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 Health-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 Marseille 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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