

Financial Mathematics Syllabus

Department of Mathematics and Statistics

MATH 3900 / ECON 3900 Winter 2025

Dalhousie University acknowledges that we are in Mi'kma'ki, the ancestral and unceded territory of the Mi'kmaq People and pays respect to the Indigenous knowledges held by the Mi'kmaq People, and to the wisdom of their Elders past and present. The Mi'kmaq People signed Peace and Friendship Treaties with the Crown, and section 35 of the Constitution Act, 1982 recognizes and affirms Aboriginal and Treaty rights. We are all Treaty people.

Dalhousie University also acknowledges the histories, contributions, and legacies of African Nova Scotians, who have been here for over 400 years.

Course Instructor

John Rumsey

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Email "office hours" preferred.
In person office hours by appointment.

Course Description

This course is an introduction to derivative pricing. Topics include: binomial tree model, stochastic calculus, Itô calculus, Black-Scholes model, market price of risk, log-normal models.

Course Prerequisites

MATH 2060.03 and (MATH 2120.03 or MATH 2135.03), or permission of the instructor

Student Resources

The material in this course is well known and online sources abound. Both academic (such as university) and practitioner (such as financial institution) sources provide useful additional information. The instructor welcomes email inquiries as well, and will respond in a timely fashion.

Course Structure

MATH/ECON 3900 will be delivered in-person and not recorded.

Lectures

On Tuesdays and Thursdays from 1:05 pm to 2:25 pm in CHASE 319

Course Materials

Lecture notes will be available on the MATH3900 BrightSpace site for the course. The text, *The Mathematics of Financial Derivatives* by P. Wilmott, S. Howison & J. Dewynne; Cambridge University Press, 15th printing, 2009, is a suitable reference.

Assessment

| Component | Weight | Date | |
|-------------|--------|--------------------|---|
| Assignments | 20% | | There will be eight assignments. Each assignment will have the same weight, 2.5% of the total 20%. The time interval between assignment due dates will be approximately one week. The Midterm be held during regular class time on Thursday, 13 February, 1:00 pm to 2:30 pm and will cover the material presented prior to that date. |
| Midterm | 35% | 13 Feb 2025 | |
| Final Exam | 45% | | |

The date of the final exam will be set by the registrar and will cover all the course material.

Assignments must be done individually but discussion about the assignments is encouraged. Submit assignments electronically before the due date to the BrightSpace for the course. Please use Portable Document Format “.pdf” files.

Conversion of numerical grades to Final Letter Grades

| | | | |
|-------------------------------|-------------------------------|-------------------------------|-------------------------------|
| (89.5, 100] → A ⁺ | (84.5, 89.5] → A | (79.5, 84.5] → A ⁻ | (76.5, 79.5] → B ⁺ |
| (72.5, 76.5] → B | (69.5, 72.5] → B ⁻ | (64.5, 69.5] → C ⁺ | (59.5, 64.5] → C |
| (54.5, 59.5] → C ⁻ | (49.5, 54.5] → D | [0, 49.5] → F | |

Course Policies on Missed or Late Academic Requirements

Late assignments will not be accepted. Missed assignments will be given a score of zero. There is no make-up midterm and a missed midterm will be given a score of zero. If a class is cancelled (due to weather, for example) on the day when the in-class tests is scheduled, the test will be rescheduled. If a class is cancelled on a non-test day, the decision to make up the class will depend on circumstances.

The goal of these policies is fairness to everyone, but the policies may not apply in unusual circumstances.

Course Policies related to Academic Integrity

Each of the eight assignments is to be done individually, but consultation about the assignments with other students and with the instructor is allowed and is encouraged.

Learning Objectives

A student who is successful in this course should be able to:

- Derive the process for the price of a derivative security, given the process for the price of the underlying.
- Derive the non-stochastic PDE for the price of a derivative security.
- Create an algorithm for pricing a derivative security using a binomial model.
- Compute an approximate price for a derivative security using “Delta Hedging” at discrete time intervals.
- Compute the “market price of risk” of the underlying.

Course Content

| <i>Week</i> | <i>Topic</i> | <i>Notes</i> |
|-------------|---|------------------|
| 1,2 | Wiener processes – Itô's Lemma | Notes §1,2; |
| 3 | The Black-Scholes-Merton PDE | Notes §3; |
| 4 | Derivative Securities | Notes §4; |
| 5 | The Diffusion Equation | Notes §5.1-§5.3; |
| 6 | The Black-Scholes Formula | Notes §5.4-§5.6; |
| 7 | Variations on the Black-Scholes Formula | Notes §6; |
| 8 | American Options | Notes §7; |
| 9 | Binomial Pricing | Notes §8; |
| 10 | Exotic Options | Notes §9; |
| 11 | Option Replication | Notes §10; |
| 12 | Interest-Rate Derivatives | Notes §11; |

"Notes" refers to the Lecture Notes posted on *BrightSpace*

University Policies and Statements

Recognition of Mi'kmaq Territory

Dalhousie University would like to acknowledge that the University is on Traditional Mi'kmaq Territory. The Elders in Residence program provides students with access to First Nations elders for guidance, counsel, and support. Visit or e-mail the Indigenous Student Centre at 1321 Edward St or elders@dal.ca. Additional information regarding the Indigenous Student Centre can be found at:

https://www.dal.ca/campus_life/communities/indigenous.html

Internationalization

At Dalhousie, 'thinking and acting globally' enhances the quality and impact of education, supporting learning that is "interdisciplinary, cross-cultural, global in reach, and orientated toward solving problems that extend across national borders." Additional internationalization information can be found at:

<https://www.dal.ca/about-dal/internationalization.html>

Academic Integrity

At Dalhousie University, we are guided in all our work by the values of academic integrity: honesty, trust, fairness, responsibility, and respect. As a student, you are required to demonstrate these values in all the work you do. The University provides policies and procedures that every member of the university community is required to follow to ensure academic integrity. Additional academic integrity information can be found at:

https://www.dal.ca/dept/university_secretariat/academic-integrity.html

Accessibility

The Student Accessibility Centre is Dalhousie's centre of expertise for matters related to student accessibility and accommodation. If there are aspects of the design, instruction, and/or experiences within this course (online or in-person) that result in barriers to your inclusion, please contact the Student Accessibility Centre

(https://www.dal.ca/campus_life/academic-support/accessibility.html)

for all courses offered by Dalhousie with the exception of Truro. For courses offered by the Faculty of Agriculture, please contact the Student Success Centre in Truro

(<https://www.dal.ca/about-dal/agricultural-campus/student-success-centre.html>)

Conduct in the Classroom – Culture of Respect

Substantial and constructive dialogue on challenging issues is an important part of academic inquiry and exchange. It requires willingness to listen and tolerance of opposing points of view. Consideration of individual differences and alternative viewpoints is required of all class members, towards each other, towards instructors, and towards guest speakers. While expressions of differing perspectives are welcome and encouraged, the words and language used should remain within acceptable bounds of civility and respect.

Diversity and Inclusion – Culture of Respect

Every person at Dalhousie has a right to be respected and safe. We believe inclusiveness is fundamental to education. We stand for equality. Dalhousie is strengthened in our diversity. We

are a respectful and inclusive community. We are committed to being a place where everyone feels welcome and supported, which is why our Strategic Direction prioritizes fostering a culture of diversity and inclusiveness (Strategic Priority 5.2). Additional diversity and inclusion information can be found at:

<http://www.dal.ca/cultureofrespect.html>

Student Code of Conduct

Everyone at Dalhousie is expected to treat others with dignity and respect. The Code of Student Conduct allows Dalhousie to take disciplinary action if students don't follow this community expectation. When appropriate, violations of the code can be resolved in a reasonable and informal manner – perhaps through a restorative justice process. If an informal resolution can't be reached, or would be inappropriate, procedures exist for formal dispute resolution. The full Code of Student Conduct can be found at:

https://www.dal.ca/dept/university_secretariat/policies/student-life/code-of-student-conduct.html

Fair Dealing Policy

The Dalhousie University Fair Dealing Policy provides guidance for the limited use of copyright protected material without the risk of infringement and without having to seek the permission of copyright owners. It is intended to provide a balance between the rights of creators and the rights of users at Dalhousie. Additional information regarding the Fair Dealing Policy can be found at:

https://www.dal.ca/dept/university_secretariat/policies/academic/fair-dealing-policy-.html

Originality Checking Software

The course instructor may use Dalhousie's approved originality checking software and Google to check the originality of any work submitted for credit, in accordance with the Student Submission of Assignments and Use of Originality Checking Software Policy. Students are free, without penalty of grade, to choose an alternative method of attesting to the authenticity of their work and must inform the instructor no later than the last day to add/drop classes of their intent to choose an alternate method. Additional information regarding Originality Checking Software can be found at:

https://www.dal.ca/dept/university_secretariat/policies/academic/student-submission-of-assignments-and-use-of-originality-checking-software-policy-.html

Student Use of Course Materials

Course materials are designed for use as part of this course at Dalhousie University and are the property of the instructor unless otherwise stated. Third party copyrighted materials (such as books, journal articles, music, videos, etc.) have either been licensed for use in this course or fall under an exception or limitation in Canadian Copyright law. Copying this course material for distribution (e.g. uploading to a commercial third-party website) may lead to a violation of Copyright law.