MATH 666: Simulation for Stochastic Systems
Spring 2024 Course Syllabus

NJIT Academic Integrity Code: All Students should be aware that the Department of Mathematical Sciences takes the University Code on Academic Integrity at NJIT very seriously and enforces it strictly. This means that there must not be any forms of plagiarism, i.e., copying of homework, class projects, or lab assignments, or any form of cheating in quizzes and exams. Under the University Code on Academic Integrity, students are obligated to report any such activities to the Instructor.

COURSE INFORMATION

Course Description: Covers the use of Monte Carlo stochastic simulation for data science, finance, and other applications. Topics include generation of various random variables and stochastic processes (e.g., point processes, Brownian motion, diffusions), simulation methods for estimating quantities of interest (e.g., probabilities, expected values, quantiles), input modeling, and variance-reduction techniques. Simulation programming assignments will be included. Students cannot receive credit for both CS 661 and CS 666/MATH 666.

Number of Credits: 3

Prerequisites: Prior coursework in probability/stochastic processes, linear algebra, and differential equations; ability to write computer programs. Students cannot receive credit for both CS 661 and CS 666/MATH 666.

Course-Section and Instructors:

Course-Section	Instructor
Math 666-102	Professor S. Subramanian

Office Hours for All Math Instructors: Spring 2024 Office Hours and Emails

Required Textbook:

Title	*Monte Carlo Methods in Financial Engineering*
Author	Paul Glasserman
Edition	1st
Publisher	978-1-4419-1822-2
ISBN #	Springer

University-wide Withdrawal Date: The last day to withdraw with a **W** is **Monday, April 1, 2024**. It will be

strictly enforced.

COURSE GOALS

Student Learning Outcomes: On successful completion, students will be able to demonstrate understanding of the following topics:

- Simulation of random variables
- Simulation of stochastic processes
- Discretization of stochastic differential equations
- Variance reduction techniques

Assessment: Will be based on regular homework, one midterm exam, and one final exam.

POLICIES

DMS Course Policies: All DMS students must familiarize themselves with, and adhere to, the Department of Mathematical Sciences Course Policies, in addition to official university-wide policies. DMS takes these policies very seriously and enforces them strictly.

Grading Policy: The final grade in this course will be determined as follows:

Homework	30%
Midterm Exam	40%
Final Exam	30%

Your final letter grade will be based on the following tentative curve.

A	90 - 100	**C +**	75 - 79
B+	85 - 89	**C**	66 - 74
B	80 - 84	**F**	0 - 65

Attendance Policy: Attendance at all classes will be recorded and is **mandatory**. Please make sure you read and fully understand the Math Department's Attendance Policy.

Homework: Homework assignments are due within a week unless announced otherwise by the instructor. Late homework will not be accepted.

Exams: One in-class midterm examination and one final examination will be given as shown below. The indicated midterm exam date is tentative and may be subject to change.

Midterm Exam	
Final Exam Period	May 3 - May 9, 2024

The final exam will test your knowledge of all the course material taught in the entire course. Make sure you read and fully understand the Math Department's Examination Policy. This policy will be strictly enforced.

Makeup Exam Policy: There will be **NO MAKE-UP QUIZZES OR EXAMS** during the semester. In the event an exam is not taken under rare circumstances where the student has a legitimate reason for missing the exam, the student should contact the Dean of Students office and present written verifiable proof of the reason for missing the exam, e.g., a doctor's note, police report, court notice, etc. clearly stating the date AND time of the mitigating problem. The student must also notify the Math Department Office/Instructor that the exam will be missed.

Cellular Phones: All cellular phones and other electronic devices must be switched off during all class times.

ADDITIONAL RESOURCES

Further Assistance: For further questions, students should contact their instructor. All instructors have regular office hours during the week. These office hours are listed on the Math Department's webpage for Instructor Office Hours and Emails.

Accommodation of Disabilities: The Office of Accessibility Resources and Services (OARS) offers long term and temporary accommodations for undergraduate, graduate and visiting students at NJIT.

If you are in need of accommodations due to a disability please If you need an accommodation due to a disability please contact the Office of Accessibility Resources and Services at oars@njit.edu. The office is located in Kupfrian Hall, Room 201. A Letter of Accommodation Eligibility from the Office of Accessibility Resources and Services office authorizing your accommodations will be required.

For further information regarding self identification, the submission of medical documentation and additional support services provided please visit the Office of Accessibility Resources and Services (OARS) website at:

https://www.njit.edu/accessibility/

Important Dates (See: Spring 2024 Academic Calendar, Registrar)

Date	Day	Event
January 16, 2024	Tuesday	First Day of Classes
January 22, 2024	Monday	Last Day to Add/Drop Classes
March 10, 2024	Sunday	Spring Recess Begins
March 16, 2024	Saturday	Spring Recess Ends
March 29, 2024	Friday	Good Friday - No Classes
April 1, 2024	Monday	Last Day to Withdraw
April 30, 2024	Tuesday	Friday Classes Meet
April 30, 2024	Tuesday	Last Day of Classes
May 1, 2024	Wednesday	Reading Day 1
May 2, 2024	Thursday	Reading Day 2
May 3 - May 9, 2024	Friday to Thursday	Final Exam Period

Course Outline

Week	Section	Topic
Week 1		First lecture on 1/22 only as classes start on a Tuesday
Week 2 1/22	Chapter 2	**Generating random variables** General sampling methods; Normal random variables and vectors
Week 3 1/29	Chapter 2	**Generating random variables** General sampling methods; Normal random variables and vectors
Week 4 2/5	Chapters 2 & 3	**Generating random variables** General sampling methods; Normal random variables and vectors **Generating sample paths** Brownian motion
Week 5 2/12	Chapter 3	**Generating sample paths** Brownian motion; Geometric Brownian motion
Week 6 2/19	Chapter 3	**Generating sample paths** Geometric Brownian motion; Ito integral
Week 7 2/26	Chapter 3	**Generating sample paths** Ito integral; Gaussian short rate models; Square-Root diffusions; Processes with jumps
Week 8 3/4	Chapter 3	**Generating sample paths** Square-Root diffusions; Processes with jumps
3/10 to 3/16		**Spring recess (No classes)**

Week 9 3/18	Chapter 4	**Variance reduction techniques** Control variates; Antithetic Variates
Week 10 3/25	Chapter 4	**Variance reduction techniques** Antithetic Variates **Review of topics**
Week 11 4/1	**MIDTERM EXAM: Monday, April 3, 2023**	
Week 12 4/8	Chapter 4	**Variance reduction techniques** Stratified sampling
Week 13 4/15	Chapter 4	**Variance reduction techniques** Latin hypercube sampling; Importance sampling
Week 14 4/22	Chapter 6	**Discretization methods** Euler scheme; second-order methods
Week 15 4/29	Chapter 6	**Discretization methods** Jump-diffusion processes; Brownian interpolation; changing variables
5/3 - 5/9		**Final EXAM WEEK**