Syllabus

Last updated: August 18, 2022

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Course description. This course provides an introduction to modeling and analyzing systems that evolve dynamically over time and whose behavior is stochastic, or uncertain. This course focuses on models that are amenable to mathematical analysis.

Course objectives. By the end of this course, students will be able to (1) think probabilistically about real-world systems; (2) identify when a Poisson process, Markov chain, or birth-death queueing process is an appropriate model for a real-world system and construct such a model; and (3) analyze these models by computing and interpreting state probabilities and performance measures.

Textbook. B. Nelson. *Stochastic Modeling: Analysis and Simulation*. Dover, 2010.

Schedule. Here is a tentative schedule.

Weeks	Topic	Reading	Homework
Introduction			
1	Course overview and logistics		
1	Sample paths	1, 2.1-2.3	
1-2	Probability review	3.1.1-3.1.3	3.1, 3.2, 3.3, 3.4, 3.5, 3.18abc, 3.19abc, 3.20abc
2-3	Conditional probability review	3.1.4-3.1.5	3.6, 3.7, 3.8, 3.9
3	Review		
4	**Exam 0**		
The Poisson process			
4-5	Introduction to stochastic processes and the Poisson process	5.1-5.5, 5.8.1-5.8.2	5.1, 5.3abcd, 5.5, 5.6, 5.8, 5.14
5-6	Decomposition and superposition of Poisson processes	5.6.1-5.6.2, 5.8.3-5.8.4	5.3ef, 5.10, 5.12, 5.13, 5.15, 5.17
7	Nonstationary Poisson processes	5.6.3, 5.8.5	5.20, 5.21
7	Computing – Poisson processes for fun and profit		
7	Review		
8	**Exam 1**		
Markov chains			
8-9	Introduction to Markov chains	6.1-6.4	6.4, 6.5 (transition diagram)
9	Time-dependent performance measures for Markov chains	6.5-6.6	6.7a, 6.17ab, 6.18
10	Time-independent performance measures for Markov chains	6.7	6.5 (transient / recurrent states), 6.6, 6.8, 6.11, 6.17c

(cont.)

Weeks	Topic	Reading	Homework
10-11	Markov chains – modeling and assumptions	6.8	6.20, 6.21, 6.27
11	Computing – Markov chains		
11-12	Review		
12	**Exam 2**		
Queueing processes			
13	A very brief introduction to Markov processes	8.2.2	7.5, 7.10
13-14	An introduction to queueing processes – the birth-death process	8.1-8.3, 8.4.1	8.4 (model as birth-death process), 8.6a
14-15	The birth-death process – performance measures	8.4.2, 8.5	8.4abc, 8.6bcd, 8.11
15	Standard queueing models	8.7	8.5, 8.8, 8.10
16	Computing – queueing systems		
16	Review		
16	Course wrap-up		