Department *of* Computer Science

Undergraduate Handbook

Bachelor of Science in Computer Science

Minor in Computer Science

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Contents

1 Introduction **1**

2 Degrees Offered **1**

2.1 ABET accreditation 2

3 Recommended Course of Study **3**

4 Degree Requirement Checklist **4**

5 Course Requirement Flowchart **5**

6 Elective Information **6**

7 Technical Elective Policies **7**

7.1 General information 7

7.2 Class specific details 8

7.3 Overlap with other courses 8

8 General Elective Policies **9**

8.1 General information 9

8.2 Approved general elective courses 9

9 Minor in Computer Science **10**

9.1 SEAS students 10

9.2 Non-SEAS students 11

9.3 Declaring the minor 11

10 Frequently Asked Questions **12**

10.1 What kind of advanced placement credit is available? 12

10.2 Can I place out of CS 101? 12

10.3 Can CS courses from another college receive credit? 12

10.4 What are the Rodman Scholar requirements? 12

10.5 Is the number of computer majors capped? 13

10.6 Where can I get information on VISTAA? 13

10.7 Can CS students study abroad? 14
10.8 How do I transfer into the CS program? 14

11 Course Descriptions **14**

12 Degree Requirement Revisions **19**
12.1 Requirement revision from fall 2005 19
12.2 Requirement revision from fall 2004 19
12.3 Requirement revision from fall 2003 20

1 Introduction

Through the development of sophisticated computer systems, processors, and embedded applications, computer scientists have the opportunity to change society in ways unimagined several years ago. A major departmental goal is the education and training of a diverse body of students who can lead this current information technology revolution. To this end, the computer science program orients students toward the pragmatic aspects of computer science and provides the learning and practices to make them proficient computing professionals. Good engineering is rooted in solid mathematics and science, and grounding in these fundamentals is essential. Provided in the context of the practice of computing, this early grounding forms the basis for an education that prepares students for a computing career.

With funding from the National Science Foundation, the Department of Computer Science has designed and developed a curriculum focused on the practice of computing, yet grounded in the mathematical and scientific fundamentals of computer science. The curriculum is structured around the introduction of modern software development techniques in the very beginning courses, and is supported by a set of "closed laboratories".

In order to provide an environment appropriate to our courses, the department has established several laboratories with hundreds of workstations. These machines have high-resolution graphics and are connected to large file handlers, as well as to the University network. The lab courses expose students to many commercial software tools and systems, and introduce modern software development techniques via object-oriented design and implementation.

The Department of Computer Science co-offers, with the Department of Electrical and Computer Engineering, a degree in computer engineering.

Students have ample opportunities to participate in cutting-edge research with department faculty members. From the senior thesis research project to independent study, one can pursue research in any conceivable area. Our former students are enrolled in all of the top graduate programs in the country. Our undergraduates have won many research awards, including winning five recent CRA research award winners.

Graduates of the computer science program at the University of Virginia will have the knowledge, skills and attitudes that will allow them to make tangible contributions, meet new technical challenges, contribute effectively to society, act as team members, and be innovators in the design, analysis and application of computer systems.

2 Degrees Offered

The Department of Computer Science offers three computing degrees, as well as a minor option.

- Bachelor of Science in Computer Science
- Bachelor of Science in Computer Engineering
- Bachelor of Arts in Computer Science
- Minor in Computer Science

The computer engineering degree, handled jointly with the Department of Electrical and Computer Engineering, focuses more on hardware-level issues, while still giving the students experience in both software and electrical engineering. The computer science degree focuses more on software, while still giving students experience in computer hardware. The undergraduate handbook for computer engineering can be found at `http://www.cpe.virginia.edu/ugradmainpage.html`. Students wishing to dual major in computer science and computer engineering should see `http://www.cpe.virginia.edu/compeng_and_cs_%20combined.pdf`.

The Bachelor of Arts in Computer Science is for students in the College of Arts and Sciences. The requirements for the Bachelor of Arts are different than those for the Bachelor of Science. The Bachelor of Arts requirements can be found at `http://www.cs.virginia.edu/ba/`.

This document deals primarily with the Bachelor of Science in computer science. However, section 9 describes the requirements for the minor.

2.1 ABET accreditation

The Bachelor of Science in Computer Science degree is accredited by the Computing Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012, telephone: (410) 347-7700.

3 Recommended Course of Study

Below is the recommended course of study for the bachelor's degree. If you have already completed some of these classes (through AP credit, for example), then your course of study would deviate from what is shown below – consult your academic advisor for details.

There are a total of 9 electives that the student can choose from. These electives are indicated by the footnotes below, and are described in detail beginning on page 6. Note that some of these requirements are for all SEAS students, while others are required for the CS bachelor's degree.

Please be aware of when the classes are offered! Some are only offered once per year, or in a particular semester. See page 14 for details as to when courses are offered.

	First semester	**15**		**Second semester**	**17**
APMA 111	Single Variable Calculus	4	APMA 212	Multivariate Calculus	4
CHEM 151	Chemistry for Engineers	3	PHYS 142E	Physics I	3
CHEM 151L	Chemistry Lab	1	PHYS 142W	Physics I Workshop	1
ENGR162	Problem Solving & Design	4	CS 101	Intro to Computer Science	3
STS 101	Engineering, Technology and Society	3	???	Science elective[1]	3
			???	HSS elective[2]	3
	Third semester	**16**		**Fourth semester**	**16**
APMA	APMA elective[5] or APMA 310	3	CS 216	Program and Data Representation	3
CS 201	Software Development Methods	3	CS 230	Digital Logic Design	3
		3	CS 302	Theory of Computation	3
CS 202	Discrete Mathematics	3	CS 290	CS Seminar	1
PHYS 241E	General Physics II	1	STS	STS 2xx/3xx elective[9]	3
PHYS 241W	General Physics Lab I	3	???	Technical elective[3]	3
???	HSS elective[2]				
	Fifth semester	**15**		**Sixth semester**	**15**
CS 333	Computer Architecture	3	CS 340	Adv. Software Develop.	3
CS 432	Algorithms	3	CS	CS elective[8]	3
APMA	APMA elective[5] or APMA 310	3	APMA	APMA elective[5] or APMA 310	3
???	Technical elective[3]	3	???	Gen Edu elective[6]	3
???	Unrestricted elective[4]	3	???	HSS elective[2]	3
	Seventh semester	**15**		**Eighth semester**	**15**
STS 401	Western Tech and Culture	3	STS 402	Engineer in Society	3
???	Computer Arch. elective[7]	3	CS	CS elective[8]	3
CS 414	Operating Systems	3	CS	CS elective[8]	3
CS	CS elective[8]	3	???	Technical elective[3]	3
???	Gen Edu elective[6]	3	???	Gen Edu elective[6]	3

4 Degree Requirement Checklist

Required computing & math courses	Grade	Semester	Comments
CS 101 Introduction to Computer Science			
CS 201 Software Development Methods			
CS 202 Discrete Mathematics			
CS 216 Program & Data Representation			
CS 230 Digital Logic Design			
CS 290 CS Seminar			
CS 302 Theory of Computation			
CS 333 Computer Architecture			
CS 340 Advanced SW Development Techniques			
CS 414 Operating Systems			
CS 432 Analysis of Algorithms			
Computer Architecture Elective (from list)			Course:
APMA 310 Probability			
APMA 213 or 308 or 312 (circle one)			
APMA 213 or 308 or 312 (circle one)			

SEAS required courses

Course	Grade	Semester
APMA 111		
APMA 212		
CHEM 151		
CHEM 151L		
ENGR 162		
PHYS 142E		
PHYS 142W		
PHYS 241E		
PHYS 241W		

CS electives

	Course	Grade	Semester
1)			
2)			
3)			
4)			

Technical electives

	Course	Grade	Semester
1)			
2)			
3)			

STS courses

Course	Grade	Semester
STS 101		
STS 2xx/3xx		
STS 401		
STS 402		

SEAS electives

Course	Grade	Semester	Course
Science elective			
HSS elective # 1			
HSS elective # 2			
HSS elective # 3			
Unrest. elective			

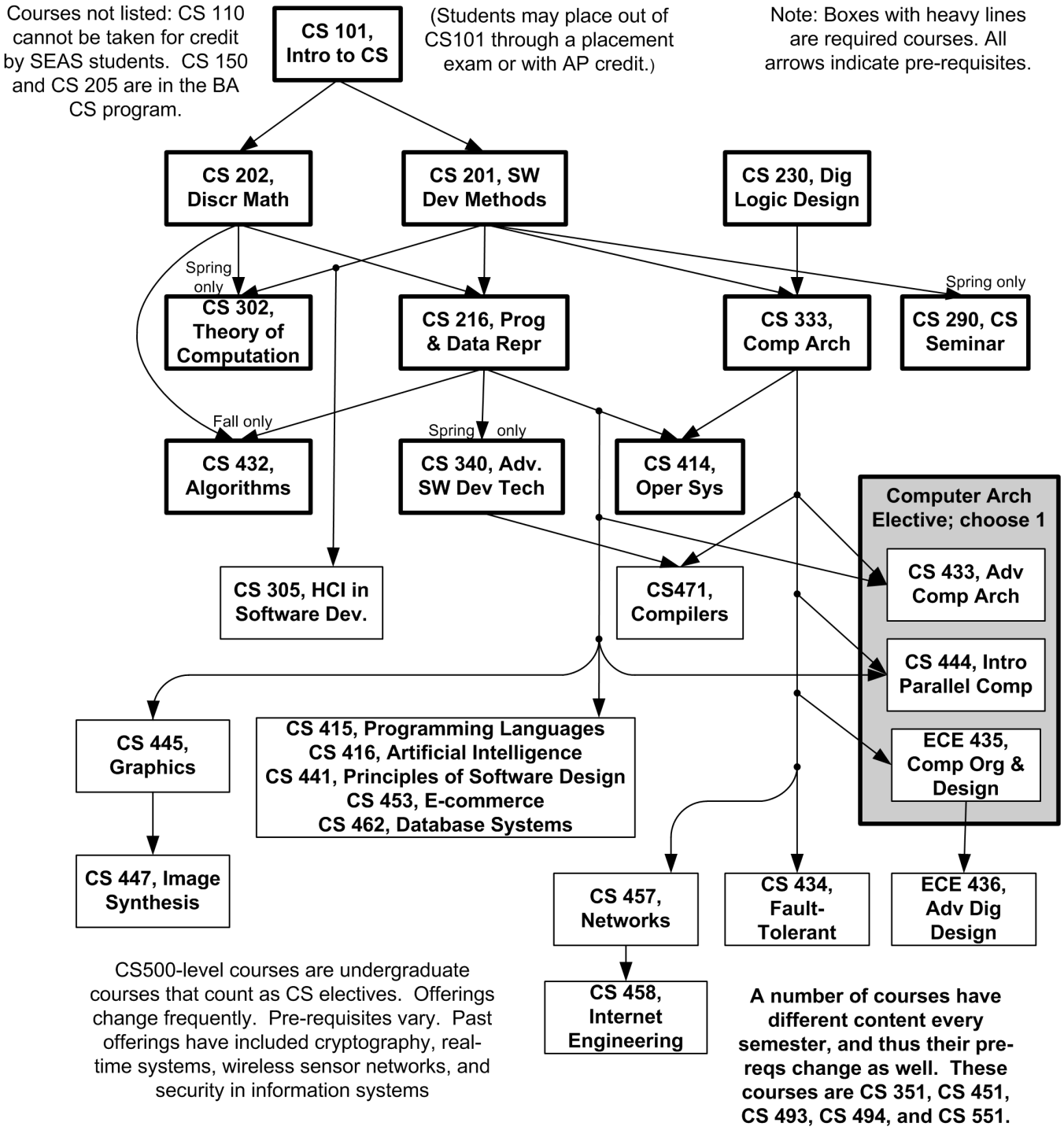
General education electives (9 credits)

	Course	Grade	Semester
1)			
2)			
3)			
4)			

5 Course Requirement Flowchart

UVa Computer Science Bachelors Degree: Course Prerequisites

(Updated December 2007)



6 Elective Information

The numbers in the list below correspond to the footnote numbers from the sample course schedule shown on page 3.

1. Science elective (1 required): Students must choose one of BIOL 201 (Introduction to Biology: Cell Biology and Genetics), BIOL 202 (Introduction to Biology: Organismal and Evolutionary Biology), CHEM 152 (Introductory Chemistry for Engineers), CHEM 162 (Introductory Chemistry for Engineers), ECE 200 (Science of Information), MSE 209 (Introduction to the Science and Engineering of Materials), or PHYS 252 (Introductory Physics IV: Quantum Physics). Additional courses in this list can count as technical or unrestricted electives.

2. HSS electives (3 required): Studies in the humanities and social sciences serve not only to meet the objectives of a broad education, but also to meet the objectives of the engineering profession. Such course work must meet the generally accepted definitions that the humanities are the branches of knowledge concerned with humankind and its culture, while the social sciences are the studies of society. See the full list of allowed courses in the SEAS Undergraduate Handbook. This list can be found online at `http://www.seas.virginia.edu/advising/undergradhandbook.php#hss`.

3. Technical electives (3 required): Technical electives are courses whose major emphasis is mathematics, science, or engineering. Technical electives can be at the 200-level, but at least two courses (6 of the 9 credits) must be at the 300-level or higher. See page 7 for more details, including courses that do not count as technical electives. Courses where there is uncertainty as to whether or not it qualifies should be approved by the student's advisor and recorded with a signature.

4. Unrestricted elective (1 required): Any graded course in the University, with a few exceptions. From the SEAS Undergraduate Student Handbook (found at `http://www.seas.virginia.edu/advising/undergradhandbook.php`):

   All Unrestricted Electives may be chosen from any graded course in the University except mathematics courses below MATH 131, including STAT 110 and 112, and courses that substantially duplicate any others offered for the degree, including PHYS 201, PHYS 202, CS 110, CS 111, CS 120, or any introductory programming course. Students in doubt as to what is acceptable to satisfy a degree requirement should obtain the approval of their advisor and the dean's office, Thornton Hall, Room A122. APMA 109 counts as a three credit unrestricted elective for students.

   Band classes (such as marching band) and ROTC classes can count for the unrestricted elective.

5. APMA elective (2 required): Must choose two from: APMA 213 (Ordinary Differential Equations), APMA 308 (Linear Algebra) or APMA 312 (Statistics). Note that APMA 310 (Probability) is a required course in addition to the two APMA electives.

6. General education elective (3 required): General education courses are designed to further broaden the student beyond the three required HSS courses. Allowed courses include all

those allowed as an HSS elective, as well as other non-technical courses. See page 9 for more information. Courses where there is uncertainty as to whether or not it qualifies should be approved by the student's advisor and recorded with a signature.

7. Computer architecture elective (1 required): A student must take one course from the list of approved computer architecture electives. The current list includes: ECE 435 (Computer Organization and Design), CS 433 (Advanced Computer Architecture), and CS 444 (Introduction to Parallel Computing).

8. CS electives (4 required): Any 3 credit CS class at the 300 level or above. A course that is fulfilling another requirement can not also count as a CS elective. If you take more than four CS electives, you can count additional CS elective course(s) as either a technical elective or an unrestricted elective. ECE 436 (Advanced Digital Design) also counts as a CS elective (although not for CpE majors, as ECE 436 is required for CpE). There are restrictions on counting independent study courses for your CS electives – see your advisor for details. Note that a previous set of degree requirements limited which courses above the 300 level counted as electives – the description here is the current requirements (changed October, 2 2006). Note that for a class that does not meet these requirements to count as a CS elective requires approval by the department (NOT by the student's academic advisor).

9. STS 2xx/3xx elective (1 required): Any STS course at the 200-level or 300-level.

Note that classes that receive no grade (such as the no longer offered TCC 100, or classes that are audited) do not count toward your degree requirements.

7 Technical Elective Policies

7.1 General information

Technical electives are courses whose major emphasis is mathematics, science, or engineering. Three technical elective courses (9 credits) are required for the bachelor's degree. One of the technical electives can be at the 200-level, but at least two courses (6 of the 9 credits) must be at the 300-level or higher. The course should be one that majors from that field can take, i.e., no "physics for poets" classes. Often the course description in the undergraduate record identifies such courses. CS majors can use CS courses as technical electives, once the requirements for the CS electives have been completed.

Any course taught by another department in SEAS may count as a technical elective as long as the department offering that course considers it to meet the standards of a technical elective.

Beware of courses with overlap substantial. For example, a linear programming course overlaps with SYS 321 (Deterministic Decision Models). You can only receive technical elective credit for one course if you take multiple courses whose subject material overlaps. If you have any questions, see your academic advisor. Courses where there is uncertainty as to whether or not it qualifies should be approved by the student's advisor and recorded with a signature.

7.2 Class specific details

Examples of what does count as a technical elective:

- EVSC 3xx or higher: Environmental Science courses of 3xx or better are accepted.
- PHIL 542 (Symbolic Logic) is a technical elective.
- PSYC 305 (Research Methods and Analysis), PSYC 306 (Research Methods and Analysis II) count as technical or general elective, **not as a HSS elective**.
- TMP 351 (The Technology and Product-Development Life Cycle) is a technical elective.
- MUSI 445 (Computer Applications in Music) is a technical elective, and does NOT count as a CS elective.
- PSYC 220 (A Survey of the Neural Basis of Behavior) is a technical elective.
- Students can take accounting courses as a technical elective.

Examples of what does NOT count as a technical elective:

- SYS 323 (Human Machine Interface) does not count as a technical elective. Note that CS 305 has similar content (and CS 305 counts as a CS elective).
- PHIL 242 (Introduction to Symbolic Logic) cannot be taken for technical elective credit, as it overlaps CS 202.
- TMP 352 (Science and Technology Public Policy) is not a technical elective.
- ECON 201 (Principles of Economics: Microeconomics) and ECON 202 (Principles of Economics: Macroeconomics) count as HSS electives (or general education or unrestricted), but not as technical electives.
- ASTR 348 (Introduction to Cosmology) is not a technical elective for CS majors.

7.3 Overlap with other courses

You can only receive technical elective credit for one course if you take multiple courses whose subject material overlaps. Examples of courses that overlap include the following.

- Only one of ENGR 488 (Business and Technical Leadership in Engineering) and CE 441 (Construction Engineering and Economics) may count as a technical elective because of significant overlap.
- Students who have taken APMA 310 (Probability) cannot use APMA 311 (Applied Probability and Statistics) as a technical elective. APMA 312 (Statistics) may be used as a technical elective; however, no student can get credit for both APMA 311 and either of APMA 310 or 312. Note that students usually use APMA 312 to fulfill the APMA elective requirement.
- The definition of MATH 404 (Discrete Mathematics) in the Undergraduate Record indicates that there is too much overlap with CS 202 to get credit for both. However, at least one instructor is doing cryptography rather than discrete mathematics in the course. Under those circumstances, you may get credit for both CS 202 and MATH 404.

- Students CAN take both SYS 321 (Deterministic Decision Models) and CS 457 (Computer Networks).
- Because of substantial overlap, a student can earn credit for only one of SYS 202 (Data and Information Engineering), SYS 204 (Data and Information Management), and CS 462 (Databases). Multiple classes taken from this set can only be used to fulfill the unrestricted elective requirement.

8 General Elective Policies

8.1 General information

The goal of this requirement is for our majors to take additional courses in humanities, social sciences, arts, and other disciplines that serve to broaden the background of the student. In this context, "broaden" means courses outside the areas required for the bachelor's degree (i.e. not science, math, engineering, or computing). Note that the general education elective courses are in addition to the nine credits of HSS electives that all SEAS students must take. Courses where there is uncertainty as to whether or not it qualifies should be approved by the student's advisor and recorded with a signature. See your advisor if you have any questions on the general education requirements.

8.2 Approved general elective courses

The following describes what courses may or may not count toward this requirement:

1. Any course that satisfies the SEAS HSS elective requirement will count. The description and list of courses for SEAS HSS requirements are listed online at `http://www.seas.virginia.edu/advising/undergradhandbook.php#hss`.
2. Any course that could satisfy the CS elective or technical elective requirement cannot count.
3. Other courses may count if they meet the spirit of the requirement (see the first paragraph of this section) and they are approved in advance by the department. The department maintains a partial list of courses that have been approved – see below.
4. Only one performance-oriented or skills-development courses may be allowed to count.
5. Band classes (such as marching band) may count for 3 of the 9 required general education elective credits. Note that band classes may also count toward the unrestricted elective.
6. Courses on communication in the student's native language, regardless of their level, may not be used to satisfy this requirement. This is the same policy as that used for the SEAS HSS electives.

7. ROTC classes can count for 6 of the 9 general education elective credits. Note that you can also count ROTC classes toward the unrestricted elective.

The following courses that satisfy the SEAS Minor in Business, and may also count for this requirement.

- COMM 180 (Making Business Work)
- COMM 341 (Commercial Law I)
- COMM 351 (Fundamentals of Marketing)
- COMM 371 (Managerial Finance I)
- COMM 381 (Business Ethics)
- COMM 467 (Organizational Change and Development)
- COMM 468 (Entrepreneurship)
- TMP 352 (Science and Technology Public Policy)
- TMP 399 (Case Studies in Technology Management and Policy)
- ISBU 327 (Investment Analysis)
- ISBU 361 (Organizational Behavior)
- ISBU 384 (International Business)
- ISBU 485 (Strategic Management)

Note that TMP 351 (The Technology and Product-Development Life Cycle), COMM 201 (Introduction to Financial Accounting) and COMM 202 (Introduction to Management Accounting) satisfy the SEAS Minor in Business, but these count as technical electives. ECON 201 (Principles of Economics: Microeconomics) and ECON 202 (Principles of Economics: Macroeconomics) count for either the HSS requirement or the general education requirement, and they also count toward the business minor.

9 Minor in Computer Science

The Department of Computer Science provides a minor program for qualified students. The courses in the minor program provide a solid foundation in computer science. The minor program is a six course, eighteen credit curriculum. The curriculum consists of the four required courses and two elective courses. Full course descriptions are at the end of this document, beginning on page 14.

9.1 SEAS students

All SEAS (School of Engineering and Applied Science) students are required to take (or place out of) CS 101, as part of the SEAS first-year curriculum. This course is also the first required course for the minor.

The following are the first four courses required for the minor.

- CS 101: Introduction to Computer Science

- CS 201: Software Development Methods
- CS 202: Discrete Mathematics
- CS 216: Program and Data Representation

Furthermore, two additional computer science electives are required. The elective courses must be computer science courses at the 300 level or above. The only restriction on elective courses is a limit to how many independent study courses one can count toward a minor – contact the minor advisor for details at `minoradvisor@cs.virginia.edu`.

Computer science courses typically build upon each other. In particular, CS 101 is a prerequisite of both CS 201 and CS 202. CS 201 and CS 202 are both prerequisites of CS 216. In addition, CS 216 is a prerequisite for almost all of the computer science electives. The Department of Computer Science also requires that its courses be passed at a certain level (typically a C- or better) in order to take successive courses. Be aware that the department strictly enforces its prerequisite policy.

9.2 Non-SEAS students

We recommend that non-SEAS (School of Engineering and Applied Science) students interested in taking a computer science minor start in the fall semester. SEAS requires that its students take CS 101 in the spring semester, and thus there are many more students enrolled in CS 101 in the spring semester.

CS 150 and CS 205 are the recommended introductory courses for non-SEAS students. These courses count for CS 101 and CS 201, respectively, for the minor requirements. However, students may choose to substitute CS 150 with CS 101 or substitute CS 205 with CS 201, but will not get credit for taking both CS 101 and CS 150 or both CS 201 and CS 205.

The rest of the minor requirements are the same: CS 202, CS 216, and two elective courses, as described in the previous section.

9.3 Declaring the minor

To declare a minor, a student should have completed CS 101 or 150, CS 201 or 205, and CS 202. Furthermore, the student should have completed, or at least be enrolled in, CS 216. The student can then declare the minor by completing the appropriate form, available from your individual school. Attach your current transcript, and bring it to Peggy Reed in Olsson 223. For additional information, please contact the computer science minor advisor at `minoradvisor@cs.virginia.edu`.

10 Frequently Asked Questions

10.1 What kind of advanced placement credit is available?

Advanced placement (AP) credit is awarded by the University for most AP tests in which the grade is a 4 or a 5. This section only deals with the AP computer science test. A student's VISTAA report will always list which courses qualify for the AP test scores (both in computer science and in other fields).

A 5 on the computer science AB test will receive course credit for CS 101 and CS 201. A 4 on the computer science AB test OR a 5 on the computer science A test will receive course credit for CS 101. If the AP exam was not in Java, proficiency in Java must be demonstrated prior to taking CS 201. Note that CS 201 is required for other majors: computer engineering, systems engineering, and electrical engineering. There is also a placement exam before the fall semester that will allow the student to place out of CS 101, but does not allow credit to be received for the course – the student must then take another 3 hour CS or technical course instead. See the next section for information about the CS 101 placement exam.

10.2 Can I place out of CS 101?

There is a placement exam for CS 101, which covers all the topics taught in the course. For the current semester's syllabus, see the CS 101 course website. Successful completion will allow a student to place out of the course, but does NOT give course credit – only a sufficient score on the AP test or transfer credit can give course credit for CS 101. A student must still take CS 201 or a technical elective to fulfill the SEAS CS 101 requirement. The test is offered before the beginning of the fall semester. Note that any student who has ever enrolled in CS 101 – even if they later dropped or withdrew from the course – is not allowed to take the placement exam. The exam may be taken by visiting the departmental office in Olsson 204.

10.3 Can CS courses from another college receive credit?

We officially discourage taking major courses elsewhere. This policy is especially true for the lab-based and required courses. If, in spite of this departmental policy, you still want to take a course elsewhere, then the student needs an advisor signature AND the signature of the current instructor of that course from UVa. To receive the required signatures, you must bring in a detailed syllabus, so that faculty can make informed decisions. Note that to receive credit for CS 216 elsewhere, you need both a data structures course and an assembly language programming course.

10.4 What are the Rodman Scholar requirements?

Rodman scholars have slightly different requirements for graduation.

- The requirement for STS 101 is changed to an additional HSS elective

- ENGR 141R counts as ENGR 162
- STS 200R counts as their STS elective
- PHYS 142R counts for PHYS 142E and PHYS 142W
- PHYS 241R counts for PHYS 241E and PHYS 241W

Furthermore, Rodman Scholars are required to complete 4 seminars (ENGR 307 or ENGR 308) prior to graduation.

10.5 Is the number of computer majors capped?

Although it is the norm that a student be accepted into either of the computing programs, circumstances can occur that cause a limit in the number of accepted applicants. Given the continuing expansion of departmental resources, no limits on the number of majors are expected in the immediate future. The Department of Computer Science wants you as a major. Both the department and the School of Engineering and Applied Science continue their efforts to ensure that any student, wishing to do so, can major in computing.

10.6 Where can I get information on VISTAA?

VISTAA is the Virginia Student Academic Audit reporting system for assisting students and their advisors in tracking programs of study. A student VISTAA report lists both the courses a student has completed and those in which s/he is currently enrolled.

A VISTAA report groups the courses according to degree, major, and minor requirements. These reports also provide information on which requirements are incomplete and which courses will satisfy them. VISTAA now supports a student and faculty record request update feature – one can use this feature to put in an override for an improper VISTAA assignment of a course toward a program of study requirement.

Further information VISTAA is available from the sources listed below.

- Home page for VISTAA: `http://www.virginia.edu/registrar/vistaa.html`. The page contains a list of frequently asked questions.
- Detailed student directions on the use of VISTAA: `http://www.virginia.edu/registrar/VISTAA2.pdf`.
- Detailed faculty directions on the use of VISTAA: `http://www.virginia.edu/registrar/vistaafsa.html`.
- Department faculty VISTAA liaison: `vistaa-cs@cs.virginia.edu`
- SEAS VISTAA liaison: `vistaa-seas@cs.virginia.edu`

It is recommended that you bring a copy of your VISTAA record with you to advising.

10.7 Can CS students study abroad?

To get more information about studying abroad, see `http://www.cs.virginia.edu/curriculum/study_abroad/`.

10.8 How do I transfer into the CS program?

There is also the Bachelor of Arts in Computer Science, offered through the College (see `http://www.cs.virginia.edu/ba/`). Students outside of the School of Engineering and Applied Science with an interest in obtaining a BS (as opposed to a BA) degree in computer science must transfer to the Engineering school.

Like other SEAS students, transfer students must formally apply to, and be approved by, the Department of Computer Science to enroll in the computer science program of study. To minimize loss of credit upon transfer, students must take a rigorous program in mathematics and the sciences. The School of Engineering and Applied Science expects a minimum of 63 credits in the first two years, instead of the 60-credit minimum that is customary in the College of Arts and Sciences. The additional credits are often completed through summer courses. Detailed information on curriculum requirements may be obtained from the Office of the Dean of the School of Engineering and Applied Science.

11 Course Descriptions

These course listings are from the undergraduate record (`http://records.ureg.virginia.edu/content.php?catoid=11&navoid=189`). The frequency code for each class specifies how often it is offered. (S) means offered each (spring and fall) semester; (Y) means offered once each academic year, and (SI) means offered upon sufficient student interest.

CS 101 - Introduction to Programming (3 credits): Introduces the basic principles and concepts of object-oriented programming through a study of algorithms, data structures and software development methods in Java. Emphasizes both synthesis and analysis of computer programs. (S)

CS 101E - Introduction to Programming (3 credits): Introduces the basic principles and concepts of object-oriented programming through a study of algorithms, data structures and software development methods in Java. Emphasizes both synthesis and analysis of computer programs. (S) Prerequisite: Prior programming experience.

CS 101X - Introduction to Programming (3 credits): Introduces the basic principles and concepts of object-oriented programming through a study of algorithms, data structures and software development methods in Java. Emphasizes both synthesis and analysis of computer programs. (SI) Note: No prior programming experience.

CS 110 - Introduction to Information Technology (3 credits): Provides exposure to a variety of issues in information technology, such as computing ethics and copyright. Introduces and provides experience with various computer applications, including e-mail, newsgroups, library search tools,

word processing, Internet search engines, and HTML. Not intended for students expecting to do further work in CS. Cannot be taken for credit by students in SEAS or Commerce. (S)

CS 150 - From Ada and Euclid to Quantum Computing and the World Wide Web (3 credits): Introduction to computer science with no previous background. Focuses on describing and reasoning about information processes using language and logic. Uses motivating examples from liberal arts and sciences areas such as art, biology, economics, narrative, physics, and sociology. (Y)

CS 201 - Software Development Methods (3 credits): A continuation of CS 101, emphasizing modern software development methods. An introduction to the software development life cycle and processes. Topics include requirements analysis, specification, design, implementation, and verification. Emphasizes the role of the individual programmer in large software development projects. (S) Prerequisite: CS 101 with a grade of C- or higher.

CS 202 - Discrete Mathematics (3 credits): Introduces discrete mathematics and proof techniques involving first order predicate logic and induction. Application areas include sets (finite and infinite), elementary combinatorial problems, and probability. Development of tools and mechanisms for reasoning about discrete problems. Cross-listed as APMA 202. (S) Prerequisite: CS 101 or 150 with a grade of C- or higher.

CS 205 - Engineering Software (3 credits): Covers tools and techniques used to manage complexity and to build, analyze, and test complex software systems including abstraction, analysis, and specification. (Y) Prerequisite: CS 150 with a grade of C- or higher. Notes: Students may not receive credit for both CS 201 and CS 205.

CS 216 - Program and Data Representation (3 credits): Introduces programs and data representation at the machine level. Data structuring techniques and the representation of data structures during program execution. Operations and control structures and their representation during program execution. Representations of numbers, arithmetic operations, arrays, records, recursion, hashing, stacks, queues, trees, graphs, and related concepts. (S) Prerequisite: CS 202 and either CS 201 or CS 205 with all grades of C- or higher.

CS 230 - Digital Logic Design (3 credits): Includes number systems and conversion; Boolean algebra and logic gates; minimization of switching functions; combinational network design; flip-flops; sequential network design; arithmetic networks. Introduces computer organization and assembly language. Cross-listed as ECE 230. (S)

CS 290 - Computer Science Seminar I (1 credit): Provides cultural capstone to the undergraduate experience. Students make presentations based on topics not covered in the traditional curriculum. Emphasizes learning the mechanisms by which researchers and practicing computer scientists can access information relevant to their discipline, and on the professional computer scientist's responsibility in society. (Y) Prerequisite: CS 201 or 205 with a grade of C- or higher, as well as a computing major (BACS, BSCS, or CpE).

CS 302 - Theory of Computation (3 credits): Introduces computation theory including grammars, finite state machines and Turing machines; and graph theory. Cross-listed as APMA 302. (Y) Prerequisite: CS 202 and either CS 201 or 250 all with grades of C- or better.

CS 305 - HCI in Software Development (3 credits): Human-computer interaction and user-centered design in the context of software engineering. Examines the fundamental principles of

human-computer interaction. Includes evaluating a systems usability based on well-defined criteria; user and task analysis, as well as conceptual models and metaphors; the use of prototyping for evaluating design alternatives; and physical design of software user-interfaces, including windows, menus, and commands. (Y) Prerequisite: CS 201 or 205 with a grade of C- or higher.

CS 333 - Computer Architecture (3 credits): Includes the organization and architecture of computer systems hardware; instruction set architectures; addressing modes; register transfer notation; processor design and computer arithmetic; memory systems; hardware implementations of virtual memory, and input/output control and devices. Cross-listed as ECE 333. (S) Prerequisite: CS 201 or 205 with a grade of C- or higher, and CS (or ECE) 230 with a grade of C- or higher.

CS 340 - Advanced Software Development Techniques (3 credits): Analyzes modern software engineering practice for multi-person projects; methods for requirements specification, design, implementation, verification, and maintenance of large software systems; advanced software development techniques and large project management approaches; project planning, scheduling, resource management, accounting, configuration control, and documentation. (Y) Prerequisite: CS 216 with a grade of C- or higher.

CS 351 - Selected Topics in Computer Science (1 to 3 credits): Content varies annually, depending on students needs and interests. Recent topics include the foundations of computation, artificial intelligence, database design, real-time systems, Internet engineering, and electronic design automation. (SI) Prerequisite: Instructor permission.

CS 414 - Operating Systems (3 credits): Analyzes process communication and synchronization; resource management; virtual memory management algorithms; file systems; and networking and distributed systems. (S) Prerequisite: CS 216 and CS (or ECE) 333 with grades of C- or higher.

CS 415 - Programming Languages (3 credits): Presents the fundamental concepts of programming language design and implementation. Emphasizes language paradigms and implementation issues. Develops working programs in languages representing different language paradigms. Many programs oriented toward language implementation issues. (Y) Prerequisite: CS 216 with a grade of C- or higher.

CS 416 - Artificial Intelligence (3 credits): Introduces artificial intelligence. Covers fundamental concepts and techniques and surveys selected application areas. Core material includes state space search, logic, and resolution theorem proving. Application areas may include expert systems, natural language understanding, planning, machine learning, or machine perception. Provides exposure to AI implementation methods, emphasizing programming in Common LISP. (Y) Prerequisite: CS 216 with grades of C- or higher.

CS 432 - Algorithms (3 credits): Introduces the analysis of algorithms and the effects of data structures on them. Algorithms selected from areas such as sorting, searching, shortest paths, greedy algorithms, backtracking, divide- and-conquer, and dynamic programming. Data structures include heaps and search, splay, and spanning trees. Analysis techniques include asymptotic worst case, expected time, amortized analysis, and reductions between problems. (Y) Prerequisite: CS 216 with a grade of C- or higher.

CS 433 - Advanced Computer Architecture (3 credits): Provides an overview of modern microprocessor design. The topics covered in the course will include the design of super-scalar

processors and their memory systems, and the fundamentals of multi-core processor design. (Y) Prerequisite: CS 216 and CS (or ECE) 333 with a C- or better.

CS 434 - Fault-tolerant Computing (3 credits): Investigates techniques for designing and analyzing dependable computer-based systems. Topics include fault models and effects, fault avoidance techniques, hardware redundancy, error detecting and correcting codes, time redundancy, software redundancy, combinatorial reliability modeling, Markov reliability modeling, availability modeling, maintainability, safety modeling, trade-off analysis, design for testability, and the testing of redundant digital systems. Cross-listed as ECE 434. (SI) Prerequisite: CS (or ECE) 333, APMA 213, and APMA 310, each with grades of C- or higher.

CS 441 - Principles of Software Design (3 credits): Focuses on techniques for software design in the development of large and complex software systems. Topics will include software architecture, modeling (including UML), object-oriented design patterns, and processes for carrying out analysis and design. More advanced or recent developments may be included at the instructor's discretion. The course will balance an emphasis on design principles with an understanding of how to apply techniques and methods to create successful software systems. (Y) Prerequisite: CS 216 with a C- or better.

CS 444 - Introduction to Parallel Computing (3 credits): Introduces the student to the basics of high-performance parallel computing and the national cyber-infrastructure. The course is targeted for both computer science students and students from other disciplines who want to learn how to significantly increase the performance of applications. (Y) Prerequisite: CS 216 and CS (or ECE) 333 with a C- or better.

CS 445 - Introduction to Computer Graphics (3 credits): Introduces the fundamentals of three-dimensional computer graphics: rendering, modeling, and animation. Students learn how to represent three-dimensional objects (modeling) and the movement of those objects over time (animation). Students learn and implement the standard rendering pipeline, defined as the stages of turning a three-dimensional model into a shaded, lit, texture-mapped two-dimensional image. (Y) Prerequisites: CS 216 with a grade of C-.

CS 447 - Image Synthesis (3 credits): Provides a broad overview of the theory and practice of rendering. Discusses classic rendering algorithms, although most of the course focuses on either fundamentals of image synthesis or current methods for physically based rendering. The final project is a rendering competition. (Y) Prerequisite: Grade of C- or better in CS 445 or equivalent working knowledge.

CS 451 - Selected Topics in Computer Science (1 to 3 credits): Content varies annually, depending on students needs and interests. Recent topics include the foundations of computation, artificial intelligence, database design, real-time systems, Internet engineering, wireless sensor networks, and electronic design automation. (SI) Prerequisite: Instructor permission.

CS 453 - Electronic Commerce Technologies (3 credits): Focuses on the history of the Internet and electronic commerce on the web; case studies of success and failure; cryptographic techniques for privacy, security, and authentication; digital money; transaction processing; wired and wireless access technologies; Java; streaming multimedia; XML; Bluetooth. Defining, protecting, growing, and raising capital for an e-business. (Y) Prerequisite: CS 216 with a grade of C- or higher.

CS 457 - Computer Networks (3 credits): Intended as a first course in communication networks for upper-level undergraduate students. Topics include the design of modern communication networks; point-to-point and broadcast network solutions; advanced issues such as Gigabit networks; ATM networks; and real-time communications. Cross-listed as ECE 457. (Y) Prerequisite: CS (or ECE) 333 with a grade of C- or higher.

CS 458 - Internet Engineering (3 credits): An advanced course on computer networks on the technologies and protocols of the Internet. Topics include the design principles of the Internet protocols, including TCP/IP, the Domain Name System, routing protocols, and network management protocols. A set of laboratory exercises covers aspects of traffic engineering in a wide-area network. (Y) Prerequisite: CS 457 with a grade of C- or better.

CS 462 - Database Systems (3 credits): Introduces the fundamental concepts for design and development of database systems. Emphasizes relational data model and conceptual schema design using ER model, practical issues in commercial database systems, database design using functional dependencies, and other data models. Develops a working relational database for a realistic application. (Y) Prerequisite: CS 216 with grades of C- or higher.

CS 471 - Compilers (3 credits): Provides an introduction to the field of compilers, which translate programs written in high-level languages to a form that can be executed. The course covers the theories and mechanisms of compilation tools. Students will learn the core ideas behind compilation and how to use software tools such as lex/flex, yacc/bison to build a compiler for a non-trivial programming language. (Y) Prerequisite: CS 340 and CS (or ECE) 333 with grades of C- or higher.

CS 493 - Independent Study (1 to 3 credits): In-depth study of a computer science or computer engineering problem by an individual student in close consultation with departmental faculty. The study is often either a thorough analysis of an abstract computer science problem or the design, implementation, and analysis of a computer system (software or hardware). (S) Prerequisite: Instructor permission.

CS 494 - Special Topics in Computer Science (1 to 3 credits): Content varies annually, depending on instructor interests and the needs of the department. Similar to CS 551 and CS 751, but taught strictly at the undergraduate level. (SI) Prerequisite: Instructor permission; additional specific requirements vary with topics.

CS 551 - Selected Topics in Computer Science (1 to 3 credits): Content varies annually, depending on students needs and interests. Recent topics included the foundations of computation, artificial intelligence, database design, real-time systems, Internet engineering, and electronic design automation. (SI) Prerequisite: Instructor permission.

12 Degree Requirement Revisions

Computer science is an evolving field, and our undergraduate curriculum reflects this. The department sometimes makes changes to the requirements for the bachelor's degree. Note that you are allowed to graduate using ANY SINGLE set of requirements that were in effect when you were a declared computer science major – thus, if the requirements change, you are allowed to complete the degree using the older version of the requirements. You cannot "mix and match" requirements from the different sets. For example, a student using the fall 2004 rules below (no general electives) is not allowed to take something other than ECE 435 (Computer Organization and Design) for the computer architecture elective.

Any changes to the requirements will occur after the spring semester and before the following fall semester, unless the change is considered minor. A minor change is something that does not in any way restrict the degree requirements. Examples of minor changes would be expanding the allowed courses for one of the elective types, or clarifying what counts as a technical elective. Note that unless the change to the requirements directly affects the third semester (i.e. the first semester of the second year), a student cannot choose to graduate using a set of requirements that were in effect during his or her first year at UVa but that were not in effect during his or her second year, as they were not a declared computer science major during their first year.

The requirement revisions below describe what major changes occurred during the previous years, and what courses students must complete to graduate using that set of requirements. Note that the older sets are kept for historical reasons, even though there may not be any more students who are eligible to graduate with those sets.

The current set of requirements, which this document reflects, became effective in the fall of 2006. No (non-minor) changes were made for the fall of 2007.

12.1 Requirement revision from fall 2005

The main change in the requirements from the fall of 2005 to the fall of 2006 was that ECE 435 is no longer an absolute requirement. Instead, students must choose one course from a list of "computer architecture electives." The list of acceptable courses is described on page 7. Because of the above change, a student can now graduate with 124.5 credits.

Students graduating using the fall 2005 requirements must take ECE 435, and are not allowed to take an alternative computer architecture elective as described on page 7. However, as this change (allowing courses other than ECE 435) only expands the allowed courses a student can take, it is not expected that anyone will graduate using this set of requirements.

12.2 Requirement revision from fall 2004

The main change in the requirements from the fall of 2004 to the fall of 2005 was the addition of general education classes. Students must complete 9 credits of general education courses, in addition to the 9 credits of HSS required of all SEAS students. Students now only need 9 technical

electives credits (at most 3 credits at 200-level) and 3 credits of unrestricted electives.

Students graduating using the fall 2004 requirements must take 12 credits of technical electives and 9 credits of unrestricted electives. This is in addition to the 9 credits of HSS courses required of all SEAS students. In addition, students must take ECE 435 (as described above, in the 'fall 2005' requirements section).

Furthermore, CS 390 was renamed to CS 290, and should be taken in the 2nd year. However, taking either class (290 or 390) will fulfill this requirement.

12.3 Requirement revision from fall 2003

The main change in the requirements from the fall of 2003 to the fall 2004 was the change in math requirements. Students must take APMA 310 and then must choose two from APMA 213, APMA 308 or APMA 312. This means a student could graduate with 125.5 credits instead of 126.5.

There are currently no students enrolled that are eligible to graduate using these requirements.