FA25 SIE 471/571 Systems Cyber Security Engineering Syllabus

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Office Hours: *On Request, in-person or via Zoom*

Course Description

The purpose of this course is to introduce selected topics, issues, problems, and techniques in Systems Cyber Security Engineering (SCSE), early in the development of a large system. Students will explore various techniques for eliminating security vulnerabilities, defining security specifications / plans, and incorporating countermeasures to achieve overall system assurance. SCSE is an element of systems engineering that applies scientific and engineering principles to identify, evaluate, and contain or eliminate system vulnerabilities to known or postulated security threats in the operational environment. SCSE manages and balances system security risk across all protection domains spanning the entire systems engineering life cycle. The fundamental elements of cyber security will be explored including: human cyber engineering techniques, penetration testing, mobile and wireless vulnerabilities, network mapping and security tools, embedded system security, reverse engineering, software assurance and secure coding, cryptography, and vulnerability analysis. After a fundamental understanding of the various cyber threats and technologies are understood, the course will expand upon the basic principles, and demonstrate how to develop a threat / vulnerability assessment on a representative system using threat modeling techniques (i.e. modeling threats for a financial banking system, autonomous automobile, or an Internet of Things device). With a cyber resilience focus, students will learn how to identify critical use cases or critical mission threads for the system under investigation, and how to decompose and map those elements to various architectural elements of the system for further analysis. Supply chain risk management (SCRM) will be employed to enumerate potential cyber threats that could be introduced to the system either unintentionally or maliciously throughout the supply chain. Additionally, the course will introduce the legal aspects of cyber security, including current policies and standards for legal and unlawful use of the internet and/or living in a "connected" world/society. Students will be introduced to both ethical and unethical hacking, by studying the differences between Black Hat, White Hat and Gray Hat hacking groups. The course culminates with the conduct of a realistic Red Team / Blue Team simulation to demonstrate and explore both the attack and defend perspectives of a cyber threat. The Red Team will perform a vulnerability assessment of the prospective system, with the intention of attacking its vulnerabilities. The Blue Team will perform a vulnerability of the system with the intention of defending it against cyber threats. For teams that select the same system to analyze, a comparison will be made between

the outcomes of both the Red Team and the Blue Team to better understand the overarching solutions to addressing the threats identified. Security protection planning employs a step-by-step analytical process to identify the critical technologies to be protected; analyze the threats; determine program vulnerabilities; assess the risks; and apply countermeasures. A Security Assessment Report (SAR) describes the findings of the system under analysis with the intent to mitigate risks to any advanced technology and mission-critical system functionality. Graduate students will be given an additional assignment to develop a Security Assessment Report (SAR) based on their team project.

Upon completion of the course, students will be proficient with various aspects of cyber security and how to identify system vulnerabilities early in the system engineering lifecycle. They will be exposed to various tools and processes to identify and protect a system against those vulnerabilities, and how to develop security protection plans and assessment to defend against and prevent malicious attacks on large complex systems.

This class does not teach the student "how to hack", but rather how to analyze a large, complex system early and throughout the lifecycle of the system to better protect against malicious activity and intent.

Course Prerequisites or Co-requisites

ECE 175 or instructor approval

Course Objectives

Upon completion of this course, students will be able to address the major questions, challenges, and processes that Systems Cyber Security engineers face, including:

1. Understanding the foundations, principles, methods and tools for developing more cyber resilient designs
2. Learning various techniques to threat model, develop system attack trees, and perform a system level vulnerability analysis
3. Understanding how the supply chain feeds into providing a cyber resilient system. Exploring techniques for managing that Supply Chain Risk and what is included in Supply Chain Risk Management (SCRM).
4. Exploring various industry standards, policies and laws related to Cyber Security principles and practices including those established by the National Institution of Standards and Technology, FedRAMP, Cloud Security Alliance and others.
5. Exercise methods used in conducting detailed Cyber Security analysis through a Blue or Red Team exercise on a self-selected commercially available product or platform.

A diverse set of topics will be covered to give students a fundamental understanding of the Cyber Security landscape, including the following:

1. Cryptography
2. Software assurance, malware and secure coding / defensive programming
3. Networking and network security tools
4. Personal data privacy
5. Understanding mobile and wireless security
6. Embedded systems security

7. Human cyber engineering techniques
8. Supply Chain Risk Management
9. Fundamentals of implementing a holistic program protection planning strategy early and throughout the Systems Engineering lifecycle
10. Threat Modeling
11. Reverse engineering
12. Penetration testing
13. Ethical and Unethical Hacking
14. National Institute of Standards and Technologies (NIST) Cyber Security Framework (CSF) and Risk Management Framework (RMF)
15. Security Assessment Planning and Reports
16. Conducting various levels of Security Assessments, including Blue Team and Red Team Assessments
17. Program Protection Plans and Program Protection Implementation Plans
18. Cyber Policy and Laws

Expected Learning Outcomes

Upon completing this course, students will be able to address the major questions and issues that System Cyber Security engineers face including:

- Describe fundamental aspects of a cyber resilient system. [ABET Student Outcomes 1]
- Develop system attack trees and perform a threat and vulnerability analysis. [ABET Student Outcomes 1 and 6]
- Identify and recommend security requirements that should be part of the system security engineering activities in product development. [ABET Student Outcomes 1 and 6]
- Use tools and techniques/methodologies to analyze the vulnerabilities in a complex product or system. [ABET Student Outcomes 1 and 6]
- Describe what Information Assurance is and the role it plays in developing a cyber resilient system. [ABET Student Outcome 1]
- Describe what Software Assurance is and the role it plays in developing a cyber resilient system. [ABET Student Outcome 1]
- Evaluate how the supply chain feeds into providing a cyber resilient system and affects the cyber threat/risk posture of supplied components. [ABET Student Outcomes 1 and 6]
- Perform a security risk assessment of an Internet of Things device or other similar product. [ABET Student Outcome 7]
- Identify the differences between Ethical and Unethical Hacking (Black Hat vs White Hat Hacking). [ABET Student Outcome 4]
- Identify laws or policies in place to protect an individual or organization in the cyber domain. [ABET Student Outcome 4]
- Develop a Security Assessment Plan. [ABET Student Outcomes 3 and 5]
- Conduct a Red Team / Blue Team assessment in a collaborate group project / simulation. [ABET Student Outcomes 5]
- Work in teams to solve a larger problem and communicate findings with peers and technical experts from diverse engineering backgrounds. [ABET Student Outcomes 5 and 7]
- **[Graduate Students only]** Demonstrate an understanding of a Security Assessment Report (SAR) by creating and submitting a SAR based on the Team Project.

Course Modality

This class is scheduled to be taught in the **On Campus / In person modality** for students registered as an **"On Campus"** student.

For students that are registered as **"Online"**, the course will be available via an **Asynchronous Online format.**

Course Format and Teaching Methods

This course is structured around interactive lectures and discussion on the topics that are covered in those lectures. We will also have several guest lectures from industry that are invited to share their experiences and perspectives on various Cyber topics throughout the semester. These guest lectures are extremely interesting and engaging.

The covered topics are grouped into "Modules". There will be a separate content section for each module on D2L. Within that module, there will be a summary of the reading assignments, homework assignments, and key objectives of the module. There may also be several additional reading resources posted for that module within that content folder. For each module, different discussion questions will also be posted to extend the learning by sharing with your classmates. These are very interesting and provide different thought-provoking perspectives and experiences.

Online students can watch lectures that have been filmed during the normal class time and it is strongly recommended that you watch all the videos to hear the real time commentary and interactions between the instructor and the class. Online students are also required to interact with their classmates through the various discussion questions posted for each module.

All exams will be given in real time for students that are registered as "On-Campus" students. For students that are registered as "Online" students, they will have the opportunity to take exams online within a specified window of time that will be given by the instructor.

All students should:

- Check D2L regularly.
- Turn-in assignments by due date/time (allow for D2L "glitches").
- Treat instructors, speakers and peers with respect.
- Always behave in an ethical manner.
- All students are required to abide by the Student Code of Academic Integrity: http://dos.web.arizona.edu/uapolicies
- Threatening behavior by students is strictly prohibited. For detailed information see: http://policy.web.arizona.edu/~policy/threaten.shtml.

On-campus students:

- Arrive to class on-time, turn off cell phones, beepers, social networks, etc.
- Attend class regularly and participate in class discussions and activities.

Online students:

View lectures in a timely manner asynchronously, preferably within 48 hours of the lecture date.

Note: **DUE DATES** for course deliverables are all posted on D2L.

Course Time Zone

All dates and times mentioned in this course represent Mountain Standard Time (Arizona), which is UTC-7 hours. Arizona does not observe Daylight Savings Time. You can use the following link to get the current local time in Tucson, Arizona: http://www.timeanddate.com/worldclock/city.html?n=393

Absence and Class Participation Policy

Participating in this course is vital to the learning process. As such, participation in class discussions via discussion boards on D2L is required. Students are responsible for all materials and discussions covered during class. As such, participation in class discussions on D2L is required and will be factored into the final grade at a factor of 20%. This class uses an active learning environment and attendance is critical for you all to be able to engage with the material. Class participation is a requirement.

Please send an email to the instructor if you are going to missing class (on-campus students only), request a homework assignment or exam extension for a valid reason (these include extended illness, death in the family, or conflict with a work commitment (this is only for those that are classified as "online students") to ask for an excused absence **in advance**. **Extensions will not be given because of workload or exams in other classes.**

Participation in all Red Team / Blue Team Simulation Out-briefs is an especially important part of the learning in this class and any unexcused absence and/or participation in project discussion prompts will result in your individual score for the team project being lowered. ***If you have an unexcused absence for your own Red Team / Blue Team simulation out-brief, it will result in you receiving a failing grade for your project.***

Class Recordings

For lecture recordings, students must access content in D2L only. Students may not modify content or re-use content for any purpose other than personal educational reasons. All recordings are subject to government and university regulations. Therefore, students accessing unauthorized recordings or using them in a manner inconsistent with UArizona values and educational policies (Code of Academic Integrity and the Student Code of Conduct) are also subject to civil action.

Course Communications

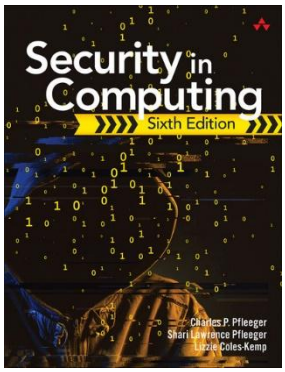
For questions that could benefit all classmates, please use the **Ask the Instructor** discussion forum on D2L to contact the instructor for content related questions. By using this means of communicating, all students can see the response and benefit from the learning as well. If you have a question regarding your personal performance in the course, please email the instructor directly or make an appointment to discuss your any concerns you have about the class. Under normal circumstances, the instructor will respond within 24 hours of your email or posting on any day of the week (quite often sooner). When appropriate, the instructor will provide feedback on course work that needs to be manually graded (e.g., papers, assignments) within 72 hours of submission. You will be able to see results for automatically graded course work after the specified deadline.

D2L Course Management System

This course uses the University of Arizona's D2L course management system. You are **required** to use D2L with this class and are encouraged to check our D2L class course space daily.

You are also encouraged to have D2L email forwarded to your primary University of Arizona email account. I will use D2L for course assignments, content distribution, and important announcements. The University of Arizona's D2L system is available at: http://D2L.arizona.edu.

Required Texts or Readings



Pfleeger, C., Pfleeger, S., and Coles-Kemp L., Security in Computing, 6th Edition, Prentice-Hall, 2023

Security in Computing, 6th Edition (oreilly.com)

Other Required or Special Materials

You will need a computer with Microsoft Office or equivalent and the ability to log into D2L. For the term project, you will also likely need access to various team collaboration tools to facilitate team sharing and work products being generated. Those tools can be agreed to by the team at the start of their project.

Assignments and Examinations: Schedule/Due Dates

There will be weekly assignments and discussion participations that all students will be expected to complete, one team project (Red Team/Blue Team Simulation), one midterm and a final exam. The schedule for all these course deliverables will be provided at the start of the semester and will be posted on the Course Calendar section of D2L. The due dates are subject to change and ample notice will be given to students when any change does occur. However, it is the student's responsibility to check and monitor the completion of all assignments. ***IN GENERAL, NO LATE WORK WILL BE ACCEPTED.***

Graduate students will develop a Security Assessment Report (SAR) based on the findings of their team project - either a Red Team or Blue Team (RTBT) Simulation. The grade for these documents will be factored into their overall grade for the team project. The instructor will go over the weighting of all aspects of the team project for both BS and MS students in class when the project is assigned.

Grades will be assigned as measures of performance on required activities. Rubrics will be made available for all assignments.

For the team project, all students will be required to individually submit 1 Team evaluation for all deliverables for the RTBT Simulation project. **An individual student's final team project grade will be factored by the average score of all team members' inputs from these evaluations.** Every team member is expected to contribute equally to the project. If there are team dynamics that are preventing a collaborative working environment, it is best to inform the instructor ahead of time so that adjustments can be made to facilitate effective teaming and communication amongst the team.

The grading distribution for course assignments, class participation, projects, and exams are as follows:

Class Participation	5%
Discussion Boards	10%
Cyber News Discussion posts	5%
Module Assignments	15%
Midterm Exam	15%
Red Team / Blue Team Simulation	25%
Final Exam:	25%
Total	***100%***

Late Work

In general, late work will not be accepted. ***Late homework and projects will not be accepted, and the student will receive 0 points for any missed or late work.***

Quality of Work Expectations

Two of the outcomes for this course is to collaborate on teams and communicate effectively with people from diverse technical backgrounds. This requires that one take personal pride in their work and be held accountable for timely and professional quality work. To this end, the following quality expectations are established for this course:

- For all out-of-class work, organization, presentation style, grammar, and spelling will be weighted into the score. Spelling will be evaluated using the Microsoft *Word* Standard United States dictionary.
- **All assignments will be scanned by the TurnItIn plagiarism tool and any assignments that have a score higher than 15% on any homework assignment or exam response, will receive a 0% on the assignment.** If you are using different sources/references you find online, then please document or reference that part of the text appropriately.

- Points will be lost for poorly organized or unprofessional work. This includes spelling and grammar errors, poor word choice, and poor sentence structure.

- Students who have writing difficulties or deficiencies, and students for whom English is a foreign language should consider using the services provided for free through the University of Arizona Writing Laboratory

Feedback on Submitted Work

For purposes of this section, feedback refers to the scored assessment of learning on any given assignment, examination, project or paper. Scores are summed, categorized, and weighted to determine the final course grade. The following policies apply to scores:

- Feedback will be provided regularly by your instructor – as quickly as possible. Every instructor has multiple responsibilities beyond his/her courses. And each instructor has a unique way of providing feedback. If you believe you are not getting enough feedback, you are encouraged to contact your instructor and ask for more.

- The instructor will make every effort to grade assignments within 72 hours, but no later than one calendar week after the assignment due date.

- To comply with federal privacy law (specifically, FERPA), graded materials will never be passed around the classroom, or placed in any publicly accessible location, physical or online. Most scored work will be returned via D2L directly to the named student or student team.

- Any student wishing to appeal any given score must return his or her graded work with a written statement explaining the appeal. An appeal must be submitted no later than one calendar week after the original score was posted. Any work submitted for re-grading will be graded in its entirety.

Final Examination

Online students will be provided instructions on how and when to take the exam asynchronously online. For online students, there will be a window of time that the exam is active. Online students must make arrangements to make themselves available to take the exam within that window of time.

Details for how the exam will be administered will be provided at a minimum of 2 weeks prior to the Final Exam date. *Note: the instructor will give students ample notice of the format, time, and any resulting stipulations about where and how the exams will be administered.*

The University's Final Exam Regulations can be found at https://www.registrar.arizona.edu/courses/final-examination-regulations-and-information, and Final Exam Schedule can be found at http://www.registrar.arizona.edu/schedules/finals.htm

Make-up exams

A make-up exam may only be given under extraordinary circumstances. The student requesting a make-up exam should contact the instructor well in advance and provide *written* documentation about why he/she will not be able to attend the regularly scheduled exam. It is up to the discretion of the instructor to accept the justification provided by the student.

Grading Scale and Policies

The following scale will be used to award the final grades, for both 400 / 500 students:

Percentage	Letter Grade
90% – 100%	**A**
80% – 89%	**B**
70% – 79%	**C**
60% – 69%	**D**
<60%	**E**

A rubric will be made available on D2L for all deliverables for the course.

Requests for incomplete (I) or withdrawal (W) must be made in accordance with University policies, which are available at http://catalog.arizona.edu/policy/grades-and-grading-system#incomplete and http://catalog.arizona.edu/policy/grades-and-grading-system#Withdrawal respectively.

Dispute of Grade Policy: Any disputes for a grade on one of the course deliverables must be made within 1 week of receiving the grade.

Scheduled Topics/Activities

The course schedule and due dates will be maintained online at D2L. Please refer to D2L often for any changes that may be made throughout the semester.

Other Course Policies

Dispute of Grade Policy

You can dispute any grade that you receive within two weeks that the grade has been awarded.

To foster a positive learning environment, students and the instructor have a shared responsibility. We want a safe, welcoming, and inclusive environment where all of us feel comfortable with each other and where we can challenge ourselves to succeed. To that end, our focus is on the tasks at hand and not on extraneous activities (e.g., texting, chatting, reading a newspaper, making phone calls, web surfing, etc.).

Online Collaboration/Netiquette

In this course, you will primarily communicate with the instructor and peers through a variety of tools such as discussion forums, email, and other forms of web conferencing. The following guidelines will enable everyone in the course to participate and collaborate in a productive, safe environment.

- Be professional, courteous, and respectful as you would in a physical classroom.

- Online communication lacks nonverbal cues that provide much of the meaning and nuances in face- to-face conversations. Choose your words carefully, phrase your sentences clearly, and stay on topic.
- It is expected that students may disagree with the research presented or the opinions of their fellow classmates. To disagree is fine but to disparage others' views is unacceptable. All comments should be kept civil and thoughtful. Remember that this course abides by university policies regarding disruptive behavior: http://policy.arizona.edu/education-and-student-affairs/disruptive-behavior-instructional-setting
- Compose your messages and posts in a word processing tool and check your spelling and grammar before submitting your post / email.

Statement of copyrighted materials

All lecture notes, lectures, study guides and other course materials disseminated by the instructor to the students, whether in class or online, are original materials and reflect intellectual property of the instructor or author of those works (with the exception of other published reference materials – i.e. course textbooks). All readings, study guides, lecture notes and handouts are intended for individual use by students. You may not distribute or reproduce these materials for commercial purposes without the express written consent of the instructor. Students who sell or distribute these materials for any use other than their own are in violation of the University's Intellectual Property Policy. Violations of the instructor's copyright may result in course sanctions and violate the Code of Academic Integrity.

Student Support

The instructor is available to assist with **content-related** issues. You may, at any time, email the instructor. This course also provides an ***Ask the Instructor*** discussion forum within the D2L environment. You are encouraged to post content-related questions to this forum at any time, especially for things that will benefit all students. *(It is not recommended that you use this forum for individual questions that are specific to your work or performance in the class.)* This forum will be monitored on a regular basis and the instructor will respond in a timely fashion. It is common for other students to participate in answering questions posted in the ***Ask the Instructor*** forum. You should feel free to contribute to the solution if you can provide knowledge or guidance related to the question.

The following are guidelines for requesting support:

- **General Course Questions:** Use the ***Ask the Instructor*** discussion forum for questions regarding course materials or policy.
- **Personal Course Questions**: Email the instructor to discuss grades or personal concern.
- **D2L Support Questions**: Email mailto:d2l@arizona.edu

Safety on Campus and in the Classroom

- For a list of emergency procedures for all types of incidents, please visit the website of the Critical Incident Response Team (CIRT): https://cirt.arizona.edu/case-emergency/overview

Accommodations for Students with Disabilities

At the University of Arizona, we strive to make learning experiences as accessible as possible. If you anticipate or experience barriers based on disability or pregnancy, please contact the Disability Resource Center (520-621-3268, https://drc.arizona.edu/)to establish reasonable accommodations.

See http://drc.arizona.edu/instructors/syllabus-statement.

Library Support

The University of Arizona Libraries provides the research tools you need at any time. For an abbreviated list of resources directly related to a specific course, select the **Library Tools** link (located in the Tools drop down on the left of the screen within the Course Navigation bar).

Course Grievance Policy

In case of grievances with a course component or grading, students are encouraged to first try and resolve the issue with the instructors. If you feel the issue is not resolved satisfactorily, please send an email to https://registrar.arizona.edu/faculty-staff-resources/grading/grading-policies/grade-appeal.

Course Surveys and Evaluations

Near the end of each semester / session, students will receive an invitation via email to complete an online course survey associated with this course administered by the Office of Instruction and Assessment through the UA Student Course Survey (SCS) tool. Refer to the Student Support website associated with the Student Course Surveys (https://scs.arizona.edu/content/5).

Your feedback is extremely valuable and will be used to make changes and enhancements to the course to better meet student needs in the future.

Subject to Change Statement

> Information contained in the course syllabus, other than the grade and absence policy, may be subject to change without advance notice, as deemed appropriate by the instructor.