

# CYBER SECURITY ENGINEERING (CYSE)

## 100 Level Courses

**CYSE 101:** *Introduction to Cyber Security Engineering*. 3 credits.

Provides comprehensive introduction to the principles, applications, and practice of cyber security engineering. Students learn the basic concepts and terminology of cyber security and how cyber security is commonly addressed after the design and implementation phases. Students are introduced to the systems engineering and design processes and learn to integrate and apply cyber security tools and techniques in these processes. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). Limited to two attempts.

**Registration Restrictions:**

Students with the terminated from VSE major attribute may **not** enroll.

**Schedule Type:** Laboratory, Lecture

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**CYSE 130:** *Introduction to Computing for Digital Systems Engineering*. 3 credits.

The course introduces students to programming in the context of Systems Design process. Students learn to take a systems perspective when approaching problems and designing solutions, how the structure and behavior of a system is modeled using SysML, and to implement the system model using programming techniques in Python. The course explores various Python modules (standard library and 3rd Party) that extend the basic language functionality in useful ways, in particular, for model based systems engineering. The students apply their programming skills to solve commonly encountered Task Automation, Data Mining, Cleansing, and Transformation. Course emphasizes the use of appropriate Web Services APIs and technologies commonly encountered in Data Analytics and AI to find, access, and analyze available data and datasets. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). Limited to two attempts. Equivalent to SYST 130.

**Mason Core:** Info Tech & Computing (<http://catalog.gmu.edu/mason-core/>)

**Recommended Prerequisite:** Passing score on the math placement test for MATH 113.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

## 200 Level Courses

**CYSE 205:** *Systems Engineering Principles*. 3 credits.

Introduction to systems engineering with a focus on cyber security engineering. Emphasize development of analytical, technical, management, and teamwork skills through exercises in planning, documentation, presentation, and the creative process of IT engineering design. Analyze case studies involving systems engineering role in cyber security. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/>

[colleges-schools/engineering/cyber-security-engineering/](http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/)). Limited to two attempts. Equivalent to SYST 205.

**Registration Restrictions:**

Students with the terminated from VSE major attribute may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**CYSE 211:** *Operating Systems and Lab*. 3 credits.

Addresses basic issues such as virtual memory, kernel and user mode, system calls, threads, context switches, interrupts, interprocess communication, coordination of concurrent activities. May also address: concurrency, processes and multi-threading, context switching, synchronization, scheduling, and deadlock. Memory management, dynamic memory allocation, address translation. Management of file systems, storage devices, directories, protection, scheduling and crash recovery. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). Limited to two attempts.

**Registration Restrictions:**

Students with the terminated from VSE major attribute may **not** enroll.

**Schedule Type:** Laboratory, Lecture

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**CYSE 220:** *Systems Modeling*. 3 credits.

Introduces modeling of dynamical systems. Formulation of mathematical models from system descriptions, including computer, economic, transportation, electrical power and mechanical systems. Analytical and numerical methods for solving models and studying their behavior. Discrete-time and continuous time systems. Linear and nonlinear systems. Introduction to computer modeling using MATLAB. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). Limited to two attempts.

**Registration Restrictions:**

**Required Prerequisites:** (MATH 203<sup>C</sup> or 203<sup>XS</sup>) and (PHYS 160<sup>C</sup> or 160<sup>XS</sup>).  
<sup>C</sup> Requires minimum grade of C.  
<sup>XS</sup> Requires minimum grade of XS.

Students with the terminated from VSE major attribute may **not** enroll.

**Schedule Type:** Laboratory, Lecture

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**CYSE 230:** *Computer Networking*. 3 credits.

Introduces network concepts; OSI reference model and layering; data coding; analog/digital communications review; physical layer and data link control; Data Link Layer Control protocols; flow control; error control; link management; common link protocols. LAN and WAN; connection-oriented and connectionless packet switching; circuit-switched networks

and control signaling; congestion control and traffic management; transport layer client-server model; domain name systems, routing methods. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). Limited to two attempts.

**Registration Restrictions:**

**Required Prerequisites:** (CS 112<sup>C</sup> or 112<sup>XS</sup>) and (CYSE 101<sup>C</sup> or 101<sup>XS</sup>) and (MATH 113<sup>C</sup> or 113<sup>XS</sup>).

<sup>C</sup> Requires minimum grade of C.

<sup>XS</sup> Requires minimum grade of XS.

Students with the terminated from VSE major attribute may **not** enroll.

**Schedule Type:** Laboratory, Lecture

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

### 300 Level Courses

**CYSE 301: *Digital Systems*.** 3 credits.

Introduces digital circuits, systems and computers. Topics include binary systems and codes, digital logic gates and circuits, microelectronics and integrated circuits, coding and multiplexing, multi-vibrators, shift registers, counters, analog-to-digital converters, and elementary computer architecture. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). Limited to two attempts. Equivalent to ECE 301.

**Registration Restrictions:**

Students with the terminated from VSE major attribute may **not** enroll.

**Schedule Type:** Laboratory, Lecture

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**CYSE 325: *Discrete Events Systems Modeling*.** 3 credits.

Introduces basic modeling of the dynamics of discrete event systems. Both analytical and simulation techniques for the modeling and analysis of such systems are considered. Relevant concepts from discrete mathematics are included and appropriate software tools are used to examine different engineering applications. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). Limited to two attempts.

**Registration Restrictions:**

**Required Prerequisites:** (STAT 344<sup>C</sup> or 344<sup>XS</sup>).

<sup>C</sup> Requires minimum grade of C.

<sup>XS</sup> Requires minimum grade of XS.

Enrollment is limited to students with a major, minor, or concentration in Cyber Security Engineering.

Students with the terminated from VSE major attribute may **not** enroll.

**Schedule Type:** Laboratory, Lecture

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**CYSE 330: *Introduction to Network Security*.** 3 credits.

Introduces cryptography and its applications in networks. Reviews basic firewalls architectures and VPNs. Overview of current network security protocols, security of routing protocols, the DNS, and e-mail security. Discuss threat of attacks that use viruses, worms, rootkits, botnets and countermeasures; distributed denial of service attacks and spam countermeasures. Introduces basic concepts of security of wireless networks. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). Limited to two attempts.

**Registration Restrictions:**

**Required Prerequisites:** (CYSE 101<sup>C</sup> or 101<sup>XS</sup>) and (CS 222<sup>C</sup> or 222<sup>XS</sup>) and (CYSE 230<sup>C</sup> or 230<sup>XS</sup>).

<sup>C</sup> Requires minimum grade of C.

<sup>XS</sup> Requires minimum grade of XS.

Enrollment is limited to students with a major, minor, or concentration in Cyber Security Engineering.

Students with the terminated from VSE major attribute may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

### 400 Level Courses

**CYSE 411: *Secure Software Engineering*.** 3 credits.

This course provides a foundation for building secure software by applying security principles to the software development lifecycle. Topics covered include: security in requirements engineering, secure designs, risk analysis, threat modeling, deploying cryptographic algorithms, defensive coding, penetration testing, fuzzing, static analysis, and security assessment. Students will learn the practical skills for developing and testing secure software. Notes: This course may be of interest to students specializing in software aspects of cyber security engineering. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). Limited to two attempts.

**Registration Restrictions:**

**Required Prerequisites:** (CS 222<sup>C</sup> or 222<sup>XS</sup>) or ((CDS 130<sup>C</sup> or 130<sup>XS</sup>) and (SYST 230<sup>C</sup> or 230<sup>XS</sup>)).

<sup>C</sup> Requires minimum grade of C.

<sup>XS</sup> Requires minimum grade of XS.

Enrollment is limited to students with a major, minor, or concentration in Cyber Security Engineering.

Students with the terminated from VSE major attribute may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**CYSE 421: *Industrial Control Systems Security*.** 3 credits.

Provides an introduction to industrial control systems (ICS). Covers fundamental concepts of control loop and its main components. Human-Machine Interface (HMI) and displays. Remote measurements through networks or through telemetry. Diagnostic and maintenance utilities. Input-Output servers. Data historian utility. SCADA systems.

ICS Security. Connectivity of the control system network to other networks. Possible security threats. Vulnerability assessments. Multilayer defense strategies. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). Limited to two attempts.

**Registration Restrictions:**

**Required Prerequisites:** (CYSE 230<sup>C</sup> or 230<sup>XS</sup>) and (ECE 301<sup>C</sup> or 301<sup>XS</sup>).

<sup>C</sup> Requires minimum grade of C.

<sup>XS</sup> Requires minimum grade of XS.

Enrollment is limited to students with a major, minor, or concentration in Cyber Security Engineering.

Students with the terminated from VSE major attribute may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**CYSE 424: Embedded and Real Time Systems.** 3 credits.

Presents design methodology, principles and practice for the development of real-time embedded systems and their application to robotics, mechatronics, sensing, signal processing, and control. They include automated sensors, switches and PLCs. Topics include system decomposition, multi-tasking, task communication and synchronization, system modeling, time analysis, principles of filter and controller implementation, 'fuzzy' engineering, and multimicrocontroller systems. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). Limited to two attempts.

**Registration Restrictions:**

**Required Prerequisites:** (ECE 301<sup>C</sup> or 301<sup>XS</sup>).

<sup>C</sup> Requires minimum grade of C.

<sup>XS</sup> Requires minimum grade of XS.

Enrollment is limited to students with a major, minor, or concentration in Cyber Security Engineering.

Students with the terminated from VSE major attribute may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**CYSE 425: Secure RF Communications.** 3 credits.

Reviews current systems of Radio Frequency (RF) communications and related cyber security issues. This course focuses on security issues in wireless networks, such as cellular networks, wireless LANs, Bluetooth, NFC, RFID, mobile security, anti-jamming communication, and physical layer security. The course will first present an overview of wireless networks, then focus on attacks and discuss proposed solutions and their limitations. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). Limited to two attempts. Equivalent to ECE 425.

**Registration Restrictions:**

**Required Prerequisites:** ((CS 222<sup>C</sup>, 222<sup>XS</sup>, 262<sup>C</sup> or 262<sup>XS</sup>) and (ECE 465<sup>C</sup>, 465<sup>XS</sup>, CYSE 230<sup>C</sup>, 230<sup>XS</sup>, CS 455<sup>C</sup> or 455<sup>XS</sup>) and (MATH 125<sup>C</sup>, 125<sup>XS</sup>, ECE 231<sup>C</sup> or 231<sup>XS</sup>)).

<sup>C</sup> Requires minimum grade of C.

<sup>XS</sup> Requires minimum grade of XS.

Enrollment is limited to students with a major, minor, or concentration in Computer Engineering, Computer Science, Cyber Security Engineering, Electrical and Computer Engr or Electrical Engineering.

Students with the terminated from VSE major attribute may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**CYSE 430: Critical Infrastructure Protection.** 3 credits.

Consists of a four week lecture course followed by ten weekly seminars presented by students. The lecture part provides a description of US Designated Critical Infrastructure Sectors and a corresponding list of federal sector specific agencies (SSAs). Each student selects a sector, develops and presents a seminar talk on critical cyber security issues involved in a given sector. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). Limited to two attempts.

**Registration Restrictions:**

**Required Prerequisites:** SYST 205<sup>C</sup> or 205<sup>XS</sup>.

<sup>C</sup> Requires minimum grade of C.

<sup>XS</sup> Requires minimum grade of XS.

Enrollment is limited to students with a major, minor, or concentration in Cyber Security Engineering.

Students with the terminated from VSE major attribute may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**CYSE 445: System Security and Resilience.** 3 credits.

Focuses on modeling and evaluation of the engineering systems that are expected to operate in a contested cyber environment. Covers architectures and modeling, uses a variety of techniques, establishing measures of performance that are relevant to the domain of operation, evaluating the security or vulnerability of the system to cyber exploits, and then assessing its resilience. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). Limited to two attempts.

**Registration Restrictions:**

**Required Prerequisites:** ((CYSE 325<sup>\*C</sup> or 325<sup>XS</sup>) and (CYSE 230<sup>C</sup> or 230<sup>XS</sup>) and (ECE 301<sup>C</sup> or 301<sup>XS</sup>)).

\* May be taken concurrently.

<sup>C</sup> Requires minimum grade of C.

<sup>XS</sup> Requires minimum grade of XS.

Students with a class of Freshman or Sophomore may **not** enroll.

Enrollment is limited to students with a major, minor, or concentration in Cyber Security Engineering.

Students with the terminated from VSE major attribute may **not** enroll.

**Schedule Type:** Lecture**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**CYSE 450: Cyber Vulnerability Lab.** 1 credit.

Lab for CYSE 445. Provides hands-on experience in security issues of network systems. Issues in ethical hacking, penetration testing, forensics and incident handling and response will be discussed. Notes: This is a hands-on lab course, with short lecture introductions. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). Limited to two attempts.

**Registration Restrictions:**

**Required Prerequisites:** (CYSE 445<sup>\*C</sup> or 445<sup>XS</sup>).

\* May be taken concurrently.

<sup>C</sup> Requires minimum grade of C.

<sup>XS</sup> Requires minimum grade of XS.

Enrollment is limited to students with a major, minor, or concentration in Cyber Security Engineering.

Students with the terminated from VSE major attribute may **not** enroll.

**Schedule Type:** Laboratory**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**CYSE 460: Power Systems and Smart Grid Security.** 3 credits.

Covers fundamentals of power systems; basics of electricity, electricity generation, economics of supply and demand, and electricity market operations in regulated and deregulated environment. The other part of the course will cover Smart Grid and its impact on the energy industry. Also includes Energy policy modeling and analysis. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). Limited to two attempts.

**Registration Restrictions:**

Enrollment is limited to students with a major, minor, or concentration in Cyber Security Engineering.

Students with the terminated from VSE major attribute may **not** enroll.

**Schedule Type:** Lecture**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**CYSE 461: Power Grid Security.** 3 credits.

Overview of integrating smart grid into the current system. Includes the seven domains (bulk generation, transmission, distribution, customer, operations, markets, and service providers) as well as the electrical and communication interfaces that connect the layers and domains. Focuses on monitoring equipment in the smart grid. Provides an overview of security principles and approaches for applying them to the smart grid. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). Limited to two attempts.

**Registration Restrictions:**

**Required Prerequisite:** CYSE 460<sup>C</sup>.

<sup>C</sup> Requires minimum grade of C.

Students with the terminated from VSE major attribute may **not** enroll.

**Schedule Type:** Lecture**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**CYSE 462: Mobile Devices and Network Security.** 3 credits.

Embedded security features of hand-held wireless devices. Data link layer encryption and authentication protocols applied in mobile devices. Security factors in the decisions on configuring wireless mobile devices and network infrastructure. Robust cryptography that is needed to attain the highest levels of integrity, authentication, and confidentiality. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). Limited to two attempts.

**Registration Restrictions:**

**Required Prerequisites:** (CYSE 425<sup>C</sup>, 425<sup>XS</sup>, ECE 425<sup>XS</sup> or 425<sup>C</sup>).

<sup>C</sup> Requires minimum grade of C.

<sup>XS</sup> Requires minimum grade of XS.

Enrollment is limited to students with a major, minor, or concentration in Computer Engineering, Cyber Security Engineering or Electrical and Computer Engr.

Students with the terminated from VSE major attribute may **not** enroll.

**Schedule Type:** Lecture**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**CYSE 465: Transportation Systems Design.** 3 credits.

Discusses common elements and differences among problems that occur securing road, rail, air and sea transportation systems. Covers threats to control systems. Introduces control measures. Discusses past, present and future of in-vehicle and on-road safety systems, and cyber threats to emerging autonomous cars. Analyzes cyber threats to aviation and sea transportation security and available countermeasures. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). Limited to two attempts.

**Registration Restrictions:**

**Required Prerequisites:** SYST 230<sup>C</sup> or 230<sup>XS</sup>.

<sup>C</sup> Requires minimum grade of C.

<sup>XS</sup> Requires minimum grade of XS.

Students with a class of Freshman or Sophomore may **not** enroll.

Enrollment is limited to students with a major, minor, or concentration in Cyber Security Engineering.

Students with the terminated from VSE major attribute may **not** enroll.

**Schedule Type:** Lecture**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)



**CYSE 467: GPS Security.** 3 credits.

Provides background in long-range navigation developments; early global systems; space based systems; GPS and GLONASS systems; system architecture; spacecraft and earth station characteristics; design concepts of the CA and P GPS signal modes; frequencies, modulation, and other design aspects; clock issues; range and accuracy calculations and limitations; advanced concepts. Explains advanced concepts in global navigation satellite systems. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). Limited to two attempts.

**Registration Restrictions:**

**Required Prerequisites:** (CYSE 425<sup>C</sup> or 425<sup>XS</sup>).

<sup>C</sup> Requires minimum grade of C.

<sup>XS</sup> Requires minimum grade of XS.

Students with the terminated from VSE major attribute may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**CYSE 470: Human Factors and Cyber Security Engineering.** 3 credits.

This course explores the human factor in cyber security engineering. The focus is on understanding human performance characteristics and limitations, and the various research, design, and evaluation methods needed to address them when engineering secure systems. Topics include, for example, perception, cognition, memory, situation awareness, decision making, stress, automation, and human-computer display and interaction design principles. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). Limited to two attempts.

**Registration Restrictions:**

**Required Prerequisites:** ((SYST 205<sup>C</sup> or 205<sup>XS</sup>) and (STAT 344<sup>C</sup>, 344<sup>XS</sup>, 346<sup>C</sup> or 346<sup>XS</sup>)).

<sup>C</sup> Requires minimum grade of C.

<sup>XS</sup> Requires minimum grade of XS.

Enrollment is limited to students with a major, minor, or concentration in Cyber Security Engineering.

Students with the terminated from VSE major attribute may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**CYSE 475: Cyber Physical Systems.** 3 credits.

Introduces cyber physical systems as an integration of physical processes, computation, and networking. Discusses modeling and simulation of cyber physical systems, system design and implementation. Analyze such systems based on abstractions for modeling physical systems and abstractions for modeling data transformations. Covers security issues in cyber physical systems and applications selected from infrastructure, energy, transportation, robotics, manufacturing, and communications domains. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). Limited to two attempts.

**Registration Restrictions:**

**Required Prerequisites:** ((CYSE 330<sup>C</sup> or 330<sup>XS</sup>) and (CYSE 421<sup>C</sup> or 421<sup>XS</sup>) and (CYSE 450<sup>C</sup> or 450<sup>XS</sup>)).

<sup>C</sup> Requires minimum grade of C.

<sup>XS</sup> Requires minimum grade of XS.

Students with the terminated from VSE major attribute may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**CYSE 476: Cryptography Fundamentals.** 3 credits.

Covers basic concepts of cryptology, types of cryptosystems, security services, and key management. Gradually introduces mathematical background required for understanding cryptography. Discusses modern secret-key stream and block ciphers, modes of operation, public key cryptosystems (RSA, elliptic curve, and post-quantum cryptography), hash functions, message authentication codes, and digital signature schemes. Covers key cracking machines, side-channel attacks, and fault attacks. Discusses popular cryptographic modules, such as True Random Number Generators and Physical Unclonable Functions, used for key generation and device authentication. Introduces educational and public domain software implementing modern cryptographic algorithms. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). Limited to two attempts. Equivalent to ECE 476.

**Registration Restrictions:**

**Required Prerequisites:** (ECE 301<sup>C</sup>, 301<sup>XS</sup>, 231<sup>C</sup>, 231<sup>XS</sup>, 331<sup>C</sup> or 331<sup>XS</sup>).

<sup>C</sup> Requires minimum grade of C.

<sup>XS</sup> Requires minimum grade of XS.

Enrollment is limited to students with a major in Computer Engineering, Computer Science, Cyber Security Engineering or Electrical Engineering.

Students with the terminated from VSE major attribute may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**CYSE 477: Intrusion Detection.** 3 credits.

The objective of this course is to provide an in depth introduction to the science and art of intrusion detection. The course covers methodologies, techniques, and tools for monitoring events in computer systems or networks, with the objective of preventing and detecting unwanted process activity and recovering from malicious behavior. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). Limited to two attempts.

**Registration Restrictions:**

**Required Prerequisites:** SYST 230<sup>C</sup> or 230<sup>XS</sup>.

<sup>C</sup> Requires minimum grade of C.

<sup>XS</sup> Requires minimum grade of XS.

Students with a class of Freshman or Sophomore may **not** enroll.

Enrollment is limited to students with a major, minor, or concentration in Cyber Security Engineering.

Students with the terminated from VSE major attribute may **not** enroll.

**Schedule Type:** Lecture**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**CYSE 478: Cyber Security Audit and Compliance.** 3 credits.

Fundamental concepts of the Cyber Security Compliance and Testing process. This will revolve around defining a control framework, the attendant control objectives and the reporting system for an organization. Covers the process of creating a control structure with goals and objectives, audit a given cyber infrastructure against it, and if found inadequate, establish a systematic remediation procedure. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). Limited to two attempts.

**Registration Restrictions:**

**Required Prerequisites:** CYSE 421<sup>C</sup> or 421<sup>XS</sup>.

<sup>C</sup> Requires minimum grade of C.

<sup>XS</sup> Requires minimum grade of XS.

Students with the terminated from VSE major attribute may **not** enroll.

**Schedule Type:** Lecture**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**CYSE 479: Methods of User Authentication.** 3 credits.

Discusses limitations of passwords and PINs and introduces alternatives. Covers user authentication based on security tokens and smart cards. Introduces basics of biometric systems, based on information such as fingerprints, facial features, iris, and voice. Discusses the use and security of electronic ID cards and passports. Covers methods of distinguishing human from internet bots over the network, such as CAPTCHA's. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). Limited to two attempts.

**Registration Restrictions:**

**Required Prerequisites:** (CYSE 211<sup>C</sup> or 211<sup>XS</sup>) and (CYSE 301<sup>C</sup> or 301<sup>XS</sup>) and (CYSE 330<sup>C</sup> or 330<sup>XS</sup>).

<sup>C</sup> Requires minimum grade of C.

<sup>XS</sup> Requires minimum grade of XS.

Students with the terminated from VSE major attribute may **not** enroll.

**Schedule Type:** Lecture**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**CYSE 480: Reverse Software Engineering.** 3 credits.

Introduces various types of malicious software (malware). Discusses malware analysis using virtual machines, sandboxes, process monitors, packet sniffers, de-obfuscation, etc. Introduces hardware Trojans and other forms of malicious hardware. Discusses prevention techniques at the design, fabrication, and post-fabrication level. Introduces various countermeasures against malicious software and hardware. The course has a lab with Windows and Android operating systems. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). Limited to two attempts.

**Registration Restrictions:**

**Required Prerequisites:** (CYSE 211<sup>C</sup> or 211<sup>XS</sup>) and (ECE 301<sup>C</sup> or 301<sup>XS</sup>).

<sup>C</sup> Requires minimum grade of C.

<sup>XS</sup> Requires minimum grade of XS.

Students with a class of Freshman or Sophomore may **not** enroll.

Students with the terminated from VSE major attribute may **not** enroll.

**Schedule Type:** Laboratory, Lecture**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**CYSE 491: Engineering Senior Seminar.** 3 credits.

This course covers a variety of responsibilities of cyber security engineers including: engineering ethics, government policies, laws and regulations affecting cyber security engineering, industry practices, entrepreneurship. Effective technical communications. Incorporates global implications of cyber security engineering. Speakers include faculty, invited guests from industry and government, as well as students. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). Limited to two attempts.

**Specialized Designation:** Writing Intensive in Major**Recommended Corequisite:** CYSE 492.**Registration Restrictions:**

Students with a class of Freshman or Sophomore may **not** enroll.

Enrollment is limited to students with a major, minor, or concentration in Cyber Security Engineering.

Students with the terminated from VSE major attribute may **not** enroll.

**Schedule Type:** Lecture**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**CYSE 492: Senior Advanced Design Project I.** 3 credits.

First semester of a two semester capstone course in the Cyber Security Engineering program. Development of a design project by a team of students. Conception of the project and determination of its feasibility. Work includes developing preliminary design and implementation plan. Projects will aim at the integration of the technical material learned in several courses and incorporation of industry input. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). Limited to two attempts.

**Registration Restrictions:**

**Required Prerequisites:** CYSE 491<sup>\*C</sup> or 491<sup>XS</sup>.

<sup>\*</sup> May be taken concurrently.

<sup>C</sup> Requires minimum grade of C.

<sup>XS</sup> Requires minimum grade of XS.

Students with a class of Freshman or Sophomore may **not** enroll.

Enrollment is limited to students with a major, minor, or concentration in Cyber Security Engineering.

Students with the terminated from VSE major attribute may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**CYSE 493:** *Senior Advanced Design Project II*. 3 credits.

Second semester of a two semester capstone course in the Cyber Security Engineering program. Project includes designing a cyber-physical security system, writing required software, assembling hardware if needed, conducting experiments or studies, and testing the complete system. Requires oral and written reports during project and at completion. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). Limited to two attempts.

**Mason Core:** Capstone (<http://catalog.gmu.edu/mason-core/>)

**Registration Restrictions:**

**Required Prerequisites:** (CYSE 492<sup>C</sup> or 492<sup>XS</sup>).

<sup>C</sup> Requires minimum grade of C.

<sup>XS</sup> Requires minimum grade of XS.

Students with the terminated from VSE major attribute may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**CYSE 498:** *Independent Study in Cyber Security Engineering*. 1-3 credits.

Research and analysis of selected problems or topics in Cyber Security Engineering. Topic must be arranged with instructor and approved by department chair before registering. Notes: May be repeated if topics substantially different. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). May be repeated within the term for a maximum 6 credits.

**Specialized Designation:** Topic Varies

**Registration Restrictions:**

Students with a class of Freshman or Sophomore may **not** enroll.

Enrollment is limited to students with a major in Cyber Security Engineering.

**Schedule Type:** Independent Study

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**CYSE 499:** *Special Topics in Cyber Security Engineering*. 3 credits.

Special Topics in the Cyber Security Engineering area, with different content in different terms. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). May be repeated within the term for a maximum 12 credits.

**Specialized Designation:** Topic Varies

**Recommended Prerequisite:** 60 credits towards BS in Cyber Security Engineering.

**Registration Restrictions:**

Enrollment limited to students with a class of Junior, Senior Plus or Senior.

Students with the terminated from VSE major attribute may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

## 500 Level Courses

**CYSE 521:** *Industrial Control Systems Security*. 3 credits.

Provides an introduction to industrial control systems (ICS) at a Graduate level. Covers fundamental concepts of control loop and its main components. Human-Machine Interface (HMI) and displays. Remote measurements through networks or through telemetry. Diagnostic and maintenance utilities. Input-Output servers. Data historian utility. SCADA systems. ICS Security. Connectivity of the control system network to other networks. Possible security threats. Vulnerability assessments. Multilayer defense strategies. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). May not be repeated for credit.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non-Degree or Senior Plus.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**CYSE 550:** *Cyber Security Engineering Fundamentals*. 3 credits.

This is the introductory graduate course in Cyber Security Engineering. It is a technical course that provides the required foundations for successful completion of the MS CYSE program. The course introduces key subjects in the area, such as engineering systems and cyber security problems in engineering; cyber security design; introduction to Cryptography; system and network security; identity management; adversarial modeling; vulnerability assessment; and industrial control and manufacturing security. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). May not be repeated for credit.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non-Degree or Senior Plus.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Satisfactory/No Credit scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**CYSE 570:** *Fundamentals of Operating Systems*. 3 credits.

Operating system design and implementation as it relates to management and interaction of processor, memory, files, and I/O devices. Includes security considerations and a review of data structures, programming concepts, and computer systems architecture. Offered by

Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). May not be repeated for credit.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non-Degree or Senior Plus.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Laboratory, Lecture

**Grading:**

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**CYSE 580:** *Hardware and Cyber Physical Systems*. 3 credits.

Covers computer architecture and hardware to support subsequent cyber-physical systems modules. Introduces cyber-physical systems as an integration of physical processes, computation, and networking. Discusses modeling and simulation of cyber-physical systems, system design, and implementation. Covers security issues in cyber-physical systems and applications selected from infrastructure, energy, transportation, robotics, manufacturing, and communications domains. Students study and build cyber-physical systems. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). May not be repeated for credit.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non-Degree or Senior Plus.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Laboratory, Lecture

**Grading:**

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**CYSE 587:** *Cyber Security Systems Engineering*. 3 credits.

This course addresses cyber security from the standpoint of systems engineers. It introduces core principles for the design and management of resilient and robust systems throughout their complete lifecycle. Topics include but are not limited to lifecycle assurance of systems, risk analysis, models for secure systems development and management, gap analysis, quantitative methods for cyber security, and special topics in cyber security. The course also covers distinct technologies for assessing system vulnerabilities, measuring and modeling risk, reducing uncertainty in risk management, and others. Target audience consists of engineers who want to expand their skill sets to better align with the demands of current cyber security jobs, as well as those who intend to work on cyber security research. Cyber security professionals would also benefit from the course by being exposed to a systems engineering, holistic perspective on cyber security design, development, and management. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). May not be repeated for credit. Equivalent to CYSE 787, SYST 687, SYST 787.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non-Degree or Senior Plus.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

## 600 Level Courses

**CYSE 610:** *Networks and Cyber Security*. 3 credits.

Introduction to architectures and protocols of computer networks and concept of packet switching. Topics include ISO standard layer model, physical interfaces and protocols, data link control, multi-access techniques, packet switching, routing and flow control, network topology, data communication subsystems, error control coding, local area network, wireless communications, satellite packet broadcasting, packet radio, interconnection of packet-switching networks, network security and privacy, and various examples of computer networks. Security threats and countermeasures are addressed in detail to include firewalls, intrusion detection and prevention, physical security, and network monitoring. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). May not be repeated for credit.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non-Degree or Senior Plus.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Laboratory, Lecture

**Grading:**

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**CYSE 650:** *Topics in Cyber Security Engineering*. 3 credits.

Topics not covered in department's regular Cyber Security Engineering offerings. Course content may vary each semester depending on instructor and the perception of students' needs. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). May be repeated within the term for a maximum 6 credits.

**Specialized Designation:** Topic Varies

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non-Degree or Senior Plus.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**CYSE 670:** *Secure Design of Connected and Automated Vehicles*. 3 credits.

This research oriented course addresses the research and engineering challenges faced in designing and implementing connected automated vehicles. These involve multiple aspects of sensing, recognition, control and communication aspects for vehicles and road-side infrastructure. Two important aspects of automated and connected vehicles are the need to minimize traffic delays and congestion while being cognizant and accommodating the needs of pedestrians, bicyclist and other entities that need to share the roads and roadside spaces. In addition, special needs such as providing the right of way for emergency vehicles and traffic arrangements around special events and parking in congested cities



are issues that needs to be addressed in a comprehensive framework for connected automated vehicles. The class will discuss current topics related to communication standards such as 5G/DSRC, basic Safety Message Systems etc., and how they would work with existing traffic signals and vehicular contr. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). May not be repeated for credit.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non-Degree or Senior Plus.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**CYSE 680: Advanced Manufacturing Automation Security.** 3 credits.

This course explores the application of Cyber Security concepts in support of advanced manufacturing. The focus is on techniques applicable to Industrial Automation and Control Systems (IACS) against threats to security through unexpected situations, activities or occasions, or through consider assault. Topics include cyber-physical security, establishing causality between cyber execution, physical production, and energy consumption for intelligent efficiency, and detection of cyber threats based on physical process anomalies in advanced manufacturing systems. The course will also cover advanced equipment and product management functions, distributed vulnerability discovery, causality analysis and attack defenses, and Cyber-physical ledger infrastructure. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). May not be repeated for credit.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non-Degree or Senior Plus.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**CYSE 682: Formal Methods for Cyber Physical Systems Security.** 3 credits.

Formal techniques applied to computer security provide a reliable way of demonstrating that a system is immune to entire classes of attacks (provided the assumptions of the models are satisfied). This is a stark contrast with the more general approach of ruling a system as secure until an attack proves otherwise. This course explores the various ways in which formal methods can be applied to the security of cyber-physical systems. Emphasis is given to CPS used in advanced manufacturing industries and their associated supply chain networks. Topics include formal specification languages for security properties, security analysis utilities, domain-specific security concerns, translating informal requirements to formal specifications in languages such as AADL, satisfiability solvers (SAT), satisfiability modulo theories (SMT), real-time model checking, verification of system requirements, and case studies of formally verified secure systems. Offered by Cyber Security

Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). May not be repeated for credit.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non-Degree or Senior Plus.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**CYSE 683: Reverse Engineering Industrial Automation.** 3 credits.

This course presents fundamental, systems-level concepts for developing an understanding of the underlying functionality of an industrial system without a prior access to the system's design specifications. Considers generalized approaches to developing a set of specifications for a complex system through orderly examination of specimens of that system. Illustrates procedures for identifying the system's components and their interrelationships. Demonstrates methods for creating representations of the system in another form or at a higher level of abstraction. Presents fundamental definitions for forward engineering, reverse engineering, design recovery, restructuring and reengineering. Case studies from several domain areas will be presented to include: integrated circuit (IC) and circuit board analysis, communications protocol analysis, software disassembly, and programmable logic verification. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). May not be repeated for credit.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non-Degree or Senior Plus.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**CYSE 690: Cyber Security Engineering Capstone Project.** 3 credits.

Analysis and design of a complex cybersecurity-engineered integrated system involving software, hardware and people. Involves application of cyber security engineering principles to the design, implementation and operation of the system. Includes requirements analysis, analysis of design alternatives, assessment of threats, and risk, economical and regulatory considerations. Requires oral and written reports throughout the course. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). May not be repeated for credit.

**Registration Restrictions:**

**Required Prerequisites:** ((AIT 660<sup>B-</sup> or 660<sup>XS</sup>) and SYST 687<sup>B-</sup> and (CYSE 570<sup>B-</sup>, CS 571<sup>B-</sup> or 571<sup>XS</sup>) and CYSE 580<sup>B-</sup> and 610<sup>B-</sup> and (ECE 646<sup>B-</sup> or 646<sup>XS</sup>)).

<sup>B-</sup> Requires minimum grade of B-.

<sup>XS</sup> Requires minimum grade of XS.

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non-Degree or Senior Plus.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Seminar

**Grading:**

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**CYSE 698:** *Independent Study and Research*. 3 credits.

Study of a selected area in Cybersecurity Engineering under the supervision of a faculty member. A written report is required. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). May be repeated within the degree for a maximum 12 credits.

**Recommended Prerequisite:** Completion of at least 2 MS CYSE core courses

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non-Degree or Senior Plus.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Independent Study

**Grading:**

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

## 700 Level Courses

**CYSE 750:** *Advanced Topics in Cyber Security Engineering*. 3 credits.

Advanced topics not covered in department's regular systems engineering offerings. Course content may vary each semester depending on instructor and the perception of students' needs. May be repeated for credit when topics are distinctly different. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). May be repeated within the term for a maximum 6 credits.

**Specialized Designation:** Topic Varies

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate or Non-Degree.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**CYSE 787:** *Cyber Security Systems Engineering*. 3 credits.

This course addresses cyber security from the standpoint of systems engineers. It introduces core principles for the design and management of resilient and robust systems throughout their complete lifecycle. Topics include but are not limited to lifecycle assurance of systems, risk analysis, models for secure systems development and management, gap analysis, quantitative methods for cyber security, and special topics in cyber security. The course also covers distinct technologies for assessing system vulnerabilities, measuring and modeling risk, reducing uncertainty

in risk management, and others. Target audience consists of engineers who want to expand their skill sets to better align with the demands of current cyber security jobs, as well as those who intent to work on cyber security research. Cyber security professionals would also benefit from the course by being exposed to a systems engineering, holistic perspective on cyber security design, development, and management. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). May not be repeated for credit. Equivalent to CYSE 587, SYST 687, SYST 787.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non-Degree or Senior Plus.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Lecture

**Grading:**

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

**CYSE 799:** *Cyber Security Engineering Master Thesis*. 1-6 credits.

Research project chosen and completed under the guidance of a graduate faculty member, which results in a technical report acceptable to a three-member faculty committee, and an oral defense. Offered by Cyber Security Engineering (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/>). May be repeated within the degree.

**Registration Restrictions:**

Enrollment limited to students with a class of Advanced to Candidacy, Graduate or Non-Degree.

Students in a Non-Degree Undergraduate degree may **not** enroll.

**Schedule Type:** Thesis

**Grading:**

This course is graded on the Satisfactory/No Credit scale. (<http://catalog.gmu.edu/policies/academic/grading/>)