Course unit: Mathematical finance

** Beware! Under construction. **

Course metadata

- Title in French: Mathématiques financières
- Course code: tba
- ECTS credits: 4
- Type: specialized course
- Semester 10 (Spring)
- Teaching period: Mid-February to Mid-April
- Teaching hours: 100h
- Language of instruction: English
- Coordinator: tba
- Instructor(s): Ismaïl Akil (Millenium), Abderrahim Ben Jazia (Meta Modelling), David Thai (position in a Hedge Fund), Sitraka Forler (Post Luxembourg), Lirone Samoun (smartpush)
- *Last update 02/09/2025 by C. Pouet*

Brief description

The aim of the course is to provide students with mathematical methods that allow valuating financial assets. Several instructors are Centrale Méditerranée alumni.

This course unit is divided into four parts:

- ** Stochastic calculus and introduction to the Black-Scholes model ** (24 hours) taught by David Thai.
- ** Volatility models ** (24 hours) taught by Ismaïl Akil.
- ** Interest rate models ** (24 hours) taught by Abderrahim Ben Jazia.
- ** Data Project: modeling and validation ** (20 hours) taught by Sitraka Forler and Lirone Samoun.

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

Data Project: modeling and validation

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Bibliography

You can 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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