Department *of* Computer Science Undergraduate Handbook

Bachelor of Science in Computer Science
Minor in Computer Science

http://www.cs.virginia.edu
Valid for the 2010-2011 academic year

This undergraduate handbook was last updated in the summer of 2010.

Any version of this handbook dated during or after the summer of 2010 is valid for the 2010-2011 academic year.

Any updates, both errata and addendums, to this version of the handbook will be listed at http://www.cs.virginia.edu/bscs/.

Contents

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. Our goal is the education and training of a diverse body of students who can lead the 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 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, students can pursue research in any conceivable area. Our former students are enrolled in top graduate programs across the country. Our undergraduates have won many research awards, including five CRA research awards in the 2007-2008 academic year.

The BS CS degree program has as its objective that graduates of the computer science program at the University of Virginia will have the knowledge and skills 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.

Diversity Statement

The members of the department envision an environment where a diversity of capable, inspired individuals congregate, interact and collaborate, to learn and advance knowledge, without barriers. We embrace this vision because:

1. We wish to be leaders and role models in reaping and sharing the benefits of diversity.
2. We seek to improve the intellectual environment and creative potential of our department.
3. We expect to produce happier, more capable and more broadly educated computer science graduates.
4. We wish to contribute to social justice and economic well being for all citizens.

2. Degrees Offered

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

- 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 broadly on computer science, giving students sufficient knowledge of hardware, software, and theory. 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 the link at 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 (page 21) describes the requirements for the minor.

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. Course Numbering

Beginning in the fall 2009 semester, the University of Virginia changed all course numbers to 4-digit numbers from the old 3-digit number system. Whenever possible, the course numbers in this version of the handbook will use both the 3-digit number and the four digit number, in the form of "CS 1110 (101)" to allow people to transition from the old numbers to the new numbers.

The table below lists the mapping of the old course numbers to the new course numbers; it is sorted by the old course numbers.

Old	New	Title
CS 100T	CS 1000T	Non-UVa Transfer/Test Credit
CS 101	CS 1110	Introduction to Computer Science
CS 101E	CS 1111	Introduction to Computer Science
CS 101X	CS 1112	Introduction to Computer Science
CS 110	CS 1010	Introduction to Information Technology
CS 120	CS 1020	Introduction to Business Computing
CS 150	CS 1120	From Ada and Euclid to Quantum Computing and the World Wide Web
CS 200T	CS 2000T	Non-UVa Transfer/Test Credit
CS 201	CS 2110	Software Development Methods
CS 202	CS 2102	Discrete Mathematics I
CS 205	CS 2220	Engineering Software
CS 216	CS 2150	Program and Data Representation
CS 230	CS 2330	Digital Logic Design
CS 290	CS 2190	Computer Science Seminar I
CS 300T	CS 3000T	Non-UVa Transfer/Test Credit
CS 302	CS 3102	Theory of Computation
CS 305	CS 3205	HCI in Software Development
CS 333	CS 3330	Computer Architecture
CS 340	CS 3240	Advanced Software Development Techniques
CS 400T	CS 4000T	Non-UVa Transfer/Test Credit
CS 414	CS 4414	Operating Systems
CS 415	CS 4610	Programming Languages

CS 416	CS 4710	Artificial Intelligence
CS 425	CS 4630	Defense against the Dark Arts
CS 432	CS 4102	Algorithms
CS 433	CS 4330	Advanced Computer Architecture
CS 434	CS 4434	Fault-tolerant Computing
CS 441	CS 4240	Principles of Software Design
CS 444	CS 4444	Introduction to Parallel Computing
CS 445	CS 4810	Introduction to Computer Graphics
CS 446	CS 4820	Real Time Rendering
CS 447	CS 4830	Image Synthesis
CS 448	CS 4840	Computer Animation
CS 453	CS 4753	Electronic Commerce Technologies
CS 457	CS 4457	Computer Networks
CS 458	CS 4458	Internet Engineering
CS 462	CS 4750	Database Systems
CS 471	CS 4620	Compilers
CS 493	CS 4993	Independent Study
CS 494	CS 4501	Special Topics in Computer Science
CS 495	CS 4998	Distinguished BA Majors Research

Course Numbering Methodology

The new 4-digit course numbers follow a system developed by the department. The first digit is the year that the course is expected to be taken. The second digit specifies the type of course, as shown below. The third and fourth digits attempted to keep the previous last two digits of the 3-digit course number, although that was not always possible.

The 2nd digit numbering scheme is:

- x000 – service courses, courses for non-majors, general interest
- x100 – core, fundamentals, theoretical (a broad category)
- x200 – SW development-oriented courses (note in ECE, this will be for electronics courses)
- x300 – hardware, architecture, etc.
- x400 – computer systems
- x500 – by University rule: "special-topics and variable one-time offerings"
- x600 – languages, compilation, etc.
- x700 – application areas including AI, databases, etc.
- x800 – computer graphics
- x900 – by university rule: thesis, dissertation, independent study, capstone, etc.

Note that currently cross-listed courses with ECE fall in the x300 and x400 categories.

4.   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 8 electives that the student can choose from. These electives are indicated by the footnotes below, and are described in detail beginning on page 15. 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 30 for details as to when courses are offered.

The recommended schedule shown below has changed slightly each year as the degree requirements have evolved. As discussed in section 12 (Degree Requirement Revisions), a student can graduate using any set of requirements that were in effect when they became a declared computer science major. Thus, as long as all the major requirements are met, students can follow any version of the recommended course schedule.

Academic requirements are managed by SIS (the Student Information System, UVa's system for handling academic requirements and registration) A sample of the BS CS requirement listing can be found online at http://www.cs.virginia.edu/bscs/bscs-reqs-in-sis.pdf; your individual one can be found via SIS. You may also want to see the FAQ question about how HSS requirements list in the SIS report (see page 28).

CS 2190 (290) Specific Details

While students can take courses in any semester, there is an issue to consider with CS 2190 (290): this course should be taken in the second year or (less preferably) the third year. If a student reaches his/her fourth year without taking the course, then s/he must take a 3 credit in ethics and technology in its place (even though CS 2190 (290) is only 1 credit). This course taken in place of CS 2190 (290) does not count towards any other requirement except to replace CS 2190 (290).

First semester		15
APMA 1110 (111)	Single Variable Calculus	4
CHEM 1610 (151)	Chemistry for Engineers	3
CHEM 1611 (151L)	Chemistry Lab	1
ENGR 1620 (162)	Problem Solving & Design	4
STS 1010/1500 (101)	Engineering, Technology & Society	3

Second semester		17
APMA 2120 (212)	Multivariate Calculus	4
PHYS 1425 (142E)	Physics I	3
PHYS 1429 (142W)	Physics I Workshop	1
CS 1110 (101)	Intro to Computer Science	3
???	Science elective[1]	3
???	HSS or unrestricted elective[2,3]	3

Third semester		16
APMA	APMA elective[4] or APMA 3100 (310)	3
CS 2110 (201)	Software Development Methods	3
CS 2102 (202)	Discrete Mathematics	3
PHYS 2415 (241E)	General Physics II	1
PHYS 2419 (241W)	General Physics Lab I	3
???	HSS or unrestricted elective[2,3]	3

Fourth semester		16
CS 2150 (216)	Program and Data Representation	3
CS/ECE 2330 (230)	Digital Logic Design	3
CS 3102 (302)	Theory of Computation	3
CS 2190 (290)	CS Seminar	1
STS	STS 2xx/3xx elective[6]	3
???	HSS or unrestricted elective[2,3]	3

Fifth semester   15
CS/ECE 3330 (333)   Computer Architecture   3
CS 4102 (432)   Algorithms   3
APMA   APMA elective[4] or APMA 3100 (310) 3
???   HSS or unrestricted elective[2,3]   3
???   HSS or unrestricted elective[2,3]   3

Sixth semester   15
CS 3240 (340)   Advanced Software Development   3
CS   CS elective[5]   3
APMA   APMA elective[4] or APMA 3100 (310) 3
???   HSS or unrestricted elective[2,3]   3
???   HSS or unrestricted elective[2,3]   3

Seventh semester   15
STS 4010/4500 (401) Western Tech and Culture   3
???   CS elective[5]   3
CS   CS elective[5]   3
CS 4414 (414)   Operating Systems   3
???   HSS or unrestricted elective[2,3]   3

Eighth semester   15
STS 4020/4600 (402) Engineer in Society   3
CS   CS elective[5]   3
CS   CS elective[5]   3
???   HSS or unrestricted elective[2,3]   3
???   HSS or unrestricted elective[2,3]   3

5.   Degree Requirements Checklist

Required computing & math courses	Grade	Semester	Comments?
CS 1110: Intro. to Computer Science			
CS 2110: Software Development Methods			
CS 2102: Discrete Mathematics I			
CS 2150: Program & Data Representation			
CS/ECE 2330: Digital Logic			
CS 2190: CS Seminar I			
CS 3102: Theory of Computation			
CS/ECE 3330: Computer Architecture			
CS 3240: Advanced SW Devel. Tech.			
CS 4414: Operating Systems			
CS 4102: Analysis of Algorithms			
APMA 3100: Probability			
APMA 2130 or 3080 or 3120 (circle one)			
APMA 2130 or 3080 or 3120 (circle one)			

SEAS required courses

Course	Grade	Semester
APMA 1110		
APMA 2120		
CHEM 1610		
CHEM 1611		
ENGR 1620		
PHYS 1425		
PHYS 1429		
PHYS 2415		
PHYS 2419		

Science elective

Course	Grade	Semester

STS courses

Course	Grade	Semester
STS 1010		
STS 2xxx/3xxx		
STS 4010/4500		
STS 4020/4600		

CS Electives

	Course	Grade	Semester
1)			
2)			
3)			
4)			
5)			

HSS electives (5)

	Course	Grade	Semester
1)			
2)			
3)			
4)			
5)			

Unrestricted electives (5)

	Course	Grade	Semester
1)			
2)			
3)			
4)			
5)			

6. Course Requirements Flowchart

UVa Computer Science Bachelors of Science Degree:
Course Prerequisites
(Updated June 2010)

CS 111X, Intro to CS

(One can place out of CS 1110 via a placement exam or with AP credit.)

Note: Boxes with bold borders are required courses. All non-bolded boxes are CS electives. All arrows indicate pre-requisites.

Courses not listed: CS 1010 cannot be taken for credit by SEAS students. CS 1120, 2220, and 4998 are in the BA CS program.

CS 2102, Discr Math

CS 2110, SW Dev Methods

CS 2330, Dig Logic Design

Spring only

CS 3102, Theory of Computation

CS 2150, Prog & Data Repr

CS 3330, Comp Arch

CS 2190, CS Seminar

Spring only

CS 4102, Algorithms

CS 3240, Adv. SW Dev Tech

CS 4414, Oper Sys

CS 3205, HCI in Software Dev.

CS 4620, Compilers

CS 4330, Adv Comp Arch

CS 4444, Intro Parallel Comp

CS 4810, Graphics

CS 4240, Principles of Software Design
CS 4615, Programming Languages
CS 4630, Defense Against the Dark Arts
CS 4710, Artificial Intelligence
CS 4750, Database Systems
CS 4753, E-commerce

ECE 4435, Comp Org & Design

CS 4830, Image Synthesis

A CS elective is any course at the CS 3000-level or above that is not otherwise required for the major (i.e. not one of the bolded courses). This includes courses through graduate offerings, should students choose to take them.

CS 4457, Networks

CS 4434, Fault-Tolerant

ECE 4440, Adv Dig Design

CS 4458, Internet Engineering

A number of courses have different content every semester, and thus their pre-reqs change as well. These courses are CS 2501, 3501, 4501, and 5501

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7. Elective Information

The numbers in the list below correspond to the footnote numbers from the sample course schedule shown starting on page 9.

1. Science elective (1 required): Students must choose one of BIOL 2010 (201) (Introduction to Biology: Cell Biology and Genetics), BIOL 2020 (202) (Introduction to Biology: Organismal and Evolutionary Biology), CHEM 1620 (152) (Introductory Chemistry for Engineers), ECE 2066 (200) (Science of Information), MSE 2090 (209) (Introduction to the Science and Engineering of Materials), or PHYS 2620 (252) (Introductory Physics IV: Quantum Physics). Additional courses in this list can count as an unrestricted elective.

2. HSS electives (5 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. Note that there are a number of courses that do not count as HSS electives, but would count as an unrestricted elective. See that URL for details.

3. Unrestricted elective (5 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 1310 (131), including STAT 1100 (110) and 1120 (112), and courses that substantially duplicate any others offered for the degree, including PHYS 2010 (201), PHYS 2020 (202), CS 1010 (110), 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 1090 (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.

4. APMA elective (2 required): Must choose two from: APMA 2130 (213) (Ordinary Differential Equations), APMA 3080 (308) (Linear Algebra) or APMA 3120 (312) (Statistics). Note that APMA 3100 (310) (Probability) is a required course in addition to the two APMA electives.

5. CS electives (5 required): Any 3 credit CS class at the 3000 level or above. A course that is fulfilling another requirement can not also count as a CS elective. If you take more than five CS electives, you can count additional CS elective course(s) as unrestricted electives. ECE 4435 (435) and 4440 (436) (Advanced Digital Design) also count as a CS electives (this is not the case for CpE majors, as they are both required courses for CpE). CS 4993 (493) (Independent Study) can be used at most once for a CS elective (i.e. no more than 3 credits); additional CS 4993 (493) credits can be used as unrestricted electives. Note that for a class that does not meet these requirements to count as a CS elective requires approval by the CS undergraduate curriculum committee (NOT by the student's academic advisor). Due to substantial overlap, one cannot get credit for both ECE 4435 (435) and CS 4330 (433). Thus, if a student takes both of those classes, the other one can ONLY count as a unrestricted elective.

6. STS 2xxx/3xxx elective (1 required): Any STS course at the 2000-level or 3000-level.

Note that classes that receive no grade (including classes that are audited) do not count toward your degree requirements.

8.   Major Focal Paths

A focal path is a selection of courses that a student can take to fulfill the various elective requirements, which are described in detail in section 7 on page 15. They do not change any of the requirements, and it is not required to follow a focal path. They are included simply to give prospective majors an idea about various classes that they can take to fulfill an interest that they may have in computing. Not all focal paths have classes to fulfill each elective requirement. And some will have more classes than are needed for the given requirement.

In an effort to keep down the space for each listing, the reason for each class is not listed – if interested, speak to a CS faculty member in that particular area. Also, as BA CS students may be interested in these focal paths, a line listing the BA CS requirements is also shown below.

There are a number of other areas for which focal paths are being developed, but are not ready for this version of the undergraduate handbook. Those areas are: Systems, Parallel & Distributed Computing, Graphics, Languages & Compilers, Software Engineering, Hardware, and Security & Privacy.

Game Design
- Science elective (1): N/A
- HSS electives (5): digital art classes, such as ARTS 2220, 2222, 3220, 3222, 4220, and 4222; sound design courses, such as DRAM 2620 and DRAM 3640; modeling classes such as ARCH 3410
- Unrestricted elective (5): see the HSS electives choices, above, and consider additional CS electives.
- APMA electives (2): linear algebra (APMA 3080)
- CS electives (5): game development courses (offered as special topics courses, CS 4501); graphics (CS 4810),

artificial intelligence (CS 4710), networks (CS 4457), databases (CS 4750), parallel computing (CS 4444)
- STS 2xxx/3xxx elective (1): N/A
- Notes: You will need a lot of C++ experience

Theory
- Science elective (1): ECE 2066 (200) (Science of Information)
- HSS electives (5): mathematical economics (ECON 3090), psycho-linguistics (PSYC 4110)
- Unrestricted electives (5): game theory (ECON 401), various math courses (MATH 4452, MATH 5700, STAT 3010)
- Unrestricted elective (1): N/A
- APMA electives (2): linear algebra (APMA 3080)
- CS electives (5): programming languages (CS 4610), artificial intelligence (CS 4710), cryptography (offered as special topics courses, CS 4501)
- STS 2xxx/3xxx elective (1): N/A
- Notes: BA students need to take CS 302 which is critical for a theory focal path, but is not (at this time) a required course for the BA

Networks (including wirelsss networks)
- Science elective (1): N/A
- HSS electives (5): N/A
- Unrestricted electives (5): electronic commerce (SYS 2057), hardware-based communications (ECE 4710, ECE 4784)
- Unrestricted elective (1): electronic commerce (COMM 4240)
- APMA electives (2): N/A
- CS electives (5): networks (CS 4457), Internet networks (CS 4458), wireless networks (offered as special topics courses,

CS 4501), electronic commerce (CS 4753), parallel computing (CS 4444)
- STS 2xxx/3xxx elective (1): N/A
- Notes: the wireless networking class is often offered as a graduate class (called wireless sensor networks), and can be added with instructor permission

Web technologies
- Science elective (1): ECE 200
- HSS and unrestricted electives (10): digital art classes
- Unrestricted electives (5): IT 323 (Web design), IT 332 (Web Tech), IT 334 (Web marketing), COMM 424 (if no 453) TMP 351
- APMA electives (2): N/A
- CS electives (5): Electronic commerce (CS 5753); networks (CS 4457); Internet networks (CS 4458); web-based courses (offered as special topics courses, CS 4501)
- STS 2xxx/3xxx elective (1): STS 2160
- Notes: N/A

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 30.

SEAS students

All SEAS (School of Engineering and Applied Science) students are required to take (or place out of) CS 1110 (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 1110 (101): Introduction to Computer Science
- CS 2110 (201): Software Development Methods
- CS 2102 (202): Discrete Mathematics
- CS 2150 (216): Program and Data Representation

Note that if you place out of CS 1110 (101) via the placement exam, you still have to take 6 CS courses; if you receive course credit for it via the AP exam or transfer credit, then you need not substitute a course in its place.

Furthermore, two additional computer science electives are required. The elective courses must be computer science courses at the 3000 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 1110 (101) is a prerequisite of both CS 2110 (201) and CS 2102 (202). CS 2110 (201) and CS 2102 (202) are both prerequisites of CS 2150 (216). In addition, CS 2150 (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 higher) in order to take successive courses. Be aware that the department strictly enforces its prerequisite policy.

Non-SEAS students

CS 1120 (150) and CS 2220 (205) are the recommended introductory courses for non-SEAS (School of Engineering and Applied Science) students. These courses count for CS 1110 (101) and CS 2110 (201), respectively, for the minor requirements. However, students may choose to substitute CS 1120 (150) with CS 1110 (101) or substitute CS 2220 (205) with CS 2110 (201), but will not get credit for taking both CS 1110 (101) and CS 1120 (150) or both CS 2110 (201) and CS 2220 (205).

If a non-SEAS student is going to take CS 1110 (101) for the minor, we recommend that taking the course in the fall semester. SEAS requires that its students take CS 1110 (101) in the spring semester, and thus there are many more students enrolled in CS 1110 (101) in the spring semester.

The rest of the minor requirements are the same: CS 2102 (202), CS 2150 (216), and two elective courses, as described in the previous section. Note that CS/ECE 2330 (230) does NOT count as a CS elective for the minor, even though it does count as a CS elective for the BA CS major.

Declaring the minor

To declare a minor, a student should have completed CS 1110

(101) or 1120 (150), CS 2110 (201) or 2220 (205), and CS 2102 (202). Furthermore, the student should have completed, or at least be enrolled in, CS 2150 (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

What computer science student groups exist?

There are three main computer science student groups at UVa.

The Association for Computing Machinery Chapter at the University of Virginia is a student chapter of the parent Association for Computing Machinery. The Chapter is a Contracted Independent Orginization (CIO) at the University of Virginia, and serves students, faculty, and staff of the University as well as members of the Charlottesville / Albermarle community. Any member of the University or Charlottesville / Albermarle community may become a Member of the Chapter. Their website is at http://acm.cs.virginia.edu/.

ACM-W is the ACM committee on Women in Computing. It celebrates, informs and supports women in computing, and works with the ACM-W community of computer scientists, educators, employers and policy makers to improve working and learning environments for women. Their website is at http://www.cs.virginia.edu/~acm-w/.

The Student Game Developers seeks to bring together students who are interested in learning and experiencing the art of computer game development. They have resources available for programmers as well as non-programmers, weekly informative meetings, and many industry contacts for lectures, resume building, and networking. Their website is at http://gamedevatuva.blogspot.com/.

What is the International Collegiate Programming Contest (ICPC) and how do I get involved?

The International Collegiate Programming Contests, abbreviated ICPC, is a world-wide contest of computer programming for college students. UVa has a very active programming contest

team. Regional contests occur in the fall – our region is the nearest 6 (or so) states and D.C. The top team(s) from each regional contest advance to the world finals, which consists of the top 100 teams from around the world. UVa has qualified for the world finals twice in the recent years: for the 2009 world finals in Stockholm, Sweden, and the 2010 world finals in Harbin, China. We typically have seven teams (of three students each) compete in the regional contest. Our programming contest teams practice throughout the year. If you are interested in more information, you can either contact UVa's local ACM chapter (at http://acm.cs.virginia.edu) or ACM's advisor, Aaron Bloomfield (aaron@virginia.edu).

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 1110 (101) and CS 2110 (201). A 4 on the computer science AB test OR a 5 on the computer science A test will receive course credit for CS 1110 (101). If the AP exam was not in Java, proficiency in Java must be demonstrated prior to taking CS 2110 (201). Note that CS 2110 (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 1110 (101), but does not allow credit to be received for the course — the student must then take another 3 hour CS or technical course (see your advisor for details about a 'technical course') instead. See the next question and answer for information about the CS 1110 (101) placement exam.

Can I place out of CS 1110 (101)? What about CS 2110 (201)?

There is a placement exam for CS 1110 (101), which covers all the topics taught in the course. For the current semester's syllabus, see the CS 1110 (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 1110 (101). A student must still take CS 2110 (201) or a technical course (see your advisor for details about a 'technical course') to fulfill the SEAS CS 1110 (101) requirement. The test is offered before the beginning of the fall semester. Note that any student who has enrolled in CS 1110 (101) or equivalent (1111, 1112) and got a letter grade – including a 'W' — is not allowed to take the placement exam (in other words, if you enroll and then drop the course without a 'W', you may still take the placement exam). The exam may be taken by visiting the departmental office in Olsson 204.

For information about the placement exam for CS 2110 (201), please contact the current CS 2110 (201) instructor.

How does SEAS handle transfer credit?

The Engineering school handles transfer credit, such as from an AP course or transfer from another school. The credit will appear on your VISTAA report, along with the UVa courses that you received credit for. Note that the credit amounts need to match - so if you are getting credit for APMA 2120 (212) (Multivariate Calculus), which is a 4 credit course, the number of credits you transfer in should (ideally) also be 4 credit hours. If it does not (your equivalent course at another school was only 3 credits), you will have to take another math or technical course (see your advisor for details about a 'technical course') to make up for the discrepancy. Note that placing out of a course (such as CS 1110 (101), APMA 2120 (212), etc.) through the respective placement

exam does not give credit – and thus the credits need to be made up through other courses (in the case of CS 1110 (101), 3 credits of a technical course will fill that spot; in the case of APMA 2120 (212), 4 credits of math or a techincal elective will fill that spot). AP exams do give course credit.

Note that half of the 128 credits that one uses to graduate must be earned at UVa. Thus, if you transfer with more than 64 credits, you must still take 64 credits at UVa.

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 2150 (216) elsewhere, you need both a data structures course and an assembly language programming course.

What are the Rodman Scholar requirements?

Rodman scholars have slightly different requirements for graduation.

- Rodman Scholars are not required to take STS 1010 (101); an HSS elective is substituted
- Rodmans fulfill the STS 2xxx/3xxx elective by taking STS 2000 (formerly known as STS 200R). For the class of 2013, Rodmans will take STS 1010 in the Spring, with a special discussion section for Rodmans only.
- In place of ENGR 1620, Rodmans take the two-course

sequence, ENGR 1410 (141R) and ENGR 1420 (142R)

- Rodmans take PHYS 1427 (142R) during their first semester, instead of PHYS 1425 (142E) and PHYS 1429 (142W) in the second semester
- Rodmans take a different Physics class during their second semester, instead of PHYS 2415 (241E) and PHYS 2419 (241W). This class used to be called PHYS 241R; as of print time, the new 4-digit course number is not yet known.

Furthermore, Rodman Scholars are required to complete 4 seminars - ENGR 3080 (formerly 307 and 308) prior to graduation. First-year students joining the Rodman program at mid-year are required to take three seminars prior to graduation.

Why do the SIS requirements for the BS CS major list 6 HSS electives, and not 5?

This has to do with how SIS (the Student Information System, UVa's system for handling academic requirements and registration) handles major requirements, and is done to allow for people to place out of STS 1010 1500 (previously STS 101, and STS 1010). If one does **not** place out of STS 1500, then STS 1500 will list both in the STS 1500 requirement, and in the HSS requirement, thus requiring students to take 5 additional HSS courses. If one **does** place out of STS 1500, they need to take an additional HSS course in its place. So the credit to place out of STS 1500 will appear in the STS 1500 requirements, and will still require 6 (not 5) HSS courses. We think this is all a bit bizarre as well, but that is how SIS handles requirements.

A sample of the BS CS requirements can be found at http://www.cs.virginia.edu/bscs/bscs-reqs-in-sis.pdf -- your individual one can be found via SIS.

Can CS students study abroad?

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

How do I transfer into the CS program?

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.

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.

Where can I find out about the Business minor?

The courses for the Engineering Business Minor can be worked into the various electives for the BSCS. More details can be found at http://www.seas.virginia.edu/advising/businessminor.php.

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.

1000 Level Courses

CS 1010 (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 1110 (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 1111 (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 1112 (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 1120 (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)

2000 Level Courses

CS 2102 (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 1110 (101) or 1120 (150) with a grade of C- or higher.

CS 2110 (201) - Software Development Methods (3 credits): A continuation of CS 1110 (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 1110 (101) with a grade of C- or higher.

CS 2150 (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 2102 (202) and either CS 2110 (201) or CS 2220 (205) with all grades of C- or higher.

CS 2190 (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 2110 (201) or 2220 (205) with a grade of C- or higher, as well as a computing major (BACS, BSCS, or CpE).

CS 2220 (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 2110 (201) and CS 2220 (205).

CS/ECE 2330 (230) - Digital Logic Design (3 credits): Includes number systems and conversion; Boolean algebra and logic gates; minimization of switching functions; combinational network design; ip-ops; sequential network design; arithmetic networks. Introduces computer organization and assembly language. Cross-listed as ECE 2330 (230). (S)

CS 2501 (251) - 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.

3000 Level Courses

CS 3102 (302) - Theory of Computation (3 credits): Introduces computation theory including grammars, finite state machines and Turing machines; and graph theory. Cross-listed as APMA 3102 (302). (Y) Prerequisite: CS 2102 (202) and either CS 2110 (201) or 2220 (205) all with grades of C- or higher.

CS 3205 (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 2110 (201) or 2220 (205) with a grade of C- or higher.

CS 3240 (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 2150 (216) with a grade of C- or higher.

CS/ECE 3330 (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 2110 (201) or 2220 (205) with a grade of C- or higher, and CS/ECE 2330 (230) with a grade of C- or higher.

CS 3501 (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.

4000 Level Courses

CS 4102 (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 2150 (216) with a grade of C- or higher.

CS 4240 (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 2150 (216) with a C- or higher.

CS 4330 (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 2150 (216) and

CS/ECE 3330 (333) with a C- or higher.

CS 4414 (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 2150 (216) and CS/ECE 3330 (333) with grades of C- or higher.

CS 4434 (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/ECE 3330 (333), APMA 2130 (213), and APMA 3100 (310), each with grades of C- or higher.

CS 4444 (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 2150 (216) and CS/ECE 3330 (333) with a C- or higher.

CS/ECE 4457 (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/ECE 3330 (333) with a grade of C- or higher.

CS 4458 (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 4457 (457) with a grade of C- or higher.

CS 4501 (451 and 494) - 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 4610 (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 2150 (216) with a grade of C- or higher.

CS 4620 (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 3240 (340) and CS/ECE 3330 (333) with grades of C- or higher.

CS 4630 (425) – Defense Against the Dark Arts (3 credits): Viruses, worms, and other malicious software are an ever-increasing threat to computer systems. There is an escalating battle between computer security specialists and the designers of

malicious software. This course provides an essential understanding of the techniques used by both sides of the computer security battle. (Y) Prerequisite: CS 2150 (216) with a grade of C- or higher.

CS 4710 (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 2150 (216) with grades of C- or higher.

CS 4750 (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 2150 (216) with grades of C- or higher.

CS 4753 (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 2150 (216) with a grade of C- or higher.

CS 4810 (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 2150 (216) with a grade of C-.

CS 4830 (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 higher in CS 4810 (445) or equivalent working knowledge.

CS 4993 (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 4998 (495) – Distinguished BA Majors Research (3 credits): Required for Distinguished Majors completing the Bachelor of Arts degree in the College of Arts and Sciences. An introduction to computer science research and the writing of a Distinguished Majors thesis. Prerequisite: in the BA program and 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 given 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 January 2010.

Requirements revision from spring 2010

In January of 2010, the elective structure was changed. Previously, majors were required to take 3 HSS electives, 3 general education electives, 3 technical electives, and 1 unrestricted elective. With the change, these 10 elective courses are now split into 5 HSS electives and 5 unrestricted electives. Students wishing to graduate using the old rules (if you were a declared major prior to 2010) should see the previous editions of this handbook for the description of what constitutes general education electives and technical electives. However, the new requirements are more general, and we expect most students to graduate using these updated requirements. The old versions of this handbook are available online at http://www.cs.virginia.edu/bscs/.

Requirements revision from fall 2009

In addition to the course numbering change, the change in the requirements was that the computer architecture elective was replaced with an additional CS elective, to bring the total number of required CS electives to 5. The previous computer architecture requirement had the students take one class from a set of 3: CS 4444 (444) (Introduction to Parallel Computing), CS 4330 (433) (Advanced Computer Architecture) or ECE 4435 (435) (Computer Organization and Design). Since all of those three courses count as CS electives, students who have already fulfilled this old requirement will still fulfill the CS elective that replaced it.

Focal paths were also added to the undergraduate handbook, although they do not change the major requirements.

Enlighten the people generally, and tyranny and oppression of body and mind will vanish like evil spirits at the dawn of day … the diffusion of knowledge among the people is to be the instrument by which it is to be effected.

- Thomas Jefferson, 1816

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