EECS 563
Spring 2024

Introduction
to
Communications Networks
Syllabus

Victor S. Frost
Dan F. Servey Distinguished Professor
Electrical Engineering and Computer Science
University of Kansas
2335 Irving Hill Dr.
Lawrence, Kansas 66045
e-mail: vsfrost@ku.edu
http://www.ittc.ku.edu/~frost

EECS 563 - Book

- Main Text:
  - Class PowerPoint slides
- Required text: Computer Networking: A Top-Down Approach, 8th Edition, J. Kurose and K. Ross
- Reference texts:
  - Free on-line networking texts
    - Computer Networks: A Systems Approach by Larry Peterson and Bruce Davie
      - https://book.systemsapproach.org/
    - Computer Networking : Principles, Protocols and Practice by Olivier Bonaventure
      - https://open.umn.edu/opentextbooks/textbooks/computer-networking-principles-protocols-and-practice
  - Computer Networks, 4th Edition, A. Tanenbaum
  - Communication Networks: Fundamentals Concepts and Key Architectures, A. Leon-Garcia and I. Widjaja
- Look to the Web:
  - Look ahead in class notes and do a web search to discover details and answers to your questions
  - Bring questions to class

Test Review and Class Make-up Sessions

- Test reviews and class make-up sessions will only meet as announced in class and on the class web page
- Day/Time/Place: TBD

EECS 563 - Class Web Site

- The class will follow notes on the Class Web site:
  http://www.ittc.ku.edu/~frost/EECS_563/index-Spring_2024.html
- Class content comes from:
  - Computer Networking: A Top-Down Approach, 8th Edition, J. Kurose and K. Ross
  - Instructors notes
  - Material alternate texts
  - Material from other sources
- Homework assignments
  - All homework assignments will be posted on the class web page
  - Solution will not be posted, problems will be worked in class or during office hours upon request.
- Project assignments: posted on class web site
- Class web site also contains
  - useful links to other resources
  - interactive graphs (using the Wolfram CDF Player)
  - Link to Download Wolfram CDF Player
- **Academic Integrity and Plagiarism**

Academic Integrity and Plagiarism

- The department, school and university have very strict guidelines regarding academic misconduct. Obviously, copying is not allowed on exams. Students are expected to submit their own work on individual homework and projects. Lending or borrowing all or part of a simulation model or program from another student is not allowed. Students ARE allowed to borrow and modify any code on this class web site in their projects. Instances of cheating will result in a referral to the department chairman and the dean of engineering.
- All sources in your written work (project reports) must be properly referenced; if you use a source from the literature or the idea of another for your work you must reference it. If you quote or copy a block of text, it must be cited and included in quotation marks (if a sentence or less in length) or in block quote style (if more than a sentence in length). If you paraphrase text (reword a phrase, sentence, or paragraph), you must also quote or blockquote followed by "[paraphrased]" in addition to proper citation. Figures taken from other sources must be referenced.
- I recommend that you take intermediate notes from which you write your own words. I strongly recommend that you not write in one window while displaying the work of others in another window; this is asking for trouble. "Unintentional" paraphrasing is also not an acceptable excuse for academic misconduct.
- Modified with permission from James P.G. Sterbenz http://www.ittc.ku.edu/~jpgs/courses/eecs800/ and John Gauch http://www.ittc.ku.edu/~jgauch/teaching/258.f03/syllabus.html

Use of EdTech Services

- Professors and instructors at the KU School of Engineering are aware that some students are actively posting homework, laboratory, and exam questions and responses to EdTech services (e.g., Chegg) even during exam time frames.
- Keep in mind that when a person signs up to participate by either uploading, and/or downloading, and/or using posted material from these sites, the "terms of service" that are agreed to do not protect the person when KU and/or the School of Engineering decide to conduct investigations related to academic misconduct (e.g., plagiarism and/or cheating).
- In fact, EdTech services, like Chegg, retain contact information of students who use their services and will release that information, which is traceable, upon request. Using these services constitutes academic misconduct, which is not tolerated in the School of Engineering. It violates Article 3r, Section 6 of its Rules & Regulations, and may lead to grades of F in compromised course(s), transcript citations of academic misconduct, and expulsion from the University of Kansas.
- If unsure about assignments, it is important that students use the allowable available resources, such as instructor office hours, graduate teaching assistants, and/or tutoring. The School of Engineering wants students to be successful; cheating is not the way to attain that success.

Use of smartphones, tablets, and laptops in class

- Use of Smartphones, tablets, and laptops during class is **strongly** discouraged.
- Use of Smartphones, tablets, and laptops may **only** be used in direct support of class activities.
- Texting, general web browsing, checking of e-mail is **NOT** permitted during class.
- Video and audio recording of the EECS 563 class lectures is prohibited.

EECS 563 - Contact Info

- Contact Information
  - e-mail: vsfrost@ku.edu (e-mail is the best ways to contact me)
  - Phone: 864-1028
- Office hours:
  - In 2054 Eaton Hall:
    - TR 10:00-Noon TR
    - I am available outside of office hours: call or e-mail to insure that I am available
- Changes announced in class and the class web site supersede these written instructions.
- Student with disabilities or special needs should see me immediately for accommodations.

EECS 563 – Course Deliverables

- Homework
  - Homework will be posted on the class web site
    - PDF
    - CDF
  - Problems will be assigned and graded
- Two in class tests (No final)
- Four network projects
- Class Attendance:
  - Enrolling for this class signifies that the students plan to participate in all of lectures, homework, projects, and exams.
  - Each student is responsible for knowing any information delivered in every class. Academic success is built upon regular class attendance and class participation.
  - Attendance will be taken randomly

EECS 563 - Grading

- Tests (2) = 54% (There maybe pop quizzes)
- Projects* = 32% (4 @ 8%/project)
- Homework = 14%
  - About 1 assignment/week
  - Homework grade **highly** correlated with final course grade

* Be prepared to present and explain your project results to me in a one-on-one meeting. I may randomly select students to explain their project results and models to me in my office.

EECS 563: Grading

- Initial grading scale:
  - 90 - 100 A
  - 80 - 89 B
  - 70 - 79 C
  - 60 - 69 D
- Lower limit on these ranges maybe reduced as a function of the distribution of the final scores.
- This class will not use +/- grading

EECS 563: Grading

- Only under **VERY** extreme conditions will make up tests be given.
- I **MUST** be notified BEFORE you miss a test otherwise you **WILL** get a 0.
- No late homework will be accepted.
- No make up quizzes will be given

Tools Used for Class Assignments

- Wireshark
  - http://www.wireshark.org/
  - Free software at http://www.wireshark.org/
  - Install on your own machine, need to install and run as administrator
- Simulation: ExtendSim (http://www.extendsim.com/)
  - Installed on all EECS Windows computers← Suggest you use
  - To run the models be sure to copy and paste the model to the local drive and run rather than trying to open the models directly from the class website.
  - EECS has a limited number of licenses, so get started early on Extend assignments
  - Limited free demo version at: https://extendsim.com/extendsim9demo
    - Can not save & print models
  - ExtendSim LT $100.00 [not required]

Tools Used for Class Assignments & Projects

- Wolfram CDF Player
  - Interactive documents
  - Installed on all EECS Windows computers
  - Can be down loaded from: http://www.wolfram.com/products/player/
- Whois
- Speed Test, e.g., http://www.speedtest.net/
- OS Commands
  - ping
  - traceroute

Electronic Submission of Homework

- Homework and projects assignments must be submitted via e-mail as pdfs files and .mox files for simulation models.
- Electronic submissions **must** use this file naming format.
  - Homework: LastName_HW#.pdf
    - For example, Frost_HW5.pdf
  - Project: Lastname_Project#.pdf
    - For example, Frost_Project1.pdf
- E-mail homework to a grader (more on next slide)
- E-mail the project reports to me at vsfrost@ku.edu

Electronic Submission

- There are two graders for this class.
  - One grader will score each homework assignment
  - Graders will switch-off homework assignment
  - The mapping of homework assignment to grader will be found on the homework webpage
- Graders:
  - Nirvan Kotha, nirvan@ku.edu
  - Ankireddy Manoj Prakash Reddy, ankireddymanoj162@ku.edu
  - E-mail the project reports to me at vsfrost@ku.edu

EECS 563 - Homework Rules

- In order to facilitate grading of homework problems, homework **must** meet the following specifications:

  1. Writing should be **legible** and literate - if the grader cannot read your handwriting, you will receive no credit for the problem.

  2. If not typed then for text and equations, use an HB or No. 2 pencil (or darker), or blue or black ink. (Pencil is preferred.) No other colors please, except in diagrams or graphs.

  3. All pages should be numbered i/j in top right hand corner, with your name appearing at the top of each page. It is O.K. to use your initials after the first page.

  4. All work must be shown for full grade - be as thorough as possible.

EECS 563 Homework Format

5. Answers are to be boxed and right justified, with the variables, values (if any) and units (if any), included in the box. Right justified means placed on the right side of the page.

6. Leave half an inch between consecutive parts of a question, and draw a line across the page at the end of each complete question.

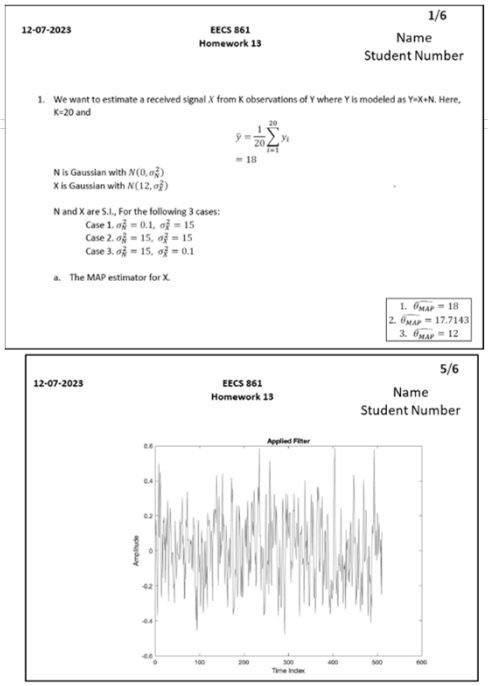
7. No part of a question should appear in any margin of the paper.

8. Diagrams and graphs should be of a good size (say at least 3x5 sq. inch), and may contain colors. Diagrams and graphs must be titled, labeled, and clearly drawn. Tables should also be titled.

9. Graphs **must** be scaled (put number on axes), labeled (put names /units on axes), and titled at the bottom of the graph. Any graph which occupies an area of less than 3x5 sq. inch and which is not titled will not be graded.

10. Where possible use conventional units such as bits/sec, Hz and km

Example



12-07-2023 EECS 861 Homework 13 1/6

Name
Student Number

1. We want to estimate a received signal X from K observations of Y where Y is modeled as Y=X+N. Here, K=20 and

$$\bar{y} = \frac{1}{20}\sum_{i=1}^{20} y_i = 18$$

N is Gaussian with $N(0, \sigma_N^2)$
X is Gaussian with $N(12, \sigma_X^2)$

N and X are S.I., For the following 3 cases:
Case 1. $\sigma_N^2 = 0.1,\ \sigma_X^2 = 15$
Case 2. $\sigma_N^2 = 15,\ \sigma_X^2 = 15$
Case 3. $\sigma_N^2 = 15,\ \sigma_X^2 = 0.1$

a. The MAP estimator for X.

1. $\widehat{\theta_{MAP}} = 18$
2. $\widehat{\theta_{MAP}} = 17.7143$
3. $\widehat{\theta_{MAP}} = 12$

12-07-2023 EECS 861 Homework 13 5/6

Name
Student Number

Project Report-Grading

- I will grade the projects
- Grading criteria
  - Clearly written, make it easy to understand.
  - Demonstrating an understanding of the project goals
  - Providing the correct answers to project questions
  - Demonstrating an understanding of the results obtained
  - Generating a professional product that is straightforward to read and understand; the provided format is a guide for writing the report.
- Report in .pdf must be submitted via e-mail.

Project Report Format

1. Title page (include your name and student number)
2. Abstract
3. Table of contents (with page numbers)
4. Introduction
5. Narrative
   a) Objective
   b) Methodology: overview of methods used, including associated theory, system model, block diagrams, and/or system parameters as appropriate
   c) Results and a Discussion of results
6. Conclusions and lessons learned.
7. References
8. Appendices (if needed)

DO NOT PAD THE REPORT! YOU WILL LOSE POINTS FOR INCLUDING MATERIAL NOT DISCUSSED IN THE TEXT OR NOT DIRECTLY RELATED TO THE ASSIGNMENT.

Project Report Format

- Figures & Tables
  - All plots and tables included in the report must be discussed in the text.
  - Each figure/table should be placed as close to the first reference to it in the text as possible. Placing the figure/table on a separate page following the first reference to it in the text is permissible.
  - Each figure/table **must** have a title.
  - All axis on graphs **must** be labeled with units.
  - Each figure/table should be self contained, that is, the title, axis labels, and other information in the figure/table should provide the reader enough information to interpret the item.
- Paper on writing technical reports: http://www.ittc.ku.edu/~frost/EECS_563/Writing%20Technical%20Reports.pdf "Writing Technical Reports" by David Dettinger, IEEE Engineering Management Review, Year: 1977, Volume: 5, Issue: 4

Course Outline

- Introduction
  - Landscape
  - Customer Expectations
  - Value and Drivers of Network Technology
  - Defining the Network
  - Issues in Networking
- Transmission, Data and Control Planes
  - Physical transmission of information
  - Multiplexing
  - Data plane-control of movement of data
  - Packet Switching
  - Control plane-routing and signaling

Course Outline

- Architectures, Layers, and Standards
  - Physical Architecture
  - Network Architecture
  - Standards
  - Layering and Protocol Stacks
- Metrics, Network Traffic, Performance
  - Define Network Performance Metrics
  - Application Requirements
  - Traffic Models
  - Theoretical Prediction of Delay and Loss
  - Simulation of Network (simulation not on tests: covered with project)

Test 1 Likely Here

Course Outline

- Network (IP) Protocols
- Access Networks and Media Access Control
- Data Link Control
- Transport Protocols and Network Control
- Network Security and Network Management → Test 2 Likely Here
- Error Control Coding

At the conclusion of this class the students are expected to:

- Understand the basics of multiplexing
- Understand the layered structure of protocols
- Understand the importance of standards and who sets them
- Understand the basics of network protocols, including,
  - Datagram/virtual circuit switching,
  - Forwarding,
  - Access control (MAC),
  - Data link control,
  - IP and supporting protocols,
  - Routing,
  - Transport protocols.
  - **Resulting in an understanding of how the Internet works.**

At the conclusion of this class the students are expected to:

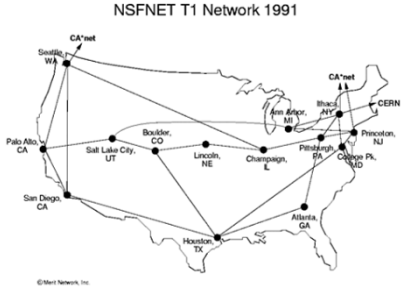
- Understand the tradeoffs involved in network design in a variety of environments - LAN and WAN, diverse link rates, and varied error and delay conditions
- Understand the nature of network traffic
- Perform basic analytic performance and design trade-off studies
- Perform simulation-based performance and design trade-off studies
- Understand the basics of network security, including public/private key systems, digital signatures, key distribution systems, and certificate authorities
- Understand the element of network management
- Use network analysis tools, e.g., Wireshark, traceroute, and ping
- Be fluent in the language of communication networks, i.e., understand the meaning of networking terms and abbreviations

Syllabus

Internet history

1980-1990: new protocols, a proliferation of networks

- 1983: deployment of TCP/IP
- 1982: smtp e-mail protocol defined
- 1983: DNS defined for name-to-IP-address translation
- 1985: ftp protocol defined
- 1988: TCP congestion control
- 1989: Professor Frost teaches this class at KU for the first time
- new national networks: CSnet, BITnet, NSFnet, Minitel
- 100,000 hosts connected to confederation of networks



Modified from: 8th edition Jim Kurose, Keith Ross Pearson, 2020

Gigabit Networking Research Testbeds

- 1990-1999
- MAGIC (Multidimensional Applications and Gigabit Internetwork Consortium)
- Sprint Long Distance Fiber

For more information about all the Gigabit Testbeds see Gigabit Networking 1st Edition, Craig Partridge, Addison-Wesley,1993

Internet history

1990, 2000s: commercialization, the Web, new applications

- early 1990s: ARPAnet decommissioned
- 1991: NSF lifts restrictions on commercial use of NSFnet (decommissioned, 1995)
- early 1990s: Web
  - hypertext [Bush 1945, Nelson 1960's]
  - HTML, HTTP: Berners-Lee
  - 1994: Mosaic, later Netscape
  - late 1990s: commercialization of the Web

late 1990s – 2000s:

- more killer apps: instant messaging, P2P file sharing
- network security to forefront
- est. 50 million host, 100 million+ users
- backbone links running at Gbps

Modified from: 8th edition Jim Kurose, Keith Ross Pearson, 2020

Internet history

2005-present: more new applications, Internet is "everywhere"

- ~18B devices attached to Internet (2017)
  - rise of smartphones (iPhone: 2007)
- aggressive deployment of broadband access
- increasing ubiquity of high-speed wireless access: 4G/5G, WiFi
- emergence of online social networks:
- Facebook: ~ 2.5 billion users
- service providers (Google, FB, Microsoft) create their own networks
  - bypass commercial Internet to connect "close" to end user, providing "instantaneous" access to search, video content, …
- enterprises run their services in "cloud" (e.g., Amazon Web Services, Microsoft Azure)