# Derivatives

### MAE, Module 2, 2019-2020

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## Course information

**Course Website:** https://my.nes.ru

**Instructor's Office Hours:** by assignment

**TAs:** TBD

## Course description

The course is an introduction to the theory and practice of derivative instruments. It will cover the non–arbitrage pricing of forward and futures contracts, binomial and Black–Scholes–Merton model for option pricing, hedging and replication of derivatives and other important topics. The material will be particularly relevant to students interested in financial markets, securities trading and structured products development involving derivatives.

## Course requirements, grading, and attendance policies

Prerequisites:
1. Calculus
2. Probability, statistics
3. An introductory finance course

Grading:

| 3 homework problem sets | 30% (each 10%) |
|---|---:|
| Game | 10% |
| Exam | 60% |

## Course contents

- **Introduction to Derivative instruments**
- **Forward and Futures contracts**: Arbitrage arguments. Pricing by arbitrage. Investing, trading, hedging, and arbitrage applications. Foreign exchange, equity, and commodity markets.
- **Interest Rate Review**: Interest rate curve. Compounding period. Forward interest rate. Swaps.
- **Introduction to Options**: Option basics. Model–free properties of option prices. Arbitrage relationship. The binomial model of asset price dynamics. Risk neutral valuation.
- **The Black–Scholes Model**: Modeling stock price behavior. Geometric Brownian motion. Lognormal distribution. Risk–neutral valuation. The Black–Scholes–Merton option pricing formula.
- **Hedging**: Option hedging. Greeks . Synthetic replication and hedging of options. Option hedging. Delta hedging. Greeks. Portfolio Insurance.
- **Volatility**: Implied volatility. Implied distribution. FX and equity smiles. The volatility surface and term structure. Historical versus implied volatility.
- **Structured Products**: Capital protected and Yield enhancement products.

## Description of course methodology

- Lectures
- Homeworks
- In-class simulation: derivative game

## Sample tasks for course evaluation

**Exotic call**:
This option has the standard call payoff pays $\max(S_T-K,0)$ at expiration T. However, the holder of the option  does not pay any premium upfront when the contract is set up, but must pay a fixed cash amount Q to the option writer at expiration only if $S_T>K$ . Derive a closed-form formula for this cash amount Q to be paid at expiration if the option expires in-the-money, and use the formula to compute Q when S=K=100, T=1Y, vol=25%, r=2%, q=1%

## Course materials

### Textbooks and materials

- Lecture notes
- John Hull, "Options, Futures, and Other Derivatives"
- Paul Wilmott on Quantitative Finance

## Academic integrity policy

Cheating, plagiarism, and any other violations of academic ethics at NES are not tolerated.