MATH49102 - 2011/2012

General Information

- Title: Stochastic Modelling in Finance
- Unit code: MATH49102
- Credits: 15
- Prerequisites: MATH37001 *Martingales with Applications to Finance* or equivalent.
- Co-requisite units: None
- School responsible: Mathematics
- Member of staff responsible: J Sexton

Specification

Aims

The unit aims to provide a concise mathematical formulation of the main characteristics of financial instruments, with an emphasis on quantitative aspects of stock price, options, and other financial derivatives.

Brief Description of the unit

Derivative securities (such as options) depend on the values of primary securities (such as stock or bond prices). During the last thirty years trading in derivative securities have undergone a tremendous development, and nowadays derivative securities are traded on markets all over the world in large numbers. The purpose of the course is to exhibit basic features of advanced financial derivatives, starting with basic model specifications, introducing the concept of arbitrage, and ending with a risk-neutral valuation formula and its analysis.

Learning Outcomes

On successful completion the students will have acquired active knowledge and understanding of some basic concepts and results in financial mathematics including:

- hedging strategies and managing market risk using derivatives;
- discrete and continuous time security markets;
- arbitrage, risk-neutral valuation, the fundamental theorem of asset pricing;
- European options, exotic options, American options;
- interest rate models and interest rate derivatives;

Future topics requiring this course unit

None.

Syllabus

1. Modern portfolio theory: variance minimisation; diversification; efficient frontier. [2]
2. Discrete-time security markets: The Cox-Ross-Rubinstein model; self-financing portfolios; contingent claims; arbitrage; martingale measures; risk-neutral valuation. [4]
3. Continuous-time security markets: The Black-Scholes model; self-financing portfolios; contingent claims; arbitrage; martingale measures; risk-neutral valuation; the fundamental theorem of asset pricing; the efficient market hypothesis. [12]
4. American options (put and call); Exotic options: forward start, chooser, compound, binary/digital, barrier, lookback, shout, Asian, basket, quantile. [7]
5. Interest rate models; Vasicek, Cox-Ingersoll-Ross and Hull-White models; the Heath-Jarrow-Morton framework. [5]

6. Credit risk: structural models; reduced form models; intensity based models. [3]

Textbooks

- Lamberton, D. & Lapeyre, B. *Introduction to Stocastic Calculus Applied to Finance,* Chapman & Hall 1996.
- Björk, T., *Arbitrage Theory in Continuous Time*, Oxford University Press 1998.
- Etheridge, A., *Options, A Course in Financial Calculus* Cambridge University Press, 2002.
- Musiela, M. and Rutkowski, M., *Martingale Methods in Financial Modelling*, Springer 2005.
- Shiryaev, A. N., *Essentials of Stochastic Finance*, World Scientific 1999.

Teaching and learning methods

Three lectures and one examples class each week. In addition students should expect to spend at least six hours each week on private study for this course unit.

Assessment

Coursework: Mid-semester coursework: 20%
End of semester examination: two and a half hours weighting 80%

Arrangements