City University of New York **Last offered Spring 2013**
GC:83600: Finance Theory and Financial Engineering

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Lecture 1: Introduction and Course Overview

Course Objectives

After completing this course, you should be able to:

- Explain the difference between no-arbitrage and risk-neutral valuation approaches to valuing a European option using a one-step binomial tree.
- Investigate the convergence property of the binomial model.
- Be familiar with Greek Letters; delta, gamma, theta, vega and rho. Understand the difference between delta hedging and gamma hedging.
- Describe a Markov process, a generalized Wiener process and an Ito process. They should be able to derive Ito's lemma.
- Describe the model of stock price behavior used by Black, Scholes and Merton. Should be able to derive the Black Scholes Merton differential equation. Be familiar with the Black-Scholes pricing formulas, their properties and their limitations.
- Carry out computations for stock options, currency options, index options and futures options using DERIVAGEM.
- Write a computer program in MATLAB for implementing numerical procedures for valuing derivatives when exact formulas are not available. Understand the difference between antithetic variable technique and control variate technique. Understand the difference between the explicit and implicit finite difference methods.
- Recognize a volatility smile. Should be able to explain how the probability distribution for an asset price at a future time can be calculated from implied volatilities.
- Recognize a stochastic volatility model. Know the issues related to estimating stochastic volatility models, for example the models of Heston. Know how to estimate volatilities and correlations and Value at risk models.
- Work with various exotic options; chooser options, barrier options, binary options, lookback options, shout options, Asian options, volatility and variance swaps.
- Explain the equivalent martingale result.
- Write an applied paper.

Course Pre-requisites

To gain the most from this class, you should already have

- Completed a course in introductory statistics or have an equivalent experience.

Course Overview

The objective of this course is to give you the skills and opportunity to advance your knowledge of financial engineering/econometric techniques. The starting point is the binomial option pricing model, the assumptions necessary to price a European option using risk-neutral valuation approach and no-arbitrage approach. In addition to binomial trees the course covers topics in Wiener processes and Ito's Lemma, Black Scholes Merton model, Greek letters, volatility smiles, Basic numerical procedures, martingales, measures and interest rate derivatives. You will have the opportunity to explore these techniques in problem sets and a research project that includes a 15-page paper.

Required Texts:
Main text. John C. Hull, "Options, Futures, and Other Derivatives," 8. ed., Prentice Hall, 2012.

Paolo Brandimarte, "Numerical Methods in Finance and Economics," 2 ed., Wiley 2002

Course Grade: Your course grade will be made up of the following components:

Group Problem Sets: 20%
There will be five Problem Sets during the semester. These problems are to be completed as a group. Three students will be assigned to each group at the start of the semester. One set of answers must be turned in on the published due dates.

Midterm Exam: 30%
The questions on this test will cover material from lectures, the textbook and the problem sets.

Individual Assignment 10%
Each student will submit written answers to questions on Stochastic Volatility, Value at Risk and Interest rate derivatives.

Research Project: 35%
The research project is designed to give students the experience of doing a quantitative research project. This project will be carried out by the same groups assigned for problem sets. The end result of the project is a 12 to 15 page paper (maximum 15 pages) that is similar to a research paper, but with the main emphasis on data and financial engineering methods.

Class Participation: 5%
Most classes will include a discussion of a topic covered in readings, lectures, assignments or research projects. Students will be expected to participate in these discussions.

Letter Grades: Your overall numerical course grade translates into a letter grade according to the following scale: 97-100 = A+ , *93-96 = A , 89-92 = A– , 85-88 = B+ , 81-84 = B, 77-80 = B– , 73-76 = C+ , 69-72 = C , 65-68 = C–*
Computer Lab and Software: MATLAB is the recommended software for working out answers to problem sets and for your research project. If you have questions about MATLAB Please contact our TA.

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Please familiarize yourself with the proper methods of citation and attribution. The University provides some useful resources online; I strongly encourage you to familiarize yourself with these various styles before conducting your research:
Violations of the Code of Academic & Professional Conduct should be reported to the Associate Dean for Student Affairs.

GC 83600 Finance Theory and Financial Engineering
Friday: 4:15-6:15
Office Hours: Fridays 2-4 and by appointments
Recitation Hour: To be announced.
The following schedule is subject to change. More details will be posted as the semester progresses.

February 1 and February 8
Introduction, Binomial trees
Chapter 12

February 15 – Problem Set 1 Due
Wiener process and Ito's lemma
Chapter 13

February 22- *Submit preliminary proposal for research project*
The Black Scholes Merton Model
Chapters 14

February 22 – Problem Set 2 Due
The Greek letters
Chapter 18

March 1 – Problem Set 3 Due

Review for Midterm Exam
Class Discussion of Research Projects

MARCH 8 - MIDTERM EXAM (30% of Course Grade). Material from February 1 to March 1

March 15 and March 22 – ***Submit proposal for research project on March 22***
Volatility Smiles and basic numerical procedures
Chapters 19 and 20
Additional required reading posted on BlackBoard

March 29 – Problem Set 4 Due
Value at risk, estimating volatilities and correlation
Chapters 21 and 22

April 19 - ASSIGNMENT (10% of Course Grade) Due
Questions on Stochastic Volatility, Value at Risk and Interest rate derivatives will be handed out on March 29 and must be submitted on April 19)

Class Discussion Value at Risk, Copula
Readings posted on BlackBoard

April 29 – ***Submit status report on research project with description of data and methodology***

Exotic Options
Chapters 25

For class on May 3 and May 10 each group will be assigned 15 minute to present a report on the data and methodology for their research project. These class sessions are an opportunity for you to share what you have learned while doing your project, to ask advice and to offer help. Everyone is expected to attend both classes and to participate in the discussion.

May 3 – Problem Set 5 Due
Class discussion of research projects
Martingales and measures
Chapter 27

May 10: Class discussion of research projects

Monday – May 13: ***Submit paper for Research Project. (Email me: tagbeyeg@hunter.cuny.edu) by 11:00pm)***

Course Format

Lectures and recitations.

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