

**ISE/OR 560: Stochastic Models in Industrial Engineering
Fall 2024**

M/W: 11:45am – 1:00 pm

Location: 04134 Fitts-Woolard Hall

Hong Wan,

hwan4@ncsu.edu, 4325 Fitts-Woolard Hall.

Office hours: Wed, 1:30-3:30, or by appointment.

Textbook:

Introduction to modeling and analysis of stochastic systems V.G. Kulkarni. Kulkarni, Vidyadhar G. New York : Springer, c2011. 2nd ed. Accessible online for free at NC State University library. (required)

The Little Book of Probability (Related material will be on slides)

<https://www.amazon.com/Little-Book-Probability-Essentials-Stochastic/dp/1452882924>

Course Website: <http://moodle.wolfware.ncsu.edu/>

Course Description:

An introduction to mathematical modeling, analysis, solution, and simulation procedures applicable to uncertain (stochastic) service and production systems. Methodologies covered include probability theory and stochastic processes. Applications relate to the design and analysis of problems, capacity planning, inventory control, bottleneck and waiting time, and system reliability and maintainability. The course will be more methodology-oriented than theory-oriented, with significant computation/simulation components.

Course Objectives:

This course has four components:

I. Probability Tools:

II. Stochastic Modeling: characterizing uncertainty over time and space using:

A. Discrete Time Markov Processes: Markov Chains & Markov decision processes

B. Continuous Time Markov Processes: Birth & Death Processes, Poisson Processes, and

Queueing Theory

C. Probabilistic Inventory Models

III. Computational Analysis and Simulation of stochastic processes.

Upon completing this course, students will be able to use the tools of probability and stochastic processes to develop analytical and computational/simulation models to improve decision-making in an uncertain environment.

Probability Objectives:

Characterizing uncertainty using probabilities and random variables.

Identify and Apply probability distributions appropriately to various applications.

Understand probability distributions (unconditional and conditional) for single and multivariate random variables

Stochastic Modeling Objectives:

Define and characterize a stochastic process

Identify, define, and apply stochastic models, particularly, Markov chains (discrete and continuous), queueing models, and inventory models

Develop Stochastic Models for various real-world applications

Apply stochastic modeling theory to a real-world problem.

Computational Objectives:

Generate data based on various distributions.

Conduct computation to characterize stochastic models, particularly Markov chains (discrete and continuous) and queueing models

Conduct simulations of stochastic systems and decision models.

General Description:

Homework: assignments are due on *Fridays at 11:59 pm*; the assignment will be posted at least one week ahead.

Software: *there will be no software restriction. The instructor will demonstrate with Python or Matlab. You should select the one you are most familiar with to conduct the calculation and simulation.*

Project: Working in your homework groups, you will develop a stochastic model for a real-world problem and prepare a written project report and a short presentation. More details on the project will follow.

Grading

Homework and Exercises	25%
Project	25%
Midterm	20%
Final Exam (Take home)	30%
Total	100%

ISE/OR 560 “Living” Course Outline (Note that the due date and reading materials may be updated along the course):

Week	Class	Topic	Reading
1	Aug. 19	Course Introduction & What is a stochastic system & Probability Review I: Conditional Probability, Independence, Bayes Formula, Random Variables, Expectation, Variance, Distributions	Appendix
	Aug. 21	Probability Review I,	Appendix
2	Aug. 26	Probability Review I	Appendix
	Aug. 28	Probability I: Joint Distributions, Conditional Probability & Conditional Expectation	Appendix
	Aug 30	HOMEWORK 0: Due	
3	Sept 2	No Class	
	Sept 4	Probability II: Conditional Expectation & Moment Generating Functions	Appendix
	Sept 6	HOMEWORK 1: Due	
4	Sept 9	Probability II: Conditional Expectation & Moment Generating Functions	Appendix
	Sept 11	Probability II: Conditional Expectation & Moment Generating Functions, Introduction to Stochastic System	Appendix
5	Sept 16	Introduction to Stochastic System, Markov Chains	Ch1-2
	Sept. 18	Markov Chains	Ch2
	Sept 19	HOMEWORK 2: DUE	
6	Sept. 23	Markov Chains	Ch2
	Sept. 25	Markov Chains	Ch2
	Sept. 27	HOMEWORK 3: DUE	
7	Sept 30	Markov Chain	
	Oct 2	Poisson Process	Ch3
	Oct. 4	Homework 4 Due	
8	Oct 7	Poisson Process	
	Oct 12	Poisson Process	
	Oct. 14	HOMEWORK 5 DUE	

ISE/OR 560 “Living” Course Outline (cont.):

Week	Class	Topic	Reading
9	Oct.14	No class	
	Oct 16	Midterm Review	
10	Oct. 21	Midterm	
	Oct. 23	Flexible	
11	Oct 28	CTMC: Continuous-time Markov Chain I:	
	Oct 30	CTMC Continuous time Markov Chain	
	Nov. 1	HOMEWORK 6 DUE	
12	Nov. 4	CTMC: Continuous-time Markov Chain II:	
	Nov. 6	Queueing Theory I:	
	Nov. 8	HOMEWORK 7 DUE	
13	Nov. 11	Queueing Theory II	
	Nov. 13	Queueing Theory III	
	Nov. 15	HOMEWORK 8 Due	
14	Nov. 18	Project Presentation	
	Nov. 20	Project Presentation	
15	Nov. 25	Final Review	
	Dec 2	Final Review	
16	Dec. 5		

Academic Integrity

Students are required to comply with the university policy on academic integrity found in the Code of Student Conduct found at

http://www.ncsu.edu/policies/student_services/student_discipline/POL11.35.1.php

Academic Honesty

See http://www.ncsu.edu/policies/student_services/student_discipline/POL11.35.1.php for a detailed explanation of academic honesty.

Attendance Policy

Absences will be excused if approved in advance. Please refer to the university attendance regulation for a list of excused absences: <http://policies.ncsu.edu/regulation/reg-02-20-03>.

Students will be allowed to make up work missed due to an excused absence within a reasonable amount of time as determined by the instructor.

Late Assignments

No late assignments will be accepted.

Accommodations for Disabilities

Reasonable accommodations will be made for students with verifiable disabilities. To take advantage of available accommodations, students must register with the Disability Services Office (<http://www.ncsu.edu/dso>) located at 1900 Student Health Center, Campus Box 7509, 919-515-7653. For more information on NC State's policy on working with students with disabilities, please see the Academic Accommodations for Students with Disabilities Regulation at http://www.ncsu.edu/policies/academic_affairs/courses_undergrad/REG02.20.1.php.

NC State University Policies, Regulations and Rules (PRR):

Students are responsible for reviewing the PRRs which pertain to their course rights and responsibilities. These include: <http://policies.ncsu.edu/policy/pol-04-25-05> (Equal Opportunity and Non-Discrimination Policy Statement), <http://oied.ncsu.edu/oied/policies.php> (Office for Institutional Equity and Diversity), <http://policies.ncsu.edu/policy/pol-11-35-01> (Code of Student Conduct), and <http://policies.ncsu.edu/regulation/reg-02-50-03> (Grades and Grade Point Average).

Transportation

NA

Safety & Risk Assumptions

None