Students can apply for admission to two distinct degree programs.

**Doctor of Philosophy (PhD) in Cybersecurity**
A research-based, interdisciplinary PhD in cybersecurity spans theory and systems, from hardware to software security, from cryptography to policy, and from malware to wireless security. 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.

**Master of Science (MS) in Cybersecurity**
An industry-focused, interdisciplinary Master of Science in Cybersecurity combines knowledge of information security technology and cybersecurity hands-on tools with relevant knowledge from law, the social sciences, criminology, and management. The Master of Science in Cybersecurity is designed for students focused on cybersecurity careers in companies or government agencies, thus applying their knowledge to their workplaces to assess security threats and manage information security risks and technical and policy controls.

Northeastern University designations by the National Security Agency (NSA) and the Department of Homeland Security (DHS):

- NSA/DHS Center of Academic Excellence in Cybersecurity—Cyber Defense Education
- NSA/DHS Center of Academic Excellence in Cybersecurity—Research
- NSA/DHS Center of Academic Excellence in Cybersecurity—Cyber Operations

**Align Master of Science (MS) in Cybersecurity**
Without exception, every organization needs to protect their information system. Every day cyber risks are becoming more complex, and the sophistication and number of threats is growing continuously. For these reasons, cybersecurity professionals need to become more prepared, with a very solid background and with the capacity to evolve and adapt to the current and future information systems challenges.

Organizations are looking for well-rounded cyber professionals, who, beside their understanding of information technologies, can also comprehend the many other dimensions that contribute to effective and efficient information systems security. Professionals with diversified backgrounds are particularly interesting because they are able to provide different approaches to complex cybersecurity problems.

Align-MSCY students are perfect cybersecurity professionals, because they have proven their adaptability to the cybersecurity field and also because they bring an invaluable experience and knowledge from other areas to contribute to a global perspective of the organization cybersecurity posture.

**Courses**

**Cybersecurity Courses**
Search CY Courses using FocusSearch (http://catalog.northeastern.edu/class-search/?subject=CY)

**CY 5001. Cyberspace Technology and Applications. (4 Hours)**
Seeks to provide a systematic understanding of cyberspace technology and applications deployed in the global digital infrastructure. Covers topics in computer networks, server architectures, operating systems, and scripting. All the techniques and tools included in the course are oriented to serve as instruments of security administrators and cybersecurity professionals. Uses practical hands-on labs running on virtual machines and containers hosted in the cloud computing environment to train students. For that reason, a practical overview of virtualization technologies, containerization, and cloud computing models is provided.

**CY 5002. Concrete Mathematics. (3 Hours)**
Offers students an opportunity to obtain a systematic understanding of mathematics necessary for mastering cyberspace tools and methods. Seeks to train students in mathematical concepts and the pragmatic use of these concepts in the field of information assurance and cybersecurity. Covers theory and hands-on exercises. Combines lectures with computer-based examples and assignments. Students not in the information assurance ALIGN program may require instructor approval for enrollment.

**CY 5004. Introduction to Cyberspace Programming 1. (3 Hours)**
Offers students an opportunity to obtain a systematic understanding of cyberspace programming languages and methods. Seeks to train students in Python using command-line interface-based editors and compilers, as well as integrated development environments, with industry-standard operating systems running on virtual machines. Trains students by implementing programming principles and methods, spanning the evolution of computer systems. Combines lectures with multiple computer-based exercises. Students not in the information assurance ALIGN program may require instructor approval for enrollment.
CY 5010. Foundations of Information Assurance. (4 Hours)

Presents an overview of basic principles and security concepts related to information systems, including operating system security, communications and network security, and software security. Introduces information security via concepts of confidentiality, integrity, and availability. Discusses ethical, legal, and privacy ramifications while reviewing various laws such as the Patriot Act, GLBA, and Global Data Privacy regulation. Covers security methods, controls, procedures, economics of cybercrime, criminal procedure, and forensics. Describes the use of cryptography as a tool, software development processes, and protection. Seeks to build a common cross-disciplinary understanding in the foundations of information assurance and cybersecurity.

CY 5040. Introduction to Cyberspace Programming 2. (4 Hours)

Offers a small-group laboratory format to cover lab requirements in labs to reinforce skills and provide practical experience. Also discusses topics in data security and virtualization. Uses hands-on authentication, access control, integrity, and audit to the modern systems security, and related topics. Applies concepts such as assurance building blocks, such as authentication, digital signatures, and hash functions (e.g., the SHA family). Discusses core information protection. Seeks to build a common cross-disciplinary understanding in the use of cryptography as a tool, software development processes, and protection.

Prerequisite(s): CS 2550 with a minimum grade of D- or CY 2550 with a minimum grade of D- or IA 5010 with a minimum grade of C- or CY 5010 with a minimum grade of D- or graduate program admission.

CY 5130. Computer System Security. (4 Hours)

Offers a practical overview of enterprise computer security, operating systems security, and related topics. Applies concepts such as authentication, access control, integrity, and audit to the modern operating system. Discusses and demonstrates system, process, memory, and file system-level defenses—and the attacks against them. Also discusses topics in data security and virtualization. Uses hands-on labs to reinforce skills and provide practical experience.

CY 5150. Network Security Practices. (4 Hours)

Explores issues involved in the security of computer networks. Topics include firewalls, viruses, virtual private networks, Internet security, and wireless security. Includes case studies and laboratory exercises. Restricted to students in the College of Computer and Information Science or by permission of instructor.

CY 5151. Lab for CY 5150. (0 Hours)

Offers a small-group laboratory format to cover lab requirements for CY 5150.

CY 5200. Security Risk Management and Assessment. (4 Hours)

Creates the opportunity for competency in the development of information security policies and plans including controls for physical, software, and networks. Discusses different malicious attacks, such as viruses and Trojan horses, detection strategies, countermeasures, damage assessment, and control. Covers information system risk analysis and management, audits, and log files. Uses case studies, site visits, and works with commercial products.

Prerequisite(s): CS 2550 with a minimum grade of D- or CY 2550 with a minimum grade of D- or IA 5010 with a minimum grade of C- or CY 5010 with a minimum grade of D- or graduate program admission.

CY 5210. Information System Forensics. (4 Hours)

Designed to allow students to explore the techniques used in computer forensic examinations. Examines computer hardware, physical and logical disk structure, and computer forensic techniques. Conducts hands-on experiences on DOS, Windows operating systems, Macintosh, Novell, and Unix/Linux platforms. Builds on basic computer skills and affords hands-on experience with the tools and techniques to investigate, seize, and analyze computer-based evidence using a variety of specialized forensic software in an IBM-PC environment.

Prerequisite(s): CS 2550 with a minimum grade of D- or CY 2550 with a minimum grade of D- or IA 5010 with a minimum grade of C- or CY 5010 with a minimum grade of D- or graduate program admission.

CY 5211. Lab for CY 5210. (0 Hours)

Offers a small-group laboratory format to cover lab requirements for CY 5210.

CY 5240. Cyberlaw: Privacy, Ethics, and Digital Rights. (4 Hours)

Describes the legal and ethical issues associated with information security including access, use, and dissemination. Emphasizes legal infrastructure relating to information assurance, such as the Digital Millenium Copyright Act and Telecommunications Decency Act, and emerging technologies for management of digital rights. Examines the role of information security in various domains such as healthcare, scientific research, and personal communications such as email. Examines criminal activities such as computer fraud and abuse, desktop forgery, embezzlement, child pornography, computer trespass, and computer piracy.

Prerequisite(s): CS 2550 with a minimum grade of D- or CY 2550 with a minimum grade of D- or IA 5010 with a minimum grade of C- or CY 5010 with a minimum grade of D- or graduate program admission.

Attribute(s): NUpath Ethical Reasoning, NUpath Writing Intensive
CY 5250. Decision Making for Critical Infrastructure. (4 Hours)
Focuses on the art and science of security program management leadership in the context of critical infrastructure protection programs. Includes selected readings, review of decision-making models in crisis, lectures and insights from accomplished leaders in infrastructure protection, and examination of the students’ own unique background and experiences. Trains students on the interaction of vulnerabilities, threats, and countermeasures and how to apply this knowledge to the protection of critical infrastructure using research and analysis of national and global strategies, historical and current legislation, and policies. Also seeks to give students a working knowledge of federal, state, and private-sector critical infrastructure protection resources and programs.

CY 5770. Software Vulnerabilities and Security. (4 Hours)
Seeks to help students to become aware of systems security issues and to gain a basic understanding of security. Presents the principal software and applications used in the Internet, discussing in detail the related vulnerabilities and how they are exploited. Also discusses programming vulnerabilities and how they are exploited. Examines protection and detection techniques. Includes a number of practical lab assignments as well as a discussion of current research in the field.

CY 5976. Directed Study. (1-4 Hours)
Seeks to provide cybersecurity (CY) students with the training experience of working on a specific IA project under the direction of an CY instructor. The instructor provides students with a plan of seminar sessions, including lectures, research, and development of project deliverables and with direction to complete the course. May be repeated without limit.

CY 5978. Independent Study. (2-4 Hours)
Offers independent work under the direction of members of the department on a chosen topic. Course content depends on instructor. May be repeated without limit.

CY 5984. Research. (2-4 Hours)
Offers an opportunity to conduct research under faculty supervision. May be repeated without limit.

CY 6120. Software Security Practices. (4 Hours)
Explores the fundamentals of software security issues from a practical perspective. Takes a deeper dive into the low-level mechanisms used in a variety of most prevalent software security issues and discusses some of the industry best practices needed to address the issues. Offers students an opportunity to learn both an attacker’s and defender’s perspectives when it comes to software security issue exploitation, detection, and mitigation. Incorporates a number of practical C and assembly coding and lab assignments. Includes an overview of some of the state-of-the-art software security issue exploitation and mitigation techniques used in the field.

Prerequisite(s): CY 5010 with a minimum grade of C-

CY 6121. Lab for CY 6120. (0 Hours)
Offers a small-group laboratory format to cover lab requirements for CY 6120.

CY 6200. Special Topics in IT Security Governance, Risk, and Compliance. (1-4 Hours)
Offers various topics in IT security governance, risk, and compliance. May be repeated for up to 8 total credits.

CY 6240. Special Topics in Privacy Law. (1-4 Hours)
Offers various topics in privacy law. May be repeated for up to 8 total credits.

CY 6720. Machine Learning in Cybersecurity and Privacy. (4 Hours)
Covers a range of theoretical and applied topics related to machine learning uses in security and privacy. Examines vulnerabilities of machine learning and deep learning algorithms and the challenges of securing these systems in real-world applications. Machine learning and AI have enabled a number of critical applications—such as machine translation, speech recognition, and precision medicine—with large positive impact to our daily lives.

CY 6740. Network Security. (4 Hours)
Studies the theory and practice of computer security, focusing on the security aspects of multiuser systems and the Internet. Introduces cryptographic tools, such as encryption, key exchange, hashing, and digital signatures in terms of their applicability to maintaining network security. Discusses security protocols for mobile networks. Topics include firewalls, viruses, Trojan horses, password security, biometrics, VPNs, and Internet protocols such as SSL, IPSec, PGP, SNMP, and others.

CY 6750. Cryptography and Communications Security. (4 Hours)
Studies the design and use of cryptographic systems for communications and other applications such as e-commerce. Discusses the history of cryptographic systems, the mathematical theory behind the design, their vulnerability, and the different cryptanalytic attacks. Topics include stream ciphers including shift register sequences; block ciphers, such as DES and AES; public-key systems including RSA, discrete logarithms; signature schemes; hash functions, such as MD5 and SHA1; and protocol schemes including identification schemes, zero-knowledge proofs, authentication schemes, and secret sharing schemes. Discusses key management problems including Needham-Schroeder protocols and certificates.

Prerequisite(s): CS 5800 with a minimum grade of C- or CS 7800 with a minimum grade of C-

CY 6962. Elective. (1-4 Hours)
Offers elective credit for courses taken at other academic institutions. May be repeated without limit.

CY 7790. Special Topics in Security and Privacy. (4 Hours)
Offers various topics in security and privacy. May be repeated for up to 8 total credits.

CY 7900. Capstone Project. (4 Hours)
Draws together candidates from diverse backgrounds (technical, legal, and/or law enforcement) in a collaborative activity to address one or more security issues from an integrated perspective. Requires a project proposal, generally industrially oriented, to be submitted and accepted prior to the semester in which the project is to be undertaken.

CY 7962. Elective. (2-4 Hours)
Offers elective credit for courses taken at other academic institutions. May be repeated without limit.

CY 7990. Thesis. (2-4 Hours)
Offers selected work with the agreement of a project supervisor. May be repeated without limit.
**CY 7995. Project. (1-4 Hours)**
Offers students an opportunity to participate in a direct cybersecurity project under the supervision of a faculty member. May be repeated once for a total of 8 credits.

**CY 8660. Research Project in National Information Security. (4 Hours)**
Engages students in national cybersecurity/information systems security problems. Offers students an opportunity to learn how to apply research techniques, think clearly about these issues, formulate and analyze potential solutions, and communicate their results. Working in small groups under the mentorship of technical clients from government and industry, each student has an opportunity to formulate, carry out, and present original research on current cybersecurity/information assurance problems of interest to the nation. Requires permission of instructor. May be repeated once.

**CY 8982. Readings. (1-8 Hours)**
Offers selected readings under the supervision of a faculty member. May be repeated without limit.

**CY 9000. PhD Candidacy Achieved. (0 Hours)**
Indicates successful completion of program requirements for PhD candidacy.

**CY 9990. Dissertation Term 1. (0 Hours)**
Offers selected work with the agreement of a thesis supervisor.

**Prerequisite(s):** CY 9000 with a minimum grade of S

**CY 9991. Dissertation Term 2. (0 Hours)**
Offers dissertation supervision by members of the department.

**Prerequisite(s):** CY 9990 with a minimum grade of S

**CY 9996. Dissertation Continuation. (0 Hours)**
Continues work with the agreement of a thesis supervisor.

**Prerequisite(s):** CY 9991 with a minimum grade of S or Dissertation Check with a score of REQ