MM21 (Quantitative and Computational Finance)

Year:	2014–2015
Code:	MATHMM21
Level:	Masters
Value:	Half unit (= 7.5 ECTS credits)
Term:	1
Structure:	3 hour lectures per week
Assessment:	90% examination, 10% coursework
Lecturers:	Dr R Ahmad

Course Description and Objectives

This is a course in the applied aspects of mathematical finance, in particular derivative pricing. The theme of the course is to develop the Partial Differential Equation approach to the pricing of options. Excel spreadsheets will be used for the computational work.

Recommended Texts

Wilmott, Paul (Wiley) June 2007, *Paul Wilmott Introduces Quantitative Finance.*

Detailed Syllabus

Applied Probability and Stochastic Calculus: Random walks and transition probability density functions; Forward and Backward Kolmogorov equations. Similarity reduction method for solving diffusion equations. Stochastic Differential Equations (SDEs) - drift, diffusion, Itôs Lemma, Itô Integral and Itô Isometry. Simulating asset price SDEs in Excel.

Financial Products and Markets: Introduction to the financial markets and the products which are traded in them: Equities, indices, foreign exchange and commodities. Options contracts and strategies for speculation and hedging.

Black-Scholes framework: Black-Scholes PDE: simple European calls and puts; put-call parity. The PDE for pricing commodity and currency options. Discontinuous payoffs - Binary and Digital options. The Greeks: theta, delta, gamma, vega & rho and their role in hedging. The mathematics of early exercise - American options: perpetual calls and puts; optimal exercise strategy and the smooth pasting condition. Volatility considerations - actual, historical and implied volatility; local vol and volatility surfaces.

Computational Finance: Solving the pricing PDEs numerically using Explicit Finite Difference Scheme. Stability criteria. Introduction to Monte Carlo technique for derivative pricing.

Fixed-Income Products: Introduction to the properties and features of fixed income products; yield, duration & convexity; yield curves & forward rates; zero coupon bonds. Stochastic interest rate models; bond pricing PDE; popular models for the spot rate (Vasicek, CIR and Hull & White); solutions of the bond pricing equation. Calibration/yield curve fitting: the importance of matching theoretical and market prices; time dependent one factor models (Ho & Lee, extended Vasicek). Multi-factor interest rate modelling: Two-factor Interest rate models and Bond pricing equation.

Introduction to Exotic Options: Basic features and classification of exotics. Barriers, Asians and Lookbacks. Sampling - continuous and discrete. Pricing using Monte Carlo and PDE approach.