University of California, Los Angeles
Department of Computer Science

CS 118: Computer Network Fundamentals

Fall 2024

Meeting Times

Lecture

Franz Hall 1178
Tuesday, Thursday at 2:00-3:50 pm

Discussion

Boelter Hall 2444
Friday at 10:00-10:50 am (**1A**) and 11:00-11:50 am (**1B**)

Royce Hall 164
Friday at 12:00-12:50 pm (**1C**) and 1:00-1:50 pm (**1D**)

Instructors

	Email	**Office Hours**
Professor George Varghese	varghese@cs.ucla.edu	Engineering VI 477, Thursday at 4:00-5:00 pm
Robert Chang (Disc. 1C, 1D)	robertchang25@g.ucla.edu	Boelter 3286, Tuesday at 12:00-1:50 pm
Omar Elamri (Disc. 1A, 1B)	omar@cs.ucla.edu	Boelter 3286, Monday at 12:00-1:50 pm

Course Philosophy

CS 118 assumes no previous background in networking. The focus of the course will be on learning various principles and techniques so you can learn networking *from a designer's point of view*.

Fun facts:

- UCLA was the first Internet node,
- Len Kleinrock and Mario Gerla were early Internet pioneers, and

- Vint Cerf, who wrote much of TCP and IP, was a graduate student at UCLA.
- Later, Deborah Estrin and Greg Pottie helped start the sensor network revolution.

Course Objectives

- Give students a complete understanding of 1 network system (TCP/IP)
- Present the Unifying Systems Ideas (multiplexing, resource allocation, naming and addressing, security) that are common to all systems
- Give students insight into designing a protocol
- Give students insight into real world constraints: what will life look like in industry?
- Give relevant homework
- Give students a glimpse of network security, and recent work in cloud and container based networking that is not in any textbook, but will be useful if you work at a FAANG company
- Give students a sense in projects and homeworks as to how to work with LLMs to get their networking code done while dealing with the errors they make
- Acquaint students with what's going on currently in the networking world and where networking jobs are to be found

Work Involved

- **Laboratory and Programming Exercises**
  There will be three programming assignments. The "zeroth" will help you set up your environment and introduce you to socket programming, the first will be a socket programming assignment that implements a reliable transport which you can do after understanding reliable packet delivery in the Data Link, and the second will be a moderately difficult assignment that does a makeshift version of Transport Layer Security (TLS). You will do all programs in C or C++17; programs will be done individually.

  Students are assumed to be competent in C or C++. Students not familiar will have to learn those outside the classroom.

- **Exams**
  There will be one midterm exam and a final, all **open book**. In previous in-person offerings, I have only allowed students to use a cheat sheet of 1 page during the exam—not because I did not want them to look at their notes during the exam, but because it would waste time as most of the exam requires thinking. Remember this class is not about memorizing networking acronyms but about understanding networking *ideas*.

- **Homework**
  There will be **3 homework problem sets** handed out spaced roughly **every two weeks**. They will be handed out on a **Tuesday** and will be due at **the start of class on the due date**. Because of the large class size, I will only randomly pick **1 or 2 of the questions to grade** and base your

grade on those. We will not accept homework after the class starts. Why? I do not want you to solve (or fine-tune) homeworks during class. Recall also that any one homework does not carry much weight in the overall scheme of things. Feel free to discuss the homework with friends after you have thought about it by yourself. Also DO write up the homework by yourself in your own style.

At times, I will put in an interesting no-grade problem for the people who are really interested. Homeworks are CRUCIAL. Since the focus is not on programming (which I assume you will learn from other courses) but on concepts, trying the homeworks yourself is important to succeed.

- **Reading**
  I post the slides I use on BruinLearn on the day of class. I will also supplement the lecture with my own notes posted on Bruin Learn before the exam, so you really have to come to lecture to solve the homework problems (the slides are hard to decipher without coming to class, and for most people who have taken my class in the past, lectures have been fun). For the routing section, if you wish, you can buy a copy of Perlman's book (see below); although, if you come to lectures and follow my slides, it should not be needed.

Grading

Boundaries

		B+	[87, 90)	**C+**	[77, 80)	**D+**	[67, 70)		
A	[93, 100]	**B**	[83, 87)	**C**	[73, 77)	**D**	[63, 67)	**F**	[0, 60)
A-	[90, 93)	**B-**	[80, 83)	**C-**	[70, 73)	**D-**	[60, 63)		

Grading boundaries will be relaxed only if the average test and homework scores are very low. They will never be made stricter. If everyone does well, everyone will get good grades. However, there will be a special A* grade (reported in your grade sheet as an A+) that I will keep track of. If you are applying for graduate school or for a job, and have an A*, I would be happy to write a very strong recommendation letter for you. The A* is reserved for true excellence, measured in terms of class participation, test, and homework scores. I will do my best to help such students with job and graduate school recommendations.

Breakdown

Three Homeworks	15% (total; 5% each)
Programming Project 0	5%
Programming Project 1	15%
Programming Project 2	20%
One Midterm (in class)	20%
Final (location TBD)	25%

Lecture Plan (subject to change)

	Tuesday Lecture	Thursday Lecture	Friday Discussion
Week 0		**Sep. 26th: Introduction** • Layering • Abstractions • Networking • A full overview	**Sep. 27th: Worksheet 1** • Review Layering • Layering Problem Set
Week 1	**Oct. 1st: Physical Layer 1** • Basic Limits • Noise • Signal Strength • Clock Recovery (start) **Homework 1 Published**	**Oct. 3rd: Physical Layer 2** • Clock Recovery (end) • Media (and how it affects network architecture)	**Oct. 4th: Worksheet 2** • Review Limits • Error Recovery • Intersymbol Interference **Project 0 Published**
Week 2	**Oct. 8th: Data Link 1** • Overview • Framing • Error Detection **Homework 1 Due**	**Oct. 10th: Data Link 2** • Error Recovery • Alternating Bit • Sliding Windows • TCP Preview	**Oct. 11th: Worksheet 3** Project 1 Intro **Project 1 Published**
Week 3	**Oct. 15th: Data Link 3** • Multiaccess Protocols • Ethernet • Error Detection **Homework 2 Published**	**Oct. 17th: Data Link 4** Bridging: the class will reinvent a classic design **Sample Midterm Published**	**Oct. 18th: Worksheet 4** • Bridge Forwarding Examples **Project 0 Due (by midnight)**

Week 4	**Oct. 22nd: Routing 1** • Bridges vs. Routers • IP Addressing **Homework 2 Due** **Homework 1, 2 Solutions Published**	**Oct. 24th:** **Midterm** (In class) **Midterm Review** is on Wednesday, Oct. 23. (Location TBD)	**Oct. 25th: Worksheet 5** Introduction to: • MAC Addresses • IP Addresses • DNS • DHCP
Week 5	**Oct. 31st: Routing 2** • IP Forwarding • Fast Lookups • Packet Scheduling	**Oct. 29th: Addressing Project 2** • Security Basics • TLS	**Nov. 1st: Worksheet 6** • Project 2 Intro, Hints • Public Key Crypto • Certificates • TLS Basics **Project 1 Due (by midnight)** **Project 2 Published**
Week 6	**Nov. 5th: Routing 3** Route Computation: • Distance Vector • Link State **Homework 3 Published**	**Nov. 7th: Routing 4** BGP: How do competing ISPs work together?	**Nov. 8th: Worksheet 7** Link State and Distance Vector Example Problems
Week 7	**Nov. 12th: DNS** How does Akamai (and other CDNs) find the closest address for a service? **Homework 3 Due**	**Nov. 14th: TCP 1** • Socket Abstraction • Connection Management • Transport Layer Security	**Nov. 15th: Worksheet 8** Walking through the BSD TCP Fast Path code
Week 8	**Nov. 19th: TCP 2** Reliability (implemented in Project 1); TCP's mechanisms, such as: • Flow Control Window • Selective Reject	**Nov. 21st: TCP 3** • Congestion Control • Reacting to Internet Overloads	**Nov. 22nd: Worksheet 9** Walking through BSD TCP Congestion Control code
Week 9	**Nov. 26th: Cloud and Container Based Networking** (New topic this year!)	**Thanksgiving Holiday**	
Week 10	**Dec. 3rd: Last Lecture** • Overview of Class • Job Search Hints	**Dec. 5th: Final Review** (Potentially make up time to cover more topics)	**Dec. 6th: Final Review** **Project 2 Due (by midnight)**
Finals Week		**Dec. 12th:** **Final** (Location TBD)	

Miscellaneous

- **Bruin Learn**
  All class material (worksheets, homeworks, slides, notes, etc.) will be posted on Bruin Learn—separated by week in the Modules tab. You may also see your current class grade. Make sure to turn on announcements (whether via email or mobile push notification) to make sure you're aware of any urgent class messages.

- **Gradescope**
  Gradescope will be used to score all project, homework, and exam submissions. Projects will be graded with an autograder but also manually reviewed for sanity. You may access Gradescope by visiting our Bruin Learn page and clicking Gradescope in the left-hand bar.

  Regrades are allowed, but **you may only request one regrade per question part**. If you'd like to contest any regrades, you must come to one of the instructors' office hours. For exams, there will be an announcement sharing the instructor that graded each question. Please visit that instructor's office hours (you may visit any instructor for homework/project regrades). If you cannot make their office hours, feel free to email them to schedule an alternate time.

- **Campuswire**
  For any quick clarifications that may benefit the entire class, our class is using Campuswire to facilitate these discussions. Please email **all** instructors if you have more urgent questions. You may access Campuswire by visiting this link: https://campuswire.com/p/GDF1C127F. The code is **9958**. Note that you're able to make posts anonymously, but instructors will be able to see your identity.

- **Recordings**
  Lectures and discussions will not be recorded.

- **Usage of AI assisted tools**
  You may not use AI assisted tools to complete any assignment (with the potential exception of one homework assignment that's about correcting the output of an LLM. More info to come later). While it's certainly infeasible to prove the usage of AI assisted tools, for projects, students may be asked about their design choices to probe for understanding. Project related questions may also appear on exams. Ultimately, the projects are designed to help you learn and apply principles you learn in class.

Textbooks (optional)

- **Computer Networking: A Top Down Approach Featuring the Internet**, *Jim Kurose and Keith Ross*.
  This is a nice book with lots of stuff on multimedia and security that's in no other book. Note that this is optional—only if you really, really want a textbook on all of networking (it's the one most universities use). I will give you notes that are all you need for the exams and homeworks.

- **Interconnections**, *Radia Perlman, Addison-Wesley, 1992*.
  As with the Kurose book, it's completely optional and only if you want a classic reference on network protocols.