



UNIVERSITÀ  
DEGLI STUDI DI MILANO-BICOCCA

## COURSE SYLLABUS

### Equity Derivatives

2122-2-F1601M064-F1601M074M

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#### Learning objectives

The aim of the course is to provide students with the main mathematical and numerical tools useful for the evaluation of equity derivatives. Furthermore, during the course the main volatility models are presented.

#### Contents

*Black&Scholes and Ito's lemma for multivariate functions*

*Change of Numéraire technique.*

*Exchange and Exotic Options*

*Numerical Methods in Finance*

*Stochastic volatility models*

*Volatility derivatives*

#### Detailed program

*Black&Scholes and Ito's Lemma for multivariate functions:*

Limits of the Black and Scholes model.  
Normal Mixture model for option pricing.  
Ito's lemma for multivariate functions.

*Change of Numéraire technique:*

Introduction to the Change of Numéraire technique.  
Derivation of B&S formula using the Change of Numéraire technique

*Exchange and Exotic Options:*

Valuation of Exchange options through change of Numéraire.  
Exotic Options: path and non-path dependent.

*Numerical Methods in Finance I*

Iterative methods: Bisection, Secant and Newton-Raphson Methods and Calibration problem (Matlab functions: fmincon and fminunc)

Monte Carlo Simulation: Theory, Confidence Intervals and Variance Reduction techniques.  
Simulation of sample paths and application for option pricing.

*Numerical Methods in Finance II*

Monte Carlo Simulation for path dependent options.  
Binomial and Trinomial tree implementation (an introduction).

*Numerical Methods in Finance III*

Finite Difference Approximation: first and second derivative.  
Application of the finite difference method for the Greeks.

*Stochastic volatility models*

Stochastic Volatility: Derivation of the valuation Equation.  
Properties of Stochastic Volatility. Implied Volatility Surface.  
Heston Model: simulation, pricing formula and volatility surface.

*Volatility derivatives*

The log-contract replication formula.  
Variance and Volatility Swaps. VIX Index: CBOE Formula.

## **Prerequisites**

Good knowledge of financial math, derivatives and coding in Matlab.

## **Teaching methods**

Standard classes (theoretical aspects and practical implementations in Matlab).

## **Assessment methods**

### **Project work and subsequent oral examination**

**Final grade=0.4\*Grade of the project work+0.6\*Grade of the Oral Examination**

#### **Project work**

-Students will be organized in groups (2-3 students) and each group will receive an assignment related to some of the topics seen during the course. Data used will be downloaded from Bloomberg.

- Each group should produce a report on the assigned project work. Matlab codes used to produce the report should also be included.

#### **Oral examination**

-The oral exam and the final grade are individual.

-During the oral examination there be a discussion on the project and on the topics covered in the course.

## **Textbooks and Reading Materials**

Slides and Matlab codes will be provided by the teacher in the elearning page of the course.

J. Hull, 'Options, Futures and other derivatives', 7th edition in English (Prentice Hall).

P. Glasserman, 'Monte Carlo Methods in Financial Engineering' Springer Science, 2003

## **Semester**

First Semester

## **Teaching language**

Italian

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