Course Outline
14 January 2010

This course covers option pricing models and the numerical methods used to compute option prices. After an initial review of some fundamental ideas, the first half of the course will provide an informal introduction to Itô processes and the stochastic calculus, and then will go on to a careful treatment of the Black-Scholes-Merton analysis, risk-neutral probabilities, and various applications of the Black-Scholes-Merton analysis. The second half of the course will provide an introduction to numerical methods used to approximate solutions to the differential equations that arise in option pricing, and then turn to models for valuing fixed-income derivatives.

Requirements

The textbook for the course is *Paul Wilmott Introduces Quantitative Finance* by Paul Wilmott (http://www.amazon.com/Paul-Wilmott-Introduces-Quantitative-Finance/dp/0470319585). Specific reading assignments that go with the various class meetings are provided in the detailed schedule below.

The course requirements consist of a **group project** due on Wednesday, 5 May (20% weight in the determination of the course grade), a **midterm examination** on Monday, 15 March during the regular class time (20% weight), and a **final examination** on Wednesday 12 May, from 8:00-11:00 a.m., (40% weight). The final examination will be cumulative, i.e. it will cover the entire course. There will also be **regular problem sets** (20% weight), because most students learn by doing rather than by listening.

The weekly problem sets and the project may be done in groups, where the maximum group size is four students. The groups need not be the same for each of the problem set assignments and your project group need not be the same as your problem set group. The group project will involve using option pricing techniques and other ideas from this class to carry out a realistic valuation of a financial instrument.

Other Relevant Information

I strongly recommend that students read *Risk*, which is available in the Business and Economics Library. *Risk* is the best source of information about current issues in risk management, financial engineering, and the OTC derivatives markets.

I may be found in room 109 Wohlers Hall, e-mail pearson2@illinois.edu, telephone 217 244 0490. Office hours are Monday and Wednesday, 2:00–3:00 p.m., and by appointment.

Problem sets and some other materials will be distributed through Illinois Compass (http://compass.illinois.edu) in the form of pdf (Adobe Acrobat) or PowerPoint files.

Topics, Schedule, and Reading Assignments
The topics and reading assignments are listed below. Wilmott means the textbook, *Paul Wilmott Introduces Quantitative Finance*. The classroom presentations will assume that students have read the assigned materials prior to class.

**Introduction and Review of Basic Ideas**

Class 1 (20 January): Valuation by Replication

   Reading: Wilmott, Chapters 1 and 2

Class 2 (25 January): Binomial Model

   Reading: Wilmott, Chapter 3

Class 3 (27 January): Implementing the Binomial Model

   Reading: Wilmott, Chapter 3

**Mathematical Tools**

Class 4 (1 February): The Random Behavior of Asset Prices and Brownian Motion

   Reading: Wilmott, Chapter 4

Class 5 (3 February): The Stochastic Integral and Itô’s Lemma

   Reading: Wilmott, Chapter 5

**The Black-Scholes-Merton Analysis**

Class 6 (8 February): The Black-Scholes-Merton Analysis

   Reading: Wilmott, Chapter 6; Carr and Bandyopadhyay, “How to Derive the Black-Scholes Equation Correctly?” (available on Compass)

Class 7 (10 February): A Tiny Bit About (Parabolic) Partial Differential Equations

   Reading: Wilmott, Chapter 7

Class 8 (15 February): The Black-Scholes Formula, the “Greeks,” and a Graphical Interpretation

   Reading: Wilmott, Chapter 8
Class 9 (17 February): Simple Generalizations of the Black-Scholes Formula; Forward and Futures Contracts

Reading: no additional reading

Class 10 (22 February): A Little Bit About Volatility

Reading: Wilmott, Chapters 9, 10

**Probabilistic or Feynman-Kac Solution**

Class 11 (24 February): The Probabilistic Solution

Reading: To be announced

Class 12 (1 March): Interpretation of the Probabilistic Solution, and Some Examples

Reading: To be announced

**Numerical Methods**

Class 13 (3 March): An Explicit Finite Difference Scheme
(28 February)

Reading: Wilmott, Chapters 27, 28

Class 14 (8 March): Implicit Finite Difference Schemes

Reading: To be announced

Class 15 (10 March): Implicit Finite Difference Schemes

Reading: To be announced

Class 16 (15 March): **Midterm examination**

The midterm examination will be administered during the regular class time.

**Numerical Methods (continued)**

Class 17 (17 March): Handling Dividends; and Approaches for American Options

Reading: To be announced
Spring break begins Saturday, 20 March

Class 18 (29 March): Monte Carlo Methods
   Reading: Wilmott, Chapter 29

**A Few Non-Vanilla Options**

Class 19 (31 March): Asian Options
   Reading: Wilmott, Chapter 11

Class 20 (5 April): Multi-Asset Options
   Reading: Wilmott, Chapter 12

Class 21 (7 April): Barrier Options
   Reading: Wilmott, Chapter 13

**Introduction to Interest Rate Modeling**

Class 22 (12 April): Swaps and FRA’s
   Reading: Wilmott, Chapters 14, 15

Class 23 (14 April) One-Factor Interest Rate Models
   Reading: Wilmott, Chapter 16

Class 24 (19 April): Hull-White Model

Class 25 (21 April): Heath, Jarrow, and Morton and Brace, Gatarek, and Musiela Models
   Reading: Wilmott, Chapters 18, 19

Class 26 (26 April): More on the HJM and BGM Models
   Reading: Wilmott, Chapter 19
Class 27 (28 April): Computing Option Prices in the HJM Framework

Reading: Wilmott, Chapter 19

**Modeling Credit Risk**

Class 28 (3 May): Credit Default Swaps

Reading: Wilmott, Chapter 23

Class 29 (5 May): The Gaussian Copula

Reading: Wilmott, Chapter 23