MATH 5765/6895, Spring 2017
Introduction to Mathematical Finance II

Time and Place: MWF 11:50 am - 12:40 pm, FASB 101

Instructor: Jingyi Zhu, 801-581-3236, `zhu@math.utah.edu`

Text: Instructor's notes

Prerequisites: Introduction to Mathematical Finance I (Math 5760), or instructor's consent.

Course Objectives: This is the continuation of Math 5760, in which the basic ideas in derivative pricing are introduced. In this semester we will formally use the tools of continues-time stochastic calculus, in particular the concepts of Brownian motion and Itô calculus, to introduce the Black-Scholes pricing theory and its various extensions. The power of continuous-time models vs discrete-time model is demonstrated in their ease and transparency in dealing with many aspects of the models to incorporate realistic factors. The second half of the semester will be devoted to practical financial markets, including interest rate derivatives, credit markets, foreign exchange products, trading strategies, and environmental finance. Specifically, we will target the following objectives:

- Understand the fundamental concepts in using stochastic processes to model security price movements.
- Understand the concepts of Brownian motion, and be familiar with some of the basic calculations involved in Itô processes.
- Understand the arguments behind the Black-Scholes model and derive the Black-Scholes formula for European options.
- Understand the general Black-Scholes model and its limitations.
- Distinguish between various kinds of interest rates and their relations, understand the procedure and importance for constructing interest rate yield curves, and be familiar with the practical uses of various interest rate products.
- Understand various risks involved in financial markets and become familiar with various products intended to transfer those risks, which lead to trading of credit instruments.
- Explain early exercise privilege in American options and understand the formulation for pricing and early exercise policies.
- Understand the basic ideas behind statistical arbitrage strategies involved in high-frequency trading.
- Learn about efforts to use environmental investments to tackle climate change, and understand real options to impact emission dynamics.

- Design and perform Monte Carlo simulations to price various products with a specific model, improve the performance with variance reduction techniques.

Programming: Computer implementation is an essential component in this field, and you will be required to do some of your coursework with computer programs. Either Matlab, R or Excel will be acceptable, but we strongly encourage you to learn some basic Matlab programming if you have no prior experience with any computer programming.

Grading:

- Weekly homework assignments (50%);
- Four projects (20%): they will require handling real world data sets and programing;
- Final exam (30%): it is compressive, and only class notes are allowed in the exam.

For Students Registered in Math 6895: Extra work for the course which may include: more theoretical exercises in homework assignments and exams, and more research oriented projects.

References:

- *Options, Futures, and Other Derivatives,* John Hull, 8th Edition (2011), Prentice Hall.
- *Financial Mathematics: A Comprehensive Treatment*, G. Campolieti and R. Makarov, 1st Edition (2014), Chapman and Hall/CRC Financial Mathematics Series, ISBN-13 978-1-4398-9242-8
- *The Concepts and Practice of Mathematical Finance,* M. S. Joshi, 2nd Edition (2008), Cambridge University Press

ADA Statement: The American with Disabilities Act requires that reasonable accommodations be provided for students with physical, sensory, cognitive, systemic, learning, and psychiatric disabilities. Please contact the instructor at the beginning of the semester to discuss any such accommodations you may require for this course.

Tentative Schedule

Week	Date	Topic
1	Jan 9 - 13	Recap of Math 5760, Bond pricing
2	Jan 18 - 20	Brownian motion
3	Jan 23 - 27	Continuous-time stochastic calculus
4	Jan 30 - Feb 3	Risk-neutral pricing in the Black-Scholes model
5	Feb 6 - 10	Interest-rate derivative pricing
6	Feb 13 - 17	Credit derivatives and energy derivatives
7	Feb 22 - 24	Volatility and multi-asset models
8	Feb 27 - Mar 3	Capital asset pricing model (CAPM)
9	Mar 6 - 10	Optimal portfolio theory
10	Mar 13 - 17	Spring break
11	Mar 20 - 24	Factor analysis and correlation structures
12	Mar 27 - 31	Principal component analysis
13	Apr 3 - 7	Statistical arbitrage
14	Apr 10 - 14	High frequency trading strategies
15	Apr 17 - 21	Alpha trading
16	Apr 24	Review