ECE 4400/6400 Section 001
Performance Analysis of Local Computer Networks
Spring 2022

Section	001
Meeting Time	(Tentative) 9:30am – 10:45am, Tuesday and Thursday
Room	Rhodes Annex 111
Course Modality	Traditional (in-person, **see special notice below**)
Webpage	Canvas
Instructor	Dr. Kuang-Ching Wang
Office	308 Fluor Daniel Building (EIB)
Email	kwang@clemson.edu
Office Hours	Monday/Thursday, 11:00am-noon. Office hours are, by default, online (zoom info below). If in-person discussion is needed, they can be individually scheduled in a conference room that can accommodate ample social distancing.
Zoom	**https://clemson.zoom.us/my/kcwang**
Prerequisites:	ECE 2720 and ECE 3170
Required textbook:	Mor Harchol-Balter, Performance Modeling and Design of Computer Systems, Cambridge, 2013, ISBN 978-1-107-02750-3.
Optional supplement:	Larry Peterson and Bruce Davie, Computer Networks: A Systems Approach, 6th ed., Elsevier, 2020. https://book.systemsapproach.org

Special Notice for Spring 2022: This is an in-person class. All lectures are delivered in Rhodes Annex 111. Between January 13 to March 3, Professor Wang will be delivering the lectures from the Charleston campus to Rhodes Annex 111. During those weeks, an assistant will come to Rhodes Annex 111 to address any potential issues with the online lectures.

Course Description

Computer networks are an essential component of modern day computing systems. In recent years, a multitude of computer network technologies have formed a global infrastructure that pervasively interconnects a broad range of devices, systems, people, and communities in unprecedented ways. From day-to-day personal applications, government, commerce, and societal operations to research computing, they all depend on the reliable operation and performance of computer networks. They are the lifelines of our modern world.

All networks around the globe and in every aspects of our society, while based on a wide range of different networking technologies, are built with local computer networks as the basic building blocks. Regardless of the technology of choice, local computer networks' operation and performance characteristics can be captured in a few simple models applicable to statistical analyses. Effective use of the analytical models allows one to evaluate computer networks and to design computer networks for specific purposes and constraints.

Offered in spring 2022 to senior undergraduate students and graduate students, the course introduces basic networking concepts and methods for modeling and analyzing the performance of local computer networks. Building on random process concepts and basic probability, basic queueing models are constructed and analyzed. The effect of performance requirements on the choice of network solutions is considered, standard architectures and protocols are examined, and practical examples are discussed in the course. Emerging software defined networking (SDN) technology and tools will be used throughout the course for students to directly observe and experiment network performance issues on real networks at varying scales.

By the end of the course, students are expected to be able to:

- Identify standard architectures and protocols of local computer networks
- Utilize standard network models and probabilistic traffic models to analyze local computer networks
- Carry out mathematical calculations required in statistical analyses, including calculus, probability functions, logical and numerical algebra
- Determine suitable models, performance measures, and design factors of local computer networks
- Utilize software defined networking tools to compose and study network protocols and performance

Tentative outline

1.	**Review of probability and Calculus**	(Chap.3 and notes)
2.	**Introduction to Networks**	(notes)
3.	**Introduction to queueing**	(Chap.1 and 2)
4.	**Network experimentation**	(notes)
5.	**Simple laws for queueing systems**	(Chap.6 and 7)
6.	**Data transfer and software defined networking**	(notes)
7.	**Single-server and multi-server systems**	(Chap.13 and 14)
8.	**Principles of medium access control**	(notes)
9.	**MAC protocol performance analysis**	(Chap.7 and 8)
10.	**Exams**	(1 week)

Assignments

In this course, assignments consist of in-class quizzes, homework, projects, and exams.

Quizzes

There will be a single quiz at the beginning of the semester on probability. It will be given after an in-class probability review.

Homework

There will be homework assignments given periodically throughout the semester. These assignments are designed to allow you to practice the material discussed in class and in the text. Collaboration on homework assignments is permitted and encouraged; however, all students must submit individual assignments. Copying of solutions from other classmates or other sources will be considered academically dishonest and will not be accepted.

Guided Projects

There will be two guided projects given during the course. The guided projects are designed for students to learn hands-on skills for network performance measurement over real network testbeds.

Midterm Exams

There will be two midterm exams given approximately 1/3 and 2/3 of the way through the semester, respectively. **The second exam is cumulative**. **No make-up exams** will be given unless an acceptable reason is presented to the instructor at least one week prior to the exam date.

Final Project

Instead of a final exam, the course requires a final project that demonstrates the understanding of network performance analysis and software tools. The topic is proposed by the student(s) and approved by the instructor, and the topic can be in a wide range of possible contexts. Detailed requirements will be announced. The final project requires a final report, due on the last scheduled lecture, and a final presentation due at the University scheduled final exam time.

Submitting Assignments

Each assignment must be turned in **as a scanned PDF file uploaded to Canvas BEFORE the start of class on the day it is due**, unless specified otherwise. No late assignments are accepted, unless accompanied by a formally documented and valid excuse provided by the student and approved by the instructor prior to the assignment due date. The instructor retains the right to deny late turn-in requests that are avoidable with cautious planning. For accepted late assignments, the instructor retains the right to deduct 20% penalty for each additional day late.

Attendance and Class Cancellation Policy

If the instructor is late, you may leave 15 minutes after the scheduled class time. Be on the lookout for an email with course updates if this situation were to arise.

You are expected to attend all classes; however, if you anticipate an absence, please notify me beforehand. If you fall ill, *please* do not come to class, but try and let me know as soon as you can. All absences will be dealt with on a case-by-case basis.

Please note that the University may convert to a purely online mode at any time.

Grading

Grades will be weighted as follows:

- 2% Probability quiz
- 8% Homework
- 20% Projects
- 20% First midterm exam
- 20% Second midterm exam
- 30% Final project

ECE 6400 students will have additional homework, exam questions, and reading assignments beyond those given to ECE 4400 students.

All grades will be kept on Canvas (https://clemson.instructure.com). It is your responsibility to ensure all your grades are correct.

Regrade Policy

Any re-grade request of an assignment or exam must be submitted in writing on a separate piece of paper **within 24 hours** from the time the graded item is returned. Students should not write any comments or marks on the graded item in question, or the re-grade will not be considered. The instructor retains the right to refuse a re-grade request turned in after the announced period.

Academic Integrity

As members of the Clemson University community, we have inherited Thomas Green Clemson's vision of this institution as a 'high seminary of learning.' Fundamental to this vision is a mutual commitment to truthfulness, honor, and responsibility, without which we cannot earn the trust and respect of others. Furthermore, we recognize that academic dishonesty detracts from the value of a Clemson degree. Therefore, we shall not tolerate lying, cheating, or stealing in any form. In instances where academic standards may have been compromised, Clemson University has a responsibility to respond appropriately to charges of violations of academic integrity. Further information on Academic Integrity can be found in the *Undergraduate Announcements* and in the *Graduate School Policy Handbook*.

Accessibility

Clemson University values the diversity of our student body as a strength and a critical component of our dynamic community. Students with disabilities or temporary injuries/conditions may require accommodations due to barriers in the structure of facilities, course design, technology used for curricular purposes, or other campus resources. Students who experience a barrier to full access to a class should let the instructor know and make an appointment to meet with a staff member in Student Accessibility Services as soon as possible. You can make an appointment by calling 864-656-6848 or by emailing studentaccess@lists.clemson.edu. Students who receive Academic Access Letters are strongly encouraged to request, obtain, and present these to their instructors as early in the semester as possible so that accommodations can be made in a timely manner. It is the student's responsibility to follow this process each semester. You can access further information here: http://www.clemson.edu/campus-life/campus-services/sds/.

Title IX

Clemson University is committed to a policy of equal opportunity for all persons and does not discriminate on the basis of race, color, religion, sex, sexual orientation, gender, pregnancy, national origin, age, disability, veteran's status, genetic information or protected activity in employment, educational programs and activities, admissions and financial aid. This includes a prohibition against sexual harassment and sexual violence as mandated by Title IX of the Education Amendments of 1972.

Safe Campus

Clemson University is committed to providing a safe campus environment for students, faculty, staff, and visitors. As members of the community, we encourage you to take the following actions to be better prepared in case of an emergency:

a. Ensure you are signed up for emergency alerts (https://www.getrave.com/login/clemson)
b. Download the Rave Guardian app to your phone (https://www.clemson.edu/cusafety/cupd/rave-guardian/)
c. Learn what you can do to prepare yourself in the event of an active threat (http://www.clemson.edu/cusafety/EmergencyManagement/)

COVID-19 Policies

The university will make timely decisions about the necessary COVID-19 safety procedures on campus. We will follow the university announced policies in this class. In the event a student chose not to abide by any university requirements, the instructor is required to ask the student to leave the academic space and may report the student's actions to the Office of Community & Ethical Standards as a violation of the Student Code of Conduct. If the student's actions disrupt the class to the extent that an immediate response is needed, the instructor may call the Clemson University Police Department at 656-2222.

Copyright

The instructor reserves the right to modify any aspect of the syllabus at any time during the semester for reasons including but not limited to COVID-related situations.