CS 4480: Computer Networks

Administrative Details and Syllabus
Spring 2025

December 31, 2024

Course Information

Description. This course is a *comprehensive* introduction to the principles and practices of computer communication networks including the design and implementation of the Internet, its protocols and applications. Topics to be covered include: layered network architectures, applications, network programming interfaces (i.e., sockets), transport, congestion control, routing and data link protocols, local area networks, and selected topics in mobile and wireless networking.

Objectives. Our goal is for students to obtain a balanced understanding of all aspects of networking through a combination of hands-on exploration and software development as well as textbook learning.

Course learning outcomes. After successfully completing this course students will be able to:

- describe the physical and logical organization of the internet;
- summarize the organization and functions of the layered internet protocol suite, including the application, transport, network, and link layers;
- explain key networking concepts such as packet switching, packet forwarding and routing, congestion control, error detection, and reliable data transfer;
- recall, summarize, and utilize major internet protocols at the application, transport, and network layers;
- create network applications that use the socket API and/or software-defined-networking (SDN) APIs;
- collect and inspect network packet traces to analyze the operation of network protocols; and
- explain key wireless networking concepts such as wireless link characteristics, wireless LANs, cellular networks, and mobility management.

Prerequisites. Full Major status in Computer Science or Computer Engineering and "C-" or better in CS 3500.

Additional requirements. Students are expected to be comfortable working in the Unix/Linux operating system environment, and be able to program in a structured high-level programming language, such as Python. (The textbook uses Python examples and all programming assignments can be completed in Python and shell scripting.) The online course *The Missing Semester of your CS Education* might be a helpful resource: `https://missing.csail.mit.edu`

Meetings. Mondays and Wednesdays, 1:25-2:45 PM in CTIHB 109 (Irish Humanities Building).

Instructor. Prof. Kobus Van der Merwe. *Email:* kobus@cs.utah.edu. *Office:* MEB 3490D.

Course Materials

Textbook. The required course textbook is *Computer Networking: A Top-Down Approach* **(8th Edition)** by James F. Kurose and Keith W. Ross, Pearson.

Instant Access Program. The textbook will be available through the University of Utah Instant Access Program:

`https://www.store.utah.edu/faculty-instant-access`

From the website:

- *Students will receive an email before the first day of class with information about Instant Access and instructions for accessing their digital materials.*
- *The first two weeks of digital content access are free for students to explore.*
- *After two weeks, access continues automatically with the charge billed to their tuition account.*

And:

If the student decides they don't want the instant access to the course materials they will have the option to OPT OUT and will be refunded accordingly. Students still need to pay for the course materials cost along with their tuition, but once they OPT OUT during the first two weeks of class they will receive a full refund of the course material cost. They will then be responsible for obtaining their own course material/textbook for that course.

The textbook is also Available as eTextbook or Print editions from the publisher (Pearson), or from Amazon.

Website. The course public website is `https://users.cs.utah.edu/~kobus/teaching/cs4480_2025.html` and in Canvas at `https://utah.instructure.com/courses/1025412`. We will use Canvas as the primary course information repository, including lecture schedule, assignments, links to course handouts etc.

Lecture notes and supplementary material. The instructor will make use of supplementary materials provided by the textbook authors (augmented as needed), including slides, lab assignments and other materials. Material used during lectures will be posted in Canvas following the lecture. However, such documents may not completely represent the material covered in the class. Students who must miss class are strongly encouraged to check with a classmate.

Student Evaluation

Grading. Grading for the course will be based on: Three (equally weighted) Programming Assignments (30%), Homework Assignments (20%), two Midterm Exams (25%) and a Final Exam (25%).

Scale for assigning letter grades. 100-93 → A, 92-90 → A-, 89-87 → B+, 86-83 → B, 82-80 → B-, 79-75 → C+, 74-70 → C, 69-65 → C-, 64-60 → D+, 59-55 → D, 54-50 → D-, 49-0 → E.

Submitting assignments. Homework Assignments will be submitted through Canvas or Gradescope. We will use different environments for the Programming Assignments; submission details will be provided in the assignments.

Late submissions. Late assignments (programming and homework) will be accepted up to two days late with a 10% penalty applied to the obtained grade for each late day.

Programming assignments. Programming assignments form an important and significant part of the course and will be thoroughly evaluated. **You have to complete all programming assignments to pass the course.**

There will be three equally weighted programming assignments. The three programming assignments currently planned are: (i) Implementing a HTTP Web Proxy Server, (ii) Implementing an SDN-based Load Balancing Switch and (iii) Implementing a NFV Orchestrator in a Docker environment.

Python programming and/or shell scripting will be required to complete these assignments. Students will be expected to learn the necessary language features on their own.

One or more of the assignments listed above might be substituted for alternative programming assignments at the discretion of the instructor.

Homework assignments. Homework assignments will involve either Wireshark labs or problems selected from the textbook. For Wireshark labs, students will use the Wireshark network protocol analyzer tool `http://www.wireshark.org` to explore the protocols covered in the course. Problems from the textbook will serve to prepare students for the type of questions they might expect to see in the exams. Students will receive a grade for each assignment. For each assignment this grade may be based on a detailed or cursory evaluation, at the discretion of the instructor.

Reading assignments. there will be reading assignments for most classes. These will almost exclusively be from the textbook. **You are expected to do the reading assignments** to enable us to discuss the material in class. *Reading Assignment/Class Participation might be added to the grading categories to encourage this.*

Exams. There will be two midterm exams and a final exam. All exams will be closed-book.

Both midterms will be given in class during regular class time. (Dates TBD.)

The final exam will be given in class **from 1-3pm on Wednesday, April 30, 2025**. **The final exam will be comprehensive.**

Students who wish to appeal a grade on an assignment or an exam must do so within one week of receiving the grade.

Getting Help

Instructor office hours. Regular office hour times TBD. (Alternatively, the instructor is always available to meet by appointment. Please send me email to schedule a meeting.)

Teaching assistants and office hours. TBD. (Details will be provided on Canvas)

Communication. The instructor and TAs will use Canvas for all out of class communication, including sending urgent messages to the class (e.g., corrections to assignments, changes in due dates etc).

For questions outside of class, students are encouraged to use the Canvas discussions function or email: If your question is of a general nature, i.e., something that your fellow students might benefit from knowing, or might be able to answer for you, please make use of the Canvas discussions function. If using the Canvas discussion function seems inappropriate for you question, please use the Canvas mail function to send email to the teaching staff (i.e., Teacher and TAs). This will reach the instructor and TAs and will be the best way to receive a timely response to questions. The instructor and/or TAs will respond to each question directly. Finally, if neither of the above options seems to fit your needs, please send email to the instructor directly.

Syllabus

Below are the key topics we plan to cover in this course, the approximate number of lectures planned for each and the corresponding chapters in Kurose and Ross.

Getting Started (2 lectures) Chapter 1

- Course overview and administrative details.
- Computer Networks and the Internet

Application Layer (4 lectures) Chapter 2

- Principles of Network Applications
- The Web and HTTP
- Electronic Mail in the Internet
- DNS - The Internet's Directory Service
- Peer-to-Peer File Distribution
- Video Streaming and Content Distribution Networks
- Socket Programming: Creating Network Applications

Transport Layer (4 lectures) Chapter 3

- Introduction and Transport-Layer Services
- Multiplexing and Demultiplexing
- Connectionless Transport: UDP
- Principles of Reliable Data Transfer
- Connection-Oriented Transport: TCP
- Principles of Congestion Control
- TCP Congestion Control
- Evolution of Transport-Layer Functionality

Network Layer: Data Plane (3 lectures) Chapter 4

- Overview of Network Layer
- What's Inside a Router?
- Internet Protocol (IP): IPv4, Addressing, IPv6
- Generalized Forwarding and SDN
- Middleboxes

Network Layer: Control Plane (3 lectures) Chapter 5

- Routing algorithms

- Intra-AS Routing in the Internet: OSPF
- Routing Among the ISPs: BGP
- The SDN Control Plane
- ICMP: The Internet Control Message Protocol
- Network Management and SNMP, NETCPNF/YANG

Link Layer and LANs (3 lectures) Chapter 6

- Error-Detection and Error-Correction Techniques
- Multiple Access Links and Protocols
- Switched Local Area Networks
- Link Virtualization: A Network as a Link Layer
- Data Center Networking
- A Day in the Life of a Web Page Request

Wireless and Mobile Networks (2 lectures) Chapter 7

- Wireless Links and Network Characteristics
- WiFI: 802.11 Wireless LANs
- Cellular Networks: 4G and 5G
- Mobility Management Principles
- Managing Mobility in Practice
- Wireless and Mobility: Impact on Higher-Layer Protocols

Course Guidelines

Behavior in class. Students are expected to maintain professional behavior in class according to the University of Utah Student Code, which is available here:

`http://www.regulations.utah.edu/academics/6-400.html`

Students should read the Code carefully and know what their responsibilities are. According to Faculty Rules and Regulations, it is the faculty responsibility to enforce responsible classroom behavior, beginning with verbal warnings and progressing to dismissal from class and a failing grade. Students have the right to appeal such action to the Student Behavior Committee.

Working together. Students are encouraged to discuss assignments with fellow classmates, however, each student is responsible for completing his/her own assignment. *Cheating is:* sharing code or other electronic files either by copying, retyping, looking at, or supplying a copy of a file. *Cheating is not:* discussing concepts, answering questions about concepts or clarifying ambiguities, helping someone understand how to use the computer systems, tools or environments used for programming assignments, or helping with high-level design issues or general debugging.

Except when explicitly designated otherwise, each assignment is to be done individually. For all assignments, the solution submitted by each student will be checked against the solutions of other students for anomalies. If an anomaly is found that cannot be explained satisfactorily, the students involved will fail the course.

Academic Misconduct and Use of Generative AI. It is expected that students will adhere to generally accepted standards of academic honesty, including but not limited to refraining from cheating, plagiarizing, misrepresenting one's work, and/or inappropriately collaborating. This includes the use of generative AI tools without citation, documentation, or authorization. Students will also be expected to adhere to the prescribed professional and ethical standards of the profession/discipline for which the student is preparing. Any student who engages in academic dishonesty or who violates the professional and ethical standards for the profession/discipline for which the student is preparing, may be subject to academic sanctions as per the University of Utah's Student Code :

`https://regulations.utah.edu/academics/6-410.php`

Students are required to adhere to the School of Computing academic misconduct policy, which is available here:

`https://www.cs.utah.edu/undergraduate/current-students/policy-statement-on-academic-misconduct/`

Any student found cheating will fail the entire course.

College of Engineering guidelines. Information on withdrawing from courses, appealing grades, and more, see the College of Engineering Academic Affairs website:

`https://www.price.utah.edu/students/academic-affairs`

and the College of Engineering Semester guidelines:

`https://www.price.utah.edu/students/current/semester-guidelines`

Students with disabilities. The University of Utah seeks to provide equal access to its programs, services and activities for people with disabilities. If you will need accommodations in class, please follow instructions from the Center for Disability and Access website:

`https://disability.utah.edu`

The center will work with you and the instructor to make arrangements for accommodations.