MASTER OF SCIENCE IN CYBERSECURITY

https://engineering.pacific.edu/engineering/academics/online-masters-cybersecurity
Phone: (209) 946-7443
Location: Stockton

Programs Offered

Master of Science in Cybersecurity

Program Overview

The Master of Science in Cybersecurity program provides students with in-depth knowledge in key areas of Computer Science and Computer Engineering such as cyber defense, cryptography, secure software development, vulnerability detection, wired and wireless networking, and low-level programming. Students learn a variety of in-demand skills, including detecting and preventing network attacks; identifying and preventing vulnerabilities in software applications; reverse engineering malware to understand its design, operation, and communications protocols; the use of cryptography in cybersecurity; and network reconnaissance, intrusion, and data exfiltration from both a defensive and offensive standpoint. This 30-unit program includes extensive hands-on labs, exercises, and projects.

Admission Criteria for Master of Science in Cybersecurity

The following admissions requirements have been set for entry into the program:

- Bachelors degree
- Official university transcript(s) showing a 2.65 GPA or above on a 4.0 scale
- Educational qualifications and/or work experience in:
  - Computer programming (any language)
- Two letters of recommendation

Academic Policies for Master of Science in Cybersecurity

Cybersecurity Prerequisite Requirement

All course prerequisites in the MS in Cybersecurity program must be passed with a grade of C or higher.

Courses Taken Pass/No Credit

All courses that count toward the MS in Cybersecurity must be taken for a letter grade.

Student Learning Outcomes

The MS in Cybersecurity program prepares graduates for careers in the field of enterprise and product security. The ten student learning outcomes are:

1. **Security Fundamental Principles** – Students will possess a thorough understanding of the fundamental principles underlying cybersecurity, how these principles interrelate and are employed to build secure systems.
2. **Cyber Defense** – Students will have a sound understanding of the technologies and methods utilized to defend computer systems and networks.
3. **Software Security** – Students will be able to apply software security design principles, secure coding practices, testing methodologies, and deployment techniques to produce secure software programs supported by secure software management lifecycles.
4. **Vulnerability Management** – Students will possess a thorough understanding of the various types of security vulnerabilities, their underlying causes, their identifying characteristics, the ways in which they are exploited, and potential mitigation strategies. Students will be able to track the entire life cycle of vulnerabilities across an organization, and report and quantify vulnerabilities with metrics.
5. **Incident Response** – Students will be equipped with the tools and techniques to detect and respond to data breaches and cyberattacks. They will be able to investigate and take action based on incident response plans, forensic analysis tools, and escalation management techniques.
6. **Networking Fundamentals** – Students will have a thorough understanding of how networks work at the infrastructure, network and applications layers, how they transfer data, how network protocols work to enable communication, and how the lower-level network layers support the upper ones to enable communications and data transfer.
7. **System Security** – Students will be able to maintain confidentiality, integrity, and availability of on-premise and cloud-based computer systems through the use of appropriate network and system security settings, best management practices, and analytics and monitoring tools.
8. **Governance, Risk, and Compliance** – Students will be able to apply cybersecurity risk management techniques as well as industry standards and certifications to real-world enterprise scenarios.
9. **Privacy Management** – Students will be able to develop a security strategy including policy and procedures to ensure compliance with both the foundational principles of data privacy and privacy-focused state and national regulations.
10. **Communication Skills** – Students will be able to communicate effectively with both technical and non-technical audiences.

Master of Science in Cybersecurity

Students must complete a minimum of 30 units with a Pacific cumulative grade point average of 3.0 to earn the Master of Science in Cybersecurity degree.

Technical On-Ramp		
COMP 280	Cybersecurity Bootcamp	4
Technical Core		
Select 6 courses:		
COMP 270	Secure Software Systems	3
COMP 271	Vulnerabilities	3
COMP 272	Software Reverse Engineering	3
COMP 275	Network Security and System Administration Essentials	3
COMP 276	Security Operations: Incident Response and Digital Forensics	3
COMP 277	Advanced Computer Networking	3
COMP 278	Cyber Defense and Offense	3
COMP 279	Cybersecurity Advanced Topics	3
COMP 283	Vulnerability Management	3
COMP 284	Cybersecurity Governance, Risk and Compliance	3
COMP 285	Mobile and Cloud Security	3

COMP 286	Cybersecurity and Privacy Management	3
Technical Electives		
Select 2 courses:		
Any 200-level COMP course		3-4
Capstone		
COMP 282	Cybersecurity Capstone Project	3
Course Substitutions: A maximum of 6 units of upper division undergraduate courses (100 level) can count towards the 30 units required for the MS in Cybersecurity.		

Computer Science Courses

COMP 025. Computers and Information Processing. 4 Units.
This introductory information technology course focuses on computer architecture, networking, internet technologies and the integration of productivity software. Lectures, readings, hands-on projects and lab assignments give a variety of learning experiences. Specific topics include computer architecture, digital data, networking, file management, spreadsheets, database systems and presentation applications. Students are exposed to JavaScript and Visual Basic scripting. Particular emphasis is placed on HTML programming and creating an interactive student website for homework and lab linking throughout the semester. Prerequisite: Fundamental Math Skills requirement. **(GE3B, GEQR)**

COMP 041. Great Ideas in Computing. 4 Units.
This course is a broad introduction to the field of computing. The concepts that are the foundation of computing are presented and placed in historical context. Discussion topics include the ways of thinking and working that make computing effective, and the future of the field. Example topics include number representation, architecture of computing systems, intelligent computing systems, and the use of computing in art and games. Prerequisite: Fundamental Math Skills requirement. **(GE3C, GEQR)**

COMP 047. Discrete Math for Computer Science. 4 Units.
This course is designed to develop skills in deductive reasoning and to apply concepts of discrete mathematics to computer science. Topics include logic, deductive reasoning, introduction to analysis of algorithms, mathematical induction, set theory, functions, recurrence relations, combinatorics and probability, graphs, and trees. Prerequisite: Fundamental Math Skills requirement. **(GE3B, GEQR)**

COMP 051. Introduction to Computer Science. 4 Units.
The course emphasizes program design and problem solving techniques that use a high-level programming language. The course introduces basic concepts such as assignment, control flow, iteration, and basic data structures in addition to a supervised lab. Credit for this course is not given if a student has credit for COMP 061. Prerequisite: Fundamental Math Skills requirement. **(GE3B, GEQR)**

COMP 053. Data Structures. 4 Units.
The course continues the development of program design and problem solving techniques. Topics include development of fundamental data structures and their associated algorithms as well as array-based algorithms, recursion, lists, generics, dynamic memory, binary trees, and associative structures. Prerequisite: COMP 051 or COMP 061 with a "C-" or better.

COMP 055. Application Development. 4 Units.
This course develops the skills and techniques required for the creation of contemporary software applications. Contemporary software applications are complex systems that involve the interaction of multiple subsystems that require teams of developers working together for extended periods of time. Topics include teamwork and communication skills, current development methodologies, analysis and design documentation and the use of libraries. This course is intended to prepare students to transition to upper division courses. Prerequisites: Completion of all Fundamental Skills and COMP 053 with a "C-" or better.

COMP 061. Introduction to Programming for Data Science. 4 Units.
This course introduces programming concepts and program design using topics in data science as examples. Basic concepts such as assignment, control flow, iteration, and simple as well as object-oriented data types and structures are developed. The course includes a supervised lab. Credit for this course is not given if student has credit for COMP 051. Prerequisite: Fundamental Math Skills requirement. **(GE3B, GEQR)**

COMP 093. Special Topics. 3 or 4 Units.

COMP 127. Web Applications. 4 Units.
The World-Wide Web consists of client-server applications operating over the Internet. This course introduces the skills and techniques for designing and developing web applications. Topics include: client-server architectures, web servers and web browsers, server-side programming, client-side programming, form processing, state management and multimedia. Prerequisites: Completion of all Fundamental Skills and COMP 053 with a "C-" or better or permission of instructor. (Fall, even years).

COMP 129. Software Engineering. 4 Units.
Students gain practical experience in dealing with medium to large scale software systems. Students learn how current analysis and design methodologies are used to develop the abstractions necessary to understand large systems. Students also learn how such methodologies and abstractions are used to communicate with coworkers and clients about the analysis and design. Because communication is an essential skill in large system development, students are expected to produce documents and presentations of professional quality and depth. Prerequisites: Completion of all Fundamental Skills and COMP 055 with a "C-" or better. (Spring, every year).

COMP 135. Human-Computer Interface Design. 3 Units.
Human-Computer Interface (HCI) Design focuses on the relationship between humans and computers or other physical devices. This course helps students develop an understanding of the common problems in designing these interfaces and presents a set of design techniques to ensure that designs are both useful and useable. Prerequisite: Completion of all Fundamental Skills. Junior standing. (Spring, every year).

COMP 137. Parallel Computing. 3 Units.
Parallel computing is a science which solves a large problem by giving small parts of the problem to many computers to solve and then combining the solutions for the parts into a solution for the problem. This course introduces architectures and implementation techniques to support parallel computation. Students are expected to design and implement an original parallel application as a term project. Prerequisite: Completion of all Fundamental Skills and COMP 053 with a "C-" or better. Corequisite: ECPE 170. (Spring, every year).

COMP 141. Programming Languages. 4 Units.
Topics in evaluation, design, and development of programming languages. Topics include type systems, variables and scope, functions, parameter passing, data hiding and abstractions, recursion, memory allocation, grammars and parsing, compiler architecture, programming paradigms, and comparison of programming languages and environments. Prerequisites: Completion of Fundamental Skills and COMP 053 with a "C-" or better.

COMP 147. Computing Theory. 4 Units.
Students study automata, formal languages and computability. Topics include finite state automata, regular languages, pushdown automata, context-free languages, Turing machines; decidability, reducibility, and time complexity that includes NP-completeness and intractability. Prerequisites: Completion of all Fundamental Skills; COMP 047 or ECPE 071 or MATH 074 with a "C-" or better.

COMP 151. Artificial Intelligence. 3 Units.
Students study fundamental concepts, techniques and tools used in Artificial Intelligence. Topics include knowledge representation, search techniques, machine learning and problem solving strategies. Also listed as ECPE 151. Prerequisites: Completion of all Fundamental Skills and COMP 053 with a "C-" or better. (Fall, odd years).

COMP 152. Machine Learning. 3 Units.
This course provides an introduction to machine learning using Python, the open source, programming language extensively adopted by the machine learning community and industry. In this course, you will use Python to learn machine learning concepts, terms and methodology, and gain an intuitive understanding of the mathematics underlying it by building actual applications. The techniques you'll learn can be a starting point to build real-world applications such as search engines, image analysis, bioinformatics, industrial automation, speech recognition, and more. Prerequisites: Completion of all Fundamental Skills and COMP 053 with a "C-" or better.

COMP 153. Computer Graphics. 3 Units.
An introduction to two and three dimensional computer graphics. Basic representations and mathematical concepts, object modeling, viewing, lighting and shading. Programming using OpenGL and other computer graphics applications. Also listed as ECPE 153. Prerequisites: Completion of all Fundamental Skills and COMP 053 with a "C-" or better. (Fall, even years).

COMP 155. Computer Simulation. 4 Units.
This course explores digital simulation, in which a model of a system is executed on a computer. The course focuses on modeling methodologies, mathematical techniques for implementing models, and statistical techniques for analyzing the results of simulations. Students develop simulations using both simulation development toolkits and general-purpose programming languages. Also listed as EMGT 155. Prerequisites: Completion of all Fundamental Skills; MATH 037 or MATH 039; MATH 045 or MATH 051, COMP 051 or ENGR 019 with a "C-" or better. (Fall, even years).

COMP 157. Design and Analysis of Algorithms. 4 Units.
Topics for this course include complexity analysis, algorithms for searching, sorting, pattern matching, combinatorial problems, optimization problems, backtracking, algorithms related to number theory, graph algorithms, and the limitations of algorithm power. Prerequisites: Completion of all Fundamental Skills; COMP 047 or MATH 074; COMP 053; MATH 045 or MATH 051 with a "C-" or better.

COMP 159. Computer Game Technologies. 4 Units.
This course surveys the technologies and processes used for modern video game development. Course topics include software engineering, media creation and management, hardware interfaces, user interaction, 3D mathematics and common algorithms and data structures to support graphics, physics and artificial intelligence. Prerequisite: Completion of all Fundamental Skills and COMP 055 with a "C-" or better. (Fall, odd years).

COMP 162. Data Analytics Programming. 4 Units.
This course develops programming skills for computational data analysis. The course emphasizes programming for statistical analysis, machine learning and predictive modeling. Other topics include programming packages for handling, preparation, and manipulation of data, as well as visualization tools for exploration and presentation of data and results. The course emphasizes hands-on data and analysis using a variety of real-world data sets and analytical objectives. Prerequisites: Completion of all Fundamental Skills; COMP 051 or COMP 061.

COMP 163. Database Management Systems. 4 Units.
A database management system (DBMS) is a computer application designed for the efficient and effective storage, access and update of large volumes of data. This course looks at such systems from two perspectives. The user-center perspective focuses on how a DBMS is used to build support for a data intensive application. This perspective includes examination of common data models, query languages and design techniques. The system implementation perspective focuses on the policies, algorithms and data structures used to design and implement a DBMS. Prerequisites: Completion of all Fundamental Skills and COMP 053 with a "C-" or better. Corequisite: COMP 047 or MATH 074. (Spring, every year).

COMP 173. Operating Systems. 4 Units.
Students are introduced to the fundamental concepts of modern operating systems. Topics include an overview of computer architecture and organization, process management, threads, and CPU scheduling. Students also study process synchronization that uses primitive and high-level languages, virtual memory management, file systems, system protection, and parallel and distributed computing. Prerequisites: Completion of all Fundamental Skills; COMP 053; COMP 175 or ECPE 170 with a "C-" or better or permission of instructor.

COMP 175. System Administration and Security. 3 Units.
This course provides an introduction to system administration of modern network servers and applications. Techniques to provide for data confidentiality, integrity, and availability are presented, both at the network security level and host security level, in order to resist common attacks and vulnerabilities. Topics include virtualization methods, resource provisioning in a cloud environment, command-line usage, installation and configuration of common network applications, containerized application deployment, password security and auditing, network configuration and firewalls, scripting, change management, and IT automation tools. Prerequisites: Completion of all fundamental skills and familiarity with console-based operating systems commands. Junior Standing.

COMP 177. Computer Networking. 4 Units.
Topics examined in this course include computer networks and the internet, LAN and WAN architectures, and packet switched networks and routing. Students learn about the internet protocol stack, socket programming and client/server systems, wireless networking and security. Also listed as ECPE 177. Prerequisites: Completion of all Fundamental Skills; COMP 053 and ECPE 170 with a "C-" or better. Junior or Senior standing. (Fall, every year).

COMP 178. Computer Network Security. 3 Units.
This course is an examination of computer security from a defensive and offensive perspective. Topics include attack methods used by threat actors (including scanning, exploits, privilege escalation, malware, and social engineering methods), their detection, and their prevention by network and host-based techniques. Additionally, cryptographic techniques are introduced in order to provide secure communications channels that guarantee message confidentiality, authenticity, and integrity. Prerequisites: Completion of all Fundamental Skills and ECPE 170 or COMP 175 with a "C-" or better.

COMP 180. Fundamentals of Computer Science. 3 Units.
The course emphasizes program design and problem solving techniques that use a high-level programming language. The course introduces basic concepts of programming and then applies them to discrete math concepts and data structures through supervised labs. Credit will not be given for this course if a student has received credit for COMP 051, COMP 061, COMP 053, COMP 047, or ENGR 019.

COMP 187. Internship in Computer Science. 1-4 Units.
This internship course offers cooperative employment in a professional computer science environment. The internship requires satisfactory completion of the work assignment and written reports. Prerequisites: Completion of all Fundamental Skills; COMP 055 and ENGR 025 with a "C-" or better. Grading is Pass/No Credit only.

COMP 191. Independent Study. 1-4 Units.
Students create student-initiated projects that cover topics not available in regularly scheduled courses. A written proposal that outlines the project and norms for evaluation must be approved by the department chairperson.

COMP 193. Special Topics. 4 Units.

COMP 195. CS Senior Project. 4 Units.
In this course, students synthesize their cumulative computer science knowledge through the development of a computer application. Students will establish design objectives and criteria, analyze solution alternatives and evaluate design performance. Students will then implement, test and evaluate the system. Results will include analysis and design documents, the implemented system, test reports and a presentation and demonstration of the project. Prerequisites: Completion of all Fundamental Skills, Senior Standing, COMP 055 with a "C-" or better.

COMP 197. Undergraduate Research. 1-4 Units.
Students conduct supervised research that contributes to current active topics in Computer Science. Topics may be selected by the student, related to faculty research, or provided by industrial sponsors. Permission of Undergraduate Research Coordinator.

COMP 227. Web Development. 3 Units.
This course is about the principles and techniques for designing and developing web applications. Topics include web application design, client-side web programming, and server-side web programming. Students are expected to read online resources and apply techniques to develop a website from scratch. Prerequisites: Programming Languages Core Skill.

COMP 229. Advanced Software Engineering. 3 Units.
Students gain practical experience in dealing with existing software systems. Students learn how existing software engineering practices are used to develop the abstractions necessary to understand and work with such systems. Students also learn how such methodologies and abstractions are used to communicate in a distributed environment with coworkers and clients surrounding the ideation, analysis, design and maintenance of systems. Because communication is an essential skill in large system development, students are expected to produce documents and presentations of professional quality and depth that can function in a remote working environment. Prerequisites: Programming Language Core Skill and Algorithms Core Skill and graduate students in the School of Engineering and Computer Science or instructor approval.

COMP 233. Software Engineering in Industry 4.0 Ecosystems. 3 Units.
In this course on Software Engineering within Industry 4.0 ecosystems, we will explore the integration and application of IoT and Cyber-Physical Systems (CPS). The course takes a dual perspective approach. First, we focus on user-centered aspects, examining how IoT and CPS are utilized to support and enhance data-driven applications, including discussions on models, communication protocols, and user interface design. The second perspective is system implementation, where we delve into the architecture, algorithms, and data structures fundamental to designing and deploying robust IoT and CPS. This comprehensive approach prepares students to meet the unique technological demands of Industry 4.0. Prerequisites: COMP 180 or COMP 053.

COMP 235. Interaction Design. 3 Units.
Interaction Design focuses on the relationship between humans and the use of interactive software applications and other physical devices. This course helps students develop an understanding of the common problems in designing interfaces for apps and devices and presents design and evaluation techniques to ensure that products are both useful and usable.

COMP 241. Programming Language Semantics. 3 Units.
This course studies the foundations of programming languages by exploring the static and dynamic language semantics from a theoretical perspective. Formal techniques are used to specify programming language semantics and the associated provable guarantees that these specifications provide. Prerequisites: Programming Language Core Skill and Computing Theory Core Skill and Graduate or blended students in the School of Engineering and Computer Science or instructor approval.

COMP 247. Computational Complexity. 3 Units.
This course provides a deep dive into the field of computational complexity, emphasizing the study of NP-completeness, the exploration of various complexity classes and the design and analysis of approximation algorithms. Students will explore the foundational theories that classify computational problems according to their inherent difficulty and investigate the limits of algorithmic efficiency. The course will cover classic approximation algorithms and randomized algorithms for a wide range of problems, including graph algorithms, scheduling, and partitioning, while also touching on recent advances and open problems in the field.

COMP 250. Computational Biology. 3 Units.
This course will provide an overview of the field of computational biology. Each week we will cover the biological background and computational details of a di#erent biological algorithm, including but not limited to: algorithms for phylogenetic tree estimation, protein folding, 3D structure prediction from DNA sequence, genome alignment algorithms, and reconstruction of gene regulatory networks. Students will gain experience using and implementing these algorithms. No previous programming experience or biological background is required.

COMP 251. Machine Learning. 3 Units.
This course introduces concepts of machine learning and statistical pattern recognition at the graduate level. The course covers topics such as linear and logistic regression, classification, clustering, model validation, support vector machines, neural networks, and decision trees. Data wrangling methods and dimensionality reduction are also examined. Prerequisites: Algorithms Core Skill and graduate students in the School of Engineering and Computer Science or instructor approval.

COMP 252. Natural Language Processing. 3 Units.
This course is an introduction to the topic of natural language processing (NLP) from a computational perspective. The course covers both formal and statistical approaches to NLP. Coursework includes programming, analysis and literature review assignments. Topics include: n-gram models, part-of-speech tagging, hidden Markov models, parsing, semantics, information extraction, question answering, dialogue agents and machine translation. Prerequisites: Algorithms Core Skill and Computing Theory Core Skill and Graduate or blended students in the School of Engineering and Computer Science or instructor approval.

COMP 253. Virtual Reality. 3 Units.
This course provides an overview of the field of virtual reality (VR). Topics include stereoscopic display, force feedback and haptic simulation, viewer tracking, virtual worlds, 3D user interface issues, augmented reality, and contemporary applications of VR in entertainment, teaching and training. Students gain practical experience designing and evaluating a virtual reality application. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science.

COMP 254. Advanced Graphics Programming. 3 Units.
This course provides a survey of advanced topics in computer graphics. Students will complete several Web-based 3D graphics programming projects, and explore a contemporary research topic related to computer graphics. Prerequisites: Programming Languages Core Skill, Algorithms Core Skill, and ENGR 201 with a "C" or better and graduate or blended students in the School of Engineering and Computer Science or instructor approval.

COMP 257. Advanced Algorithms. 3 Units.
This course will cover the fundamentals of algorithm design. We will discuss some basic paradigms for reasoning about algorithms and their asymptotic complexity and survey many of the techniques that apply broadly in the design of efficient algorithms. Prerequisites: Algorithms Core Skill and graduate or blended students in the School of Engineering and Computer Science or instructor approval.

COMP 258. Design/Assess of Serious Games. 3 Units.
This course develops the skills and techniques required for the creation of serious games. Serious games are games that have an additional purpose beyond simple entertainment. Topics include understanding and evaluating the current landscape of serious games, undergoing the research to design a serious game, and assessing the games created to see if they fulfill their goals as a serious game. This course is intended to prepare students to design, develop and assess multi-purpose software. Prerequisites: Algorithms Core Skill and Programming Languages Core Skill and graduate students in the School of Engineering and Computer Science or instructor approval.

COMP 259. Character Animation. 3 Units.
Investigation of algorithmic and data#driven techniques for directing the motion of computer generated characters, with a focus on human#like motion. Coursework will include analysis of published research, programming assignments and an original research project/investigation. Prerequisite: Graduate students in the School of Engineering and Computer Science or permission of the instructor.

COMP 261. Data Science. 3 Units.
This course is about the principles and methods for handling big data. Topics include data sources, data products, data analysis, and data visualization. Students are expected to read technical papers and apply techniques to solve real-world big data problems. Prerequisite: Algorithms Core Skill or EMGT 162 with a "C" or better and graduate students in the School of Engineering and Computer Science or instructor approval.

COMP 262. Advanced Data Analytics. 3 Units.
This course will cover advanced topics in computational data analysis with an emphasis on programming for deep learning and natural language processing. Students will learn to perform big data analysis on real-world data sets with Python and visualization tools. Prerequisites: Algorithms Core Skill or COMP 162 or EMGT 162 with a "C-" or instructor approval.

COMP 263. Database Management Systems II. 3 Units.
The course highlights the importance of learning how to manage large volumes of unstructured, offline, and continuously changing data in today's data-driven world. Given the evolving nature of data, the course places a strong emphasis on developing practical skills through hands-on labs, comprehensive projects, and direct engagement with real-world industry domains, including the Internet of Things (IoT) applications across sectors such as agriculture, automotive, retail, and healthcare. The course will critically contrast and evaluate these modern data management challenges against traditional SQL concepts, enabling students to understand the strengths and limitations of both paradigms and to apply the most appropriate solutions in different scenarios. Prerequisites: COMP 163 with a Minimum Grade of C-.

COMP 264. Storytelling and Visualization. 3 Units.
Current information professionals are faced with an overwhelming amount of information every day. The information is typically unstructured, abstract, large-scale, and needs a more efficient and intuitive way to represent the relationships, reveal the patterns, and/or discover potential opportunities. Information visualization has thus recently gained increasing attention and begun to be widely applied to scientific, engineering, and social disciplines to help people understand and present their information better. According to Gershon et al. (1998), visualization can provide "an interface between two powerful information processing systems—the human mind and the modern computer." A picture is worth a thousand words". We are all familiar with this expression. It especially applies when trying to explain the insights obtained from the analysis of increasingly large datasets. Data visualization plays an essential role in the representation of both small and large-scale data. Data visualization is the graphical representation of data in order to interactively and effectively convey insights to stakeholders general. With ever increasing volume of data, it is impossible to tell stories without visualization. Data visualization is an art of how to turn numbers in to useful knowledge. The growing availability of informative datasets and software tools has led to increased reliance on data visualizations across many areas. Data visualization provides a powerful way to communicate data-driven findings, motivate analyses, and detect flaws. The fact that it can be difficult or impossible to notice a mistake within a dataset makes data visualization particularly important. In this course, you will learn how to leverage a software tool to visualize data that will also enable you to extract information, better understand the data, and make more effective decisions. This course provides a practical approach to learning the theories and techniques of data visualization for data analysis. Python lets you learn the art of visualization by offering a set of inbuilt functions and libraries to build visualizations and present data. In this course you will learn functionality for visualization and basics of data visualization and exploratory data analysis using Matplotib and seaborn, a data visualization packages for the statistical programming language Python. The course will give you the skills you need to leverage data to reveal valuable insights and advance your career. You will study the application of primary drawing functions and advanced drawing functions and will focus on understanding the methods of data exploration by visualization. The ultimate goal of this course is to provide students with an alternative powerful tool to process information in the specific domain of their own interests.

COMP 265. ML Methods for Cybersecurity. 3 Units.
This course will cover basic machine and deep learning algorithms and explore their usage in cybersecurity research. Areas of research will include intrusion detection, malware analysis, user behavior modeling, anti-phishing, and threat identification. Students will have a chance to try out several of these models on practical problems.

COMP 270. Secure Software Systems. 3 Units.
In this course, students will study best practices for secure software development. Topics will include software security requirements, compliance requirements, misuse and abuse cases, security design principles, secure software architecture and design, secure coding practices, cryptography, code analysis for risks, software testing, lifecycle management, deployment, operations, and supply chain security. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science.

COMP 271. Vulnerabilities. 3 Units.
In this course, students will systematically study the fundamental principles of computer system security. Students will learn to identify vulnerabilities in computer systems and mitigate them. The course takes a practical approach to information security by focusing on real-world examples and hands-on lab activities. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science, and COMP 280 or ECPE 170 or COMP 173 with a "C" or better.

COMP 272. Software Reverse Engineering. 3 Units.
The objective of this course is to familiarize students with the practice of reverse engineering programs where the source code is unavailable. By this process, students can discover the specification for a given software program, thereby understanding its operation as well as any data it uses or communication protocols it employs. This knowledge is valuable for identifying and neutralizing malware on a system or discovering software vulnerabilities and patching them during the course of a security audit. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science, and COMP 280 or COMP 173 or ECPE 170 with a "C" or better.

COMP 274. Reliable Software Design. 3 Units.
With the technological advancements, critical systems (e.g., in the aerospace industry, healthcare industry, etc.) are being deployed and used in a widespread fashion. This trend, along with the increasing complexity of such systems, necessitate their software components to provide guaranteed reliability and assurance. This course introduces a mathematical foundation for rigorous analysis of computer programs by exploring the logical underpinnings and the tools that are used to reason about program correctness in order to develop high quality and robust software. In this course, students engage in developing programs that formally define system constructs, specifying the properties of interest, and proving the satisfaction of those properties in the system. Prerequisites: Programming Languages Core Skill and Computing Theory Core Skill and graduate or blended students in the School of Engineering and Computer Science or instructor approval.

COMP 275. Network Security and System Administration Essentials. 3 Units.
This course provides students with a comprehensive understanding of system administration and the technologies used to maintain confidentiality, integrity, and availability. Students will learn command-line usage, user management, database administration, fundamentals of network security, network security tools including firewalls and intrusion detection and prevention systems, and security analytics tools. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science.

COMP 276. Security Operations: Incident Response and Digital Forensics. 3 Units.
This course provides students with the tools and techniques to detect and respond to data breaches and cyberattacks. Topics include an overview of incident management, incident response plans, the lifecycle of an incident, the use of digital forensics to investigate and manage an incident, forensic analysis tools, and escalation management. The course includes case studies in incident response and digital forensics. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science.

COMP 277. Advanced Computer Networking. 3 Units.
The modern Internet is a communications system of global scale and high complexity. In this course, students will study the technological underpinnings that enable modern network communication, including routing, network, and application-layer protocols. Wired, wireless, and cellular networks will be examined. The course will include a laboratory, with emphasis placed on determining the current state of a network through network mapping, traffic analysis, and protocol analysis. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science, and COMP 280 or COMP 177 or ECPE 177 with a “C” or better.

COMP 278. Cyber Defense and Offense. 3 Units.
This course offers a comprehensive study of the principles and practices of computer system security including operating system security, network security, software security, and web security. Students will learn common threats and vulnerabilities, along with basic principles and techniques when designing a secure system. Hands-on labs will help students gain an understanding on how to think like an adversary, how modern cyber-attacks and defenses work in practice, and how to assess threats and protection mechanisms. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science, and COMP 280 or ECPE 170 or COMP 173 with a “C” or better.

COMP 279. Cybersecurity Advanced Topics. 3 Units.
This course covers elements of advanced topics in the field of cybersecurity, including tools and techniques for cyber offense, security information and event management, endpoint detection and security orchestration, cybersecurity analytics, API security, and development security and operations. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science.

COMP 280. Cybersecurity Bootcamp. 4 Units.
The Bootcamp course provides students with the hands-on technical skills and knowledge base to succeed in the Cybersecurity graduate program. Topics covered include computer networking (both network programming and network configuration), computer operating systems, virtualization, fundamentals of cybersecurity, and cybersecurity current events. Prerequisites: Graduate student in the Master of Science in Cybersecurity program, or permission of instructor.

COMP 282. Cybersecurity Capstone Project. 3 Units.
In this capstone design course, students synthesize their cumulative cybersecurity knowledge through the development of a computer application or system. Students will establish design objectives and criteria, analyze solution alternatives, and evaluate design performance and capabilities. Students will then implement, test and evaluate the resulting prototype system. Complete documentation is required, including oral presentations, written reports, and demonstration of the final working system. Prerequisites: Graduate student in the Master of Science in Cybersecurity program, and COMP 280 with a ‘C’ or better.

COMP 283. Vulnerability Management. 3 Units.
The process of vulnerability management is systematically studied in this course. Students will learn how to use management tools like scanners and ticketing systems, how to design, develop, and rollout systems to track the entire life cycle of vulnerabilities across an organization, and how to report and quantify vulnerabilities with metrics. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science.

COMP 284. Cybersecurity Governance, Risk and Compliance. 3 Units.
This course provides the students with a high-level overview of cybersecurity governance, risk, and compliance. Students will study risk management fundamentals including assessment, NIST processes, and risk management tools, as well as the overall place of risk management in the field of cybersecurity. Governance processes and techniques will also be explored, including business impact analysis, asset management and tools, alignment of cybersecurity and business objectives, SWOT and GAP analysis, and security process maturity assessment. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science.

COMP 285. Mobile and Cloud Security. 3 Units.
This course examines the architecture and security implications of cloud-based applications and mobile applications. For cloud computing, fundamental principles and common cloud-based architectures are studied, along with technical methods to secure both the cloud platform itself and data stored in cloud-based systems by applications. Fundamentals of popular industry cloud platforms such as AWS and Azure are also covered. For mobile applications, fundamental principles of mobile device and application security are studied, along with secure development for mobile applications, architectural layers of mobile device security, and testing and auditing. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science.

COMP 286. Cybersecurity and Privacy Management. 3 Units.
This course provides students with a fundamental background of security strategy, policy, standards and procedures. Management-focused topics include cybersecurity awareness and education, COBIT and ISO governance principles, security programs and project management fundamentals, security metrics, and security reporting at the operational, tactical, and CISCO level. Privacy-focused topics include an introduction to privacy and its principals, privacy focused regulations and security controls, and privacy impact assessments. Includes agile programming and applications to security. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science.

COMP 287. Graduate Internship. 1-4 Units.

COMP 287A. Graduate Internship. 1-4 Units.

COMP 287B. Graduate Internship. 1-4 Units.

COMP 291. Graduate Independent Study. 1-4 Units.
Special individual projects are undertaken under the direction of one or more faculty. Prerequisite: Graduate or blended students in the School of Engineering and Computer Science or permission of instructor.

COMP 293. Special Topics. 4 Units.
Special courses are organized and offered from time to time to meet the needs or interests of a group of students. Prerequisite: Graduate or blended students in the School of Engineering and Computer Science or permission of the instructor.

COMP 297. Graduate Research. 1-5 Units.
Applied or basic research in engineering or computer science under faculty supervision. Approval by the faculty supervisor and the department chairperson is required. Prerequisite: Graduate or blended students in the School of Engineering and Computer Science or permission of instructor.

COMP 297D. Graduate Research. 1-4 Units.

COMP 297E. Graduate Research. 1-4 Units.

COMP 297F. Graduate Research. 1-4 Units.

COMP 297G. Graduate Research. 1-4 Units.

COMP 299. Thesis. 1-6 Units.
Minimum of six units is required for Thesis Option students.
Prerequisites: Graduate or blended students in the School of Engineering and Computer Science and permission of the research advisor.