Baruch College, CUNY
MTH 4115, Numerical Methods in Finance
4 Hours - 4 Credits

Enrollment Requirements.

Pre-requisite: MTH 3020, MTH 3030, or MTH 3050
Pre- or co-requisite: MTH 4100.

Programming. Programming is required in this course.

Calculator. You will need a calculator in the quizzes and exams.

Lecture#	Topic
1	Binary numbers
2	Floating point representation
3	Loss of significance&Review calculus
4	Bisection method&Fixed-point interation
5	Newton's method
6	Numerical differentiation
7	Newton-Cotes formulas
8	Initial value problems
9	Analysis of IVP solvers, part 1
10	Exam 1
11	Analysis of IVP solvers, part 2
12	Runge-Kutta methods
13	Implicit methods and stiff equations
14	N-step tree model and American options
15	Brownian motion and stochastic integration
16	Stochastic differential equation and Itô formula
17	The Black-Schole formula
18	Forward difference method for parabolic equations
19	Stability analysis for finite difference method
20	Exam 2
21	Backward difference method
22	Crank-Nicolson method
23	Black-Scholes equation
24	Pricing a vanilla European option by an explicit method
25	Pricing a vanilla European option by a fully implicit method
26	Pricing a barrier option by the Crank-Nicolson method
27	Monte Carlo method for SDE and option pricing
28	Review

Text.

1. Timothy Sauer, *Numerical Analysis, 3e,* Pearson, 2019.
   Chapters 0.3-0.4, 1, 2, 5.1-5.2, 6, 7, 8, 9*.

2. Paolo Brandimarte, *Numerical Methods in Finance and Economics A MATLAB-Based Introduction, 2e,* John Wiley & Sons, Inc., 2006.

   Chapters 2, 8*, 9.

3. Instructor's notes.

   $*$ if time allows.

Suggested reading:

- Dan Stefanica, *A Primer for the Mathematics of Financial Engineering*, Financial Engineering Advanced Background Series. FE Press, LLC, 2011.
- John Hull, *Options, Futures, and Other Derivatives, 11e*, Pearson, 2021,
- Manfred Gilli, Dietmar Maringer, and Enrico Schumann, *Numerical Methods and Optimization in Finance, 2e*, Academic Press, 2018.

Learning Objectives.

This course introduces and applies various numerical and computational techniques useful to tackle problems in mathematical finance, including root solving methods and their properties, systems of equations and matrix factorizations, numerical differentiation and integrations and error analysis, the finite difference method for both ordinary and partial differential equations and stability.

The focus of this course is the pricing of the derivative security and related issues. We will discuss the PDE approach and compare it with the other main approaches, namely the tree models and the Monte Carlo methods. The course will provide students with practical numerical tools for financial derivatives valuation.