**Федеральное государственное автономное образовательное учреждение высшего образования**
**"Национальный исследовательский университет**
**"Высшая школа экономики"**


Факультет экономических наук
Департамент финансов


**Рабочая программа дисциплины «Количественные финансы»**
(Quantitative Finance)


для образовательной программы «Финансовые рынки и финансовые институты»
направления 38.04.08 «Финансы и кредит»
подготовки магистра

Разработчики программы
Лапшин В.А., доцент, vlapshin@hse.ru, bdemeshev@hse.ru

Одобрена на заседании департамента финансов
«___»_____ 201_ г.
Руководитель департамента
И.В. Ивашковская_____

Утверждена Академическим советом образовательной программы «Финансовые рынки и финансовые институты»
«___»_____ 201_ г., № протокола_____

Академический руководитель образовательной программы
Т.В. Теплова _____


Москва, 2016

# Syllabus

*Faculty of Economic Sciences*

**Quantitative Finance (fall semester)**

**Victor Lapshin, Boris Demeshev**

Class Times and Locations

Email: vlapshin@hse.ru, bdemeshev@hse.ru

Phone

Office Location

Office Hours

## Section 1.  General information about the course

- Modern banks, investment companies and other financial institutions can't be thought of without quantitative analysis. The people involved, quantitative analysts (quants), are often considered the 'elite' of financial analysts.
- This course provides an introduction to the exciting world of pricing derivative instruments via solving stochastic equations and numerical procedures on a computer. You will learn the basics of stochastic processes in continuous time: martingales, Ito's lemma, stochastic differential equations and some other words, which are used by quants in their everyday conversations. You will also learn how to find the price of a derivative instrument numerically, using a computer, and why modern banks buy supercomputers. Most of the methods considered will be Monte-Carlo methods, which is one of the main modeling tools in derivative pricing.
- The theoretical part of the course will assume that the student is knowledgeable in probability theory, calculus and basic financial instruments (stocks, bonds, futures, options and swaps). Taking the 'Derivatives II' course prior to this one is recommended, but not required. The computer part of the course will be using the Matlab software and will assume either basic programming knowledge (a high-school-level course will suffice: you need to know the notions of variables, loops and functions) or the readiness to acquire it.
- This is not a 'push-this-button-to-get-the-answer' course. Be ready to spend several hours in front of a computer each week (more if you are only learning programming at the same time).

## Section 2. Course goals, learning objectives, expected  learning outcomes

The course aims to provide students with an overview of the tools and methods used in quantitative finance. This includes both theoretic topics (elements of stochastic processes in continuous time) and practical computer-oriented skills (using a computer for numerical computations, including Monte-Carlo methods).

A successful student is expected to:

- Be knowledgeable of basic notions of stochastic processes in continuous time, stochastic differential equations (SDEs) and their solutions, both analytic and numerical, methods of simulation modeling, and pricing derivative instruments.

- Be able to solve simple SDEs, both analytically and numerically, to plan and carry out simulation-based computations using a computer, and to price financial instruments.

## Section 3.  Course Outline

| № | Topic/Focus/Activity | Week | Course format (in hours) | | | | | Readings and assignments |
|---|---|---|---|---|---|---|---|---|
| | | | Total | lectu | seminars | practical | independe | |
| 1.1 | Martingales, Brownian Motion | 1 | 14 | 2 | | 4 | 8 | |
| 1.2 | Stochastic Integral and Ito formula | 2 | 14 | 2 | | 2 | 10 | |
| 1.3 | Stochastic Differential Equations | 3 | 12 | 2 | | 2 | 8 | |
| 1.4 | Change of Measure and Girsanov Theorem | 4 | 12 | 2 | | 2 | 8 | |
| 1.5 | Analytic Solutions of SDEs | 5 | 12 | 2 | | 2 | 8 | |
| 1.6 | Numerical Solutions of SDEs. | 6 | 14 | 2 | 2 | 2 | 8 | |
| 1.7 | Transition Densities and Kolmogorov-Chapman equations. | 7 | 10 | | | 2 | 8 | |
| 1.8 | Midterm Exam | | | | | | | |
| 2.1 | Foundations of Simulation Modeling: Random Number Generators | 8 | 16 | 2 | 2 | 2 | 10 | |
| 2.2 | Risk-Neutral Pricing. Basic Methods of Pricing: Tree-based, PDE-based, SDE-based. | 9 | 14 | 2 | | 2 | 10 | |
| 2.3 | Simulating SDEs Using Transition Densities. | 10 | 12 | 2 | | 2 | 8 | Home Assignment 1: Basic Monte-Carlo Derivative Pricing |
| 2.4 | Pricing Path-Dependent Instruments | 11 | 12 | 2 | | 2 | 8 | |
| 2.5 | Basic Interest Rate Models | 12 | 12 | 2 | | 2 | 8 | |
| 2.6 | Variance Reduction Techniques | 13 | 10 | | | 2 | 8 | |
| 2.7 | Sensitivity Analysis | 14 | 12 | | | 2 | 10 | |
| 2.8 | Risk Analysis Using Monte-Carlo | 15 | 14 | | | 4 | 10 | Home Assignment 2: Advanced Monte-Carlo Derivative Pricing |
| | **Total** | | **190** | **22** | **4** | **34** | **130** | |

Description of course methodology and forms of assessment to be used:_____

## Section 4. Texts, readings and other informational resources

1.  Required readings:
    - Glasserman P. Monte-Carlo Methods in Financial Engineering. Springer. 2004.
    - Shreve S. Stochastic Calculus for Finance II. Springer. 2004.
    - Oksendal B. Stochastic Differential Equations. Springer 2003.
2.  Additional readings:
    - Bjork T. Arbitrage Theory in Continuous Time. Oxford University Press. 2009.
    - Wilmott P. Paul Wimott on Quantitative Finance. Wiley. 2006.
3.  Websites and other informational resources (databases, software, etc.)
    - Integrated Help for Matlab Software

## Section 5. Examination/Evaluation

- The course consists of two parts, theoretical and practical. Each contributes 50% to the overall mark.
- The theoretic part is marked by means of a written exam with problem-solving-like tasks.
- The practical part is marked using 2 home assignments, each contributing 25%.

## Section 6. Academic Integrity

The Higher School of Economics strictly adheres to the principle of academic integrity and honesty. Accordingly, in this course there will be a zero-tolerance policy toward academic dishonesty. This includes, but is not limited to, cheating, plagiarism (including failure to properly cite sources), fabricating citations or information, tampering with other students' work, and presenting a part of or the entirety of another person's work as your own. HSE uses an automated plagiarism-detection system to ensure the originality of students' work. Students who violate university rules on academic honesty will face disciplinary consequences, which, depending on the severity of the offense, may include having points deducted on a specific assignment, receiving a failing grade for the course, being expelled from the university, or other measures specified in HSE's Internal Regulations.