

# Course unit: Mathematical finance

## Course metadata

- Title in French: Mathématiques financières
- Course code: tba
- ECTS credits: 3
- Teaching hours: 72h
- Type: specialized course
- Language of instruction: English
- Coordinator: tba
- Instructor(s): Sébastien Darses (AMU), Ismaïl Akil (tba), Abderrahim Ben Jazia (RSM Paris)
- *Last update 27/08/2021 by C. Pouet*

## Brief description

The aim of the course is to provide students with mathematical methods that allow valuating financial assets.

This course unit is divided into three parts:

- **Stochastic calculus and introduction to the Black-Scholes model** (24 hours) taught by Sébastien Darses.
- **Volatility models** (24 hours) taught by Ismaïl Akil.
- **Interest rate models** (24 hours) taught by Abderrahim Ben Jazia.

## Learning outcomes

- Understand stochastic calculus and know how to apply its main results
- Know how to apply stochastic methods to price financial products
- Understand the mathematical contexts under which the classical financial mathematics models hold
- Know and understand the relevance and limits of financial mathematics models
- Understand the impact of volatility on the profit and losses of a hedged position
- Know how to build numerical methods for pricing financial products

## Course content

### Stochastic calculus and introduction to the Black-Scholes model

1. Gaussian variable and stochastic processes
2. Brownian motions
3. Stochastic integration and semi-martingales
4. Stochastic differential equations
5. Parabolic partial differential equations and semigroups
6. Measure change and Girsanov theorem

## 7. Introduction to financial mathematics

### Volatility models

1. Elementary financial mathematics notions
2. PDE: Black Scholes and risk neutral measure
3. Dupire's local volatility: advantages and drawbacks
4. Stochastic volatility (Heston and SABR)
5. Tutorial: discretization of the Heston's model

### Interest rate models

1. A Mathematical Toolkit
2. Interest rates, swaps and options
3. One-factor Short-Rates Models
4. Two-factor Short-Rates Models
5. The Heath-Jarrow-Morton (HJM) Model
6. The change of numeraire
7. Derivatives Pricing under the Libor Market Model

### Bibliography

Check the availability of the books below at [Centrale Méditerranée library](#). - Stochastic calculus

- Evans, L. (2010). An Introduction to Stochastic Differential Equation. American Mathematical Society.
- Le Gall, J.-F. (2006). Intégration, Probabilités et Processus Aléatoires. Ecole Normale Supérieure de Paris

#### - Volatility models

- El Karoui, N. (2004) Couverture des risques dans les marchés financiers. Ecole Polytechnique

#### - Interest rate models

- Brigo, D., & Mercurio, F. (2007). Interest rate models-theory and practice: with smile, inflation and credit. Springer Science & Business Media
- Privault, N. (2012). An elementary introduction to stochastic interest rate modeling. World Scientific.

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