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-computing/engineering/cyber-security-engineering/). Limited to two attempts.

Registration Restrictions:
Students with the terminated from CEC 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-computing/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-computing/engineering/cyber-security-engineering/). Limited to two attempts. Equivalent to SYST 205.

Registration Restrictions:
Students with the terminated from CEC 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-computing/engineering/cyber-security-engineering/). Limited to two attempts.

Registration Restrictions:
Students with the terminated from CEC 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-computing/engineering/cyber-security-engineering/). Limited to two attempts.

Registration Restrictions:
Required Prerequisites: (CS 112C or 112XS) and (CYSE 101C or 101XS) and (MATH 113C or 113XS).
C Requires minimum grade of C.
XS Requires minimum grade of XS.

Students with the terminated from CEC 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-computing/engineering/cyber-security-engineering/). Limited to two attempts. Equivalent to ECE 301.

Registration Restrictions:
Students with the terminated from CEC 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/)

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-computing/engineering/cyber-security-engineering/). Limited to two attempts.

Registration Restrictions:
Required Prerequisites: (CS 222\(^C\) or 222\(^XS\)) or ((CDS 130\(^C\) or 130\(^XS\)) and (SYST 230\(^C\) or 230\(^XS\)).
\(^C\) Requires minimum grade of C.
\(^XS\) 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 CEC 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-computing/engineering/cyber-security-engineering/). Limited to two attempts.

Registration Restrictions:
Required Prerequisites: (ECE 301\(^C\) or 301\(^XS\)).
\(^C\) Requires minimum grade of C.
\(^XS\) 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 CEC 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 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-computing/engineering/cyber-security-engineering/). Limited to two attempts. Equivalent to ECE 425.

Registration Restrictions:
Required Prerequisites: ((CS 222\(^C\) or 222\(^XS\)), ECE 240\(^C\), 240\(^XS\), CS 262\(^C\) or 262\(^XS\)) and (ECE 465\(^C\), 465\(^XS\), CYSE 230\(^C\), 230\(^XS\), CS 455\(^C\) or 455\(^XS\)) and (MATH 125\(^C\), 125\(^XS\), ECE 231\(^C\) or 231\(^XS\)).
\(^C\) Requires minimum grade of C.
\(^XS\) 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 CEC 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/](http://catalog.gmu.edu/policies/academic/grading/))

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

**Registration Restrictions:**
**Required Prerequisites:** (SYST 205\(^C\), 205\(^XS\), CYSE 205\(^C\) or 205\(^XS\)).
\(^C\) Requires minimum grade of C.
\(^XS\) 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 CEC 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/](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-computing/engineering/cyber-security-engineering/](http://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/cyber-security-engineering/)). Limited to two attempts.

**Registration Restrictions:**
**Required Prerequisites:** ((ECE 301\(^C\), 301\(^XS\), CYSE 301\(^C\) or 301\(^XS\)) and (CYSE 230\(^C\) or 230\(^XS\)) and (CYSE 450\(^C\) or 450\(^XS\))).
\(^C\) May be taken concurrently.
\(^C\) Requires minimum grade of C.
\(^XS\) 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 CEC 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/](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-computing/engineering/cyber-security-engineering/](http://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/cyber-security-engineering/)). Limited to two attempts.

**Registration Restrictions:**
**Required Prerequisite:** CYSE 460\(^C\).
\(^C\) Requires minimum grade of C.

Students with the terminated from CEC 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/](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-computing/engineering/cyber-security-engineering/](http://catalog.gmu.edu/colleges-schools/engineering-computing/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 CEC 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/](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-computing/engineering/cyber-security-engineering/](http://catalog.gmu.edu/colleges-schools/engineering-computing/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 CEC 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/](http://catalog.gmu.edu/policies/academic/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-computing/engineering/cyber-security-engineering/). Limited to two attempts.

**Registration Restrictions:**
**Required Prerequisites:** (CYSE 425^C, 425^XS, ECE 425^XS or 425^C).

^C Requires minimum grade of C.  
^XS 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 CEC 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.

**Registration Restrictions:**
**Required Prerequisites:** SYST 230^C or 230^XS.  
^C Requires minimum grade of C.  
^XS 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 CEC 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-computing/engineering/cyber-security-engineering/). Limited to two attempts.

**Registration Restrictions:**
**Required Prerequisites:** (ECE 301^C, 301^XS, 231^C, 231^XS, 331^C or 331^XS).  
^C Requires minimum grade of C.

Students with the terminated from CEC 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-computing/engineering/cyber-security-engineering/). Limited to two attempts.

**Registration Restrictions:**
**Required Prerequisites:** ((SYST 205^C or 205^XS) and (STAT 344^C, 344^XS, 346^C or 346^XS)).  
^C Requires minimum grade of C.  
^XS 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 CEC 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 Uncloneable 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-computing/engineering/cyber-security-engineering/). Equivalent to ECE 476.

**Registration Restrictions:**
**Required Prerequisites:** (ECE 301^C, 301^XS, 231^C, 231^XS, 331^C or 331^XS).  
^C Requires minimum grade of C.
XS 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 CEC 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-computing/engineering/cyber-security-engineering/). Limited to two attempts.

Registration Restrictions:
Required Prerequisites: SYST 230\(^C\) or 230\(^XS\).
\(^C\) Requires minimum grade of C.
\(^XS\) 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 CEC 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-computing/engineering/cyber-security-engineering/). Limited to two attempts.

Registration Restrictions:
Required Prerequisites: CYSE 421\(^C\) or 421\(^XS\).
\(^C\) Requires minimum grade of C.
\(^XS\) Requires minimum grade of XS.

Students with the terminated from CEC 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-computing/engineering/cyber-security-engineering/). Limited to two attempts.

Registration Restrictions:
Required Prerequisites: ((CYSE 211\(^C\) or 211\(^XS\)) and (CYSE 301\(^C\), 301\(^XS\), ECE 301\(^C\) or 301\(^XS\)) and (CYSE 230\(^C\) or 230\(^XS\)) and (CS 222\(^C\), 222\(^XS\), SYST 230\(^C\) or 230\(^XS\)).
\(^C\) Requires minimum grade of C.
\(^XS\) Requires minimum grade of XS.

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

Students with the terminated from CEC 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 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-computing/engineering/cyber-security-engineering/). Limited to two attempts.

Registration Restrictions:
Required Prerequisites: (CYSE 211\(^C\) or 211\(^XS\)) and (ECE 301\(^C\) or 301\(^XS\)).
\(^C\) Requires minimum grade of C.
\(^XS\) Requires minimum grade of XS.

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

Students with the terminated from CEC 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-computing/engineering/cyber-security-engineering/). Limited to two attempts.

**Specialized Designation:** Writing Intensive in Major

**Registration Restrictions:**

**Required Prerequisites:** ((CYSE 411 C, 411 XS, 421 C, 421 XS, 425 C, 425 XS, 476 C or 476 XS), MATH 213 C or 213 XS) and (CYSE 492 C)).

* May be taken concurrently.

C Requires minimum grade of C.

XS 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 CEC 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-computing/engineering/cyber-security-engineering/). Limited to two attempts.

**Registration Restrictions:**

**Required Prerequisites:** ((CYSE 411 C, 411 XS, 421 C, 421 XS, 425 C, 425 XS, 476 C or 476 XS), MATH 213 C or 213 XS) and (CYSE 491 C)).

* May be taken concurrently.

C Requires minimum grade of C.

XS 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 CEC 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-computing/engineering/cyber-security-engineering/). Limited to two attempts.

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

**Registration Restrictions:**

**Required Prerequisites:** (CYSE 492 C or 492 XS).

C Requires minimum grade of C.

XS Requires minimum grade of XS.

Students with the terminated from CEC 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-computing/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-computing/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 CEC major attribute may **not** enroll.

**Schedule Type:** Lec/Sem #1, Lec/Sem #2, Lec/Sem #3, Lec/Sem #4, Lec/Sem #5, Lec/Sem #6, Lec/Sem #7, Lec/Sem #8, Lec/Sem #9, Lecture, Sem/Lec #10, Sem/Lec #11, Sem/Lec #12, Sem/Lec #13, Sem/Lec #14, Sem/Lec #15, Sem/Lec #16, Sem/Lec #17, Sem/Lec #18

**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
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-computing/engineering/cyber-security-engineering/). May not be repeated for credit.

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, 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 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-computing/engineering/cyber-security-engineering/). May not be repeated for credit.

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, 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-computing/engineering/cyber-security-engineering/). May not be repeated for credit.

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, 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-computing/engineering/cyber-security-engineering/). May not be repeated for credit.

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, 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-computing/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, Junior Plus, Non-Degree or Senior Plus.

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

**Schedule Type:** Lec/Sem #1, Lec/Sem #2, Lec/Sem #3, Lec/Sem #4, Lec/Sem #5, Lec/Sem #6, Lec/Sem #7, Lec/Sem #8, Lec/Sem #9, Lecture, Sem/Lec #10, Sem/Lec #11, Sem/Lec #12, Sem/Lec #13, Sem/Lec #14, Sem/Lec #15, Sem/Lec #16, Sem/Lec #17, Sem/Lec #18

**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 need 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 conti. Offered by Cyber Security Engineering (http://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/cyber-security-engineering/). May not be repeated for credit.

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Students in a Non-Degree Undergraduate degree may **not** enroll.
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-computing/engineering/cyber-security-engineering/). May not be repeated for credit.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, 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/academicgrading/)

CYSE 685: Unmanned Aerial Systems Security. 3 credits. This course provides engineers with a background in the essential components and operation of Unmanned Aerial Systems (UAS), related counter measures and protective measures. It introduces core principles for the safe and secure operation of UAS, especially in the C4I context. Topics are focused on UAS components, characteristics, and operational environment, such as weather and radio propagation. The course also covers active and passive detection of UAS, methods to avoid detection and for disrupting UAS operations, such as electromagnetic interference and cyberattacks, as well as measures against these methods, such as RADAR and IR stealth concepts. Finally, this course brings a holistic view of UAS security and its future trends. The target audience consists of engineers interested in planning, designing, or participating in UAS operations from a safety and security standpoint. Offered by Cyber Security Engineering (http://catalog.gmu.edu/colleges-schools/engineering-computing/engineering/cyber-security-engineering/). May not be repeated for credit.

Recommended Prerequisite: Engineering graduate standing, solid understanding of calculus, statistics, and probability theory

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, 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/academicgrading/)
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-computing/engineering/cyber-security-engineering/). May be repeated within the degree for a maximum of 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, Junior Plus, 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-computing/engineering/cyber-security-engineering/). May be repeated within the term for a maximum of 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 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-computing/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, Junior Plus, Non-Degree or Senior Plus.

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/)

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-computing/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/)