Syllabus
ECE 642: Design and Analysis of Computer Networks

Course Number: ECE 642
Recommended Prerequisite: ECE 528 or equivalent or permission of instructor
Semester: Spring 2022
Lecture Time: Tuesday 4:30-7:10 pm, Planetary Hall 126

Instructor: Bijan Jabbari, Professor
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Office hours: Tuesday 2:00- 3:00 pm, other times by appointment

Teaching Assistant: N/A
Administrative Assistant: N/A

Course Description
The course covers the foundations of computer communication networks and introduces principles upon which the Internet and other computer networks are designed. It discusses the performance, analytical, and design aspects of packet-switched and forwarding networks, routing, and path computation algorithms. The course starts with a treatment of a single node (e.g., a router or a switch) as a queueing system such as state-dependent queues and imbedded Markov chains. It continues with the modeling of virtual channels through a network of queues. Additional topics covered include admission control algorithms modeling, performance evaluation of local and wide-area computer networks (e.g., LANs, IP/Internet, MPLS Traffic Engineering), and analysis of random-access techniques.

Note to those who are taking the course
This is a graduate-level (MS/PhD) course in performance modeling of contemporary communications networks. In addition to analytical models, students are taught how to develop simulation models for queueing systems as well as other stochastic processes using MATLAB. More specifically, the typical solutions for projects assigned in the class will be made available using MATLAB programming. In addition to weekly homework, there will be five to six weekly or bi-weekly projects to help students learn how to use MATLAB for simulation of single queue, network of queues and applications. These projects complement the analytical modeling technique and have considerable pedagogic value in helping students understand random processes, performance evaluation of a node or a network. Projects also represent real-life examples of network design. Note that while use of MATLAB is encouraged for carrying out the simulation projects, students may use other general-purpose programming languages such as C, C++, JAVA or Python.

Course outline
- Background and review of basic concepts in computer networks, review of transform techniques, random processes, and point processes.
- Introduction to queueing theory, M/M/1 queue, state probabilities, expected queue size and delay, Little's formula.

- Analysis of state-dependent queues, Markov chains, M/M/C queues and variations, priority queues.
- Imbedded Markov chain: the M/G/1 queue.
- The imbedded Markov chain analysis of time-division multiplexing.
- Networks of queues, open queueing systems, closed queueing systems, Independence assumption.
- Congestion control and modeling using closed queueing networks.
- Solutions to closed queueing networks: Norton model, Buzen's algorithm, and mean value analysis.
- Constraint-based routing, Multi-Protocol Label Switching (MPLS), and traffic engineering.
- Statistical multiplexing gain, congestion control and routing.
- Performance of local and wide area networks incorporating routers.
- Performance analysis of polling and random-access techniques.
- Queueing modeling of QoS, weighted fair queueing, or other selected topics as time permits.

Textbook and References:

- **Required Textbook:** D. Bertsekas, and R. Gallager, *Data Networks*, Prentice-Hall, latest edition
- B. Jabbari, lecture notes (will be made available to students through web posting).

Grading:

There will be weekly homework assignments along with several projects. Homework will be assigned on Tuesdays and will be due by 4:30 pm of the following Tuesday (except holidays). Projects should be typed and follow a specific given format. You should upload your solutions to Blackboard. Projects will typically be due two weeks after being assigned. Late submissions will not be accepted.

There will be one Mid-Term exam, and a final exam (comprehensive). Both Midterm Exam and Final Exam will be in-class and closed-book. Students will be provided with formula sheets to avoid memorization. Student performance will be evaluated by all items above, they will count towards the grade as follows:

- Homework and MATLAB Projects 20%
- Mid-term (mid-to late March) 35%
- Final Exam (see the schedule of Final Exams) 45%

Mason expects students to pursue their academic work with honesty and integrity. Students should feel free to work in groups to discuss lecture material and homework assignments; however, under no circumstances should a student represent another's work as his/her own. Copying solutions for assigned homework problems, from any source, constitutes a violation of the university honor code. Any forms of cheating may cause penalties, from getting a failing grade in this course to academic actions in accordance with university policy.

Course and University Policies

Academic Integrity and Honor Code:
Honesty and integrity are at the core of Mason academic programs, research and community. George Mason University's honor code states the following:

Honor Code Statement To promote a stronger sense of mutual responsibility, respect, trust, and fairness among all members of the George Mason University Community and with the desire for greater academic and personal achievement, we, the student members of the university community, have set forth this Honor Code: Student Members of the George Mason University community pledge not to cheat, plagiarize, steal, or lie in matters related to academic work.

Avoid Reposting Course Material: It is not allowed to reposting course material. The course materials (lecture notes, homework, projects, exams, solutions, and anything else posted on the course website) are copyrighted. You may not upload them to any other website or share them with any on-line or off-line test bank.

Communications and Technology: Students should use their Mason email account to receive important university information, including messages related to this class (see https://mail.gmu.edu/). Also, please write ECE542 on the subject line when you send me an email. Blackboard is used to complement the course webpages hosted at Mason https://CNL.gmu.edu. If you need to familiarize yourself with Blackboard, please see https://mymasonportal.gmu.edu. All course materials posted to course webpages, including Blackboard, are private to this class; by federal law, any materials that identify specific students (via their name, voice, or image) must not be shared with anyone not enrolled in this class. Similarly, any video recordings of class meetings that include audio, video, or textual information from other students are private and must not be shared outside the class. Live video conference meetings (e.g. Collaborate or Zoom) that include audio, textual, or visual information from other students must be viewed privately to the extent possible, and should not be shared with others in your household or recorded and shared outside the class.

University Policies: The University Catalog, https://catalog.gmu.edu/, is the central resource for university policies affecting student, faculty, and staff conduct in university academic affairs. Other policies are available at http://universitypolicy.gmu.edu/. All members of the university community are responsible for knowing and following established policies. Academic integrity is of great importance to the Mason community. Mason provides accommodations through the Office of Disability Services.

Office of Disability Services: Mason provides accommodations through the Office of Disability Services (ODS) http://ods.gmu.edu. If you are a student with a disability and you need academic accommodations, please see me and contact ODS at 993-2474.

Student Support Resources on Campus: are available through Stearn Learning Center: See https://stearnscenter.gmu.edu/knowledge-center/knowing-mason-students/student-support-resources-on-campus/

Inclusion and Non-Discrimination Policy: See https://ssac.gmu.edu/

Other Useful Campus Resources:
Writing center: See http://writingcenter.gmu.edu or 703-993-1200
University libraries: See *https://library.gmu.edu*

Counseling and Psychological Services: For CAPS see https://caps.gmu.edu/ or 703-993-2380.

Safe return to campus: Responsibility for complying with health and wellness policies: See: https://www2.gmu.edu/safe-return-campus/faqs-safe-return
All students taking courses with a face-to-face component are required to follow the university's public health and safety precautions and procedures outlined on the university Safe Return to Campus webpage

(https://www2.gmu.edu/safe-return-campus). Similarly, all students in face-to-face and hybrid courses must also complete the Mason COVID Health Check daily, seven days a week. The COVID Health Check system uses a color code system and students will receive either a Green, Yellow, or Red email response. Only students who receive a "green" notification are permitted to attend courses with a face-to-face component. If you suspect that you are sick or have been directed to self- isolate, please quarantine or get testing. Faculty are allowed to ask you to show them that you have received a Green email and are thereby permitted to be in class. As of August 11, 2021, George Mason University **will require all individuals** on our campus **to wear facemasks indoors**, including classrooms and laboratories, **regardless of vaccination status**. The facemask must cover your nose and mouth at all times in the classroom. For more information, please see Mason's updated mask policy.