

## **Finance and Derivatives (coordinator: E. Vannucci)**

### **Course Description:**

Pricing and hedging techniques of the major derivative contracts. First, the binomial model framework is used to introduce the ideas of absence of arbitrage, completeness (perfect replication of any derivative) and consequent unique pricing rule. Pricing of American and Exotic options. In more general tree models perfect replication may not be possible, namely the market is incomplete. On the basis of these examples we illustrate the first and second fundamental Theorems of the Asset Pricing, which are the basis of the use of martingale methods in Finance. Then, we focus on continuous trading market models, specifically the Black-Scholes Merton model: absence of arbitrage, pricing and Delta hedging. The Black-Scholes evaluation PDE for European options is derived. Simulation methods for the evaluation of exotic derivatives are described. Discrete time hedging error. Beyond Black-Scholes: volatility smile.

### **Objectives:**

Skills: mathematical interpretation of the derivative contract, with ability to price and compute the hedging Greeks in specific models

Knowledge: basic financial principles and issues; major derivative contracts; classic pricing models: binomial and trinomial trees, and the Black-Scholes Merton model;

Attitudes: mathematical approach to the complex financial world. This is the key to concretely produce numbers for evaluation and hedging, but a critical attitude is essential to prevent overconfidence.

### **Main Contents:**

1. Binomial model: self-financing portfolio, absence of arbitrage, completeness
2. Pricing of European derivatives
3. Pricing of American and Exotic derivatives along the tree
4. Trinomial tree and market incompleteness
5. First and Second Fundamental Theorems of Asset Pricing in a nutshell
6. Black-Scholes-Merton (B-S-M) model; self-financing portfolios in continuous time
7. Absence of arbitrage, completeness and hedging of European derivatives in B-S-M model
8. Evaluation PDE for European options in B-S-M model
9. Topics in practical hedging: discretization error
10. Beyond Black-Scholes: volatility smile and surfaces