Mathematics of Financial Markets
ACTSC 446/846, Winter 2022

Zoom University and the University of Waterloo

Instructor	Ruodu Wang	
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Course website:	https://learn.uwaterloo.ca/	
Piazza:	http://piazza.com/uwaterloo.ca/winter2022/actsc446846	
Time and Location	04:00-05:20 TTh	MC 2066 or Zoom

Format

The plan was to teach in person. Due to COVID-related regulations, the first three weeks of lectures will be online. The instructor is still hopeful that there will be possible physical teaching this term. *If you are not in Waterloo, please do not register in this course, and any requests caused by not being in Waterloo will not be accommodated.*

1. When physical teaching is possible, we will meet physically and I will teach in a lecture room (4-5:20pm Tuesdays and Thursdays). The lecture room is MC 2006.

2. When physical teaching is not possible (this includes at least the first three weeks), we will meet on Zoom. There is a Zoom link on Learn (Course Information - Zoom Meetings). We will meet online in the allocated time. There will be no recording of the lectures. Students are required to attend the online session at the specific time.

3. Switching between physical and online teaching will follow Ontario regulation and will be communicated over emails and through Learn.

The instructor will provide lectures slides, supplemented by notes and exercises. Lecture slides will be available on Learn before the corresponding lectures.

Office hours and Piazza

- Every Tuesday 5:30pm to 6:30pm I will host office hours on Zoom (during online time) or in my office (during physical teaching time) after the lecture on Tuesday. The Zoom information can be found on Learn (same link as lectures).

- Piazza is used only as a discussion forum. TA will work a couple of hours per week to answer some of the questions.
- Please attend office hour or contact me by email if you have any course related questions.

References

1. Main reference book:

   [1] Tomas Björk. *Arbitrage Theory in Continuous Time*. 3rd edition, Oxford, 2009.

   We do not exactly follow this book. The primary reference will be the lecture notes and lecture videos. Test materials are based on lecture notes.

2. Recommended reading on the understanding of financial markets:

   [2] Robert L. McDonald. *Derivatives Markets*, 3rd edition, Pearson, 2013.

   [3] John C. Hull. *Options, Futures, and Other Derivatives*. 9th edition, Prentice Hall, 2014.

3. Recommended reading on advanced mathematical materials:

   [4] Steven E. Shreve. *Stochastic Calculus for Finance I: The Binomial Asset Pricing Model*. Springer-Verlag, New York, 2004.

   [5] Steven E. Shreve. *Stochastic Calculus for Finance II: Continuous-Time Model*. Springer-Verlag, New York, 2004.

Teaching Assistants

- To be announced

Course evaluation

Tentative exam schedule and evaluation breakdown:

1. Take-home assignments, 10%

   (a) Monday of Week 3 (due Friday of Week 4)

   (b) Monday of Week 5 (due Tuesday of Week 7)

(c) Monday of Week 11 (due Friday of Week 12)

2. Midterm 1 (February 17, Thursday), 1.5 hours, 25% (Lectures 1-12)

3. Midterm 2 (March 24, Thursday), 1.5 hours, 25% (Lectures 13-18)

4. Final exam (date to be determined), 2.5 hours, 40% (All)

Midterm exams will be hosted in the usual lecture hours. Final exam time will be decided later. They are **physical exams** if possible. In case a physical exam is not possible, we will host them on Crowdmark. All assignments will be collected using Crowdmark. For questions regarding exam regrading, please contact the leading TA who will then connect you with the TA who mark your paper. I will be the last resort in case you and the TAs remain to disagree.

Course Content and Tentative Schedule

	Weeks	Topics	Björk reference
Part I	1-3	**Introduction to derivatives markets** options, futures and other derivatives arbitrage and trading strategies model independent properties of options	Chapter 1
Part II	3-6	**Discrete-time models** one-period models binomial tree models American and exotic options fundamental theorems of asset pricing	Chapters 2-3
Part III	7-8	**Basic stochastic calculus** Brownian motions and martingales Itô integrals and the Itô lemma	Chapter 4
Part IV	9-11	**The Black-Scholes framework** basics of continuous-time financial markets Black-Scholes equation Black-Scholes formula hedging and Greeks risk-neutral valuation	Chapters 6-9
Part V	12	**General continuous-time models** risk-neutral valuation in general models basics of fixed income products short-rate models	Chapters 10, 22-23

CIA Accrediation

This course is accredited under the Canadian Institute of Actuaries (CIA) University Accreditation Program (UAP) for the 2021-2022 academic year. Achievement of the established minimal grade in this course may qualify a candidate for CIA credit toward certain preliminary exams. Please note, a combination of courses may be required to achieve a single exam credit. Please see `http://www.cia-ica.ca/membership/university-accreditation-program---home/information-for-candidates` for full details.

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Lecture content, spoken and written (and any audio/video recording thereof); Lecture handouts, presentations, and other materials prepared for the course (e.g., PowerPoint slides); Questions or solution sets from various types of assessments (e.g., assignments, quizzes, tests, final exams); and Work protected by copyright (e.g., any work authored by the instructor or TA or used by the instructor or TA with permission of the copyright owner). Course materials and the intellectual property contained therein, are used to enhance a student's educational experience. However, sharing this intellectual property without the intellectual property owner's permission is a violation of intellectual property rights. For this reason, it is necessary to ask the instructor, TA and/or the University of Waterloo for permission before uploading and sharing the intellectual property of others online (e.g., to an online repository).

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Please alert the instructor if you become aware of intellectual property belonging to others (past or present) circulating, either through the student body or online. The intellectual property rights owner deserves to know (and may have already given their consent).

Relevant University Policies:

Policy 71 - Student Discipline Policy 73 - Intellectual Property Rights