Mathematical Methods in Finance

Master's in Mathematical Finance

1º Semester of 2025/2026

Lecturer Team:

- Carlos Oliveira (Course Coordinator) - carlosoliveira@iseg.ulisboa.pt
    - Office hours: Monday from 10am to 12pm
- Nuno M. Brites - nbrites@iseg.ulisboa.pt
    - Office hours: Monday from 10am to 12pm

Students should contact in advance the lecturer by email to book an appointment preferable 48 hours before it.

Course Syllabus

1. Overview of linear algebra and differential calculus
2. Optimization in R^n
    a. Optimization without constraints
    b. Optimization with constraints
    c. Portfolio Optimization and Risk Measures
3. Ordinary and Partial differential equations
    a. First and second order ODEs
    b. PDEs
4. Basic concepts of option theory
    a. European and American options.
    b. The Black-Scholes model.
    c. The Black-Scholes equation.
    d. Explicit Solution for European Call and Put Options
5. Free boundary problems and variational inequalities
    a. American Options
    b. Real Options
6. Introduction to R
    a. R and RStudio, R basics, Data structures
    b. Functions, Loops and flow control
    c. Simulation and optimization, Graphics
7. Computational Option Pricing
    a. Introduction
    b. The binomial model (one-period and multiperiod)
    c. Portfolios and arbitrage
    d. Risk-neutral pricing
    e. R packages for the binomial model
    f. Brownian motion
    g. The Black-Scholes formula

h. Greeks

Bibliography

- Giorgi, Giorgio, Bienvenido Jiménez, and Vicente Novo. Lectures on Mathematics for Economic and Financial Analysis. Springer, 2025.
- Wilmott, Paul. Jeff Dewynne, Sam Howison. Option Pricing: Mathematical Models and Computation. Oxford Financial Press, 1993
- Brites, N. M. (2024) Mathematical Methods in Finance - Lecture notes. Available at https://cemapre.iseg.ulisboa.pt/~nbrites/MMF
- Ohsaki, S., Ruppert-Felsot, J. and Yoshikawa, D. (2018) R Programming and Its: Applications in Financial Mathematics. Taylor & Francis. ISBN: 9781498766098.
- Bjork, T. (2009) Arbitrage Theory in Continuous Time. Third edition. Oxford. ISBN: 9780199574742.

Assessment

- The assessment consists of a final exam, which is composed of two parts: one theoretical and one computational (no personal laptop is required).
- No consultation materials are permitted during the exam.
- Students may bring a calculator, provided it does not have graphical capabilities.
- Mobile phones, laptops, and any devices with communication functions or digital storage are strictly prohibited. Their use or presence near the student will result in the cancellation of the exam and further sanctions as defined by ISEG and the University of Lisbon.

Scheduele

- Lectures take place in room 109, Building F2, during September and October, and in room 111, Building F1 during November.
    - Mondays: 15:30 – 17:30
    - Tursday: 15:00 – 17:30