Summary
Participants of this course will master computational techniques frequently used in mathematical finance applications. Emphasis will be put on the implementation and practical aspects.

Content
1. Brief introduction to option pricing
   - Basic stochastic models in finance
   - Basic tools of stochastic calculus
   - Monte Carlo simulation based methods

2. Transformation based methods
   - Affine models
   - Option pricing via Fourier transforms

3. Density approximation techniques
   - Polynomial models and calculation of moments
   - Option pricing via density approximation

4. Option pricing via PDE models
   - Finite difference approximation of Black-Scholes PDE
   - American options and free boundary problems
   - Jump-diffusion processes and integro-differential equations

Keywords
financial models, stochastic calculus, option pricing, numerical methods, Matlab, Monte Carlo simulation, PDE, Fourier transform, density approximation techniques, volatility surface

Learning Prerequisites
Recommended courses
- Stochastic processes / stochastic calculus
- Numerical Analysis
- Introduction to Finite Elements
- Derivatives

Important concepts to start the course
- Basic background in numerical analysis, linear algebra, and differential equations.
- Command of Matlab.

Learning Outcomes
By the end of the course, the student must be able to:
• Choose method for solving a specific pricing or calibration problem.
• Implement numerical algorithms.
• Interpret the results of a computation.
• Recall the advantages and limitations of different methods.
• Assess / Evaluate the performance of several financial models.
• Compare the results from different pricing algorithms.
• Recall the basic concepts behind the theory of option pricing in financial models.
• Choose method for solving a specific pricing problem.

Transversal skills
• Use a work methodology appropriate to the task.

Teaching methods
Ex cathedra lecture, exercises in the classroom and with computer.

Expected student activities
Attendance of lectures.
Completing exercises.
Solving problems on the computer.

Assessment methods
60% of the grade is determined by a computer-based final examination. 40% of the grade is determined by take-home exams / graded exercises.

Resources
Virtual desktop infrastructure (VDI)
No

Bibliography

Hilber, Norbert; Reichmann, Oleg; Schwab, Christoph; Winter, Christoph. Computational methods for quantitative finance. Springer, 2013.


Lamberton, Damien; Lapeyre, Bernard. Introduction to stochastic calculus applied to finance. Second

Additional lecture material will be provided by the instructors.

Ressources en bibliothèque

• Computational methods for quantitative finance / Hilber
• Arbitrage theory in continuous time / Björk (order in process)
• Stochastic calculus for finance II: Continuous-Time models / Shreve
• Computational methods in finance / Hirsa
• Introduction to stochastic calculus applied to finance / Lamberton
• Computational methods for option pricing / Achdou
• Tools for computational finance / Seydel
• Monte Carlo methods in financial engineering / Glasserman

Notes/Handbook

• Computational methods in finance / Hirsa
• Computational methods for quantitative finance / Hilber
• Tools for computational finance / Seydel
• Computational methods for option pricing / Achdou
• Monte Carlo methods in financial engineering / Glasserman
• Arbitrage theory in continuous time / Björk
• Stochastic calculus for finance II: Continuous-Time models / Shreve
• Introduction to stochastic calculus applied to finance / Lamberton