Course Syllabus
Stochastic Processes and Modeling (MATH6660)

Instructor: F. M. Faulstich (faulsf@rpi.edu), Office: Amos Eaton 406
Office hours: Tuesday/Friday, 4-5 p.m.

Class webpage: https://fabianfaulstich.github.io/MATH6660_2026/
RPI LMS page: https://lms.rpi.edu/ultra/institution-page
Piazza webpage: https://piazza.com/rpi/spring2026/math6660
access code: 220o5fnu4mk
Gradescope webpage: https://www.gradescope.com/courses/1224265
access code: 4DDJV4

Course Content & Goals:
This course provides a rigorous treatment of the fundamental theory and modeling principles of stochastic processes, with emphasis on methods that are both mathematically sound and practically effective. Topics include discrete-time processes and martingales, continuous-time processes and filtrations, Brownian motion, stochastic integration and Itô calculus, stochastic differential equations, and core measure-change and representation results (Girsanov transformation and martingale representation). The course culminates in applications to mathematical finance, including the Black–Scholes market model, risk-neutral pricing, numerical pricing methods, and an introduction to portfolio/trading optimization, highlighting computational paradigms that can provide advantages for large-scale simulation and optimization problems.

Designed as a culminating graduate course in probability theory (typically the second or third course in a four-course sequence, and in some cases within a five-course sequence), this class builds on core preparation in analysis and applied mathematics. Prerequisites include Multivariable Calculus and Matrix Algebra (MATH 2010), Introduction to Differential Equations (MATH 2400), Introduction to Topology (MATH 4040), Foundation of Analysis (MATH 4090), Mathematical Analysis I–II (MATH 4200/4210), Ordinary Differential Equations and Dynamical Systems (MATH 4400), Advanced Calculus (MATH 4600), Real Analysis (MATH 6200), Probability Theory and Applications (MATH 4600), and Measure Theory. The course is intended to synthesize these foundations into a unified framework for modern stochastic modeling, with a pathway toward stochastic calculus, stochastic differential equations, and applications in mathematical finance and computation.

Students completing this course will be well-equipped to formulate, analyze, and simulate stochastic models that arise in finance, engineering, physics, and data science. They will be able to work fluently with discrete- and continuous-time stochastic processes, apply martingale methods, analyze Brownian motion, and use stochastic integration and Itô calculus to derive and solve stochastic differential equations. Students will also be able to apply measure-change techniques (Girsanov) and martingale representation to obtain risk-neutral pricing formulas, derive the Black–Scholes model, and implement numerical pricing methods (e.g., Monte Carlo–type approaches) together with basic portfolio/trading optimization workflows, with awareness of where emerging quantum computational approaches may offer advantages for large-scale simulation and optimization.

In Lieu of Textbooks

The course content will consist of selected chapters from the following resources:

1. *Measure Theory* — Donald L. Cohn
2. *Probability with Martingales* — David Williams
3. *Stochastic Differential Equations: An Introduction with Applications* — Bernt Øksendal
4. *Stochastic Calculus and Applications* (Probability and Its Applications) — Samuel N. Cohen and Robert J. Elliott

Logistical structure of the class:

- **Piazza**: Piazza will be the main forum for all communication outside of classroom and office hours, and this will include the announcements.
- **Questions in Addition to Office Hours**: If it is not class time or office hour and you want an answer more or less right away, please ask the question on Piazza. You can use the "private question" mode on Piazza if necessary. In case of an emergency (that does not include homework questions), we may be able to set up a WebEx appointment in my personal room.
- **Homework**: A few problems will be assigned and graded on a mostly weekly basis. This will be the only means of assessment of your work, so you should put a real effort into it. I encourage collaboration on the homework. However, copying is forbidden. In other words, you can exchange ideas as much as you want, but, in the end, you must write your work up on your own without looking at anybody else's work. Copying off the internet is also forbidden as is using AI helpers such as ChatGPT.
- **Gradescope**: Please submit your homework through Gradescope. You should submit a typeset .pdf file. Place different problems on different (sets of) pages, and connect the pages to the corresponding problems in Gradescope. Please submit the homework on time. Late homework will not be accepted.

Student Commitment and Expectations:

As a graduate-level course, students are expected to engage actively with the material both inside and outside the classroom. Mastery of the concepts requires independent study beyond the lectures, including reviewing references, experimenting with algorithms, and exploring connections to the students' research interests.

Homework assignments are designed to guide and support this process, but they represent only a portion of the necessary practice. To fully benefit from the course, students should plan to dedicate significant time outside of class each week to reading, problem solving, and programming exercises.

Ultimately, the student's success in this course will depend not only on participation during lectures but also on a sustained, self-directed effort to deepen the individual understanding of the subject.

Academic Integrity:

Copying the homework from anybody or anywhere is forbidden. This includes fellow students, the internet, recycled solutions from previous versions of the class, or ChatGPT. Violating this policy will result in a score of zero for the entire assignment and a referral to the dean of students. Penalties for repeat offenses can be quite harsh; you should check the

Academic Integrity Policy page provided by the Dean of Students Office for more information about this: https://info.rpi.edu/dean-students/05/29/2020/notice-student-rights-and-responsibilities

Grade Appeals:

All appeals must be made within one week of the date when the item was returned to the class. You can do this through a regrade request on Gradescope.

Disability Services:

Rensselaer Polytechnic Institute is committed to providing equal access to our educational programs and services for students with disabilities. If you anticipate or experience academic barriers due to a disability, please get in touch with the Office of Disability Services for Students (DSS) (dss@rpi.edu; 518-276-8197) to establish reasonable accommodations. Once you have been approved for accommodations, please provide me your Faculty Memorandum (a letter provided to students by DSS).