Cybersecurity, PhD

A research-based, interdisciplinary Doctor of Philosophy (PhD) in Cybersecurity combines a strong security technical foundation with a security policy and social sciences perspective. It seeks to prepare graduates to advance the state of the art of security in systems, networks, and the internet in industry, academia, and government. The interdisciplinary nature of the program distinguishes it from traditional doctoral degree programs in computer science, engineering, or social sciences and makes it unique in the Boston area.

Students who choose the PhD in Cybersecurity program have a strong desire to pursue academic research solving critical cybersecurity challenges facing today's society. The PhD program is a natural path for students in the college's Master of Science in Cybersecurity (http://www.ccs.neu.edu/graduate/degree-programs/m-s-in-information-assurance/)program who want to pursue research and students with bachelor's degrees and an interest in research-focused careers. Students who pursue careers in advancing the state of the art of cybersecurity have an opportunity to gain:

- A strong technical foundation in cybersecurity and an interdisciplinary perspective based on policy and social science
- A path to a research-focused career coupled with depth in information assurance research at a leading institution, one of the earliest designees by NSA/DHS as a National Center of Academic Excellence in Information Assurance Research, Information Assurance/Cyber Defense, and Cyber Operations
- The opportunity to work with and learn from faculty who are recognized internationally for their expertise and contributions in information assurance from Northeastern University's Khoury College of Computer Sciences, the Department of Electrical and Computer Engineering, and the College of Social Sciences and Humanities
- Access to research projects at Northeastern's research centers focused on security:
  - The Cybersecurity and Privacy Institute (https://cyber.ccis.northeastern.edu/about/): The mission of Northeastern's Cybersecurity and Privacy Institute is to safeguard critical technology. Forging partnerships with experts in industry, government, and academia worldwide, the Institute's faculty and students develop, protect, and enhance technologies on which the world relies—from mobile devices and "smart" IoT applications to tomorrow's self-driving cars and delivery drones. Their expertise spans algorithm auditing; cloud security; cryptography; differential privacy; embedded device security; internet-scale security measurements; machine learning; big data; security, malware, and advanced threats; network protocols and security; web and mobile security; and wireless network security.
  - The International Secure Systems Lab (http://www.iseclab.org/), affiliated with Northeastern, a collaborative effort of European and U.S. researchers focused on web security, malware, and vulnerability analysis; intrusion detection; and other computer security issues.
  - The ALERT Center (http://www.northeastern.edu/alert/), where Northeastern is the lead institution, a multiuniversity Department of Homeland Security Center of Excellence involved in research, education, and technology related to threats from explosives.

The benefits of the Boston area:

- World-renowned for academic and research excellence, the Boston area is also home to some of the nation's largest Department of Defense contractors and government and independent labs such as MIT Lincoln Lab, MITRE, and Draper Lab.

Degree Requirements

The PhD in Cybersecurity degree requires completion of at least 48 semester semester hours beyond a bachelor's degree. Students who enter with an undergraduate degree will typically need four to five years to complete the program, and they will be awarded a master's degree en route to the PhD.

Doctoral Degree Candidacy

A student is considered a PhD degree candidate after completing the core courses with at least a 3.500 GPA, with no grades lower than a B in the core courses, and either publishing a paper in a strong conference or journal or passing an oral exam that is conducted by a committee of three cybersecurity faculty members and based on paper(s) written by the student.

RESIDENCY

One year of continuous full-time study is required after admission to the PhD candidacy. During this period, the student will be expected to make substantial progress in preparing for the comprehensive examination.

TEACHING REQUIREMENT

All cybersecurity PhD students must satisfy the teaching requirement in order to graduate. This requirement is fulfilled when the student works as a teaching assistant or instructor of record for one semester and during this semester:

- Teaches at least three hours of classes
- Prepares at least one assignment or quiz or equivalent

PhD students are expected to satisfy the teaching requirement some time after completing their first year and at least one semester prior to scheduling their PhD defense.

DISSERTATION ADVISING
The doctoral dissertation advising team for each student consists of two cybersecurity faculty members, one in a technical area. When appropriate, the second faculty advisor will be from the policy/social science area.

DISSERTATION COMMITTEE
With the help of the advisor, a student selects the committee, consisting of at least four members, to be approved by the PhD cybersecurity curriculum committee. The four members must include the advisor, two internal members, and an external member.

COMPREHENSIVE EXAMINATION
A PhD student must submit a written dissertation proposal and present it to the dissertation committee. The proposal should identify the research problem, the research plan, and the potential impact of the research on the field. The presentation of the proposal will be made in an open forum, and the student must successfully defend it before the dissertation committee after the public presentation.

DISSERTATION DEFENSE
A PhD student must complete and defend a dissertation that involves original research in cybersecurity.

AWARDING OF MASTER'S DEGREES
Students who enter the PhD in Cybersecurity program with a bachelor's degree have the option of earning a master's degree from one of the departments participating in the program. To do so, they must meet all of the department's degree requirements.

Program Requirements

- Concentrations and course offerings may vary by campus and/or by program modality. Please consult with your advisor or admissions coach for the course availability each term at your campus or within your program modality.
- Certain options within the program may be *required* at certain campuses or for certain program modalities. Please consult with your advisor or admissions coach for requirements at your campus or for your program modality.

Bachelor's Degree Entrance
Complete all courses and requirements listed below unless otherwise indicated.

Milestones
Teaching
Qualifying exam and area exam
Annual review
Dissertation proposal
Dissertation committee
Dissertation defense

Core Requirements
A grade of B or higher is required in each core course. A cumulative 3.500 grade-point average is required for the core requirement.

Code	Title	Hours
Foundations		
CY 5240	Cyberlaw: Privacy, Ethics, and Digital Rights	4
CY 5770	Software Vulnerabilities and Security	4
or EECE 5641	Introduction to Software Security	
CY 6740	Network Security	4
or EECE 5699	Computer Hardware and System Security	

Electives and Tracks

Code	Title	Hours
Note: Consult faculty advisor for other acceptable courses.		
Tracks		
Select at least two courses from one track:		8
Hardware Security		
CS 6410	Compilers	
CS 6710	Wireless Network	
EECE 5666	Digital Signal Processing	
EECE 7352	Computer Architecture	

EECE 7364	Mobile and Wireless Networking
EECE 7390	Computer Hardware Security
Machine Learning	
CS 5700	Fundamentals of Computer Networking
CS 6140	Machine Learning
CS 7150	Deep Learning
EECE 5644	Introduction to Machine Learning and Pattern Recognition
EECE 7397	Advanced Machine Learning
Network Security	
CS 6710	Wireless Network
CY 6740	Network Security
CS 7610	Foundations of Distributed Systems
CS 7775	Seminar in Computer Security
CY 5130	Computer System Security
EECE 5155	Wireless Sensor Networks and the Internet of Things
EECE 5576	Wireless Communication Systems
EECE 7336	Digital Communications
EECE 7364	Mobile and Wireless Networking
EECE 7374	Fundamentals of Computer Networks
Systems Security	
CS 6410	Compilers
CS 7600	Intensive Computer Systems
CS 7610	Foundations of Distributed Systems
CY 5130	Computer System Security
CY 6740	Network Security
CY 6760	Wireless and Mobile Systems Security
EECE 7352	Computer Architecture
Theory	
CS 7800	Advanced Algorithms
CS 7805	Complexity Theory
CS 7810	Foundations of Cryptography
CS 7870	Seminar in Theoretical Computer Science
EECE 7337	Information Theory
Usable Security and Privacy	
CS 6350	Empirical Research Methods
CS 6760	Privacy, Security, and Usability
CS 7340	Theory and Methods in Human Computer Interaction
INSH 6300	Research Methods in the Social Sciences
INSH 6302	Qualitative Methods
INSH 6500	Statistical Analysis
INSH 7400	Quantitative Analysis
Cybersecurity Policy	
CRIM 6200	Criminology
CRIM 6262	Evidence-Based Crime Policy
CY 5200	Security Risk Management and Assessment
CY 5210	Information System Forensics
CY 5250	Decision Making for Critical Infrastructure
POLS 7341	Security and Resilience Policy
Electives	
Selected in consultation with advisor from graduate-level CS and ECE courses and graduate-level courses offered by the College of Social Sciences and Humanities, including CRIM, CS, CY, DS, EECE, INSH, MATH and POLS.	28

Dissertation

Code	Title	Hours
CY 9990	Dissertation Term 1	
CY 9991	Dissertation Term 2	
Complete the following (repeatable) course until graduation:		
CY 9996	Dissertation Continuation	

Program Credit/GPA Requirements

48 total semester hours required
Minimum 3.000 GPA required

Advanced Entry Program Requirements

- Concentrations and course offerings may vary by campus and/or by program modality. Please consult with your advisor or admissions coach for the course availability each term at your campus or within your program modality.
- Certain options within the program may be *required* at certain campuses or for certain program modalities. Please consult with your advisor or admissions coach for requirements at your campus or for your program modality.

Degree Requirements

Incoming PhD in Cybersecurity students who have already completed a Master of Science in an adjacent field may petition to the graduate program administration for advanced entry. Advanced entry petitions are reviewed by the program administration on a case-by-case basis. Please note that advanced entry does not waive by itself any part of the PhD coursework requirements. As a degree conferral requirement, a minimum of 16 semester hours of coursework beyond the 32 semester hours of the master's degree is required of advanced entry PhD students (48 semester hours is required of standard entry PhD students). A grade of B or higher is required in each course. A cumulative 3.500 GPA is required for the core requirement.

Doctoral Degree Candidacy

Refer to the PhD Cybersecurity overview (p. 1) for admission to candidacy requirements.

Residency

Refer to the PhD Cybersecurity overview (p. 1) for residency requirements.

Teaching Requirement

Refer to the PhD Cybersecurity overview (p. 1) for teaching requirements.

Dissertation Advising

Refer to the PhD Cybersecurity overview (p. 1) for dissertation advising requirements.

Dissertation Committee

Refer to the PhD Cybersecurity overview (p. 1) for dissertation committee requirements.

Comprehensive Examination

Refer to the PhD Cybersecurity overview (p. 1) for comprehensive examination requirements.

Dissertation Defense

Refer to the PhD Cybersecurity overview (p. 1) for dissertation defense and completion requirements.

Complete all courses and requirements listed below unless otherwise indicated.

Milestones

Teaching
Qualifying exam and area exam
Annual review
Dissertation proposal
Dissertation committee
Dissertation defense

Core Requirement

Students must maintain a minimum GPA of 3.500 as well as earn a grade of B or better in each core course.

Code	Title	Hours
Consult your faculty advisor for approved courses.		16

Dissertation

Code	Title	Hours
CY 9990	Dissertation Term 1	
CY 9991	Dissertation Term 2	
Complete the following (repeatable) course until graduation:		
CY 9996	Dissertation Continuation	

Program Credit/GPA Requirements

Minimum 16 semester hours required
Minimum 3.000 GPA required