

ORI 390R.8 - Queueing Theory

Unique 16790

- **Time & Place:** Tue & Thurs 12:30-2:00pm, ETC 5.132
- **Instructor:** John J. Hasenbein
- **Office:** ETC 5.128B
- **Phone:** 471-3079
- **Email:** jhas@mail.utexas.edu (This is the best way to contact me.)
- **Class Web Page:** <http://www.me.utexas.edu/~has/Queue.html>
- **Office Hours:** Mondays 2:30-4pm & Wednesdays 10am-Noon. You can also email me for an appointment.
- **Required Texts:**
 - *Stochastic Modeling and the Theory of Queues* by Ronald W. Wolff (Prentice-Hall). This will be the basis for the first half of the course.
 - *Stability of Fluid and Stochastic Processing Networks* by Jim Dai. These notes will be used during the second half of the class. You will receive copies of these notes in class. The notes are part of an upcoming book, *Brownian Models of Stochastic Processing Networks* by Jim Dai and Ruth Williams. This book is in the process of being written and we will be using a preprint of the book.
- **Grading:** Problem sets will be assigned every one or two weeks. There will be no exams, your class grade will be based on your homework average and class participation, which will comprise 15% of the grade.

For the problem sets, you may discuss problems with your classmates and in fact are encouraged to do so. However, you should understand and write-up your own solutions. A good rule of thumb is that you should be able to explain to me the solutions you have submitted.
- **Final Exam:** None.
- **Prerequisites:** For this course, you should have a good knowledge of Poisson processes and discrete and continuous-time Markov chains. It is highly recommended that you have taken a course equivalent to ORI 390R.5 - *Applied Stochastic Processes*.
- **Students with disabilities:** The University of Texas at Austin provides, upon request, appropriate academic adjustments for qualified students with disabilities.

- **Course Evaluation:** Near the end of the course you will have an opportunity to anonymously evaluate the course and instructor using the standard College of Engineering evaluation form.

Course Topics

Queueing theory is the study of stochastic processing systems, whose primary elements are “servers” and “customers.” Customer arrival times and service times are assumed to possess some randomness and we use utilize a variety of methods from the theory of stochastic processes to analyze these systems. Applications of the theory are wide-ranging, including manufacturing, telecommunications, computer networks and servers, internet traffic, inventory, and insurance/risk theory.

This course will be divided into two major parts. In the first part we will discuss “classical” queueing theory, which generally involves one server systems or networks (many-server systems) with somewhat restrictive probabilistic assumptions, i.e. exponential service and interarrival times. In the second part, we will investigate the modern theory of multiclass queueing networks, developed primarily in this decade. This theory involves possibly non-Markovian queueing networks and related approximations such as the multiclass fluid model. The modern theory is quite powerful and the subject of intense research in the field.

Additional References

- **Stochastic Processes**
 - *Stochastic Processes*, by Sheldon M. Ross (2nd Edition, Wiley 1996).
 - *Modeling and Analysis of Stochastic Systems*, by Vidyadhar G. Kulkarni (Chapman and Hall 1995).
 - *A First Course in Stochastic Processes*, by Samuel Karlin and Howard M. Taylor (2nd Edition, Academic Press 1975).
- **Queueing Theory**
 - *Introduction to Queueing Theory* by Robert B. Cooper (2nd Edition, North Holland 1981).
 - *Reversibility and Stochastic Networks* by Frank P. Kelly (Wiley 1979).
 - *Fundamentals of Queueing Theory* by Donald Gross and Carl M. Harris (3rd Edition, Wiley 1997).
 - *Queueing Methods: For Services and Manufacturing* by Randolph W. Hall (Prentice Hall, 1991).

Course Outline

I. Stochastic Processes Review (3-4 lectures)

- Poisson Processes
- Discrete Markov chains, transition probabilities
- Communication classes and class properties
- Recurrence and Transience
- Continuous-time Markov chains
- Birth and death processes

II. Classical Queueing Theory (11-13 lectures)

- Queueing models & nomenclature
- Little's Law
- The M/M/1 queue
- Birth and death queueing models, other Markovian models
- The PASTA property
- Reversibility in queueing networks
- Open and closed Jackson networks
- General routing schemes, Kelly networks
- The M/G/1 queue

III. The Modern Theory of Multiclass Queueing Networks (12-14 lectures)

- Open multiclass queueing network models & dynamics
- Service disciplines & dispatch rules
- Traffic equations
- FIFO, Priority, and Processor sharing networks
- Fluid networks and the fluid model equations
- Fluid approximations, fluid limits, the Functional Strong Law of Large Numbers
- Stability of queueing and fluid network, Dai's Theorem
- Stability analysis via Lyapunov functions
- Capacity analysis and efficient dispatching rules
- Stabilizing networks
- Networks with setup times, Kumar-Seidman policies, Jennings' heuristics.
- Optimally draining fluid networks, Weiss' algorithm.