MATH 5760/6890, Fall 2010
Introduction to Mathematical Finance I

Time and Place: TH 9:10-10:30 a.m., LCB 121

Instructor: Jingyi Zhu, telephone: 801-581-3236, e-mail: zhu@math.utah.edu

Office Hours: TH 12:00-2:00 p.m. or by appointment, at LCB 335

Text: S. E. Shreve, *Stochastic Calculus for Finance I: The Binomial Asset Pricing Model,* (2005), Springer

Prerequisites: Fundamental probability (Math 5010) and differential equations (Math 2280)

Programming: Computer implementation is an essential part of this subject, and you will be required to do some of your coursework with computers. Either Matlab or Excel will be accepted for the class and you are strongly encouraged to learn some basic Matlab programming if you have no prior experience with computer programming.

Outline: This is the first part of a two-semester sequence course on mathematical finance. In the Fall semester, we will examine the fundamental principles of financial derivatives from both financial and mathematical perspectives, and demonstrate how the mathematical tools from stochastic calculus, differential equations and numerical methods join forces to form an essential part in modern finance. The emphasis of the course is a mathematical understanding of the intrinsic relationships among various financial instruments, which serves as a basis for investment decisions and trading strategies. This can be accomplished on a theoretical level by combining concepts of arbitrage-free pricing, risk-neutral world, and equivalent martingale measures in one framework. The central theme of the Fall semester is the classic Black-Scholes-Merton model, and we plan to give a thorough treatment, in preparation for more extended topics towards the end of the semester, and more advanced continuous time models in the Spring semester. One of the most intuitive and transparent approaches to illustrate and also extensively used in practice is the binomial tree model, which is the tool used in the textbook listed above. It contains most of the essential ideas of the Black-Scholes-Merton methodology, and it can be naturally extended to build more general continuous-time models. The semester will end with an introduction to interest rates, with a discussion of some basic term structure models. Whenever time permitting, we will include as much real life examples as possible to make this a rewarding experience for those who plan to pursue a career in this direction, as well as those who are just intrigued by the daily practice.

Topics to be Covered:

- Introduction to financial derivatives
- Binomial models (one-period and multi-period)
- Basic no-arbitrage principle, state prices, martingale
- Black-Scholes-Merton model to price an European call or put option
- American options and early exercises
- Random walks and Brownian motion

- First passage and barrier options
- Introduction to bond mathematics and interest-rate securities

Grading:

- Homework assignments (60%) taken from the textbook, supplemented by realistic problems developed in class;
- Midterm (10%): a 50-minute in-class, open-book and open-note test to prepare you for the final exam;
- Final (30%): a two-hour in-class, open-book and open-note exam.

Final Exam: Tuesday, December 14, 2010, 8:00 to 10:00 am, in LCB 121.

For Students Registered for Math 6890: If you are a PhD student in a non-mathematics program, you may register at the 6000 level. However, you will be required to do extra work for the course which include: more theoretical exercises in homework assignments and exams, and more research oriented projects. Grading curve for 6890 is separated from the rest of the class.

Other references:

- *Options, Futures, and Other Derivatives,* John Hull, 7th Edition (2008), Prentice Hall.
- *Financial Calculus: An Introduction to Derivative Pricing,* M. Baxter and A. Rennie, (1996), Cambridge University Press.
- *Dynamic Asset Pricing Theory,* Darrell Duffie, 3rd Edition (2001), Princeton University Press.
- *The Mathematics of Financial Derivatives: A Student Introduction,* Paul Wilmott, Sam Howison, Jeff Dewynne, (1995), Cambridge University Press.
- *Derivatives in Financial Markets with Stochastic Volatility,* J-P Fouque, G. Papanicolaou, and K. R. Sircar, (2000), Cambridge University Press.
- *The Volatility Surface,* Jim Gatheral, (2006), John Wiley and Sons.

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.