# **SECURE COMPUTING MAJOR**

### **Program Curriculum**

i iogiani o			
Code	Title	Credits	
Degree Core Requ	irements		
CS 1114	Introduction to Software Design (C)	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	
MATH 2114	Introduction to Linear Algebra	3	
MATH 2204	Introduction to Multivariable Calculus	3	
or CMDA 2005	Integrated Quantitative Sciences		
MATH 2534	Introduction to Discrete Mathematics	3	
or MATH 3034	Introduction to Proofs		
Subtotal		24	
Major Requirement	nts		
CS/BIT/PSCI 2164	Foundations of Contemporary Security Environments	3	
CS 3314	Programming Language Theory and Practice	3	
CS 4264	Principles of Computer Security	3	
CS 4XXX	Secure Computing Capstone	3	
Secure Computing	g Electives <sup>3</sup>	9	
Subtotal	-	21	
Additional Course	Requirements		
CS 1944	Computer Science First Year Seminar	1	
CS 2114	Software Design and Data Structures (C)	3	
CS 4944	Seminar	1	
MATH 3134	Applied Combinatorics and Graph Theory	3	
or MATH 3124	Modern Algebra	-	
Subtotal	······································	8	
Elective Courses			
CS 3/4/5XXX Elec	tive <sup>3</sup>	3	
CS Technical Elec	tive <sup>3</sup>	3	
Advanced Natural	Science Elective	4	
Communications	Flective	. 3	
Professional Writi	ng Elective	3	
Statistics Elective		3	
Free Flectives		1	
Subtotal			
Bathways to Cons	val Education	25	
Pathways Concent			
ENCL 1105	First-Voor Writing (1E)	2	
ENGL 1106	First Veer Writing (1F)	2	
Soloot three hours	rist-real writing (IF)	3	
course-search/?at	ttrs_pathways=attrs_pathways_G01A) (use		
Elective)	,		
Pathways Concept	2 - Critical Thinking in the Humanities		
Select six hours in search/?attrs_pat	n Pathway 2 (https://catalog.vt.edu/course- hways=attrs_pathways_G02)	6	
Pathways Concept 3 - Reasoning in the Social Sciences			

Select six hours in Pathway 3 (https://catalog.vt.edu/course- search/?attrs_pathways=attrs_pathways_G03)			
Pathways Concept 4 - Reasoning in the Natural Sciences			
Natural Science Elective			
Natural Science E	lective	4	
Pathways Concept	5 - Quantitative and Computational Thinking		
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	
Pathways Concept	6 - Critique and Practice in Design and the Arts		
Select three hours search/?attrs_pat	s in Pathway 6a (https://catalog.vt.edu/course- hways=attrs_pathways_G06A)	3	
ENGE 1215 & ENGE 1216	Foundations of Engineering and Foundations of Engineering (6D)	4	
or ENGE 1414	Foundations of Engineering Practice		
Pathways Concept United States	7 - Critical Analysis of Identity and Equity in the		
Pathways Concep concept. In this ca maintain a minim	ot 7 should be double counted with another core ase, additional free elective credits must be taken to um of 123 credits.	3	
Subtotal		47	
Total Credits		123	

### **Additional Requirements and Notes**

**Minor Restriction:** students pursing a Major in Secure Computing may not minor in Cybersecurity.

### **Secure Computing Electives**

Note: Some elective courses may include prerequisites not required by this checksheet. 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 Electives: Choose 8 credits

	Code	Title	Credits
	BIOL 1105 & BIOL 1115	Principles of Biology and Principles of Biology Laboratory	4
	CHEM 1035 & CHEM 1045	General Chemistry and General Chemistry Laboratory	4
	PHYS 2305	Foundations of Physics	4
2.	Advanced Natura	I Science Elective: Choose 4 credits	
	Code	Title	Credits
	BIOL 1106 & BIOL 1116	Principles of Biology and Principles of Biology Laboratory	4
	CHEM 1036 & CHEM 1046	General Chemistry and General Chemistry Laboratory	4
	PHYS 2306	Foundations of Physics	4

3. Communications Elective. Students must take one of the following:

Code	Title	Credits
COMM 2004	Public Speaking	3
COMM 2014	Speech Communication	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.

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

. on o ming.		
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.

#### 5. 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:** 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. Students considering a possible change of major to Data-Centric Computing should take one of STAT 4705 Probability and Statistics for Engineers, STAT 4105 Theoretical Statistics, or CMDA 2006 Integrated Quantitative Sciences, since that major uses a more restrictive list of statistics electives.

 CS 3/4/5XXXX Electives<sup>3</sup>. Other than the exceptions listed below, 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 and . Additionally, the following cross-listed courses are allowed for CS 3/4/5XXX elective credit.

Code	Title	Credits
AOE 4434	Introduction to Computational Fluid Dynami	cs 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 4514		3
BIT 4544	Artificial Intelligence, Machine Learning, and Deep Learning in BIT	3

BIT 4604	Data Governance, Privacy and Ethics	3
BIT 4614	Cybersecurity Management II	3
BIT 4624	Cybersecurity Analytics for Business	3
CEM 4624	Construction Robotics and Automation	3
CEM 4644	Artificial Intelligence for Design, Construction, and Operations	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
ENGE 4735	Interdisciplinary Design Capstone	3
ENGE 4736	Interdisciplinary Design Capstone	3
ENGE 4964	Field Study	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
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

#### Exceptions (not allowed to count towards CS 3/4/5XXX electives)

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

#### 7. Secure Computing Elective<sup>3</sup>. Students must take three of the

following:		
Code	Title	Credits
BIT 4604	Data Governance, Privacy and Ethics	3
BIT 4614	Cybersecurity Management II	3
BIT 4624	Cybersecurity Analytics for Business	3
CS 3274	Software Reverse Engineering	3
CS 3754	Cloud Software Development	3
CS 4254	Computer Network Architecture and Programming	3

ECE 4560	Computer and Network Security Fundamentals	3
FIN 4014	Cyberlaw and Policy	3
MATH 4175	Cryptography	3
MATH 4176	Cryptography	3
CS 5264	Advanced Linux Kernel Programming	3
CS 5580	Cryptographic Engineering	3
CS 5584	Network Security	3
CS 5590	System and Software Security	3
CS 5594	Blockchain Technologies	3

 Secure Computing Capstone Requirement. Students must complete one 4000-level CS capstone course in the secure computing area. Students may choose the course listed here, or other 4/5000-level CS courses that have received prior approval as fulfilling the secure computing capstone requirement.

Code	Title	Credits
CS 4284	Systems & Networking Capstone	3
CS 4274	Secure Computing Capstone	3

With prior departmental approval, ENGE 4735 Interdisciplinary Design Capstone or ENGE 4736 Interdisciplinary Design Capstone can fulfill the capstone requirement in semesters where the course includes a significant software security aspect.

- 9. **CS Technical Elective**<sup>3</sup>. Secure Computing majors must satisfy a 3 credit hour technical elective requirement by taking one of:
  - a. Any 3-credit CS 3/4/5000-level course meeting the CS 3/4/5XXX elective requirements under (6) above.
  - b. Any Secure Computing Elective listed under (6) above that is not otherwise used to fulfill a Secure Computing requirement.
  - c. 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.
    - ii. Below is a listing of non-CS courses that are approved as technical electives.

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.

Code	Title	Credits
AOE 4434	Introduction to Computational Fluid Dynami	cs 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 4514		3
BIT 4544	Artificial Intelligence, Machine Learning, and Deep Learning in BIT	3

BIT 4604	Data Governance, Privacy and Ethics	3
BIT 4614	Cybersecurity Management II	3
BIT 4624	Cybersecurity Analytics for Business	3
CEM 4624	Construction Robotics and Automation	3
CEM 4644	Artificial Intelligence for Design, Construction, and Operations	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
ENGE 4735	Interdisciplinary Design Capstone	3
ENGE 4736	Interdisciplinary Design Capstone	3
ENGE 4964	Field Study	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
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

**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.

- <sup>2</sup> 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 Undergraduate Research (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.
- <sup>3</sup> Undergraduates Taking Graduate Courses. Students within 2 semesters of graduating and with a 3.0 or better GPA may enroll in 5000-level courses satisfying undergraduate degree requirements within their department if they have been accepted into the Accelerated Undergraduate/Graduate Program, or by permission of the course

instructor and the Department. For students not accepted into the Accelerated Undergraduate/Graduate Program, these courses may not be used on the Plan of Study for a graduate degree.

### **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.

### **Graduation Requirements**

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

- 1. Completed at least 123 credit hours
- Earn a "C" (2.0) or better in CS 1114 Introduction to Software Design, 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.
- 3. Earn 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).

### **Acceptable Substitutions**

- 1. MATH 2405H may be substituted for MATH 2114
- 2. MATH 2405H + MATH 2406H may be substituted for MATH 2114 + MATH 2204 + free elective (4 cr)
- 3. CS 2064 (C) may be substituted for CS 1114 (C)
- 4. ECE 2514 (C) may be substituted for CS 1114 (C)
- 5. ECE 3514 (C) may be substituted for CS 2114 (C)
- 6. ECE 2564 (C) may be substituted for CS 2505 (C)

## Foreign Language Requirement

Students must have had 2 years of a foreign language in high school or one year at the college level (6 credit hours) of the same language. College-level credits used to meet this requirement do not count towards the degree.

First Year		
Fall Semester		Credits
CS 1114	Introduction to Software Design (C)	3
ENGE 1215	Foundations of Engineering	2
ENGL 1105	First-Year Writing	3
MATH 1225	Calculus of a Single Variable (C-)	4
Natural Science Elective		4
	Credits	16
Spring Semester		
CS 2114	Software Design and Data Structures (C)	3
ENGE 1216	Foundations of Engineering	2
ENGL 1106	First-Year Writing	3
MATH 1226	Calculus of a Single Variable	4
Natural Science Elective		4
	Credits	16
Second Year		
Fall Semester		
CS 1944	Computer Science First Year Seminar	1
CS/BIT/PSCI 2164	Foundations of Contemporary Security Environments	3
CS 2505	Introduction to Computer Organization (C)	3
MATH 2534	Introduction to Discrete Mathematics	3
or MATH 3034	or Introduction to Proofs	
Pathways 2, 3, 6a, or 7		3
Pathways 2, 3, 6a, or 7		3
	Credits	16
Spring Semester		
CS 2506	Introduction to Computer Organization (C)	3
MATH 2204	Introduction to Multivariable Calculus	3
or CMDA 2005	or Integrated Quantitative Sciences	
MATH 2114	Introduction to Linear Algebra	3
Communications Elective		3
Advanced Natural Science	Elective	4
	Credits	16
Third Year		
Fall Semester		
CS 3114	Data Structures and Algorithms (C)	3
MATH 3134	Applied Combinatorics and Graph Theory	3
Secure Computing Elective	3	3
Professional Writing Electiv	/e	3
Pathways 2, 3, 6a, or 7		3
	Credits	15
Spring Semester		
CS 3214	Computer Systems	3
CS 3604	Professionalism in Computing	3
Statistics Elective		3
Pathways 2, 3, 6a, or 7		3
Pathways 2, 3, 6a, or 7		3
	Credits	15
Fourth Year		
Fall Semester		
CS 3314	Programming Language Theory and Practice	3
CS 4264	Principles of Computer Security	3
CS Technical Elective <sup>3</sup>		3
Secure Computing Elective	3	3
Free Elective		3
	Credits	15
Spring Semester		
CS 4944	Seminar	1
CS 4XXX: Secure Computir	ng Capstone	3
Secure Computing Elective	5	3
CS 3/4/5XXX Elective <sup>3</sup>		3
Pathways 2, 3, 6a, or 7		3

Roadmap

Free Elective		1
	Credits	14
	Total Credits	123