

# MATHEMATICS FOR FINANCE

(40 hours)

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## PROGRAMME AND AIM OF THE COURSE

The aim of the course is to introduce some of the most important mathematical tools commonly used in the financial literature. The course is divided into three parts:

### *Part I: Review of Calculus*

#### Deterministic calculus

- Derivability, differentiability and Taylor's formula for functions of one variable
- Derivability, differentiability and Taylor's formula for functions of  $n$  variables

#### Optimization

- Quadratic forms and their signature
- Maxima and minima (unconstrained and constrained) for functions of  $n$  variables

### *Part II: Basics of Finance*

#### Term structure of interest rates

- Spot rates and forward rates
- Duration and convexity

#### Risk-neutral pricing

- Fundamental Theorem of asset pricing
- Binomial trees and replicating portfolios
- Girsanov Theorem

#### Expected utility

- Expected utility and certainty equivalent
- Risk-aversion
- Popular utility functions

### *Part III: Dynamic Analysis*

#### Ordinary differential equations (ODE's)

- Classification of ODE's, Cauchy problems
- Differential equations with separable variables
- First-order linear differential equations
- First-order linear differential systems
- Second-order linear differential equations

### Partial differential equations (PDE's)

- Classification of PDE's
- The method of separation of variables
- The Black-Scholes equation

### Dynamic programming

- Bellman's principle
- Applications in Finance

## **READING LIST**

- Baxter, M. and Rennie, A., "*Financial Calculus*", Cambridge, Cambridge University Press, 1996.
- Chiang, A., "*Fundamental Methods of Mathematical Economics*", New York, McGraw-Hill, 1984.
- Duffie, D., "*Dynamic Asset Pricing Theory*", Princeton, Princeton University Press, 1996.
- Hull, J. C., "*Options, Futures, and Other Derivatives*", New Jersey, Pearson Education, 2003.
- Neftci, S., "*An Introduction to the Mathematics of Financial Derivatives*", San Diego, Academic Press, 1996.
- Wilmott, P., Howison, S. and Dewyne, J., "*The Mathematics of Financial Derivatives*", Cambridge, Cambridge University Press, 1995.

Lecture notes and problem sets (with solutions) will be distributed each week.

## **EXAM**

The exam is written, closed-book and it consists of 3 exercises and 3 theoretical questions.