CSEE 4119 - Computer Networks

Fall 2020

Instructor: Ethan Katz-Bassett

Tuesdays/Thursdays 2:40pm-3:55pm

Online - Zoom links via CourseWorks

Updates to this Document

See Piazza for the newest version of this document.

List of updates:
2020-09-05: added TAs, added options for acquiring textbook, added info on asynchronous exams and hackathon
2020-08-31: Initial version.

Description

This course provides an introduction to computer networks and the technical foundations of the Internet, including applications, protocols, algorithms for routing and transport/congestion control, and local area networks. The course assumes students have background in computer science and/or electrical engineering, but it does not assume background in networks.

The course will cover key network “layers” and how they operate together to provide services, with an emphasis on:

- Application, transport, network, and link layers.
- A “top-down” approach, starting from applications we all use every day in order to derive the requirements they place on the network, moving to how the layers below the applications provide these requirements.
- How these layers manifest in the Internet, and how the Internet’s design has facilitated its tremendous growth.
- The emerging *software-defined networking (SDN)* separation of the network control plane from the network data plane.

Logistics

Location

Tuesdays/Thursdays 2:40pm-3:55pm
Online - Zoom links via CourseWorks

Prerequisites

Comfort with basic probability.

Programming fluency: the course will require some programming in Python. Students only comfortable in another language (Java, C++, Ruby, etc) will be expected to pick up basic Python on their own, with course-specific material on network socket programming covered in class.

Instructors and Office Hours

- Contacting us:
    - Use Piazza unless there is a specific reason you cannot.
        - Unless explicitly private (e.g., about your grade), please make it visible to your classmates. It's fine to make it anonymous to classmates.

        - If private, please send to professor and all TAs if possible.
    - Only if you can't use Piazza, email the appropriate list:
        - csee4119f20-instructor@googlegroups.com (TAs and professor)
        - csee4119f20-ta@googlegroups.com (TAs)
    - Only if you can't email the list, email professor or individual TA
        - Please only email me if Piazza is not an option
        - Please put [csee4119] as a prefix in the subject of all email to make sure we don't miss it
- Professor: Ethan Katz-Bassett <ebk2141@columbia.edu>. Office hour: 5:30-6:30pm Thursdays on Zoom (starting September 10), or by appointment.
- TAs
    - Jiayang Zhou
    - Julius Song
    - Qianrui Zhang
    - Shiv Vidhyut
    - Thomas Koch

Book

We will use the 7th edition of the book "Computer Networking: a top-down approach" by James F. Kurose and Keith W. Ross. (Unfortunately, I have to recommend against using earlier editions for this class, as they are missing important material and are organized differently in places. I expect students to use the 7th edition, but I may incorporate some new material from the new 8th edition as well). We will cover chapters 1-6. If time remains, we will cover one of chapters 7-9.

A copy of the book is on reserve at the Science & Engineering Library [NWC Building]. Due to the coronavirus, reserve books are not available for lending. However, students can place requests for scans of a small portion of a work for private use, study and to support teaching [but DO NOT share the scans publicly or with others outside class]. Anecdotally, I believe you can usually request a chapter at a time. Turnaround time is usually 2 business days (sometimes faster). If students space out requests and plan ahead, it should be manageable. In the CLIO record for the book, there is a "Scan" request link on the right hand side of this page underneath the location info:
https://clio.columbia.edu/catalog/12362941

The library also mentions that the book can be rented through Amazon for around $30. It may be worth it to some students to rent to avoid having to deal with scan requests. I (Ethan) have rented other textbooks from Amazon, and it worked well.

We may also occasionally cover supplemental material, which will be indicated on the detailed syllabus.

The detailed Syllabus describes which chapters we will cover on which days. It is subject to change depending on how quickly we progress through the material, and the up-to-date version is available on Piazza. It is strongly recommended that you read the material before class.

Course Structure and Grading

In addition to reading the book and participating in class, you will complete homework assignments, in-class midterm, and a final exam at the university-designated time during the finals period. By "in-class," we mean that most students will take the midterm during the lecture period, but both the midterm and final will have options for students in other timezones who are watching lectures asynchronously. The grading breakdown is as follows (percentages may be adjusted):

- **33%: Project assignments:**
  - ~2 projects, which will include both programming/network configuration plus written answers about the project.
  - The projects will have intermediate graded deadlines to help you stay on track to complete them correctly.
  - The programming assignments will likely cover Application Layer, Transport Layer, and Network Layer, plus a bit of Link Layer.
- **17%: Written homework assignments:**
  - The course will have a handful of written assignments throughout the semester.
- **15%: Midterm:**
  - The midterm is one class period, closed book, closed notes. The midterm will cover all material discussed in the course up to the week before the exam.
- **35%: Final:**
  - The final exam is scheduled at the normal final exam time for this class period. The final is closed book, closed notes. The final is cumulative and will cover all material discussed in the course.
- **0%:**
  - No "extra credit" work.

Your overall numeric grade in the course is:

```
      33% * project points awarded / total possible project points
+     17% * homework points awarded / total possible homework points
+     15% * midterm points awarded / total possible midterm points
+     35% * final exam points awarded / total possible final points
```

Implications of this calculation:

- Points within one category ARE on the same scale; for example, if homework 1 is worth 100 points and homework 2 is worth 200 points, then homework 2 accounts for twice as much of your homework grade AND your overall grade.

- Points in different categories are NOT necessarily on the same scale.

Numeric grades are scaled to letter grades such that top students in the class receive A/A+ grades. There is no fixed curve in the sense of a fixed % of students receiving A's--I hope everyone does well in the course and receives an A!

Regrading Policy

If you disagree with any grading, submit your grievance via private Piazza note (directed to all instructors) in the following format.

Title: Regrading Request
Name:
UNI:
Assignment [e.g., HW1]:
Problem [e.g., 2(a)]:
Reason:
Problem:
Reason:
…

Please write the regrading reason for each requested problem. Reasons include but are not limited to "my answer is correct", "I should have received partial credits according to the rubric", and "Instructors gave me wrong instructions for this problem". Provide details. The grader responsible will respond (typically within 48 hours) by replying to your post, either marking it as resolved or rejected. If you are still dissatisfied, you can dispute it in the follow up discussions.

Assignment Submission and Late Policy

The due date and time of an assignment will be specified in the assignment (usually one or two weeks after it is issued). Please submit your assignment electronically, through CourseWorks. Each assignment will include complete submission instructions.

You can submit your assignment multiple times, but the last submission is what counts. Each submission will be time stamped. Proper submission is your responsibility; we strongly urge you to make sure you understand the submission process and submit early. You can always submit again up until the deadline, so we strongly urge you to submit well before the deadline and then submit again if you have a more updated assignment to submit later.

Each day (24-hour period) or partial day late incurs a 20% penalty on the assignment. However, you are allowed a total of 4 *slip days*, to be used as you wish throughout the semester (on written homeworks and/or projects). That means you can be four days (24 hour periods) late for

Homework 2 (for example), or one day late for each of the first four homework assignments, with no point penalty. Each slip day entitles you to submit up to an additional 24 hours late without penalty (and slip days can only be used atomically, not subdivided fractionally). Keep in mind that projects are worth more than homeworks, and that the last project is larger (and hence worth more) than the first one.

To use a slip day, you **must** add a CourseWorks comment to your assignment submission **after** submitting, in the following format:

Title: Slip Day Request
Name:
UNI:
Assignment (e.g., HW1):
# of Slip Days Requested:

The TAs will process your slip day request while grading, replying either to say that they have applied the slip day or that it is rejected (for instance, because you already exhausted your 4 slip days). You must add the comment no later than 12 hours after submitting the assignment (and **do not ask to use the slip days before submitting**). We will not accept slip day requests via any other means. No other extensions will be given, except for medical emergencies certified by University Health Services or a family emergency. Naturally, you may hand in incomplete assignments for partial credit by the deadline.

Academic Integrity

The rules for Columbia University, the CS Department, and the EE Department (via SEAS: 1 and 2) apply. It is your responsibility to carefully read these policies and ask the professor (via Piazza) if you have any questions about academic integrity. Please ask the professor before submitting the assignment, with enough time to resolve the issue before the deadline. A misunderstanding of university or class policies is not an excuse for violating a policy.

This class requires closely obeying the policy on academic integrity, and has zero tolerance on plagiarism for all assignments, including both projects/programming assignments and written assignments. By zero tolerance, we mean that the minimum punishment for plagiarism/cheating is a 0 for the assignment, and all cases will be referred to the Dean of Students.

Unless explicitly stated otherwise on the assignment itself, assignments must be completed individually. For programming assignments, in particular, you must write all the code you hand in yourself, except for code that we give you as part of the assignments. You are not allowed to look at anyone else's solution (including solutions on the Internet, if there are any), and you are not allowed to look at code from previous years. You may discuss the assignments with other

students at the conceptual level, but you may not write pseudocode together, or look at or copy each other's code. Please do not publish your code or make it available to future students -- for example, please do not make your code visible on Github. You may look at documentation from the tools' websites. However, you may not use external libraries or any online code unless granted explicit permission by the professor or TA. For written (non-programming) answers, if you quote material from textbooks, journal articles, manuals, etc., you **must** include a citation that gives proper credit to the source to avoid suspicion of plagiarism. If you are unsure how to properly cite, you can use the web to find references on scientific citations, or ask fellow students and TAs on Piazza.

For each programming assignment, we will use software to check for plagiarized code.

Note: You *must* set permissions on any homework assignments so that they are readable only by you. You may get reprimanded for facilitating cheating if you do not follow this rule.

Course Announcements, Submissions, and Questions

Please be sure you are signed up for the class's Courseworks and Piazza pages, and please monitor emails from them about class. The course is listed as "`CSEEW4119_001_2020_3: COMPUTER NETWORKS`" for both. Homework assignments are submitted via Courseworks (Canvas). The Piazza mailing list (and occasionally the Courseworks list) will be used for announcements. We are using the Piazza Discussion Forum for class discussions.

Please submit questions about the class (assignments, logistics, clarifications about things that came up in lecture, etc) via Piazza:

- Unless the topic is sensitive, please address your question to the professor and all TAs. This will help you get an answer sooner and help us all stay on the same page.
- Unless the topic is sensitive, please make the question visible to your classmates, so that others can benefit. You are welcome to submit questions anonymously (to classmates, instructors will still see your name) if you prefer.
- If you email us a question, we may miss it or will ask you to instead post it on Piazza.
- An important aspect of engineering and computer science is problem solving, and so an important aspect of your education is developing problem solving and troubleshooting skills. Before asking a question on Piazza, please try to answer questions yourself first, by double-checking the book/lecture material, by looking at previous Q/A on Piazza, by experimenting, and by using appropriate online resources as allowed by the course policy. Of course, we are then happy to help if you are unable to resolve it yourself.

Feedback

We would like the course to run smoothly, and we'd like you to enjoy the course and learn from it. Feel free to let us know what you find good and interesting about the course. Let us know sooner about the reverse. See us during office hours or send us a message via Piazza.

Statement for Students with Disabilities

We will make reasonable accommodations for persons with documented disabilities. In order to receive disability-related academic accommodations, students must first be registered with Disability Services (DS). More information on the DS registration process is available online at www.health.columbia.edu/ods. Faculty must be notified (via appropriate documentation) of registered students' accommodations before exam or other accommodations will be provided. Students who have, or think they may have, a disability are invited to contact Disability Services for a confidential discussion at (212) 854-2388 (Voice/TTY) or by email at disability@columbia.edu. As your instructor, I am happy to discuss specific needs with you as well.

2020 Fall CSEE4119 Syllabus and Class Schedule

The schedule will be updated through the semester if we run fast/slow. Please check Piazza for the newest version.

Course Overview and Intro

1. Tues. Sept. 8. Course Intro and Overview (1): What is the Internet?

Required reading
Kurose/Ross 1.1

2. Thurs. Sept. 10. Course Intro and Overview (2): Edge and Core

Required reading
Kurose/Ross 1.2-1.3

3. Tues. Sept. 15. Overview (3): Performance, Protocol Layering

Required reading
Kurose/Ross 1.4-1.5

Recommended reading
Dave Clark, "The Design Philosophy of the DARPA Internet Protocols," SIGCOMM CCR 1995

4. Thurs. Sept. 17. Overview (4): Protocol Layering, Security

Required reading
Kurose/Ross 1.6

Recommended reading
Kurose/Ross 1.7-1.8, Kleinrock interview

Application Layer

5. Tues. Sept. 22. Application (1): Principles of Network Applications

Required reading
Kurose/Ross 2.1

6. Thurs. Sept. 24. Application (2): ***OUT OF ORDER RELATIVE TO BOOK*** Socket Programming

Required reading
Kurose/Ross 2.7

7. Tues. Sept. 29. Application (2): The World Wide Web and HTTP

Required reading
Kurose/Ross 2.2

8. Thurs. Oct. 1. Application (3): Email

Required reading
Kurose/Ross 2.3

9. Tues. Oct. 6. Application (5): DNS

Required reading
Kurose/Ross 2.4

10. Thurs. Oct. 8. Application (6): P2P, Video Streaming, CDNs

Required reading
Kurose/Ross 2.5-2.6

Transport Layer

11. Tues. Oct. 13. Transport (1): Principles of Transport, UDP

Required reading
Kurose/Ross 3.1-3.3

12. Thurs. Oct. 15. Transport (2): Reliable Data Transfer

Required reading
Kurose/Ross 3.4

13. Tues. Oct. 20. Transport (3): Reliable Data Transfer Continued

Required reading
Kurose/Ross 3.4

14. Thurs. Oct. 22. Transport (4): TCP Basics and Reliable Transfer

Required reading
Kurose/Ross 3.5

15. Tues. Oct. 27. Transport (5): TCP's Congestion Control

Required reading
Kurose/Ross 3.6-3.8

Network Layer Part 1: The Data Plane

16. Thurs. Oct. 29. Network Data Plane (1): Overview, Routers and Forwarding

Required reading
Kurose/Ross 4.1-4.2

No Class Tues. Nov. 3. **Election Day, University Holiday - Vote!**

17. **MIDTERM** Thurs. Nov. 5. (Tentative) **MIDTERM.**

IMPORTANT NOTE: The exact date of the midterm may change depending on how quickly we progress through material. It will be in class and will cover up through as much of the transport layer material as we can finish. By "in-class," we mean that most students will take the midterm during the lecture period, but both the midterm and final will have options for students in other timezones who are watching lectures asynchronously.

18. Tues. Nov. 10 Network Data Plane (2): Addressing

Required reading
Kurose/Ross 4.3

Network Layer Part 2: The Control Plane

19. Thurs. Nov. 12. Network Control Plane (1): Routing Basics, and Internet Routing: Intradomain OSPF and Interdomain BGP

Required reading
Kurose/Ross 4.5, 5.1, 5.2 (not including 5.2.1 or 5.2.2), 5.3-5.4

20. Tues. Nov. 17. Network Control Plane (2): BGP Policy

Required reading
Kurose/Ross 5.4

21. Thurs. Nov. 19. Network Control Plane (3): Routing Algorithms

Required reading
Kurose/Ross 5.2.1-5.2.2

22. Tues. Nov. 24. (Tentative) In-Class Networking Hackathon

IMPORTANT NOTE: The exact date of the in-class hackathon may change depending on how quickly we progress through material. It will be in class and will be related to the BGP material (so will come after it, but perhaps not immediately after). Participation and attendance is required (CVN students will participate remotely). By "in-class," we mean that most students will participate during the lecture period, but we will have options for students in other timezones who are watching lectures asynchronously.

No Class Thurs. Nov. 26. **Thanksgiving, University Holiday.**

23. Tues. Dec. 1 Network Control Plane (4) and Data Plane (4): SDN and Generalized Forwarding

Required reading
Kurose/Ross 4.4, 5.5-5.8.

Link Layer and LANs

24. Thurs. Dec. 3. Link (1): Intro to Link Layer, Multiple Access Links

Required reading
Kurose/Ross 6.1-6.3

25. Tues. Dec. 8. Link (2): LANs, Virtual networks/links, and Data Centers

Required reading
Kurose/Ross 6.4-6.6

26. Thurs. Dec. 10. Bringing it all Together

Required reading
Kurose/Ross 6.7

No Class Tues. Dec. 15. **Study Days**

Final Tentatively Thurs. Dec. 17. 1:10-4:00pm **Final Exam**

IMPORTANT NOTE: The final exam will be at the university-designated day and time. It is tentatively Thursday December 17 1:10-4:00pm but is currently subject to change. The final will have options for students in other timezones who are watching lectures asynchronously.