

## MATH-UA 250, MA-UY 4324 – Mathematics of Finance - Fall 2020

**Instructor** – Amir Sadr, as73@nyu.edu

**Time:** M, W, 9:30-10:45am, Recitation: F 12:30-1:45pm

**Location:** Online, Zoom invite will be posted on course website at classes.nyu.edu

**Office Hours:** Mondays 2-4pm or by Appointment (Email for a time)

### Course Description

Introduction to the mathematics of finance. Topics include: Linear programming with application pricing and quadratic. Interest rates and present value. Basic probability: random walks, central limit theorem, Brownian motion, lognormal model of stock prices. Black-Scholes theory of options. Dynamic programming with application to portfolio optimization.

### Prerequisites

MATH-UA 123 Calculus III or MATH-UA 213 Math for Economics III (for Economics majors), and an introductory course in probability or statistics (MATH-UA 233 Theory of Probability, MATH-UA 235 Probability and Statistics, ECON-UA 18 Statistics, ECON-UA 20 Analytical Statistics, STAT-UB 103 Statistics for Business Control and Regression/Forecasting Models, or equivalent) with a grade of C+ or better.

### Programming

- **Required:** The course will use Excel and its statistical tools and financial functions in lecture notes and homework assignments.
- *Optional:* Students can instead use **Python 3.x** together with a scientific stack (*numPy, SciPy, pandas, matplotlib*) - **Anaconda 3.x** distribution (Python+scientific stack+...) is highly encouraged, <https://www.anaconda.com/products/individual>.

### Textbook

*None:* Lecture notes and extra material will be provided before each class on course website at classes.nyu.edu

### Grading

- 50% based on homework assignments, including Excel spreadsheet calculations
- 20% In-class Midterm
- 30% In-class Final

**Syllabus** - See next page

**MATH-UA 250, MA-UY 4324 – Mathematics of Finance - Fall 2020 - Syllabus**

<b>Session</b>	<b>Date</b>	<b>Syllabus</b>	<b>Test, HW</b>	<b>Grade %</b>
Lecture 1	Wed, Sep 02	Finance, Market Participants, Money, Time Value		
Lecture 2 Recitation	<del>Mon, Sep 07</del> Wed, Sep 09 Fri, Sep 11	<del>Labor Day – No Classes Scheduled</del> PV, FV, Rates, Simple vs. Compounding		
Lecture 3 Lecture 4 Recitation	Mon, Sep 14 Wed, Sep 16 Fri, Sep 18	Interest rates, Single cash flows, Yield, IRR Bonds, Level pay loans, Root solving		
Lecture 5 Lecture 6 Recitation	Mon, Sep 21 Wed, Sep 23 Fri, Sep 25	Sensitivities, PV01, Convexity Numerical derivatives, Taylor series	HW # 1 Due	10%
Lecture 7 Lecture 8 Recitation	Mon, Sep 28 Wed, Sep 30 Fri, Oct 02	Random returns, Risk appetite Utility Theory, Markowitz Mean-Variance Theory		
Lecture 9 Lecture 10 Recitation	Mon, Oct 05 Wed, Oct 07 Fri, Oct 09	Efficient Frontier, MVP, Lagrange Multipliers Risk-Free Asset, Market portfolio, CAPM	HW # 2 Due	10%
Lecture 11 Lecture 12 Recitation	Mon, Oct 12 Wed, Oct 14 Fri, Oct 16	Performance Ratios, Regression, Z-Score Paradoxes, Kelly's Criterion, Gambler's ruin		
Lecture 13 Lecture 14 Recitation	Mon, Oct 19 Wed, Oct 21 Fri, Oct 23	Forward contracts, Cash and carry Binomial model, No arbitrage, Self-financing	HW # 3 Due	10%
Lecture 15 <b>Lecture 16</b> Recitation	Mon, Oct 26 <b>Wed, Oct 28</b> Fri, Oct 30	Risk-neutral valuation, CRR model <b>In-class Midterm</b>		<b>20%</b>
Lecture 17 Lecture 18 Recitation	Mon, Nov 02 Wed, Nov 04 Fri, Nov 06	Random walk, Brownian Motion, Black-Scholes Black-Scholes PDE, Greeks		
Lecture 19 Lecture 20 Recitation	Mon, Nov 09 Wed, Nov 11 Fri, Nov 13	Strategies: Straddles, strangles, call-spreads, ... American options, Backward induction		
Lecture 21 Lecture 22 Recitation	Mon, Nov 16 Wed, Nov 18 Fri, Nov 20	Path-dependent Options, Simulation Options review	HW # 4 Due	10%
Lecture 23 Lecture 24 Recitation	Mon, Nov 23 Wed, Nov 25 Fri, Nov 27	Interest rate curves, Yield Curve Bootstrap method, interpolation		
Lecture 25 Lecture 26 Recitation	Mon, Nov 30 Wed, Dec 02 Fri, Dec 04	Interest rate models Arrow-Debreu prices, Forward induction	HW # 5 Due	10%
Lecture 27 Lecture 28 Recitation	Mon, Dec 07 Wed, Dec 09 Fri, Dec 11	Interest rate options Review		
	<b>Wed, Dec 16</b>	<b>In-Class Final</b>		<b>30%</b>
			Total	<b>100%</b>