# Derivatives

**Academic Year: ( 2023 / 2024 )** **Review date: 25-09-2023**

**Department assigned to the subject: Business Administration Department**

**Coordinating teacher: SERRANO JIMENEZ, PEDRO JOSE**

**Type: Compulsory ECTS Credits : 3.0**

**Year : 1 Semester : 1**

## REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Target Audience: This course is adequated for any student in the master (she could be an Economics, Engeniering, Matematicians, Physicist or from Business Administration bachelor).
Course Language: This course is totally taught in English.
The courses of Computer Science for Finance (First Term) and Financial Markets (First Term) should have been completed previously.
The exercises will be solved using a calculator and/or mathematical software.

## OBJECTIVES

The student will learn how to price and use vanilla derivative products written on equity and commodities. This includes designing a hedging strategy against financial and commodity price risk using positions in forwards, futures options and volatility. This requires the skills to compute precisely the value of any position in derivatives at any given point in time as well as to foresee its dynamics over time as a response to changes in the underlying variables.

Instructors of the course:
1.- Pedro Serrano (Associate Professor University Carlos III of Madrid, PhD)
2.- Miguel Artola (Bankinter, Teaching fellow at University Carlos III of Madrid, PhD)

## DESCRIPTION OF CONTENTS: PROGRAMME

The course provides a thorough grounding in the theory and practice of financial derivatives and financial engineering. The emphasis is on the application of derivatives pricing and hedging methodology to equity and commodity derivatives.
This syllabus lists and describes the topics covered in this course. In a nutshell, the course aims to cover the basics in derivatives theory, and to apply them to financial securities and commodity markets, with an introduction to recent products in the equity and volatility derivative worlds. We review selected exercises and case studies based on current data in order to gain a better understanding of their practical usage. We also implement the models numerically in Excel and Matlab.

DETAILED PROGRAM OF THE COURSE

Lecture 1: Introduction to Derivatives. Forwards and futures.

1.1 Introduction to Derivatives
1.2 Mechanics of Futures Markets
1.3 Hedging Strategies with Futures
1.4 Interest Rates
1.5 Determination of Futures Prices

Lecture 2: Options and Binomial Trees

2.1 Mechanics of Options Markets
2.2 Properties of Stock Options
2.3 European and American Call and Put prices
2.4 Binomial Trees
2.5 Continuous Time Limit

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Lecture 3: Introduction to Continuous Time Stochastic Processes

3.1. The Markov Property
3.2. Wiener Processes
3.3. Ito Process
3.4. Ito´s Lemma

Lecture 4: Continuous Time Stochastic Processes

4.1 Martingale Property
4.2 Geometric Brownian Motion
4.3 The Lognormal Property

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Lecture 5: Black-Scholes-Merton. Options in a Continuous-Time Framework.

5.1 Derivation of Black-Scholes-Merton Differential equation
5.2 Black-Scholes pricing formulas
5.3 Options on stock indices, currencies, and futures
5.4 Options as Volatility Instruments
5.5 Volatility term structure and volatility smile
5.6 The VIX index and volatility derivatives

Lecture 6: The Greeks and Their Uses

6.1 Naked, Covered Positions and Stop-Loss
6.2 Delta and Delta hedging
6.3 Gamma
6.4 Vega
6.5 Theta and Rho
6.6 Trading Strategies and Risk Management

## LEARNING ACTIVITIES AND METHODOLOGY

The course comprises different learning activities and methodologies:
1.- Teaching: Professor presents the main theoretical concepts using slides.
2.- Weekly problem sets in classes: students work on different problem sets based on real situations of the market. Students have to submit an individual report of the exercises every week.
3.- Programming: complementary to the teaching courses, Lectures 3 and 4 end with a program implementation of the theoretical concepts using mathematical software.
During the 2020/2021 academic year, the onsite teaching is maintained, and the structure and disposition of the classrooms will follow the public health measures indicated by the university.

## ASSESSMENT SYSTEM

Grades consist of:

- Exercise sets (40%). For any student, this mark is obtained by averaging the individual grade of each homework sets.
- A final examination (60%). It consists of a two-hour written exam. This exam comprises the usage of Excel for solving some cases and some theoretical questions related to the day-to-day classes.

Students that do not meet the minimum passing grade should retake the subject. If the resit is taken, the above grade criteria also apply

IMPORTANT: Final exam consists of two parts. There is a minium requirement of 4.0 out of 10.0 in EACH part of the final exam for passing the course.

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| **% end-of-term-examination:** | 60 |
| **% of continuous assessment (assigments, laboratory, practicals…):** | 40 |

## BASIC BIBLIOGRAPHY

- Ali Hirsa and Salih N. Neftci An Introduction to the Mathematics of Financial Derivatives, Academic Press - Elsevier, 2014, 3rd Edition
- John Hull Options, Futures, and Other Derivatives, Pearson Prentice Hall, 2006

## ADDITIONAL BIBLIOGRAPHY

- John Cochrane Asset Pricing, Princeton University Press, 2005
- Salih N. Neftci Principles of Financial Engineering, Elsevier, 2008