in the semester that the student intends to graduate. Degree cannot be awarded without this form on record even if the student has satisfied all requirements.
Web: http://www.grads.vt.edu/forms/index.html

Application for Certificate Conferral Form*
Purpose: Used when students augment their degree program with certificates such as the "HCI certificate" (see Section 5.5). There are more certificates offered by other departments. Similar deadlines as "Application for Degree" apply. Use the same form as the AFD (now called the AFDC).
Applies to: M.S. thesis, M.S. coursework, and Ph.D. students.
When to submit: As early as possible in the semester that the student intends to receive the certificate.
Web: http://www.grads.vt.edu/forms/index.html

Please also consult the graduate school's website (http://www.grads.vt.edu/forms/) for an authoritative list of all forms.

Appendix F: Guidelines for Constituting Ph.D. Qualifying Exam Committees

A PhD qualifying examination committee may be formed in any area recognized by the Department (see Appendix B). There may only be one committee for any area. A faculty member may serve on at most two committees during a given year. Each year, AGS will appoint a chair for each examination committee from among the volunteers for that semester.

The PhD Qualifying Examination is given during a period spanning the end of Fall semester and the start of Spring semester of each year. During early Fall semester, students interested in taking the exam should discuss potential research areas with faculty members so that examination areas of mutual interest can be discovered. Examination committees must post the reading list for their exam by November 1. The exam is normally administered during January and February, with scores reported to GPC by mid February.

Each examination committee will publish a reading list of 10-20 research papers by November 1. It is not a requirement that the papers broadly cover the area, or be "seminal papers" in the area. A list containing papers with results spanning a wide spectrum in regards to quality and relevance is desirable to gauge the student's ability to judge quality and importance of results. The body of work should serve as a good introduction to one or more aspects of the area, but is also selected in part to serve as a vehicle for the exam. For example, a committee giving an exam in algorithms might choose one year to assign a set of papers on NP-complete problems in bioinformatics. The following year, the papers assigned by that committee might be on a completely different topic.

All students taking the exam in a given year from a given examination committee should be given the same reading list, undergo the same examination process, and be graded using the same criteria.

The exam is meant to probe the student's understanding of the content of the papers, the student's ability to synthesize the content into a meaningful understanding of the issues involved, and from there, the student's ability to determine potential "next step" paths of research (based on the papers assigned). In general, the exam is testing the student's ability to critically analyze the material, make judgments regarding the quality and relevance of the results, as well as deriving ideas for future research directions for the specific subtopic addressed in the papers.

At the end of the examination process, the committee must arrive at a scoring in the range 0 to 3 (integer only), and report this score to the AGS by the deadline.