

CS 4316/5313: Computer Networks

Instructor: Dr. Deepak K. Tosh

Class Hrs.: TR, 4:30–5:50PM

Semester: SPRING 2023

Office Hrs.: TR, 1–2 PM/Appt.

Email: dktosh@utep.edu

Classroom: UGLC 346

A. Course Description

This course offers in-depth concepts of computer networks and with technical foundations of the Internet. Topics to cover include overview of network models, architectures, applications, network programming interfaces (e.g. sockets), protocols and algorithms for routing and transport, congestion control, addressing, local area networks, medium access control, and network security. This course will cover various networking concepts as well as protocols and discuss on how they cohesively work together to provide unique Internet services, with emphasizing on

1. Application, transport network, and link layers
2. Layering benefits through top-down approach in TCP/IP and OSI stack
3. Emergence of software-defined networking and its performance impacts
4. Security of various protocols on TCP/IP stack

B. Course Objective

The objective of this course is to provide deeper understanding of the generic principles, components, design, and security of modern computer networks with a focus to learn the working mechanism of important protocols and enable secure communication in untrusted Internet.

C. Course Outline (TENTATIVE)

1. Course Overview and Intro (1.5 Week)
 - a. What is the Internet?
 - b. Performance, Protocol Layering
 - c. Protocol Layering
 - d. Network Security Basics
2. Application Layer (2 Weeks)
 - a. Principles of Network Applications
 - b. The World Wide Web, HTTP(S), and Email
 - c. Email, DNS
 - d. DNS attacks, DNSSEC
3. Transport Layer (3.5 Weeks)
 - a. Principles of Transport, UDP
 - b. Reliable Data Transfer
 - c. TCP and Congestion
 - d. Transport layer attacks
 - e. Transport layer security (TLS)
4. Network Layer: Data Plane (2 Weeks)
 - a. Overview and Addressing
 - b. Dissecting a Router
 - c. Internet Protocol (IP)

- d. Generalized forwarding and SDN
- e. IP and ICMP attacks
- 5. Network Layer: Control Plane (2 Weeks)
 - a. Routing Algorithms
 - b. Intra-AS routing
 - c. BGP and its security
 - d. SDN control plane
- 6. Link Layer and LANs (2 Weeks)
 - a. Intro to Link Layer, Multiple Access Links
 - b. Error detection and correction
 - c. ARP
 - d. LANs, Virtual networks/links
 - e. MAC layer attacks (ARP Poisoning, MITM)

Note: We may cover advanced topics that are beyond the textbook. In that case, the instructor will upload the electronic copies of the handouts/weblinks in the Blackboard. Therefore, you will need regular access to a computer, stable/consistent Internet, Blackboard, and your UTEP email account for succeeding in this class.

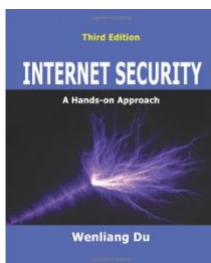
D. Prerequisite

C or better in CS 3432: Computer Organization

E. Required Materials/Books



“Computer Networking: A Top-Down Approach” by James F. Kurose and Keith W. Ross. (8th Edition)



“Internet Security: A Hands-on Approach” by Wenliang Du (3rd Edition)

Other Reference Book – Computer Networks: A systems Approach by Larry Peterson and Bruce Davie, Sixth Edition. <https://book.systemsapproach.org/>

Required Prior Knowledge – (1) You must know how to write programs in C and Python. These two programming languages will be heavily used in the assignments; (2) You must be familiar to use VirtualBox or VMWare to configure and network among multiple VMs. Please visit the following links to learn more about them.

- 1) Learn C - <https://www.learn-c.org/>

- 2) Socket Programming - <https://beej.us/guide/bgnet/>
- 3) Learn Python - <https://www.learnpython.org/>
- 4) VirtualBox - <https://www.virtualbox.org/manual/>

F. Course Assignments and Grading Policies

Your semester grade will be based on a weighted combination of homework assignments, quizzes, participation, and exam. The approximate percentages for each category are given in the following and the final grade will be calculated using weighted average of these items.

Tentative Grade Distribution⁺

- 15% - Quizzes and Participation (QP)
- 40% - Homework and Programming Assignments (A)
- 20% - Midterm Exam (M)
- 25% - Final Exam (F)

⁺**5313 Students** will have (i) additional homework and programming assignments that will cover the advanced topics in the computer networks domain; (ii) different questions in the midterm and final exams to test their analytical capabilities. Therefore, the instructor expects the graduate students to rigorously read and self-learn many of the networking topics, which will help them succeeding in this course.

Total Score	90-100	80-89	70-79	60-69	59 and Below
Grade	A	B	C	D	F

**** Students are required to agree to the UTEP College of Engineering's [Honor Code](#).**

Important Note: You will have one week to appeal for your grades after the graded assignments and tests are returned. So, please keep this in mind if you think that there is a problem/issue with the grading of your work.

a. Homework and Programming Assignments

There will be tentatively 4-5 homework assignments to let the students practice theoretical notions of computer networks. To build competency on network programming and security, there will be 3-4 programming assignments. Through these assignments, students will develop concrete understanding on various protocols at each layer of TCP/IP stack along with their security issues.

Note-1: Students/Teams may be asked to demonstrate their assignments and answer additional follow up questions, whenever the instructor needs to verify the originality of their works. It is student's responsibility to come prepared while demonstrating his/her work. If the student could not answer, the 50% of the respective question's score will be deducted.

Note-2: Uniqueness and plagiarism will be strictly checked in the submitted codes, documents, reports etc. If the instructor finds plagiarized submission, the student will be reported to dean's office and score for that assignment will be given as zero.

Note-3: Any external materials referred to solve the assignment tasks must be CITED as references in the reports.

b. Quizzes, and Participation

There will be 6-7 **surprise quizzes** starting from 2nd week of the semester. Students must attend all lectures and come prepared before every class. Quizzes cannot be retaken unless the student has a very special reason (with proof).

c. Midterm and Final Exam

Midterm exam is scheduled to be on **7th March 2023** and Final exam will be conducted on the day of UTEP's allotted day, which is **9th May 2023, 4-6:45pm**. Each test will have estimated duration of 80-100 minutes. The format of the exams will be further discussed in the class and announced later.

Late Submission Policy:

- **No extension** on the **assignments** submission due dates will be given unless there are special medical emergencies.
- Late submissions will be penalized with 10% deduction per day up to a maximum of 5 days. Submission after 5 days of due date will receive 0 points.

Make-up Work Policy:

Make-up work will be given only in the case of a documented emergency. Note that make-up work may be in a different format than the original work, may require more intensive preparation, and may be graded with penalty points. If you miss an assignment and the reason is not considered excusable, you will receive a **zero**. It is therefore important to reach out to me—in advance if at all possible—and explain with proper documentation why you missed a given course requirement. Once a deadline has been established for make-up work, no further extensions or exceptions will be granted.

Incomplete Grade Policy:

Incomplete grades may be requested only in exceptional circumstances after you have completed at least half of the course requirements. Talk to me immediately if you believe an incomplete is warranted. If granted, we will establish a contract of work to be completed with deadlines.

G. Course Outcomes

Knowledge and Comprehension

1. Understand and describe the layered design of protocol model
2. Working mechanism of application layer protocols: http, email, ftp, etc.
3. Understand the unreliable and reliable transport protocols along with various flow control and error control mechanisms
4. Understand routing protocols, network filtration techniques, and network virtualization
5. Learn the importance of network and data plane segregation in SDN
6. Understand security implications of various protocols at each layer

Application and Analysis

1. Compare performance of both reliable and unreliable transport protocols.
2. Design addressing mechanism for predefined local area network
3. Analyze and evaluate a number of data link, network, and transport layer protocols

4. Capture and process the live network traffic for deep packet analysis

Synthesis and Evaluation

1. Program network communication services for client/server and construct network filtering components.
2. Design and implement a reliable transport protocol using network programming interface (e.g. datagram sockets)
3. Evaluate performance metrics of the implemented reliable transport protocol

H. Course Communication

- **Office Hours:** Tuesdays and Thursdays: **1-2pm**, Mountain Standard Time
- **Email:** UTEP e-mail is the best way to contact me, in case you were not able to meet during office hours. I will make every attempt to respond to your e-mail within 24-48 hours of receipt. When e-mailing me, be sure to email from your UTEP student account and please put the course number in the subject line. In the body of your e-mail, clearly state your question. At the end of your e-mail, be sure to put your first and last name, and your university identification number.
- **Discussion Board:** If you have a question that you believe other students may also have, please post it in the Help Board of the discussion boards inside of Blackboard. Please respond to other students' questions if you have a helpful response.
- **Announcements:** Check the Blackboard announcements frequently for any updates, deadlines, or other important messages.

I. Netiquette and Standards of Conduct

Students are expected to conduct themselves in a professional and courteous manner, as prescribed by the Standards of Conduct. Students may discuss work assignments and programming exercises in a general way with other students, but the solutions must be done independently. Similarly, groups may discuss group project assignments with other groups, but the solutions must be done by the group itself. Graded work should be unmistakably your own. You may not transcribe or copy a solution taken from another person, book, or other source, e.g., a web page. Professors are required to -- and will -- report academic dishonesty and any other violation of the Standards of Conduct to the Dean of Students. Some **key points** to remember:

- Always consider audience. Remember that members of the class and the instructor will be reading all the postings.
- Respect and courtesy must be provided to classmates and to instructor at all times. No harassment or inappropriate postings will be tolerated.
- When reacting to someone else's message, address the ideas, not the person. Post only what anyone would comfortably state in a F2F situation.
- Blackboard is not a public Internet venue; **all postings to it should be considered private and confidential.** Whatever is posted on in these online spaces is intended for classmates and professor only. Please do not copy documents and paste them to a publicly accessible website, blog, or other space. If students wish to do so, they have the ethical obligation to first request the permission of the writer(s).

J. Copyright Statement for Course Materials

All materials used in this course are protected by copyright law. The course materials are only for the use of students currently enrolled in this course and only for the purpose of this course. They may not be further disseminated.

K. Academic Dishonesty and Code of Honor

Academic dishonesty is strictly prohibited and is considered a violation of the UTEP Handbook of Operating Procedures. It includes, but is not limited to, cheating, plagiarism, and collusion. Cheating may involve copying from or providing information to another student, possessing unauthorized materials during a test, or falsifying research data on laboratory reports. Plagiarism occurs when someone intentionally or knowingly represents the words or ideas of another as one's own. Collusion involves collaborating with another person to commit any academically dishonest act. Any act of academic dishonesty attempted by a UTEP student is unacceptable and will not be tolerated. All suspected violations of academic integrity at The University of Texas at El Paso must be reported to the [Office of Student Conduct and Conflict Resolution \(OSCCR\)](#) for possible disciplinary action. To learn more [HOOP: Student Conduct and Discipline](#).

Note: Students are required to agree to the UTEP College of Engineering's [Honor Code](#).

L. Accommodations Policy

UTEP is committed to providing reasonable accommodations and auxiliary services to students, staff, faculty, job applicants, applicants for admissions, and other beneficiaries of University programs, services and activities with documented disabilities in order to provide them with equal opportunities to participate in programs, services, and activities in compliance with sections 503 and 504 of the Rehabilitation Act of 1973, as amended, and the Americans with Disabilities Act (ADA) of 1990 and the Americans with Disabilities Act Amendments Act (ADAAA) of 2008. Reasonable accommodations will be made unless it is determined that doing so would cause undue hardship on the University. Students requesting an accommodation based on a disability must register with the [UTEP Center for Accommodations and Support Services](#).

M. Student Resources

UTEP provides a variety of student services and support:

- [UTEP Library](#): Access a wide range of resources including online, full-text access to thousands of journals and eBooks plus reference service and librarian assistance for enrolled students.
- [Help Desk](#): Students experiencing technological challenges (email, Blackboard, software, etc.) can submit a ticket to the UTEP Helpdesk for assistance. Contact the Helpdesk via phone, email, chat, website, or in person if on campus.
- [University Writing Center \(UWC\)](#): Submit papers here for assistance with writing style and formatting, ask a tutor for help and explore other writing resources.
- [Math Tutoring Center \(MaRCS\)](#): Ask a tutor for help and explore other available math resources.

- [Military Student Success Center](#): UTEP welcomes military-affiliated students to its degree programs, and the Military Student Success Center and its dedicated staff (many of whom are veterans and students themselves) are here to help personnel in any branch of service to reach their educational goals.
- [RefWorks](#): A bibliographic citation tool; check out the RefWorks tutorial and Fact Sheet and Quick-Start Guide.

Course Calendar

Week	Date (Tue)	Topic	Date (Thu)	Topic	Reading
1	1/17/23	Course Overview and Introductions to networks	1/19/23	Introductions to networks -- protocol layering	
2	1/24/23	Introductions to networks – Internet, performance metrics, Network security	1/26/23	Application Layer – WWW, HTTP, Socket Programming	KR 1.1 – 1.5
3	1/31/23	Application Layer – Email, DNS	2/2/23	Application Layer – P2P, CDNs	KR 2.1 – 2.4
4	2/7/23	Application Layer Security	2/9/23	Transport Layer – Principle, UDP	KR 2.5 - 2.7
5	2/14/23	Transport Layer – Reliable transport protocol design	2/16/23	Transport Layer – Pipelined protocols, GBN, SR	KR 3.1 - 3.4
6	2/21/23	Transport Layer – congestion control (causes, costs)	2/23/23	Transport Layer – congestion control (approaches), TCP fairness	KR 3.4 - 3.7
7	2/28/23	Transport Layer – Attacks and Security	3/2/23	Midterm Review	KR 3.7
8	3/7/23	MIDTERM	3/9/23	Network Data Plane Layer – Forwarding, inside of router	KR 4.1 - 4.2
9	3/14/23	SPRING BREAK	3/16/23	SPRING BREAK	
10	3/21/23	Network Data Plane Layer – inside of router, scheduling, IPv4 overview	3/23/23	Network Data Plane Layer – IPv6, General forwarding, SDN	KR 4.3 - 4.5
11	3/28/23	Network Data Plane Layer – IPv4 addressing, fragmentation, NAT	3/30/23	Network Control Plane Layer – Intra AS and inter AS routing (OSPF and BGP protocols)	KR 5.1 - 5.4
12	4/4/23	Network Control Plane Layer – Routing algorithms (LS and DV)	4/6/23	Network Control Plane Layer – SDN control plane, OpenFlow, other SDN controllers	KR 5.5
13	4/11/23	Network Layer – Security, BGP attacks	4/13/23	Link Layer - Introduction, Error detection and correction, media access protocols	KR 5.6-5.7; 6.1-6.2
14	4/18/23	Link Layer - ARP, Self-learning switch, and summarize	4/20/23	Network Control Plane Layer – ICMP and SNMP	KR 6.3 6.4; 6.7; 8.1-8.3
15	4/25/23	Network security-1	4/27/23	Network security-2	KR 8.4 - 8.7
16	5/2/23	Practice with Examples	5/4/23	Final Review	
				May 9, 2023 @ 4 - 6 PM	