MATH 5760/6890, Fall 2019
Introduction to Mathematical Finance I

Time and Place: TuTh 9:10-10:30 am, LCB 121

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

Office Hours: TuTh 2:00-3:00 pm, or by appointment, LCB 335

Text: A. Petters and X. Dong, *An Introduction to Mathematical Finance with Applications*, 1st Edition (2016), Springer Undergraduate Texts in Mathematics and Technology, ISBN-13:978-1493937813, ISBN-10: 1493937812.

Prerequisites: Introduction to Probability (Math 5010) and Linear Algebra (Math 2250/2270)

Course Objectives: Mathematical finance has become a standard field in applied mathematics, and also a toolkit that is believed to lead to a highly rewarded profession. Actually it is also a subject that all ordinary citizens should obtain a proper education to navigate in today's world. In this course, we will get a good picture of this complex financial world in mathematically solid terms, and relate the valuation to practical parameters that we can measure or estimate. We will also understand the principles behind the diversification advice in allocating capitals, and can start to make suggestions and guidelines to investors as how to begin building the portfolio for their particular objectives. Specifically, we will target the following objectives:

- Familiarize with today's financial markets, understand what roles these financial institutions play in dealing with various securities.
- Understand the fundamental concepts of investment return and risk, and their quantifications.
- Fully understand the concept of time value of money, and be able to calculate bond prices from bond yields and vice versa.
- Quantify and model the return and risk from an investment in financial assets.
- Explain the basic stock valuation and the no-arbitrage principle.
- Analyze a portfolio of financial assets and use mathematical tools to optimize the portfolio performance according to a set of criteria.
- Understand the CAPM model and design optimal portfolios using market portfolios.
- Be able to extract a collection of factors from a market to explain the price movements of the securities.
- Characterize a financial derivative according to its payoff and other parameters, and decompose into a collection of known instruments in some cases.

- Build a discrete time model to explain the pricing of a financial derivative.
- Demonstrate the Black-Scholes formula for an option price as a limit in the binomial model as the number of steps becomes infinitely large.

Course Outline: This is the first part of a two-semester sequence course, where we will introduce some basic concepts about financial markets and their products, portfolio theory, and the basic discrete time pricing models. We begin with a practical discussion of financial markets to become comfortable with the terminology and motivate the interests in this profession and the relevance in our daily lives. Next we will revisit the idea of compound interests to introduce the conventions in bond prices and yields. This will help us to view any future income in the eyes of discounting. As investment returns become uncertain, it is important to identify the sources of risk and establish probability models to describe the uncertainty, and consequently the concept of volatility is introduced. Given the uncertain outcomes of a security in the future, it is natural to find the present value as an expectation of the future values, with a proper discount to acknowledge the time value. With investments questing for high returns but concerning over risk measured in terms of volatility, we introduce the basic portfolio theory and the show how to build so-called optimal portfolios. Towards the end of the semester, we will bring in the well publicized financial instruments called derivative, and close the semester with the celebrated Black-Scholes-Merton model to price options.

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

Grading:

- Homework assignments (50%): taken from the textbook;
- Midterm projects (20%): two projects that will require handling real world data sets;
- Final exam (30%): Monday, Dec 9, 2017, 8:00 - 10:00 am, in LCB 121. The comprehensive exam is closed-book and closed-notes, and all materials from the semester will be covered. However most of the problems will be based on homework assignment problems.

Table 1: Grading Scales

%-age	90-100	85-89	80-84	75-79	70-74	65-69	60-64	55-59	45-54	0-44
Grade	A	A-	B+	B	B-	C+	C	C-	D	E

For Students Registered for Math 6890: If you are a PhD student, you may register at the 6000 level with a course number 6890. However, you will be required to do extra work for the course which may include: reading of some more advanced materials from the text, more theoretical exercises in homework assignments and exams, and research oriented projects that will be presented in a small discussion session. Grading curve for Math 6890 is separated from that of Math 5760.

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.

Campus Safety: The University of Utah values the safety of all campus community members. To report suspicious activity or to request a courtesy escort, call campus police at 801-585-COPS (801-585-2677). You will receive important emergency alerts and safety messages regarding campus safety via text message. For more information regarding safety and to view available training resources, including helpful videos, visit `safeu.utah.edu`.

Tentative Schedule

Week	Date	Chapter	Topic
1	Aug 20, 22	1	Banks and Rates
2	Aug 27, 29	1	Security Markets
3	Sept 3, 5	2	Time Value of Money: Different Interest Rates
4	Sept 10, 12	2	Net Present Values, Annuities
5	Sept 17, 19	2	Stock and Bond Valuations
6	Sept 24, 26	3	Markowitz Portfolio Theory
7	Oct 1, 3	3	Efficient Frontier
8	Oct 8, 10		Fall Break
9	Oct 15, 17	3	Utility Function
10	Oct 22, 24	4	Capital Market Theory
11	Oct 29, 31	4	Linear Factor Models
12	Nov 5, 7	5	Binomial Tree Model
13	Nov 12, 14	5	Continuous-Time Limit
14	Nov 19, 21	7	Derivative Securities, Binomial Tree Model
15	Nov 26	8	Pricing Options
16	Dec 3, 5	8	Black-Scholes-Merton Model
Final	Dec 9	-	Final Exam

Other references:

- G. Campolieti and R. Makarov, *Financial Mathematics: A Comprehensive Treatment*, 1st Edition (2014), Chapman and Hall/CRC Financial Mathematics Series
- J. Hull, *Options, Futures, and Other Derivatives,* 10th Edition (2017), Prentice Hall.
- M. S. Joshi, *The Concepts and Practice of Mathematical Finance,* , 2nd Edition (2008), Cambridge University Press