

FIN-404

**Derivatives**

Hugonnier Julien

Cursus	Sem.	Type
Financial engineering minor	E	Opt.
Financial engineering	MA2, MA4	Obl.
Statistics	MA2, MA4	Opt.

Language of teaching	English
Credits	6
Session	Summer
Semester	Spring
Exam	Written
Workload	180h
Weeks	14
<b>Hours</b>	<b>5 weekly</b>
Courses	3 weekly
Exercises	2 weekly
<b>Number of positions</b>	

**Summary**

This course provides a detailed presentation of the standard models for the valuation and hedging of derivatives products such as European options, American options, forward contracts, futures contract and exotic options.

**Content****Part I: Discrete-time models**

- Introduction to derivatives products and markets
- Model free results and static models
- Multiperiod discrete-time models
- American options and applications
- Convergence

**Part II: Continuous-time models**

- Arbitrage, valuation and hedging in continuous-time
- The Black-Scholes model
- Foreign exchange products
- American derivatives
- Implied, local, and stochastic volatility
- Exotic options

**Keywords**

Derivatives, options, arbitrage valuation, hedging

**Learning Prerequisites****Required courses**

- Introduction to finance
- Stochastic calculus

**Recommended courses**

- Econometrics

### Important concepts to start the course

To follow this course students need to have taken an introduction to finance, and must possess solid foundations in probability theory and stochastic calculus.

### Learning Outcomes

By the end of the course, the student must be able to:

- Describe the principal types of derivatives contracts including forwards, futures and options and compare their basic usages for hedging or speculation
- Describe and analyse the most common types of options strategies such as spreads, straddles, collars, and covered calls or puts.
- Formulate the no-arbitrage principle and illustrate its basic application in a model-free setting: cash and carry relations for different types of underlying securities with or without dividends, put/call parity, arbitrage bounds on option prices, early exercise of American options.
- Discuss the main characteristics of a general discrete time model with finitely many states of nature, multiple securities and possibly stochastic interest rates.
- Work out / Determine whether a given discrete-time model with finitely many states of nature is arbitrage free and has complete markets; Relate these properties to the existence and uniqueness of an equivalent martingale measure.
- Discuss and apply risk-neutral valuation to price and hedge derivatives of either European or American type in the context of a given discrete time model with finitely many states and complete markets.
- Construct and implement a binomial model to price and hedge both plain vanilla derivatives of European or American type as well as any exotic derivative.
- Describe the main assumptions of the Black-Scholes model and its limitations, derive the valuation partial differential equation and the Black-Scholes-Merton formula for the price of standard European options.
- Discuss the main option Greeks and use them appropriately for risk management and financial engineering purposes in the context of the Black-Scholes model or its extensions to futures contracts and foreign exchange.
- Work out / Determine whether a general Brownian-driven model of financial markets admits an equivalent martingale measure, relate the uniqueness of this probability measure to market completeness, and derive the risk-neutral dynamics of traded securities prices and relevant state variables.
- Derive the partial differential equation satisfied by the price of a European derivative in a given Markovian model, and use it with appropriate boundary conditions to price options in specific models.
- Formulate the valuation of American options as a free boundary problem for the valuation PDE in the context of the Black-Scholes model, derive and discuss exact solutions for the infinite horizon case and the Barone-Addeesi-Whaley approximation for the finite horizon case.

### Transversal skills

- Plan and carry out activities in a way which makes optimal use of available time and other resources.
- Evaluate one's own performance in the team, receive and respond appropriately to feedback.
- Continue to work through difficulties or initial failure to find optimal solutions.
- Use both general and domain specific IT resources and tools

### Teaching methods

Lectures and exercise sessions

### Expected student activities

- Participate in weekly lectures

- Participate in weekly exercise sessions
- Turn in assignments/projects
- Write a midterm exam (30%) and a final exam (40%)

### Assessment methods

- Assignment/Project: 30%
- Midterm exam: 30%
- Final exam: 40%

### Resources

#### Bibliography

- K. Back, A course in derivative securities, Springer Verlag, New York, 2005.
- N. Bingham and R. Kiesel, Risk neutral valuation, Springer Verlag, New York, 2004.
- J. Hull, Options, futures and other derivatives, Prentice Hall.
- D. Lamberton & B. Lapeyre, Introduction to stochastic calculus applied to finance, Second edition, Chapman and Hall, 2008.
- S. Shreve, Stochastic Calculus for Finance I and II, Springer Verlag, New York, 2004.
- T. Bjork, Arbitrage theory in continuous-time, 2nd Edition, Oxford University Press, New York, 2004

#### Ressources en bibliothèque

- [Risk neutral valuation / Bingham](#)
- [Arbitrage theory in continuous-time / Bjork](#)
- [Introduction to stochastic calculus applied to finance / Lamberton](#)
- [Stochastic Calculus for Finance / Shreve](#)
- [A course in derivative securities / Back](#)
- [Options, futures and other derivatives / Hull](#)

#### Moodle Link

- <https://go.epfl.ch/FIN-404>

### Prerequisite for

- Advanced derivatives
- Financial econometrics (taken concurrently)
- Interest rate and Credit risk models
- Quantitative Risk Management
- Real options and financial structuring