

The Cyber Security Focus Area in the Computer Science Major
Department of Computer Science
Tufts University

Last updated by Ming Chow on May 16, 2018

Overview

The crux of Cyber Security is to understand how systems, applications, algorithms, and protocols work and fail. The purpose of this focus area is to provide you with breadth and depth in the broad area of Cyber Security with a strong technical foundation. This focus area applies equally well for Arts and Sciences (A&S) and School of Engineering (SoE) students.

The Computer Science Core

1. Introduction to Computer Science (COMP 11)
 - Importance for Cyber Security (the “why”): Being proficient in programming is an essential skill to have as a cyber security practitioner or researcher.¹
2. Data Structures (COMP 15)
 - Importance for Cyber Security (the “why”): How to organize information and what it costs.
3. Machine Structure & Assembly-Language Programming (COMP 40)
 - Importance for Cyber Security (the “why”): Bits, bytes, pointers; memory management; basic assembly programming, debugging, and reverse engineering.
4. Programming Languages (COMP 105)
 - Importance for Cyber Security (the “why”): Your next “n” programming languages --how to use them well; secure and insecure type systems and language design; defensive execution of unsafe languages.²
5. Algorithms (COMP 160)
 - Importance for Cyber Security (the “why”): How to write a convincing argument about code or a task so that confidentiality, integrity, availability are not violated.
6. Theory of Computation (COMP 170)
 - Importance for Cyber Security (the “why”): Study of the inherent capabilities and limitations of any computer.

The Cyber Security Core

1. Introduction to Computer Security / Computer System Security (COMP 116)
 - Importance for Cyber Security (the “why”): Basics of networking, attacking and defending networks, cryptography, vulnerabilities and vulnerability disclosure, web security, malware, static analysis. *Caveat: this is broad course where you will learn a little on a lot.*
2. Operating Systems (COMP 111)
 - Importance for Cyber Security (the “why”): How systems work; concurrency, resource management, interfaces, and hiding complexity, system design; no magic.³
3. Networks (COMP 112)

¹ <https://twitter.com/jeremiahg/status/875111993463644160>

² <https://security.stackexchange.com/questions/11700/programming-language-for-network-security>

³ <https://blog.regehr.org/archives/164>

- Importance for Cyber Security (the “why”): How computers talk to each other; not understanding networks and you will not understand the attribution problem.
4. Web Programming (COMP 20)
 - Importance for Cyber Security (the “why”): How the web works; HTTP, Same-Origin Policy, JavaScript, client-server architecture, basic web security. Web application attacks accounted for over 60% of all incidents.⁴
 5. The Cyber Security Capstone (see below)

Cyber Security Cluster Electives

Pick at least 2 courses from the following list:

1. Cyberlaw and Cyberpolicy (COMP 150)
2. Program Analysis, Verification, and Synthesis (COMP 150)
3. Cyber Security and Cyber Warfare (COMP 50 / PS 188)
4. Foundations of International Cyber Security (DHP P249)
5. Intelligence and National Security (PS 187)
6. Cyber in the Civil Sector (COMP 150)
7. Privacy in the Digital Age (COMP 250)

Capstone

Doing the bare minimum coursework is not good enough. To be successful in cyber security, you will need practical hands-on experience. To quote:

*"When I joined the Facebook security team last year, it was in large part because of the experience I gained through CTFs. When I was a student at the University of Michigan, the TA for my security class introduced me to CTFs, which exposed me to a fun and practical side of security that I didn't get in class. For example, I learned about RSA encryption in my computer science courses, but CTFs taught me how to break it when it wasn't properly implemented, which happens all the time in the real world. It's a lot of fun to learn this offensive side of security, but at the same time learning about these flaws makes you a better defender as well. Eventually I helped start the CTF club at the University of Michigan and later joined an international CTF team called Samurai, that competes at DEF CON every year."*⁵

You can fulfill the capstone de facto requirement in our Cyber Security focus area by one of the following ways:

1. Do a year long senior capstone project via COMP 97 and COMP 98
2. Compete in the MITRE Embedded Capture the Flag Competition in spring semester of junior or senior year.
3. Compete in the Booz Allen Hamilton and Maryland Cybersecurity Center Build it Break it Fix it Competition in the fall semester of junior or senior year.
4. Compete in the National Collegiate Cyber Defense Competition (CCDC) Competition in the spring semester of junior or senior year.

⁴ <https://www.scmagazine.com/web-application-attacks-accounted-for-73-of-all-incidents-says-report/article/682294/>

⁵ <https://www.facebook.com/notes/facebook-ctf/facebook-ctf-is-now-open-source/525464774322241/>

- Compete in the Atlantic Council Cyber 9/12 Student Competition in the fall or spring semester of junior or senior year.

Roadmap

Your experience may vary, but this table represents a typical student's progression through the program based on the School of Engineering degree sheet for Computer Science⁶:

| Fall Semester, Year 1 | SHUs | Spring Semester, Year 1 | SHUs |
|---|------|---|------|
| Introductory Engineering (EN1) | | Intro to Computing in Engineering (ES2) | |
| Calculus I (MATH 32) | | Calculus II (MATH 34 or 36) | |
| Physics I (PHY 11) | | Chemistry I (CHEM 1) | |
| First Year Writing (ENG 1) | | Data Structures (COMP 15) | |
| Intro. to Computer Science (COMP 11) | | Web Programming (COMP 20) | |
| | | | |
| Fall Semester, Year 2 | SHUs | Spring Semester, Year 2 | SHUs |
| Machine Structure & Assembly-Language Programming (COMP 40) | | Intro. to Digital Logic Circuits (ES4) | |
| Discrete Mathematics (MATH 61) | | Calculus III (MATH 42) | |
| Introduction to Electrical Engineering (ES3) | | Physics II or Chemistry II | |
| HASS | | Algorithms (COMP 160) | |
| | | HASS | |
| | | | |
| Fall Semester, Year 3 | SHUs | Spring Semester, Year 3 | SHUs |
| Programming Languages (COMP 105) | | Networks (COMP 112) | |
| Intro. to Computer Security (COMP 116) | | Cyber Security Cluster Elective | |
| HASS | | HASS | |
| Free Elective | | Probability & Statistics | |
| | | Breadth Elective | |
| | | | |
| Fall Semester, Year 4 | SHUs | Spring Semester, Year 4 | SHUs |
| Theory of Computation (COMP 170) | | Capstone (COMP 98) | |
| Operating Systems (COMP 111) | | Breadth Elective | |
| Capstone (COMP 97) | | Breadth Elective | |
| Cyber Security Cluster Elective | | Free Elective | |
| Natural Science Elective | | HASS | |

⁶ http://students.tufts.edu/sites/default/files/BSCS2021-DegreeSheet_0.pdf