Soochow University

STA 409 Advanced Probability, Stochastic Processes,

and Advanced Probabilistic Models

Winter 2024

Course Credits: 4
Contact Hours: 56 hours
Instructor: TBA
Email: TBA

COURSE OBJECTIVES

This advanced course delves deep into the intricacies of probability theory, focusing on the construction of complex probabilistic models and their applications in cutting-edge scientific domains. Emphasizing stochastic processes, including advanced topics in Martingale theory, this course challenges high-level university students to explore the nuances of uncertainty in diverse contexts. Students will tackle sophisticated mathematical concepts, conduct rigorous analyses, and engage in intensive problem-solving exercises, preparing them for advanced research and real-world applications.

Upon Completion of this Course, students will be able to:

1. Develop intricate probabilistic models for multifaceted applications, showcasing creativity and depth in their designs;

2. Critically analyze and synthesize advanced probability theories, including intricate concepts within Stochastic Processes and Martingale theory;

3. Apply advanced mathematical techniques with precision, particularly in complex Data Science, Machine Learning, Mathematical Finance, and Mathematical Biology scenarios;

4. Foster comprehension of advanced probability principles and analytical methodologies, encompassing Stochastic Processes and Martingale theory;

5. Master high-level problem-solving strategies, demonstrating adaptability in approaching novel and challenging probabilistic problems.

PREREQUISITES

STA 310 Probability and Stochastic Processes

GRADING

Grades will be determined by accumulating points, with 100 points being the maximum, as follows:

ITEM	POINTS
2 Research Papers	30 Points
2 Projects	20 Points
2 Exercise	10 Points
Midterm Test	20 Points
Final Exam	20 Points
Total	100 Points

Late submissions will be graded at the end of the course. Grades will be assigned according to the following rule:

A ≥ 90 > B ≥ 80 > C ≥ 70 > D ≥ 60 > F.

We reserve the right to make adjustments to the overall grading policy.

COURSE MATERIALS

Required Texts:

1. J. Durrett, ***Advanced Probability and Stochastic Processes***, 1st Edition, Cambridge University Press, 2016.

2. Steven Shreve, ***Stochastic Calculus for Finance II: Continuous-Time Models***, 1st Edition, Springer, 2004.

3. Sheldon Ross, ***Stochastic Processes***, 2nd Edition, Wiley, 2008.

Recommended (Optional) Texts or Other Materials:

Michael Kouritzin, ***Step by Step Probability,*** Volume 1.

COURSE TOPICS

Soochow University

MODULE	TASKS
Module 1	**Topics:** Topic 1: Advanced Probability Concepts and Probabilistic Models Topic 2: Measure theory and probability spaces Topic 3: Advanced random variables and distributions Topic 4: Multivariate probability distributions **Assessments:** Research Paper#1
Module 2	**Topics:** Topic 5: Non-standard probabilistic models and applications Topic 6: Stochastic Processes: Theory and Applications Topic 7: Renewal processes and regenerative phenomena Topic 8: Continuous-time Markov chains and applications **Assessments:** Research Paper#2 Exercise#1
Module 3	**Topics:** Topic 9: Diffusion processes and stochastic calculus Topic 10: Advanced applications in finance, biology, and physics Topic 11: Martingales and Complex Stochastic Models Topic 12: Martingale convergence theorems and applications **Assessments:** Project#1 Midterm Test
Module 4	**Topics:** Topic 13: Martingale representation theorems Topic 14: Stochastic differential equations and their solutions Topic 15: Advanced Topics in Probability and Research Seminar Topic 16: Limit theorems: Weak and strong convergence **Assessments:** Exercise#2
Module 5	**Topics:** Topic 17: Large deviations theory and applications Topic 18: Student-led research seminar Topic 19: Comprehensive Projects and Advanced Problem-Solving Topic 20: Real-world applications and theoretical analyses In-depth problem-solving sessions **Assessments:** Project#2 Final Exam

ATTENDANCE

1) Class attendance is required. Missing classes without permission will lead to decrease in overall grade.

Missing less than two classes: no penalty.

Missing more than two classes: 7% will be taken off from the overall grade.

If the instructor reports a student's frequent missing of class to the Soochow University Academic Administration Office, the student might get a written warning and might be prohibited from attending final exam.

2) Participants in this course are expected to arrive in class promptly and adequately prepared. The primary objective of this course is to critically engage with the readings and the subject matter. Therefore, course participants are expected to have completed the reading prior to class and prepare thoughtful reflections/commentaries to share with fellow colleagues.

LEARNING REQUIREMENTS

1) Late assignments are not acceptable and are subjected to grade deductions.

2) Assignments submitted in the wrong format will be counted as not submitted.

3) Failure to submit or fulfill any required course component results in failure of the class.

4) Make-up for midterm and final exams only with valid excuses, as defined by the University.

5) In order to earn a Certificate of Completion, participants must thoughtfully complete all assignments by stated deadlines and earn an average quiz score of 50% or greater.

TECHNOLOGY POLICY

The use of electronic devices in class is distracting, both for the user and for the rest of the class. Only non-programmable calculators can be used in the tests and exam. Any attempts to use cell phones and other electronic communication devices will be seemed as cheating. Laptops are discouraged, unless you use them for activities DIRECTLY related to the course (eg., note taking, reading course documents).

ACEDEMIC INTEGRITY POLICY

Soochow University highly values the academic integrity and aims to promote the academic fairness, honesty and responsibility. Any academic dishonesty behaviors and any attempts to cheats and plagiarism will be reported to the university administration office. A written warning and the relevant penalties will be imposed. The record might be shown on the official university transcript.

DISABILITY ACCOMMODATION

Soochow University is committed to maintaining a barrier-free environment so that students with disabilities can fully access programs, courses, services, and activities at Soochow University. Students with disabilities who require accommodations for access to and/or participation in this course are welcome.

Note:

Please contact the University Administrative Office immediately if you have a learning disability, a medical issue, or any other type of problem that prevents professors from seeing you have learned the course material.