CSE 4351: Computer Security

Instructor: Dr. MD Armanuzzaman

Academic Integrity

Your first assignment is to to read the UTEP academic integrity policies

Here are examples for your consideration

- you work on your laptop at a library with friends and step away from your computer without locking it
- you look at your neighbors' papers during an exam, but don't copy their answers
- you take a piece of code from some website and give a link to the website at the end of the homework
- you work on a homework problem with friends, type the solution at home, but it's the same as that of your friends

Academic Integrity

- The university, college, and department policies against academic dishonesty will be strictly enforced. To understand your responsibilities as a student read: UTEP Student Code of Conduct.

- Plagiarism or any form of cheating in homework, or exams is subject to serious academic penalty.
- Any violation of the academic integrity policy will result in a 0 on the homework or exam, and even an **F** or **>F<** on the final grade. And, the violation will be reported to the Dean's office.

Logistics

Attend the class in-person

There will be attendance check

https://tomal-kuet.github.io/armanuzzaman/courses/Fall26/index.html

Feel free to interrupt me and ask questions.

Instructor and Teaching Assistant

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TEAMS LINK

About T3SLab

Research areas:

- Embedded system and software security (Arm Cortex-M, ARM CCA, Cortex-A, RISC-V, FPGA, etc.)
- Agentic Systems Security
- Security in/with machine learning/deep learning
- Formally verify the security properties of crypto protocols and system code
- Confidential Computing
- IoT hacking/CTF platforms (Roblox for hacking)
    - We participate in MITRE eCTF competition in springs semester of each year.

We need students at all levels for funded research, volunteer work, independent study, etc.

Course Goals

The objectives of this course consist of developing a solid understanding of **fundamental principles** of the **security** field and building knowledge of tools and mechanisms to safeguard a wide range of software and computing systems.

Topics:

- Cryptographic background and tools;
- Access control; authentication;
- Software security, malware;
- Internet security protocols and standards (SSL/TLS, IPsec, secure email);
- Intrusion detection and intrusion prevention systems (firewalls);
- Database security;
- Privacy; identity management;
- Security management and risk assessment;
- Legal and ethical aspects (cybercrime, intellectual property)

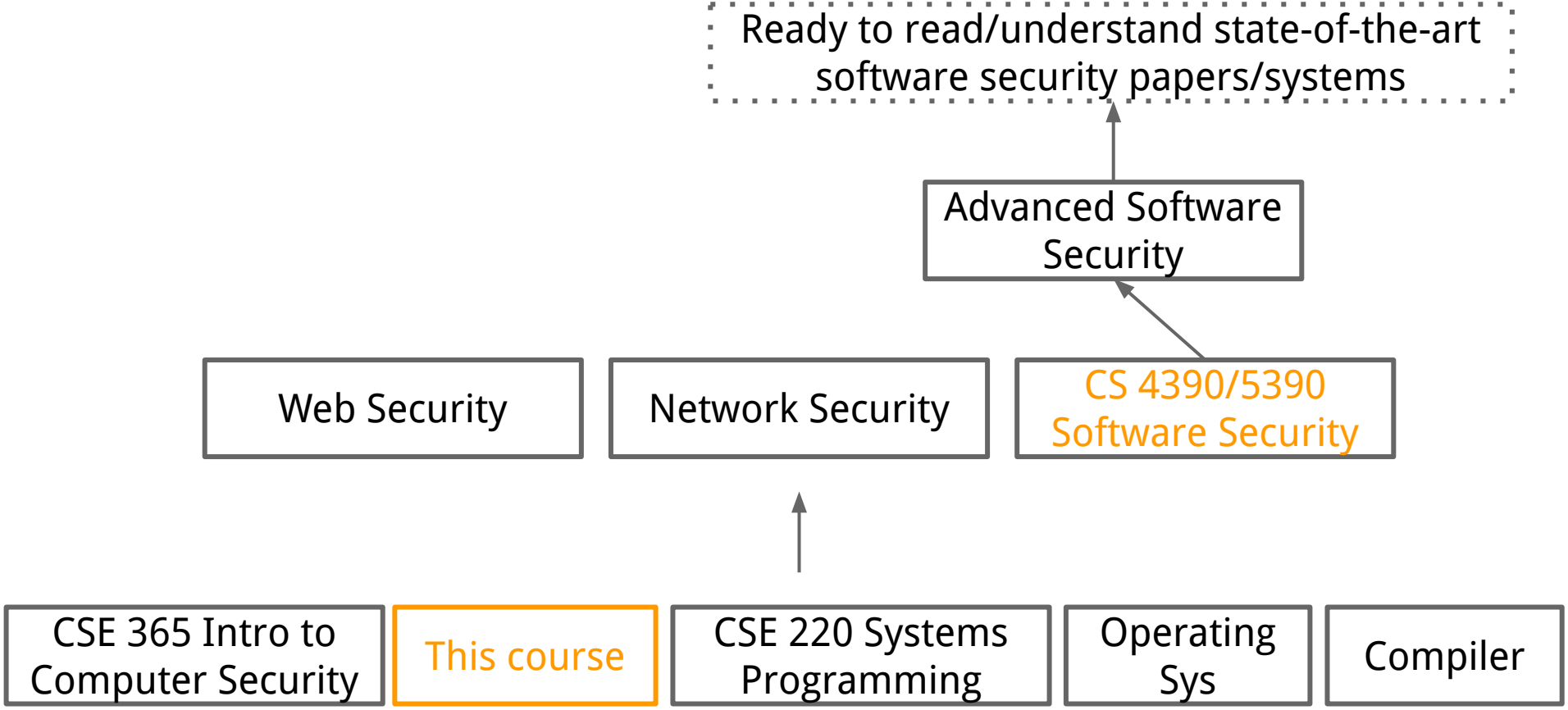
What is Computer Security as a field?

Computer security is very broad as a field

It covers many areas:

- Network security
- Software security
- System security
- Web security
- Safety in programming language
- Database security
- Usable security
- Access control
- LLM Security
- Cybercrime
- …

If you want to be a security researcher …



CS 4390/5390 System Security - Attack and Defense for Binaries - Topics

Binary attack and defense using x86 and x86-64 as examples. Discover **vulnerabilities**. Develop **exploits**. Memory corruption attacks.

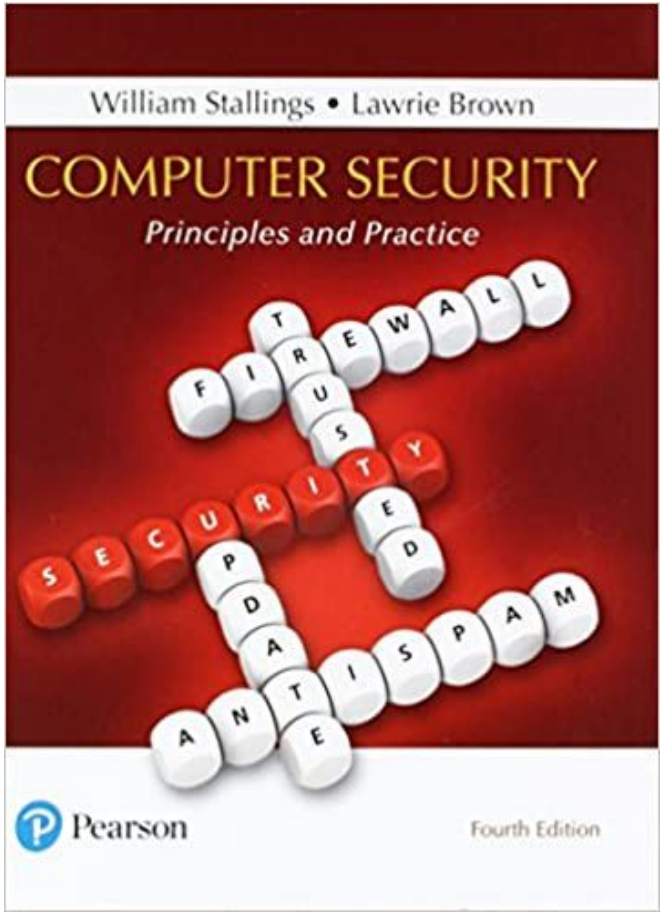
1. Stack-based buffer overflow
2. Defenses against stack-based buffer overflow
3. Shellcode development
4. Format string vulnerabilities
5. Heap-based buffer overflow
6. Integer overflow
7. Return-oriented programming
8. …

CS 4390/5390 System Security - Attack and Defense for Binaries - The Hacking Environment

Only UTEP students can access this website. If you are off-campus, you need to VPN to connect to UTEP network to access. Register an account with your UTEP username and email address.

http://yeast.utep.edu:2223/

Textbooks


William Stallings • Lawrie Brown
COMPUTER SECURITY
Principles and Practice
FIREWALL
TRUSTED
SECURITY
UPDATE
ANTISPAM
Pearson
Fourth Edition

Homework

Reading: book chapters

Hands-on: programming

- All assignments must be done **individually** unless announced otherwise; no collaboration on solving or writing assignments
- Searching for homework answers online is not permitted
- The use of any external resources should be properly documented when answering the question (i.e., not at the end of the homework) and the nature of the help the document provided (i.e., what information it contained and how it helped with answering the question)
- Homeworks will be submitted via Blackboard; they must be typed (diagrams can be hand-drawn) and normally would need to be submitted as a PDF.
- Late submissions in 48 hours will be accepted with a **15% (0 - 24 hours late)** and **30% (24 - 48 hours late) penalty**, respectively. Late submissions beyond **48 hours will not be accepted**.
- **0 points** for homework if plagiarising is found. No exceptions.

Regrading requests

- Homework or exam regrade requests need to be submitted within two weeks of releasing the graded material to the class
- The request needs to be in writing clearly describing the error in grading

Disability Accommodations

If you need DA, please inform me in the first two weeks.

Exams

Midterm: 1 hour 20 minutes

Final exam: 3 hours

Grades

Area	No. Items	Points per Item	Points for Area
Homework	6	60	360
Exams	2		630
Midterm	1	250	
Final	1	380	
Attendance	14	1	14
Anonymous Course Evaluation Bonus	2	10	20
Total			1024

Points	Grade
930 -	A
900 - 930	A-
870 - 900	B+
830 - 870	B
800 - 830	B-
770 - 800	C+
700 - 770	C
670 - 700	D+
600 - 670	D
0 - 600	F

Basic Computer Security Concepts

Jonathan Greig

January 6, 2023

Cybercrime | Malware | News

SickKids: 80% of hospital priority systems back online after LockBit ransomware attack

Toronto's Hospital for Sick Children, Canada's largest pediatric health center, said it has restored 80% of its systems that have a direct impact on hospital operations following a ransomware attack.

A spokesperson for the hospital told The Record that patients and families dealt with diagnostic and treatment delays because clinical teams struggled to receive lab reports and imaging results after the LockBit ransomware group launched an attack on the night of December 18.

While the hospital's electronic medical record system was not affected by the attack, several other tools connected to the system were damaged – including dictation services, pharmacy systems and the ability to view diagnostic imaging results. The hospital's internal timekeeping system for staff and intranet were

JD Sports says 10 million customers hit by cyber-attack

6 hours ago

GETTY IMAGES

By Michael Race

Business reporter, BBC News

Sportswear chain JD Sports has said stored data relating to 10 million customers might be at risk after it was hit by a cyber-attack.

The company said information that "may have been accessed" by hackers included names, addresses, email accounts, phone numbers, order details and the final four digits of bank cards.

What is Computer Security?

The NIST Internal/Interagency Report NISTIR 7298:

Computer Security: Measures and controls that ensure **confidentiality**, **integrity**, and **availability** of information system assets including hardware, software, firmware, and information being processed, stored, and communicated.

Security Objectives

Confidentiality

Integrity

Availability

Authenticity

Non-repudiation

Security Objectives (CIA Triad)

Confidentiality: Prevent/detect/deter improper disclosure of information.

- data confidentiality: sensitive information is available to authorized parties only
- privacy: individuals can control what information about them can be collected and stored and to whom it is made available
- …

Security Objectives (CIA Triad)

Integrity: Prevent/detect/deter improper modification of information

- data integrity: information and software can be modified only in a predetermined and authorized manner
- system integrity: a system performs its intended functions in an expected manner and has not be manipulated in an unauthorized way
- …

Security Objectives (CIA Triad)

Availability: Prevent/detect/deter improper denial of access to services provided by the system

Examples

Confidentiality: You should not come to know the scores of your classmates in this class

Integrity: You should not be able to change your or others' scores in this class

Availability: Your scores should always be available on Blackboard

In Addition to CIA Triad

Authenticity: The assurance that a message, transaction, or other exchange of information is from the source it claims to be from.

Non-repudiation: The assurance that someone cannot deny something, such as the receipt of a message or the authenticity of a statement or contract.

Examples

Authenticity: You should not pretend as the TA to send an email to your classmates

Non-repudiation: The TA can not pretend he did not send out the message

How to we achieve the objectives? What are the possible measures and controls?

The means of achieving these objectives greatly differ

- cryptographic techniques
- access control policies
- software checking tools
- virus scanners
- firewalls
- spam filters, etc.

Each system must be evaluated uniquely in terms of its requirements

- security mechanisms must be adequately chosen in accordance with those requirements

Why is security hard?

- Identifying security requirements of a system is non-trivial
  - must take into account services, environment, etc.
- Finding adequate (often complex) solutions is not easier
  - the decision must take into account known and unknown attacks and threats
  - security mechanisms must be logically placed
- Securing a system is **not a one-time task**
  - the system must be constantly monitored in face of changing threats
  - security mechanisms need to be re-evaluated

Why is security hard?

- Managers do not perceive value in security investment (until a security failure occurs)
  - system administrators might not influence decisions or not make good decisions
- Users view security measures as an obstacle on the way of getting their work done
  - we would like security mechanisms to be as intuitive and robust as possible
- Adding security to an existing system might not be pretty
  - ideally, security is an integral part of the design

Takeaways

- Security is not absolute
  - assets can have different security grades depending on the impact of a security breach that can range from low to high
  - by building more secure systems, we make it harder for an attacker to breach security
  - the more resources we can invest in a system, the more secure we can make it
  - there is a trade-off between security and resources (money, equipment, personnel, training)
  - training must cover all users, as security can often be easiest breached by exploiting human error

More Concepts

- **Security policy** – a set of rules or practices that specify how a system or organization is prescribed to protect its assets
- **Vulnerability** – a flaw or weakness in system's design, implementation, or operation that could be exploited to violate the security policy
- **Threat** – a potential for violation of security, i.e., a possible danger that might exploit a vulnerability

More Concepts

- **Attack** – a deliberate and intelligent attempt to violate the security policy of a system or get around security services
- **Adversary or attacker** – an entity that attacks a system or is a threat to it
- **Countermeasure** – an action, procedure, or technique that reduces a threat or vulnerability, prevents or mitigates an attack
- **Risk** – an expectation that a particular threat will exploit a particular vulnerability with a particular harmful result

Type of Adversaries

- **passive**: observes information without intervention
  - e.g., passively monitoring a communication link
- **active**: alters system resources or affects their operation
  - e.g., changing messages, replaying old messages on the network, corrupting users, etc.

- **insider**: is legitimately a part of the system with access to internal data or is inside the security perimeter
- **outsider**: is outside of the security perimeter or is not a legitimate user

Security Design Principles

- economy of mechanism
- open design, modularity
- layering
- complete mediation
- fail-safe defaults
- separation of privilege, least privilege
- least common mechanism
- psychological acceptability, least astonishment
- isolation, encapsulation