

## ODA 75100: Stochastic Modeling: Fundamentals

<b>Semester</b>	Fall 2025
<b>Class Days/Times</b>	Wed 1:00 PM – 4:00 PM
<b>Classroom</b>	NVC 9-215
<b>Department</b>	Narendra Paul Loomba Department of Management
<b>Instructor</b>	Yuan-Mao Kao
<b>Email</b>	<a href="mailto:yuan-mao.kao@baruch.cuny.edu">yuan-mao.kao@baruch.cuny.edu</a>
<b>Office</b>	NVC 9-253
<b>Office Hours</b>	By appointment

### Course Description

The course introduces the fundamental knowledge in probability models, stochastic processes, and their applications. Fundamental concepts include discrete and continuous distributions, transforms, stochastic orders, counting processes, discrete- and continuous-time Markov chains, and queueing theory. Applications in operations management include inspection and reward problems, queueing networks, and optimization in queueing. Applications in other fields include pricing and analysis of financial assets, insurance policies, and warranties. In addition to mathematical analysis, students will analyze stochastic models numerically using appropriate software.

### Prerequisites

1. ECON 72500 or equivalent (mathematical analysis and linear algebra).
2. Knowledge of probability and statistics
3. A high-level programming language (e.g., C, C++, C#, VB, Python, MATLAB, ...)

### Learning Goals:

1. Students will know the mathematical foundations of stochastic modeling and its applications, as well as state and prove relevant theoretical results.
2. Students will formulate and analyze stochastic models to represent business phenomena in relevant manufacturing and service settings and distinguish stochastic optimization applications at the interface of decision analytics and other disciplines.
3. Students will apply stochastic modeling fundamentals, discrete- and continuous-time Markov chains, Poisson processes, queueing theory and its applications, renewal theory, and simulation basics, and will correctly identify the settings wherein a specific stochastic modeling methodology should be used.
4. Students will employ widely used stochastic modeling methods and develop computer code to formulate, solve, and manipulate stochastic optimization models.

## Course Materials

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- *Introduction to Probability Models* by S. M. Ross, Academic Press, 12<sup>th</sup> Edition, 2019 (ISBN: 0128143460 / 978-0128143469).
  - The 12<sup>th</sup> or any newer editions are suggested.
  - The older versions should be fine but lack coupling (Chapter 12).
- Lecture notes on Brightspace

## Optional Textbooks

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- *Adventure in Stochastic Processes* by S. Resnick, Birkhauser, 1<sup>st</sup> Edition, 1992.
- *A Second Course in Probability* by S. M. Ross and E. A. Peköz, Cambridge University Press, 2<sup>nd</sup> Edition, 2023.
- *Stochastic Processes* by S. M. Ross, Wiley, 2<sup>nd</sup> Edition, 1996.
- *Comparison Methods for Stochastic Models and Risks* by A. Muller and D. Stoyan, Wiley, 1<sup>st</sup> Edition, 2002.

## Grading Policy and Course Requirements

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The course requirements are weighted as follows:

Components	Weights
Individual Assignments (problem sets and brief coding projects)	40%
Class Participation	10%
Midterm Exam (In-class)	25%
Final Exam (In-class)	25%
<b>TOTAL GRADE POINTS</b>	<b>100%</b>

**Individual Assignments:** There will be several problem sets and brief coding projects in this course. The problem sets may ask for calculation or theoretical proof. Therefore, students must be familiar with at least one programming language and mathematical proof.

**Class participation:** Students should participate in class discussions and will be asked to present a result to the class on the whiteboard.

**Midterm and Final Exams:** Exams will be in class with an open-book format.

## Academic Integrity

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Learning involves the pursuit of truth, which cannot be pursued by presenting someone else's work as your own. Our goal is to help you become an excellent professional candidate. Therefore, cheating and plagiarism are serious offenses. The following definitions are based on the College's Academic Honesty website at [http://www.baruch.cuny.edu/academic/academic\\_honesty.html](http://www.baruch.cuny.edu/academic/academic_honesty.html)

## Students with Disabilities

Students with disabilities may be eligible for a reasonable accommodation to enable them to participate fully in courses at Baruch. If you feel you may be in need of accommodation, please contact the staff at the Office of Services for Students with Disabilities, Newman Vertical Campus, Room 2-271, in person or by phone at (646) 312-4590.

For more information, see

<http://www.baruch.cuny.edu/studentaffairs/ossd/disabilityServices.htm>.

## Tentative Course Schedule and Topics

Date	Class Topic	References
09/03/2025	Probability Theory: Random Variables, Generating Functions, Conditional Probability and Expectation	Ch 2 & 3
09/10/2025	Stochastic Orders and Coupling	Ch 12
09/17/2025	Discrete-Time Markov Chain (DTMC)	Ch 4
10/08/2025	Applications of DTMC and Markov Decision Process	Ch 4 Supplement
10/15/2025	Exponential Distribution & Poisson Process	Ch 5
10/22/2025	Midterm Exam	
11/05/2025	Continuous-Time Markov Chain (CTMC)	Ch 6
11/12/2025	Uniformization and Applications of CTMC	Ch 6 Supplement
11/19/2025 11/26/2025	Renewal Theory and Renewal Reward Processes	Ch 7
12/03/2025	Queueing Theory and Applications	Ch 8
12/10/2025	Brownian Motion & Simulation	Ch 10 & 11
12/17/2025	Final Exam (Tentative)	

\* No classes on:

- 08/27 (The class will be rescheduled due to a schedule conflict with the ECON 72500 for the first-year PhD student)
- 09/24 (No classes scheduled)
- 10/01 (No classes scheduled)
- 10/29 (INFORMS Annual Meeting)

## **Academic Expectations**

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In the spirit of a collegial academic research environment, when working on coursework, you are allowed and encouraged to work with other students and with the instructor, and to consult textbooks and literature. However, **all submitted or presented work (whether in paper format, presentation format, or in the form of computer code) must be produced by you and represent your ideas, except where proper attribution is given.**

You are encouraged to incorporate the ideas of others in your work. However, these must be cited or attributed.

You must abide by the CUNY Graduate Center Policy on Academic Honesty and the CUNY Policy on Academic Integrity. Any case of academic dishonesty will be dealt with according to the policies of the Graduate Center and CUNY, which state in part: “Any student who has submitted a paper, examination, project, or other academic work in part or in full not his or her own without appropriate attribution is subject to disciplinary charges. Such charges may result in the imposition of a grade of “F” or other penalties and sanctions, including suspension and termination of matriculation.” You are responsible for obtaining, reading, and understanding these policies.

## **APPENDIX: Doctoral Program Learning Goals**

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### **Goal 1: Comprehensive and Intensive Disciplinary Knowledge**

Students who earn a doctorate degree in business will be able to demonstrate a comprehensive and intensive knowledge of the theories, concepts, frameworks, empirical findings, and controversies in a chosen business discipline.

### **Goal 2: Comprehensive and Intensive Knowledge of Research Methods**

Students who earn a doctorate degree in business will be able to demonstrate a comprehensive and intensive knowledge of the research methods and analytical techniques applicable to a chosen business discipline.

### **Goal 3: Communication of Disciplinary Research**

Students who earn a doctorate degree in business will be able to design, conduct, and communicate – in both written and oral formats – original research that makes a substantial contribution to a selected business discipline.

### **Goal 4: Evaluations of Disciplinary Research**

Students who earn a doctorate degree in business will be able to evaluate research ideas and complete research projects critically, assessing their conceptual and methodological soundness and the importance of their contribution to existing knowledge in the field.

### **Goal 5: Teaching**

Students who earn a doctorate degree in business will be able to teach effectively in a selected discipline at the university level.