CS 656: Internet and Higher Layer Protocols

SECTIONS: 001, 003, 853, 855 — Fall 2023

Instructor Information
Name: Asif Kunwar
Office: GITC-4406
Email: ak459@njit.edu
Office-hours: Monday 4-5:30pm

Course Description

This course delves into Internet architecture and protocols, covering an array of topics, such as naming, web protocols, peer-to-peer networks, socket programming, transport protocols, routing, multicasting, quality of service, SDN, multimedia, virtualization, 4G/5G wireless networks, network measurement, network management, and security. Additionally, students will engage with research papers to gain a deeper understanding of networking concepts and apply their knowledge by designing network protocols or services in a semester-long programming project. The focus of paper discussions will be on innovative research concepts and methodologies rather than foundational networking knowledge.

This class follows a "flipped" approach, requiring students to watch lectures online prior to class meetings. During class, students should be prepared to ask questions and collaborate with peers on interactive exercises.

Assignments in this course involve programming in Java, C, and Python. While prior experience in all of these languages isn't mandatory, students should feel comfortable learning new programming languages and independently seeking resources when tackling challenges. This course will expose students to various programming languages and environments.

Goals

- In-depth study of the Internet architecture and protocols
- Understand how networking research is done by reading and presenting research papers
- Apply what the knowledge learned in a semester-long project

Learning Outcomes

At the end of this class, the students will be able to:

- Given a network configuration, demonstrate how various Internet protocols work.
- Analyze and compare the features of several Internet protocols and network architectures.
- Identify problems with various network protocols and propose solutions to solve these problems.
- Write a program that emulates a computer network running IP and link-state routing.
- Identify the main ideas along with the strengths and the weaknesses of research articles, and clearly present these articles.

Prerequisites

CS 356 or equivalent. Students should be capable of programming in Python, Java or C/C++.

Class Materials

- **Course Textbook(Main): Computer Networking: A Top-Down Approach (8th Edition, 2021)**
  by James F. Kurose and Keith W. Ross
  Publisher: Pearson
  ISBN: 0136681557
- Larry L. Peterson and Bruce S. Davie, **Computer Networks: A Systems Approach**, available online
- Systems Approach Substack
- Other good textbooks that you might read are **Computer Networks**, Andrew Tanenbaum and David Wetherall, Prentice Hall.
- There are a few recommended texts which are useful references (especially if networking becomes your career).
- **TCP/IP Illustrated, Volume 1: The Protocols** by W. Richard Stevens.
- **Unix Network Programming: Networking APIs: Sockets and XTI (Volume 1)** by W. Richard Stevens.
- **Advanced Programming in the Unix Environment** by W. Richard Stevens, Addison-Wesley, 1993

Schedule

Detailed schedule with deadlines is available in Canvas.

Paper Reading and Discussion

A significant component of this course involves reading and engaging in discussions about research papers during precepts. We focus on one paper per precept to facilitate in-depth discussions. To ensure an active and focused conversation, please thoroughly read each paper and contribute comments and questions on Canvas by 11:59pm ET on the Friday night before the corresponding precept. Aim to provide at least five comments or questions for each paper and engage with comments from other students and course staff. Additionally, prepare several points that will substantially enhance the group discussion during precept.

For each lecture, a group of students (likely 3, but size may vary) will present the paper being discussed. Presentations should be 20 minutes long and cover the paper comprehensively, including not only high-level concepts but also detailed solutions, systems, evaluations, and baselines. Presenters should come prepared with questions and ideas to stimulate discussion, drawing from their own insights and questions/feedback from the class on Canvas (available by Friday at 11:59pm). It's important to note that even non-presenters should actively participate in the discussion and should have thoroughly read the paper before class.

Overall participation grades will consider both your paper presentation and your participation throughout the course, both in-class and on Canvas.

Precepts

Precepts will be conducted during the latter part of the course, with an expectation of active attendance unless otherwise specified. While precepts will primarily be in-person, Webex information and protocols will be posted here in case of any university policy changes related to remote instruction.

Research Project

This course includes a semester-long research and systems-building project, typically done in groups of 2 or 3 students and involving programming. Projects can take two main forms:

1. **Reproducing research:** These projects aim to replicate, challenge, or expand upon results from a published paper. They involve implementing the solution described in the chosen paper, evaluating it to reproduce key results, and addressing new questions not covered in the original paper. The selected research paper doesn't have to be one discussed in this course but should relate to computer networking and the covered topics.

2. **Novel research:** These projects involve developing original research solutions and their corresponding implementations and measurements. They can tackle problems discussed in class or new ones, provided they directly relate to computer networking and CS 656 topics. Proposals not closely related to the course's subject matter may be rejected.

Feel free to reach out to the staff if you have concerns about the relevance of your proposed project.

Grading

The final course grade will be calculated using the following categories:

Assessment	Grade Percentage	
Participation and Attendance	5%	
Foundation Review	15%	(Wireshark Labs, Programming assignments, End of chapter problems from Text).
Programming Projects	25%	
Midterm	20%	
Final research project	35%	Participation in precept paper discussions (including paper presentation) (Final Report and presentation)

Students achieving a 90% total score or higher will earn at least an A-; 80% or higher, a B-; 70% of higher a C-; and 60% or higher a D. We reserve the right to “curve” these cutoffs to be lower (e.g., assign an A- to a student with an 89%). We will not curve the cutoffs to be higher.

Grades will be released via Gradescope. If you think that we made a mistake in grading, please submit a regrade request via the Gradescope interface within one week. Note that we cannot “negotiate” points: regrade requests may only be used if you think we made a mistake.

Incomplete grades are a serious matter and will only be granted in the face of a crisis or emergency, in consultation with the student's advisor and, if appropriate, with the Dean of Student Affairs.

Submission Time

Our project and homework schedule is carefully structured to help you manage your workload over the fifteen-week semester. Without deadlines, it's easy to fall behind and end up with an overwhelming amount of work in the final week.

Recognizing that you may have other commitments, we've included some flexibility in the form of "slip days." You can use up to four free slip days to submit homework or projects after the original due date. However, no assignment may be submitted more than 48 hours late, meaning you can use a maximum of two slip days for each assignment.

If you require additional slip days due to exceptional circumstances, please send an email to the professor and copy your advisor, explaining the need for an extension. Crises or emergencies, such as a medical situation like your roommate's appendix bursting, are valid reasons to request additional slip days. In such cases, your focus should rightfully be on resolving the issue rather than coursework. It's important to note that a job interview is not considered a crisis or emergency, and we expect you to utilize your four free slip days to accommodate interruptions of that nature.

Any slip days beyond the initial four free ones will result in a 10% penalty off the final grade.

Timeline and deliverables for Research Project:

- Team selection (due by Monday of 3rd Week)
- Project proposal (due by Monday of 6th week)
- Final project presentation (in class starting 13th week)
- Final project report (due 12/17 at 5pm ET); this should be submitted as a PDF generated using the Usenix conference research paper format..

Collaboration Policy

Programming, much like creative writing, is an individual and creative process. It requires individuals to develop their own understanding of the problem and devise their own path to its solution. While we encourage discussions with friends during the problem-solving phase, once it's time to write the actual code that resolves the problem, these discussions are no longer appropriate. The program you submit must be entirely your own work.

Under no circumstances are you allowed to copy another person's program, comments, README description, or any portion of the assignment you submit. This prohibition encompasses even direct transliterations of another's work, whether done visually or digitally. It also includes derivative works, such as changing variable names or subtly rearranging statements in an attempt to conceal copying. You are not permitted to use code, comments, or results from others, even if you attempt to cite them. Any use of another person's code in any form, or providing code for someone else to use, constitutes academic fraud and will be addressed with the utmost seriousness.

Additionally, it's your responsibility to ensure that the code you create for assignments is not easily readable by others.

Academic Integrity

Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the academic code of integrity policy that is found at: NJIT Academic Integrity Code.

Please note that it is my professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. Any student found in violation of the code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university. If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at dos@njit.edu

Acknowledgements

This class and its contents were inspired by Computer Networking courses at various institutions, including:

  - NJIT’s Internet and Higher Layer Protocols taught by my teacher Cristian Borcea (Recipient of best teacher award) CS 656 – 2010-14
  - CMU’s Networking and the Internet Course, 15-441/641
  - Princeton’s Advanced Computer Networks, COS 561
- Past iterations of CS656 at NJIT, as prepared by Kumar Mani, Asad Raza, and Larry Lay.