Course content for MT3470/MT4570, Mathematics of Financial Markets

Note: The Year 4 version of MT3470 has course code MT4570, not MT4470.

Prerequisites:
MT1720; and one of MT1300 or MT2320

Aims:
This course aims to show how mathematics and statistics are used (and sometimes misused) by those who work in securities markets. Since many of our graduates find employment in this area, the topics in the course are chosen to demonstrate the most important applications. They are portfolio theory, two simple asset pricing models, the general behaviour of markets (how random, how chaotic are they?) and the theory of derivative securities.

Learning outcomes:
On completion of the course the student should be able to:

- understand the ideas of risk and return and how they can be measured;
- formulate Markowitz portfolio theory as an optimisation problem and use simple algorithms to solve it;
- understand the assumptions behind asset pricing models and the mathematical arguments leading to them;
- appreciate the consequences of a random walk model of price change and the arguments for and against such a model;
- understand the Black and Scholes formulation of option pricing and find simple solutions of the equation.
- MT4570: appreciate the mathematical tools used in financial applications, be able to understand their limits and to reproduce proofs of selected mathematical results.

Course content:
Portfolio analysis: Risk and return. Mean-variance portfolio theory, the efficient frontier. Lending and borrowing: finding the market portfolio. Utility theory. Correlation models: single-index and multi-index.
Pricing models: Capital asset pricing model, arbitrage pricing model. Looking for opportunities. **Market movements**: The random walk model and its shortcomings. The efficient market hypothesis. Skewness and kurtosis. Brief discussion of ideas from chaos theory.
Futures and options: Introduction to derivatives. Pricing of futures. Options: payoff at expiry, use in hedging positions. Put-call parity and related inequalities. Pricing by binomial trees. Brief discussion of Wiener and Ito processes. Delta-hedging and the Black-Scholes equation. Reduction to a diffusion equation and solution for a European call. The American put problem.