CS 535
Section A1

MET 122
1010 Comm Ave
Tuesday 12:30 – 3:15 pm
Spring 2024

Course Description: This course provides a robust understanding of networking. It teaches the fundamentals of networking systems, their architecture, function and operation and how those fundamentals are reflected in current network technologies. Students will learn the principles that underlie all networks and the application of those principles to current network protocols and systems. The course explains how layers of different scope are combined to create a network. There will be a basic introduction to Physical Media, the functions that make up protocols, such as error detection, delimiting, lost and duplicate detection; and the synchronization required for the feedback mechanisms: flow and retransmission control, etc. Students will be introduced to how these functions are used in current protocols, such as Ethernet, WiFi, VLANs, TCP/IP, wireless communication, routing, congestion management, QoS, network management, security, and the common network applications as well as some past applications with unique design solutions. Prereq: MET CS 575 and MET CS 201. Or instructor's consent. Restrictions: This course may not be taken in conjunction with MET CS 625 or MET CS 425 (undergraduate). Only one of these courses can be counted towards degree requirements.

Office Hours: I am generally not on campus, so office hours can be quite flexible. Contact me by email and we will set up a time. I am frequently available before class I should be in my office 319 MET (upstairs from our class), and of course Zoom is available (after class, I will be trying to make a 4pm train.)

Read and familiarize yourself with this whole document, not just the schedule.

Schedule

23 Jan Week 1 – Introduction
Read: PNA-Preface.pdf
Week 1-MET CS535-Lecture1-Intro to Networks
Week 1-MeT CS535-Lecture2-Networking Is IPC

30 Jan Week 2 – Upper Layer Architecture and Intro to Data Transfer Protocols
Read: Week 2-MET CS535-Lecture1-Stalking the Upper Layer Architecture
Week 2-MET CS535-Lecture2-Types of Networks
Week 2-MET CS535-Lecture3-Fundamentals Of Protocols

06 Feb Week 3 – Basic Physical Layer
Read: Week 3-MET CS535-Lecture1-PhysicalLayer

13 Feb Week 4 – Multi-Access Media
Read: Week 4-MET CS535-Lecture1-Multi-Access Media
Week 4-MET CS535-Lecture2-Assembling What We Have
Tanenbaum Chapter 4 as indicated

20 Feb Week 5 – Layers with Relaying
Read: Week 5-MET CS535-Lecture1-Routing
Week 5-MET CS535 Lecture2-The Traditional Network Layer

27 Feb Week 6 – Naming and Addressing
Read: Week 6-MET CS535-Lecture1-Naming and Addressing
Week 6-MET CS535-Lecture2-Naming and Addressing
Week 6-MET CS535-Lecture3-Mobility

05 Mar Week 7 – Mid-Term

12 Mar NO CLASS SPRING BREAK!!

PROJECT OUTLINES DUE

19 Mar Week 8 – Error and Flow Control over Relays
Read: Week 8-MET CS535-Lecture1-Error and Flow Control over Relays
Week 8-MET CS535-Lecture2-Congestion Management
Week 8-MET CS535-Lecture3-Traffic Engineering

26 Mar Week 9 – Network Infrastructure and Network Management
Read: Week 9-MET CS535-Lecture1-Network Infrastructure
Week 9-MET CS535-Lecture2-Network Management

02 Apr Week 10 – Current Applications
Week 9-MET CS535-Lecture2-Current Applications

09 Apr Week 11 – Security Mechanisms
Read: Week 10-MET CS535-Lecture1-Security Mechanisms

16 Apr Week 12 – Project Presentations

23 Apr Week 13 – Project Presentations

30 Apr Week 14 – Final Exam or when University schedules it.

Textbooks
There are no good networking textbooks. They are all written for vocational schools, not a university, and they are full of errors. The primary reading for the course will be the Lecture Readings. I have found Tanenbaum to be the broadest and the least objectionable. The Lecture Reading will point to the relevant portions of Tanenbaum. Mainly, the Lecture Reading provide the principles and corrections to the errors in the textbook. The Lectures point at the relevant parts of Tanenbaum to read. Tanenbaum will provide readings for details of specific techniques. Exams will cover both the Lectures and Tanenbaum. I guarantee that this is not an ordinary networking course.

The Lecture Readings are probably more complete than what I say in any one class. ;-) In most cases, the lectures and the readings go beyond what was covered in Patterns in Network Architecture: A Return to Fundamentals. However, if the student is curious, the relevant chapters of Patterns are on Blackboard.

So what should you do as a student? First read the Lecture Reading before class, as you read it read the portions of Tanenbaum that are pointed to. Then come to class ready to pepper me with questions about what you read that you didn't understand, don't agree with what you have been taught before or believe I am wrong. ;-)

Tanenbaum, A; Wetherall, D.; Feamster, N. **Computer Networks**, 6th Ed. ISBN 13: 978-0-13-676402-1 Pearson, 2020. NOT THE GLOBAL EDITION. (We will have to be careful. There are known errors in the homework problem numbers. Tanenbaum has been notified of these and other errors in the book.)

Day, John. **Patterns in Network Architecture: A Return to Fundamentals**, Prentice Hall, 2008. Supplemental only. The relevant chapters are posted on Blackboard.

Grading. The course grade will calculated as follows: 20% on Assignments, 40% on the Mid-term and the Final Exam, and 40% on the Project. All exams are open book/open note. Study for understanding (and where to find things!).

Class: The Schedule above indicates the readings for each class. It will be best if you have read the material before class. (However, I know how that works as the pressures of the semester mount.) All lecture slides will be posted the day before class. (If not, yell, I have screwed up.) There will be a homework assignment at class time. (If not, yell, I screwed that up again!) ;-) We will go over homework in class.

The purpose of homework assignments is to get you to think about the concepts and develop a "feel for the topics." Searching the Web for answers, won't accomplish that, and it will show up in the exams. In class I will lecture based on the important topics for that aspect of the course. There is a lot of well-established material in this field that must be covered, and will be. But at the same time, we will consider these results in the current context.

Nota Bene: With homework being 20% your grade, it does not affect your grade much. The purpose of the homework is to help you ensure that you understand the material. If I find you copying from Tanenbaum's answers or other blatant examples, that homework will get a zero and a strong talking to from me. A second time, it will be reported as plagiarism to the University. The University does not go easy on such infringements.

Cheating has become rampant. It has made us (the professors) suspicious of anything out of the ordinary. This can reflect badly on honest students doing good work. Please do what you can to restore my confidence in your work. The best way to avoid this is to interact in class, ask questions, so I get to know who you are. The more I understand you, or think I do, the less likely I am to suspect you of cheating. ;-)

Projects

By the end of Week 6, we will have discussed most of the common structures in networking. It is time to start focusing on the project. This is a broad field and there are many topics that are quite interesting and important that we won't have time to cover in this course. Even with the topics we do cover, there are very interestinog aspects that we won't have time for. These are all potential topics for a project, a chance to delve more deeply into a topic that interests you.
Networking projects that attempt implementation require sufficient infrastructure that it can take considerable time away from the topic of the project. Therefore, most projects are paper studies of some networking topic. The topic can be most anything. *A major aspect of the grading will be on how well it applies the principles covered in this course.* Needless to say, projects that re-hash what was covered in class will not fare well. We know (or are supposed to) that material. ;-)

For a project, one might take a protocol or group of protocols from the lower layers or a relaying application protocol and apply this structure to it. Identify and document the mechanisms and policies in the protocol, what aspects are error and flow control and what aspects are relaying and multiplexing, does this protocol follow the structure outlined in class? If not, how does it differ, why does it differ, and should it? Does your example contradict the theory? Is the protocol wrong or is the theory wrong? If you choose a protocol that was discussed in class, then you must go well-beyond what was covered, e.g., actually defining the policies that the protocol uses. I will provide a list of the policies. Possible protocols: 802.11, SCTP, Bluetooth, X.25, HDLC, Ethernet and its LLCs, Transaction Processing, ATM, ISDN, MPLS, etc.

Or a project of your interest. Possible topics might include: A specific application with unique properties: p2p, process control in an electric grid, or a refinery or chemical plant, air traffic control, on-line trading, etc. A specific aspect of networking: error detection/correction, flow control, security, multiplexing, re-transmission strategies, routing, congestion control, wireless protocol performance, distributed calculations, updating multiple copies, etc.

Projects on security tend to be discouraged. Many of you will be pursuing a security concentration. You will be taking other of security courses. Use those ideas for a project there. This is an opportunity to broaden your knowledge, use it! ;-) However, there are security projects that would be interesting for the class, so run the idea by me.

The project paper should be a minimum of 10 pages *single-spaced not counting a cover page, abstract, or a table of contents.* A 10 page paper with any of these will lose points. (A table of contents for a 10-page paper is ridiculous!) If you use an AI tool, cite it as a reference. Also, the project will include a presentation to the class of 10 minutes or so of the major points of the project. The project is graded on its content, not its appearance and how well concepts from the course have been applied. While figures can be useful and even necessary, the use of content free figures to take up space is discouraged. Generating an outline is key, not only to organize your thoughts but I might be able to suggest sources.

Course Mechanics

- **Attendance** – I don't take attendance. You are all adults and responsible for yourselves. There is material I will cover in class that may be on the exam that is not in the book or the lecture slides. If something comes up, that is out of the ordinary and requires you to miss class, especially multiple classes, please let me know.

- **Homework**: There will be approximately eight homework assignments. Homework will be due at the beginning of class after it was assigned (usually the next week). (Holidays and Exams may modify that slightly.) Homework should be submitted via the "Dropbox for Everything" on Blackboard. (Email is okay, but has proved unreliable. Hence, Dropbox is preferred.) (Don't use spaces or "#" in file names submitted to Dropbox. The Blackboard programming staff weren't that good.) Also, file names should be more descriptive than "homework1" or "hw1". You aren't the only one submitting homework! ;-)

  Late homework will be penalized as appropriate. You are encouraged to work together to learn the material and to discuss approaches to solving homework problems. However, *you must come up with and write up the solutions on your own.*

Administration

- **Office Hours:** Before class is best. I will generally be on campus well before class. Contact me by email if you wish to see me before class.

- **Email**: You are required to periodically check your email for unexpected occurrences like errors in assignments, cancellations, etc. Check blackboard frequently as well.. Questions via email are always good. If the

question/answer has general interest, I will answer you but probably ask you to bring it up in class; if the solution is very involved, we may need to go over it in person.

- **BlackBoard Site:** We will use Blackboard (learn.bu.edu). I will use it to post class notes, lab and homework assignments, homework solutions, and other course information.

- **Incompletes**: Incompletes will only be granted in accordance with university policy, which (broadly) requires a major crisis near the end of the semester.

- **Course Notes**: Class notes will be posted before the class. You are encouraged to annotate them during class.

- **Academic Honesty**: Please read the university academic code of conduct. If something is not clear, then ask. In particular, plagiarism is regarded as a serious offence and students engaging in this activity will be reported. If you use a source, cite it. (Not related to academic Honesty, but germane. I do not consider wikipedia an authoritative source on any subject. It may be used to find more primary sources or cite it to illustrate opinions. But it cannot be considered definitive.)

- **In Class Distractions**: Please turn off cell phones and close laptops at the start of class. If you must text during class, please leave the class to do it. If you need to leave the class to text, there is no need to return to the class.

- **Instructer Errosr**: Don't be shy! If you see me make a mistake, please let me know right away. If you are not sure, that's even better – it will give me a chance to clarify something. Class lecture is a test to see if you are listening. ;-)

Keys to Success in this (and most other) Course(s)

Attendance! Coming to class is important. Some of the material (and much of the perspective) in this course will be found nowhere else**.**

Do the readings! Work out the examples as you read. If you do not believe that you completely understand something, try inventing and solving your own problems. If that doesn't work, come see me! And we will figure it out.

Take notes! In particular, print out the course notes ahead of time and annotate them during class.

Participate! Ask questions; talk with your fellow students. Be active**.**

Keep up! Before each class, read over the notes from the previous class**.**

Allocate enough time! Much of the material is time-consuming to master. There is a big difference between "kind of" understanding a subject and "really" understanding it.

***How do you know that you know the material*?** A good metric is whether you would feel comfortable standing in front of a class explaining it. Another is whether you think that you could explain it to a job interviewer!

(Not So) Picky Things I *REALLY* Care About

- **Punctuality**. Please come to class on time. Unfortunately, unlike coming late to a movie, coming in late to class distracts the presenter as well as the presentees. Unfortunately, given some of you are coming from work and Boston traffic being what it is, this may be hard. Let me know if you *can't* make it. We will assume you are coming!
- **Preparation**. Come to class prepared. If you haven't reviewed new terminology, etc. it makes it very difficult to follow what's going on. (The six Ps: Proper Preparation Prevents Poor Performance)
- **Presence**. Frankly, I don't care. If you can pass the exams without coming to class that is fine. (I know I shouldn't say this. But it was our attitude when we were in school so I can't in all honesty require it from you.) However, in this class especially, much of the important information isn't in the textbook and it could show up on an exam. If I test you on what was said in class (and I am likely to) and you weren't there, that was your decision. If you decide to take me up on this, you better be good. Like showing your work with homework, if I know who you are I can better gauge your work. If you make yourself just a number, I will tend to see you that way.
- **Participation**. The best way to learn is to be involved. Conversely, being distracted is the worst. In particular, working on homework during class the day it is due is unacceptable. Get involved. I think this subject is really fascinating from a number of perspectives: scientific, historical, social, political, epistemological, etc. This stuff is fun.
- **Powers of 2 and logs.** Know them up to 2^{16} (at least) and why this is important.
- **Your success!! If you are having problems, arrange a conference with me! (and sooner rather than later.)**