ACTSC 446/846

Mathematics of Financial Markets

Michael Boyuan Zhu

UNIVERSITY OF
WATERLOO

Fall 2023

About this course

Section 001

Instructor:	Michael Boyuan Zhu mbzhu@uwaterloo.ca	
Lectures:	8:30 - 9:50 TTh	MC 4058
Tutorials:	12:30 - 1:20 F (sometimes)	MC 2038
Office hours:	1:00 - 2:00 Th	M3 4001
Teaching Assistants:	Rhoda Dadzie-Dennis	rdadzied@uwaterloo.ca
	Mwasi Mboya	mmboya@uwaterloo.ca

References

- Main reference book:

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

  The primary reference will be the lecture notes given in class. Test material will be based on lecture notes.

- Recommended reading for 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.

- Recommended reading for 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.

Evaluation

Assignments

No graded assignments. Practice questions with partial solutions will be provided.

Midterms

Two midterms are planned. Both occur at 4:30-6:00pm in STC 0040.

(1) Friday, October 6th

(2) Friday, November 10th

Course Evaluation Breakdown[1]

(1) Midterms 40% (20% each)

(2) Final Examination 60%

[1] ACTSC 846 students may receive a different grading scheme on exams.

Content

In this course we look at mathematical techniques used to price and hedge derivative securities in modern finance. Topics include (rough weights):

Part I Introduction to derivatives markets: options, derivatives, arbitrage, complete market, ... (20%)

Part II Discrete-time models: one-period and multi-period models, binomial tree models, ... (25%)

Part III Mathematics for continuous-time models: Introduction to stochastic calculus, Brownian motion, martingales, Itô-Doeblin Lemma, ... (15%)

Part IV Continuous-time models: Black-Scholes framework, risk-neutral valuation, hedging and the Greeks, ... (30%)

Part V General continuous-time models, interest rate models, ... (10%)

The mathematical level of this course will be quite high compared to other 400 level ACTSC courses.

Kiyoshi Itô and Vincent Doeblin

Kiyoshi Itô (September 7, 1915 – November 10, 2008) and Vincent Doeblin (March 17, 1915 – June 21, 1940) developed stochastic calculus independently, which is regarded as the most fundamental tool for continuous-time mathematical finance.

Fischer Black and Myron Scholes

Fischer Black (1938 - 1995) and Myron Scholes (1941 -) developed the famous Black-Scholes market model, which is the foundation of modern quantitative techniques for option pricing.

Robert C. Merton

Robert C. Merton (1944 -) was the first to publish a paper expanding the mathematical understanding of the options pricing model, and coined the term "Black-Scholes options pricing model".

$\Longrightarrow$ Merton and Scholes received the 1997 Nobel Memorial Prize in Economic Sciences.