MATH0031 Financial Mathematics

Year:	2024–2025
Code:	MATH0031
Level:	6 (UG)
Normal student group(s):	Year 3 Mathematics degrees
Value:	15 UCL credits (= 7.5 ECTS credits)
Term:	2
Assessment:	90% examination, 10% coursework
Normal Pre-requisites:	MATH0016, MATH0057
Lecturer:	Dr J Walton

Course Description and Objectives

This is a first course at the advanced undergraduate level in mathematical finance; centring on the mathematics of financial derivatives which relies on both probability theory and PDE based approaches. It assumes no prior knowledge of finance. The module begins with an introduction to the type of language and terminology used in the investment banking arena, followed by the essential elements of probability theory and stochastic calculus required for the pricing of options later in the course.

Recommended Texts

Bjork, Tomas (Oxford Finance Series) 2009. Arbitrage Theory in Continuous Time.

Shreve, Steven (Springer Finance) 2004. Stochastic Calculus for Finance I: The Binomial Asset Pricing Model.

Shreve, Steven (Springer Finance) 2008. Stochastic Calculus for Finance II: Continuous-Time Models.

Detailed Syllabus

Financial Products and Markets: Time value of money and applications to annuities and perpetuities; the fixed income world - zero coupon bonds and coupon bearing bonds; yield curves, duration and convexity. Equities, indices, foreign exchange and commodities. Futures, Forwards and Options. Plain vanillas and digitals. Payoff and P&L diagrams; strategies for speculation and hedging. Put-Call parity.

Stochastic Calculus: Brownian motion, quadratic variation, continuous-time Martingale, Itô's lemma. Stochastic Differential Equations and Geometric Brownian Motion. Martingale Representation Theorem.

Binomial Model: No arbitrage, delta hedging. Replicating strategy. Risk-neutral probability, risk-neutral measure and discrete Martingale property (partitions and filtrations). Complete markets. One and multi-period models. CRR valuation. European and American options.

Black-Scholes Model: Self-financing trading strategy. Change of Measure (Girsanov Theorem and Radon-Nikodym derivative). Fundamental Theorem of asset pricing. Nobel prize winning Black-Scholes pricing formula for European options by expectations and change of measure. Derivation of Black-Scholes PDE and solution by similarity reduction. Feynman-Kac

formula. Dividends and time dependent parameters. Introduction to risk management and the greeks – delta, gamma, theta, rho, vega.