

ACT460 — Stochastic Methods for Actuarial Science and Finance
University of Toronto, Department of Statistical Sciences
Fall 2024

Instructor: Emma Kroell (emma.kroell@mail.utoronto.ca)

Lectures:

Tuesday 2:00 PM - 4:00 PM

Thursday 3:00 PM - 4:00 PM

Office hours: TBA

Teaching Assistant: Hassan Abdelrahman

Course Overview

Course description: This course introduces students to the mathematical theory, probabilistic tools, and computational approaches for continuous-time modelling in actuarial science and financial engineering. Topics include continuous-time stochastic processes, martingales, Brownian motion, Itô's Lemma and stochastic calculus, Monte-Carlo methods, variance reduction techniques, and applications related to actuarial science and financial engineering. Prerequisites to this course are ACT350 or STA347 (or their equivalent). ACT370 is strongly recommended. In addition, you should be comfortable with probability theory and coding in Python.

Textbooks: The course is based on the following textbooks, which cover the theory (first book) and numerical methods (second book) we will see in the course. *Assessments will be based on the material presented in class.* You are encouraged to consult the books for additional details.

- *Arbitrage Theory in Continuous Time*, Tomas Björk, 4th edition. Available through the library [here](#).
- *Monte Carlo Methods in Financial Engineering*, Paul Glasserman. Available through the library [here](#).

Course communication: Students are expected to check Quercus regularly to stay up to date with the course. Having Quercus announcements delivered immediately to you via email is recommended.

Students are strongly encouraged to attend office hours to discuss questions and practice problems in detail with the instructor.

Questions about the course material and assessments may be posted to Piazza. Before you post a question, please, make sure that you are not asking for information that is already on the course outline/Quercus/Piazza, nor asking questions about the course material that are more appropriately discussed during office hours. You should expect a response to your question in 1-2 business days.

For personal matters only, such as a missed quiz or test due to illness, please email the instructor directly using your University of Toronto email address. The email subject line should contain the course number "ACT460" and a relevant subject (indicating what the email is about). Be sure to include your full name in the body of the message.

Course resources:

- Practice problems will be posted on Quercus every week along with sketches of the solutions. You are encouraged to work through the problems before consulting the solutions.
- Lecture notes will be posted on Quercus following every lecture for students who prefer not to take notes or have to miss a lecture. Please note that these notes do not replace in-person lecture attendance, as they miss verbal comments given by the instructor.
- Code, slides, and other visual aids used in class will be posted on Quercus.

Course evaluation: Your final grade will be based on the following assessments:

| Assessment | Weight | Details |
|---------------|-----------------------------------|-------------------------------|
| Quizzes | 15%: 5% each (lowest dropped) | 4 quizzes through Quercus |
| Tests | 50%: 25% each | In class, Oct 1 and Nov 12 |
| Final project | 35%: 10% presentation, 25% report | Group project – details below |

Assessments

Quizzes: Four quizzes will be given through Quercus during the term. The quizzes will be available from Tuesday at 5pm to Thursday at 1pm (between the Tuesday and Thursday lectures). **You will have 45 minutes to complete the quiz once you begin, and you must complete the quiz individually.** There will be quizzes in week 2 (Sept 10–12), week 4 (Sept 24–26), week 7 (Oct 15–17), and week 9 (Nov 5–7) of the course. The lowest quiz grade will be dropped from your final mark, meaning the best three quiz grades will each be worth 5% of your final mark.

Term Tests: Term tests will be held on October 1st and November 12th, during the regular Tuesday lecture time. The tests will be held in-person and will be 100 minutes (1h40min) in length. The second test will focus on material taught after the first test, but as the material builds on itself, content from the first test will still be testable.

Final Project: The final project will be a group project with an oral presentation component, worth 10%, and a written submission with accompanying code, worth 25%. More details on the project will be presented midway through the term. Presentations will take place in the last week of class, on **November 26 and 28**. The final project, including a written report and reproducible code, will be **due on Wednesday, December 4th**, before the exam period begins.

Tentative course schedule

Below is a schedule of course topics and assessments for the term. The schedule is tentative and may be adjusted as the term progresses.

| Week | Date | Tuesday | Thursday | Deliverables |
|------|------------------|--------------------------|-------------------------|---------------|
| 1 | Sept 2 to 8 | Discrete time models I | Discrete time models II | |
| 2 | Sept 9 to 15 | Probability theory | Probability theory | Quiz 1 |
| 3 | Sept 16 to 22 | Stoch. processes | Martingales | |
| 4 | Sept 23 to 29 | Itô integral | Test 1 review | Quiz 2 |
| 5 | Sept 30 to Oct 6 | Test 1 | Simulating RV | Test 1 |
| 6 | Oct 7 to 13 | Itô's lemma and SDEs | Simulating sample paths | |
| 7 | Oct 14 to 20 | Continuous time market | Introduction to project | Quiz 3 |
| 8 | Oct 21 to 27 | Black-Scholes model | Variance reduction | Project topic |
| RW | Oct 28 to Nov 3 | | | |
| 9 | Nov 4 to 10 | Greeks and sensitivities | Test 2 review | Quiz 4 |
| 10 | Nov 11 to 17 | Test 2 | Group work | Test 2 |
| 11 | Nov 18 to 24 | Special topics | Group work | |
| 12 | Nov 25 to Dec 1 | Group presentations | Group presentations | Presentations |
| 13 | Dec 2 to Dec 8 | - | - | Project due |

Policy on missed assessments and regrade requests

If you miss an assessment for a valid reason, you must notify the instructor via email within 48 hours of the missed assessment. In addition, you must declare your absence to the University using the Absence Declaration area in ACORN. The following policies will be followed if you miss an assessment for a valid reason.

Quizzes: If you miss a quiz, the weight of that quiz will be shifted to the other quizzes (i.e., your quiz mark will be from the best two out of three quizzes).

Term Tests: A single make-up test will be offered for students who miss either term test. The make-up test will cover material from **both** term tests and will be held in late November.

Final Project: A one-on-one make-up presentation will be scheduled if you miss the group presentation. As the project is a group project, extensions for the written project submission will only be considered in exceptional circumstances with consent from all group members. Late projects will be penalized 10% of the maximum grade for every day (24-hour period from the deadline) that it is late.

Regrade requests: Please submit regrade requests to the instructor by email or in person as soon as possible, at latest within two weeks of receiving the assignment. The course regrade policy exists to correct mistakes, and any request should clearly identify the error (for example, a question that was not marked, or a total incorrectly calculated). You must include a concise reason for a regrade request, referring to a possible error or omission by the marker.

Other course policies

Academic Integrity: Academic integrity is fundamental to learning and scholarship at the University of Toronto. As a result, U of T treats cases of cheating and plagiarism very seriously. Please read the University of Toronto's Code of Behaviour on Academic Matters available at:
<http://www.governingcouncil.utoronto.ca/policies/behaveac.htm>.

All suspected cases of academic dishonesty will be investigated following procedures outlined in the Code of Behaviour on Academic Matters. If you have questions or concerns about what constitutes appropriate academic behaviour or appropriate research and citation methods, please reach out to the instructor. Note that you are expected to seek out additional information on academic integrity from other institutional resources (for example, the University of Toronto website on Academic Integrity).

Accessibility Needs: The University of Toronto is committed to accessibility. If you require accommodations for a disability, or have any accessibility concerns about the course, the classroom, or course materials, please contact the Accessibility Resource Center as soon as possible.

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