The Wharton School, University of Pennsylvania

OIDD 9320 – Queueing Theory

Syllabus

Q4, March 14 - April 25, 2023
Tentative – Last Update February 22, 2023

Note: OIDD 9320 is a half semester course worth 0.5 cu.

Instructor: Prof. Maria Rieders
Operations, Information and Decisions Department
The Wharton School
University of Pennsylvania
Office: 517 Jon M. Huntsman Hall
Phone: (215) 898-0535
e-mail: rieders@wharton.upenn.edu

Lectures: Tuesday, Thursday 10:15-11:45 pm, JMHH F92
Office Hours: Tuesdays 3:30-4:30 pm. in 517 JMHH,
Wednesdays 5-6 pm via zoom,
and by appointment
Website: Canvas

Evaluation: Homework assignments (60 %)
Participation (10 %)
Project & Presentation (30 %)

Prerequisites: OIDD 930, OIDD 931 or similar; please, check in with the instructor.

- The Poisson process (homogeneous, non-homogeneous, splitting and merging properties, conditional arrival times)
- Stopping times, Wald's equation
- Renewal theory (elementary and key renewal theorem, renewal reward processes)
- Markov chains in discrete and continuous time (Markov property, transient and limiting analysis)

Graduate standing; target audience: PhD students

Course Materials:

- Ronald W. Wolff**,** *Stochastic Modeling and the Theory of Queues,* Prentice Hall (main text)
- John F. Shortle, James M. Thompson, Donal Gross, and Carl Harris, *Fundamentals of Queueing Theory,* 5th edt, Wiley
- Articles and handouts, posted on Canvas

Course Description: Queues and the act of waiting are ubiquitous in our lives. We experience queuing at airports, in stores, on the phone, and in traffic. Operations management deals with queueing phenomena in production, service, and logistics environments. Communication network designs depend on understanding queueing effects of design choices. This course presents the mathematical foundations for the analysis of queueing systems. We will study general results like Little's law and the PASTA property, analyze standard queueing systems and networks using stochastic processes tools, and introduce relevant aapproximations and computational approaches along the way. Applications relevant to Operations Management, communication networks, and related fields will be studied throughout the course.

Course Topics: The following lists a set of potential topics. Actual contents may vary depending on interests by students and/or the instructor.

- Review of Stochastic Models
  Introduction to Queueing Systems (Notation, M/M/1 Queue)
  Basic Laws (Little's Law, PASTA Property)
- Variations of the M/M/1 Queue
  Expanding the Markovian Queue
  Networks of Queues
  Non-Poisson Arrival Processes
- The M/G/1 Queue
  Embedded Markov Chain Analysis, Workload, Busy Period
  Variations (exceptional first service time, priority systems)
- Infinite Server System
  Many Server Approximations
- GI/G/1 Queue
  Random Walk, Duality, and Ladder Heights
- Approximations and Bounds

Communication:
We will be using a Canvas website for information sharing, course logistics and assignments. Please, check the Canvas website frequently during the semester for up to date information, assignments, and class handouts.

Homework:
Assignments will be handed out on a weekly/biweekly basis. Unless otherwise stated, homework is to be done individually. You may discuss the problems with each other; yet the work that you submit must be your own. If you do obtain a solution from some other source (e.g. from a peer, another text, or an online site), it is expected that you cite the source.

Student Participation:
This is a Ph.D. level course. Students are expected to thoroughly review lecture material before coming to class, and actively participate through discussions, questions, and answers.

Project/Presentation:
Students are to design a project and submit a report by the end of the term. The topic is to be approved by the instructor and may consist of a survey of one or more research papers, an attempt to answer an open question, or the computational implementation and experimentation of a queueing related algorithm. Each student will give a short presentation during the last class meeting.