MATH0093 Finance and Numerics

Year:	2022-2023
Code:	MATH0093
Value:	15 UCL credits (= 7.5 ECTS)
Term:	1
Structure:	3 hour lectures
Assessment:	100% examination. To pass the course, students must obtain an overall pass mark of 50% for all sections combined.
Pre-requisites:	None
Lecturers:	Dr R Ahmad

Course description and objectives
It is essential for financial mathematicians to have a robust grounding in finance terminology and the day to day functioning/mechanics of the markets; and also to understand and apply the numerical techniques required to approach the solution to the main problems in mathematical finance (pricing, risk management, etc.).

This module addresses the subjects highlighted above and is divided in two equally weighted components:

- Part 1 is a largely qualitative based module covering various aspects of the global financial markets and products traded in them. It is necessary for a mathematician working in the investment banking arena to have a robust grounding in finance terminology and the day to day functioning/ mechanics of the markets.
- Part 2 introduces aspects of Numerical Methods that are useful in Quantitative Finance. Due to the complexity of modern finance, an understanding of numerical techniques is required for a responsible approach to pricing and risk management problems.

Recommended texts

John Hull; Options, Futures and Other Derivatives **9th Edition**, Pearson, (2017)

R. L. Burden, J. D. Faires, and A. C. Reynolds, Numerical analysis. Brooks/cole Pacific Grove, CA, 2001.

P. Glasserman, Monte Carlo methods in financial engineering. 2003.

Detailed syllabus

1. **Asset Classes:** Equities - exchanges, dividends, stock-splits, short selling. Currencies - FX markets, currency pairs, Commodities - different types. Seasonality effects. Indices. (NPV).

2. **Derivatives:** Futures and forwards; options. No arbitrage. Payoff diagrams; P&L diagrams. Option strategies. Put-Call parity. Speculation, hedging, gearing. The greeks and their role in risk management.

3. **Exotic Options:** Classification features of exotics. Sampling types - discrete and continuous. Asian options - arithmetic and geometric averaging; running averages. Lookbacks. Fixed and floating strike rate exotics.

4. **Fixed-Income Markets and Analysis:** Fixed income markets and products - zero-coupon bonds, swaps and their relationship; coupon bearing bonds. Analysing market value of instruments - yield, duration and convexity.

5. **Volatility consideration:** Different types of volatility - actual; realised; implied. Vega and associated risks. Local volatility. Volatility smiles and skews. Volatility surfaces. Term structure and calibration.

6. **Direct and Indirect Methods for linear and nonlinear equations:** bisection, Newton-Raphson, secant.

7. **Numerical methods for solving Partial Differential Equations:** Explicit and Implicit finite difference methods. Stability analysis. Numerical linear algebra.

8. **Probabilistic Methods:** Manipulating and simulating stochastic differential equations. Monte Carlo integration and applications to derivative pricing.

September, 2022