

# COMPUTER SCIENCE MAJOR

## Program Curriculum

Code	Title	Credits
<b>Degree Core Requirements</b>		
CS 1114	Introduction to Software Design (C-)	3
MATH 2204	Introduction to Multivariable Calculus	3
or CMDA 2005	Integrated Quantitative Sciences	
MATH 2534	Introduction to Discrete Mathematics	3
MATH 2114	Introduction to Linear Algebra	3
CS 2505	Introduction to Computer Organization (C)	3
CS 2506	Introduction to Computer Organization (C)	3
CS 3214	Computer Systems	3
CS 3604	Professionalism in Computing	3
Subtotal		24
<b>Major Requirements</b>		
CS 2104	Introduction to Problem Solving in Computer Science (C)	3
CS 3304	Comparative Languages	3
CS 4XXX	Capstone	3
CS 3/4/5XXX	Elective	3
CS 4/5XXX	Elective	3
CS Technical	Elective	3
CS Theory	Elective	3
Natural Science	Elective	3
Communications	Elective	3
Professional Writing	Elective	3
Statistics	Elective	3
Subtotal		33
<b>Additional Course Requirements</b>		
CS 1944	Computer Science First Year Seminar	1
CS 2114	Software Design and Data Structures	3
CS 4944	Seminar	1
MATH 3134	Applied Combinatorics and Graph Theory	3
Subtotal		8
<b>Free Elective Credits</b>		
Select remaining credits required for the degree:		8
<b>Pathways to General Education</b>		
<i>Pathways Concept 1 - Discourse</i>		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Select three hours in Pathway 1a ( <a href="https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A">https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A</a> )		3
<i>Pathways Concept 2 - Critical Thinking in the Humanities</i>		
Select six hours in Pathway 2 ( <a href="https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02">https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02</a> )		6
<i>Pathways Concept 3 - Reasoning in the Social Sciences</i>		
Select six hours in Pathway 3 ( <a href="https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03">https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03</a> )		6
<i>Pathways Concept 4 - Reasoning in the Natural Sciences</i>		
CHEM 1035	General Chemistry	4
& CHEM 1045	and General Chemistry Laboratory	

PHYS 2305	Foundations of Physics	4
<i>Pathways Concept 5 - Quantitative and Computational Thinking</i>		
MATH 1225	Calculus of a Single Variable (5F ; C-)	4
MATH 1226	Calculus of a Single Variable (5F)	4
CS 3114	Data Structures and Algorithms (5A ; C)	3
<i>Pathways Concept 6 - Critique and Practice in Design and the Arts</i>		
Select three credits in Pathway 6a ( <a href="https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A">https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A</a> )		3
ENGE 1215	Foundations of Engineering	4
& ENGE 1216	and Foundations of Engineering (6D)	
<i>Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States</i>		
Pathways Concept 7 can be double-counted with another core concept. In this case, additional free elective credits must be taken to maintain a minimum of 123 credits		3
Subtotal		58
<b>Total Credits</b>		<b>123</b>

## Pathways to General Education

Consult the pathways course table: <https://www.pathways.prov.vt.edu/about/table.html>. Pathways courses must be completed prior to graduation.

## Additional Requirements and Notes

- CS Non-Technical Course Requirement.** B.S. in CS students must complete 30 credits of non-technical courses. All courses are approved as non-technical courses except those in the departments of Biological Sciences, Chemistry, Geosciences, Physics, Mathematics, and Statistics, and all departments in the College of Engineering, except for engineering courses satisfying Pathways 7. Also excluded are courses listed as CS technical electives.
- Independent Study/Undergraduate Research.** No more than a total of 6 credits of CS 4974 Independent Study and/or CS 4994 Undergraduate Research may be used to fulfill CS degree requirements. To take Independent Study (CS 2974 Independent Study or CS 4974 Independent Study), a minimum overall and in-major GPA of 2.5 is required. To take CS 4994 Undergraduate Research, a minimum overall GPA of 2.5 and an in-major GPA of 3.0 is required. CS 4974 Independent Study and CS 4994 Undergraduate Research also require completion of CS 3114 Data Structures and Algorithms with a grade of C or better.
- See checksheet page 3 for definitions of each elective category and a list of approved courses for each.

## Change of Major Requirements

Please see <http://www.eng.vt.edu/em> (<http://www.eng.vt.edu/em/>)

## Foreign Language Requirements

Complete an 1105-1106 foreign language (e.g., FR, GR, SPAN) grouping or the equivalent.

## Satisfactory Progress Towards Degree

University Policy 91 outlines university-wide minimum criteria to determine if students are making satisfactory progress towards the completion of their degrees. The CS Department fully supports this policy.

Specific expectations for satisfactory progress for Computer Science majors are as follows:

- Each student must meet the minimum University-wide criteria as described in Policy 91 and summarized in the Undergraduate Catalog: <http://www.undergradcatalog.registrar.vt.edu/1920/academic-policies.html#22>
- Be registered in at least one 3-credit course **required** in the major during each on-campus semester of the regular academic year.
- Maintain an in-major GPA of 2.0 or better (calculated using all classes with a CS designator).
- Not take any CS course required in the major more than twice, including attempts ending in course withdrawal.
- Not repeat more than 3 CS courses required in the major, including attempts ending in course withdrawal.

## Statement of Prerequisites

Pre-requisites for each course are listed after the course title. The (letter grade) notation, such as (C), indicates the minimum grade students must earn in the pre-requisite course. There are no hidden pre-requisites in the program of study. Prerequisites may change from what is indicated. Be sure to consult the University Catalog or check with your advisor for the most current pre-requisites.

## Computer Science Electives

Note: Some elective courses may include prerequisites not required by this checklist. It is the student's responsibility to be aware of prerequisites and to ensure that all prerequisites are completed prior to enrolling in the chosen course. Some courses may be restricted to majors other than CS in some semesters. Check the Undergraduate Course Catalog and consult with an academic advisor to confirm your eligibility for specific electives. Actual course offerings are subject to availability of sufficient resources, including faculty availability and student demand.

1. **Natural Science Elective.** A minimum of 12 hours of natural science is required. Of those hours, 8 hours must be in a sequence. In addition to the required CHEM 1035 General Chemistry/CHEM 1045 General Chemistry Laboratory and PHYS 2305 Foundations of Physics, this requirement may be satisfied by taking
  - a. CHEM 1036 General Chemistry/CHEM 1046 General Chemistry Laboratory
  - b. PHYS 2306 Foundations of Physics, or
  - c. an eight hour sequence in Biology: BIOL 1105 Principles of Biology-BIOL 1106 Principles of Biology & BIOL 1115 Principles of Biology Laboratory-BIOL 1116 Principles of Biology Laboratory.

2. **Communications Elective.** Students must take one of the following:

Code	Title	Credits
COMM 2004	Public Speaking	3
COMM 2014	Communication Principles of Teamwork	3

**Note:** COMM 2004 Public Speaking can be used to satisfy Pathways 1A. Students who do not take COMM 2004 Public Speaking as their communications elective will need to satisfy Pathways 1A through a suitable professional writing elective or free elective.

3. **Professional Writing Elective.** Students must take one of the following:

Code	Title	Credits
ENGL 3764	Technical Writing	3
ENGL 3804	Technical Editing and Style	3

ENGL 3814	Creating User Documentation	3
ENGL 3824	Visual Rhetoric and Document Design	3
ENGL 3834	Intercultural Issues in Professional Writing	3
ENGL 3844	Writing and Digital Media	3
ENGL 4824	Science Writing	3

**Note:** ENGL 3764 Technical Writing can be used to satisfy Pathways 1A. Students who do not take ENGL 3764 Technical Writing as their communications elective will need to satisfy Pathways 1A through a suitable communications elective or free elective.

4. **Statistics Elective.** Students must take one of the following:

Code	Title	Credits
STAT 4705	Probability and Statistics for Engineers	3
STAT 4105	Theoretical Statistics	3
STAT 4714	Probability and Statistics for Electrical Engineers	3
STAT 4604	Statistical Methods for Engineers	3
STAT 3704	Statistics for Engineering Applications	2
CMDA 2006	Integrated Quantitative Sciences	6

Note that students taking STAT 3704 Statistics for Engineering Applications must take an additional 1 free elective credit to meet the total number of credits required for the degree.

5. **CS 3/4/5XXXX Electives.** Any 3-credit CS 3/4/5000-level course not otherwise used to fulfill a Computer Science requirement can be used as a CS 3/4/5XXX elective, including both CS 4974 Independent Study and CS 4994 Undergraduate Research, except for the following:

Code	Title	Credits
CS 5040	Intermediate Data Structures and Algorithm Analysis	3
CS 5044	Object-Oriented Programming with Java	3
CS 5045	Computation for the Data Sciences	3
CS 5046	Computation for the Data Sciences	3
CS 5644	Machine Learning with Big Data	3
CS 5664	Social Media Analytics	3
CS 5904	Project and Report	1-19
CS 5944	Graduate Seminar	1
CS 5974	Independent Study	1-19
CS 5994	Research and Thesis	1-19

6. **CS 4/5XXXX Elective.** Any 3-credit CS 4/5000-level course not otherwise used to fulfill a Computer Science requirement can be used as a CS 4/5XXX elective, including both CS 4974 Independent Study and CS 4994 Undergraduate Research, except for the following:

Code	Title	Credits
CS 5040	Intermediate Data Structures and Algorithm Analysis	3
CS 5044	Object-Oriented Programming with Java	3
CS 5045	Computation for the Data Sciences	3
CS 5046	Computation for the Data Sciences	3
CS 5644	Machine Learning with Big Data	3
CS 5664	Social Media Analytics	3
CS 5904	Project and Report	1-19
CS 5944	Graduate Seminar	1

CS 5974	Independent Study	1-19
CS 5994	Research and Thesis	1-19

7. **CS Theory Elective.** Students must take one of the following:

Code	Title	Credits
CS 4104	Data and Algorithm Analysis	3
CS 4114	Introduction to Formal Languages and Automata Theory	3
CS 4124	Theory of Computation	3
CS 5104	Computability and Formal Languages	3
CS 5114	Theory of Algorithms	3

8. **Capstone Requirement.** Students must complete one 4000-level CS capstone course. Students may choose from the courses listed here, or other 4/5000-level CS courses that have received prior approval as fulfilling the capstone requirement.

Code	Title	Credits
CS 4274	Secure Computing Capstone	3
CS 4284	Systems & Networking Capstone	3
CS 4624	Multimedia, Hypertext and Information Access	3
CS 4634	Design Of Information	3
CS 4644	Creative Computing Studio	3
CS 4664	Data-Centric Computing Capstone	3
CS 4704	Software Engineering Capstone	3
CS 4784	Human-Computer Interaction Capstone	3
CS 4884	Computational Biology and Bioinformatics Capstone	3

9. **CS Technical Elective.** Computer Science majors must satisfy a 3 credit hour technical elective requirement by taking one of:

- Any 3-credit CS 3/4/5000-level course meeting the CS 3/4/5XXX elective requirements under (5) above.
- Any approved 3000- or 4000-level course in another discipline that has significant technical content relevant to the science or application of computer science can be used as a technical elective.
  - Requests to have a non-CS course approved as a technical elective are made by submitting a course syllabus to your CS advisor for review prior to enrolling in the course. This includes non-CS Independent Study (4974) and Undergraduate Research (4994) courses.
  - Below is a listing of non-CS courses that are approved as technical electives.

## Computer Science Technical Elective Courses

Code	Title	Credits
AOE 4434	Introduction to Computational Fluid Dynamics	3
ART 3704	Topics in Computer Animation	3
BIT 4424	Business Information Visualization and Analytics	3
BIT 4434	Computer Simulation in Business	3
BIT 4444	Web-Based Decision Support Systems	3
BIT 4544	Advanced Methods in Business Analytics	3
BIT 4604	Data Governance, Privacy and Ethics	3
BIT 4614	Information Security	3
BIT 4624	Cybersecurity Analytics for Business	3

CMDA 3606	Mathematical Modeling: Methods and Tools	3
ECE 3544	Digital Design I	4
ECE 3574	Applied Software Design	3
ECE 4524	Artificial Intelligence and Engineering Applications	4
ECE 4550	Real-Time Systems	3
ECE 4560	Computer and Network Security Fundamentals	3
ECE 4564	Network Application Design	3
ECE 4580	Digital Image Processing	3
ECE 4704	Principles of Robotics Systems	3
GEOG/GEOS 4084	Modeling with Geographic Information Systems	3
GEOG 4314	Spatial Analysis in Geographic Information Systems	3
GEOG 4324	Algorithms in Geographic Information Systems	4
JMC 4374	New Communications Technology	3
MATH 4175	Cryptography	3
MATH 4176	Cryptography	3
MATH 4445	Introduction to Numerical Analysis	3
MATH 4454	Applied Mathematical Modeling	3
ME 4524	Introduction to Robotics and Automation	3
MUS 3064	Digital Sound Manipulation	3
MUS 3065	Computer Music and Multimedia Design	3
MUS 3066	Computer Music and Multimedia Design	3
PHYS 4755	Introduction to Computational Physics	3

## Graduation Requirements

To qualify for a B.S. degree in CS, a student must:

- Earn a "C" (2.0) or better in CS 1114 Introduction to Software Design, CS 2104 Introduction to Problem Solving in Computer Science, CS 2114 Software Design and Data Structures, CS 2505 Introduction to Computer Organization, CS 2506 Introduction to Computer Organization and CS 3114 Data Structures and Algorithms.
- Complete at least 123 semester credit hours with a minimum overall GPA of 2.00 and a minimum in-major GPA of 2.00 (the in-major GPA is calculated using all classes with a CS designator).

## Roadmap

Course	Title	Credits
<b>First Year</b>		
<b>Fall Semester</b>		
CHEM 1035	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
ENGL 1105	First-Year Writing	3
MATH 1225	Calculus of a Single Variable (C-)	4
ENGE 1215	Foundations of Engineering (C-)	2
Pathways		3
		<b>Credits</b>
		<b>16</b>
<b>Spring Semester</b>		
PHYS 2305	Foundations of Physics	4
ENGL 1106	First-Year Writing	3
MATH 1226	Calculus of a Single Variable	4
ENGE 1216	Foundations of Engineering (C-)	2
CS 1114 or CS 2064	Introduction to Software Design (C) or Intermediate Programming in Python	3
		<b>Credits</b>
		<b>16</b>

**Second Year****Fall Semester**

MATH 2204 or CMDA 2005	Introduction to Multivariable Calculus or Integrated Quantitative Sciences	3
MATH 2534	Introduction to Discrete Mathematics	3
CS 2114	Software Design and Data Structures (C)	3
CS 1944	Computer Science First Year Seminar	1
CS 2104	Introduction to Problem Solving in Computer Science (C)	3
Natural Science Elective		4
<b>Credits</b>		<b>17</b>

**Spring Semester**

Communications Elective		3
MATH 2114	Introduction to Linear Algebra	3
CS 2505	Introduction to Computer Organization (C)	3
Pathways		3
Pathways		3
<b>Credits</b>		<b>15</b>

**Third Year****Fall Semester**

MATH 3134	Applied Combinatorics and Graph Theory	3
CS 2506	Introduction to Computer Organization (C)	3
CS 3114	Data Structures and Algorithms (C)	3
Professional Writing Elective		3
Pathways		3
<b>Credits</b>		<b>15</b>

**Spring Semester**

Statistics Elective		3
CS 3214	Computer Systems	3
CS 3604	Professionalism in Computing	3
CS 3/4/5XXX	Elective	3
Pathways		3
<b>Credits</b>		<b>15</b>

**Fourth Year****Fall Semester**

CS 3304	Comparative Languages	3
CS Theory Elective		3
CS 3/4/5XXX	Elective	3
CS Technical Elective		3
Free Elective		3
<b>Credits</b>		<b>15</b>

**Spring Semester**

CS 4944	Seminar	1
CS 4XXX	Capstone	3
CS 4/5XXX	Elective	3
Pathways		3
Free Elective		4
<b>Credits</b>		<b>14</b>

<b>Total Credits</b>		<b>123</b>
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