

Math 114/214: Introduction to computational stochastics

Instructor: Vishal Patil

Email: vipatil@ucsd.edu

Office: APM 6341

Winter 2026

Time: MWF 12:00pm - 12:50pm

Place: Warren Lecture Hall

Course page: <https://canvas.ucsd.edu/courses/72720>

Outline: Stochastic models are vital for modeling real-world systems. This class will introduce computational methods for stochastic processes. Topics include sampling theory, Markov chain Monte Carlo, and stochastic differential equations, from an applied perspective. The focus is on computational methods, including both numerical simulations and analytical techniques. Applications will be drawn from a range of systems including biology and physics. The course is co-listed as Math 114 (for undergraduate students) and Math 214 (for graduate students). A course project is part of Math 214.

Prerequisites: The prerequisite for Math 114 is Math 180A. In addition, students are strongly recommended to have completed a computer programming course before enrolling in Math 114. Examples of such a course include: CSE 5A, CSE 8A, CSE 11, or ECE 15.

TA and discussion sections: The TA for the class is Zihan Shao (Office: HSS 5067, Email: z6shao@ucsd.edu). There will be two discussion sessions (starting week 2)

- Thursdays 12:00pm - 12:50pm, in HSS 4025
- Thursdays 1:00pm - 1:50pm, in HSS 4025

Office hours: I will hold office hours on Mondays 10:00am - 11:00am and Fridays 2:00pm-3:00pm (APM 6341). The TA will also hold two hours of office hours a week (see Canvas announcements for schedule).

Homeworks: Homework is assigned, collected, and partially graded regularly. For computationally oriented homeworks, Matlab / Python are preferred. Gradescope will be used to collect and grade homework and exams.

Exams and Projects:

- **Math 114:** There will be one 50-minute midterm (in-class) and one 3-hour final exam. Both exams will be closed-book and closed-note exams. The final exam will be cumulative.
 - Midterm Exam: 12:00 pm - 12:50 pm, Wednesday, Feb 11, 2026, Warren Lecture Hall (same time and place as lectures).
 - Final Exam: 11:30 am - 2:29 pm, Wednesday, March 18, 2026 (Warren Lecture Hall).
- **Math 214:** There will be a 50-minute, closed-book and closed-note, midterm exam (in-class) and a final course project.
 - Midterm Exam: 12:00 pm - 12:50 pm, Wednesday, Feb 11, 2026, Warren Lecture Hall (same time and place as lectures).
 - The final course project is due 11:59 pm, Wednesday, March 18, 2025.

Grading policy:

- **Math 114:** The final course grade will be determined based on the homework (30%, lowest homework dropped), midterm exam (30%), and final exam (40%). The final course grade will be curved within Math 114.
- **Math 214:** The final course grade will be determined based on the homework (25%, lowest homework dropped), midterm exam (25%), and final course project (50%). The final course grade will be curved within Math 214.

Course plan:

- **Sampling:** Transformation, acceptance - rejection, Monte Carlo integration, variance reduction, importance sampling.
- **Markov Chain Monte Carlo (MCMC):** Basics of Markov chains, Metropolis-Hastings algorithm, Simulated annealing.
- **Stochastic differential equations (SDE):** Introduction to Brownian motion and white noise, Ito's lemma, methods for solving SDEs, Euler-Maruyama and Milstein's method, Kolmogorov forward and backward equations, applications to PDEs.

Course resources: The following books are good companions for the class (UCSD has access to both eBooks)

- R. Y. Rubinstein and D. P. Kroese, *Simulation and the Monte Carlo Method*, 3rd ed., John Wiley & Sons, 2017.
- M. Holmes-Cerfon, *Applied Stochastic Analysis*. Vol. 33. American Mathematical Society, Courant Institute of Mathematical Sciences at New York University, 2024.

Here is a list of additional reference books; UCSD has the electronic access to many of these books.

- G. R. Grimmett and D. R. Stirzaker, *Probability and Random Processes*, Oxford University Press, 3rd ed., 2001.
- G. F. Lawler, *Introduction to Stochastic Processes*, 2nd ed., Chapman & Hall/CRC, 2006.
- M. A. Pinsky and S. Karlin, *An Introduction to Stochastic Modeling*, 4th ed., Academic Press, 2010. (UCSD has access to the ebook.)
- S. Asmussen and P. W. Glynn, *Stochastic Simulation*, Springer, 2007. (UCSD has access to the ebook.)
- D. P. Kroese, T. Taimre, and Z. I. Botev, *Handbook of Monte Carlo Methods*, John Wiley & Sons, 2011. (UCSD has access to the ebook.)
- J. S. Liu, *Monte Carlo Strategies in Scientific Computing*, Springer, 2004. (UCSD has access to the ebook.)

- C. P. Robert and G. Casella, Monte Carlo Statistical Methods, 2nd ed., Springer, 2004. (UCSD has access to the ebook.)
- N. Madras, Lectures on Monte Carlo Methods, Amer. Math. Soc., 2002.
- C. Graham and D. Talay, Stochastic Simulation and Monte Carlo Methods, Springer, 2013. (UCSD has access to the ebook.)
- P. E. Kloeden and E. Platen, Numerical Solution of Stochastic Differential Equations, Springer, 1992. (UCSD has access to the ebook.)

Accommodations: Students requesting accommodations for this course due to a disability must provide a current Authorization for Accommodation (AFA) letter issued by the Office for Students with Disabilities: <https://osd.ucsd.edu>. Students are required to discuss accommodation arrangements with instructors and OSD liaisons in the department in advance of any exams or assignments.

Academic integrity: All students are expected to conduct themselves with academic integrity. Violations of academic integrity will be treated seriously. Please see <https://academicintegrity.ucsd.edu>.