

**ICEF, Higher School of Economics Moscow
MSc Programme in Financial Economics
2019-2020 academic year**

Course Syllabus for

Derivatives

Lecturer Part 1: Dmitry Makarov

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Lecturer Part 2: Brian Eales

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Course description

Prerequisites: Financial Economics 1, intermediate calculus, probability theory

The course consists of two parts. The first part examines fundamental topics and approaches in derivative pricing; it is taught by Dmitry Makarov. The second part focuses on practical aspects of applying derivative pricing techniques; it is taught by Brian Eales.

The objective of Part 1 of the course is to undertake a rigorous study of derivative financial instruments. The course is quantitatively oriented and requires some background in calculus and statistics.

Derivative financial instruments are instruments whose value is “derived” from the value of some underlying asset or assets. Our goal is to learn how to price such instruments using a no-arbitrage principle, and how to hedge them.

The course will be particularly relevant to students interested in financial markets, securities trading and structured products development involving derivatives.

At the end of Part 1, my hope is that students will obtain two types skills. First, students will know key properties of standard derivative instruments, such as forwards, futures, swaps, and call and put options. Second, students will be comfortable with analyzing new derivative products using the techniques presented in class.

Part 2 will provide a thorough understanding of the applications to which derivative securities can be put in modern financial markets. It will cover the operational characteristics of the instruments and the infra-structure in which they operate. The course will start with a review of the major derivative exchanges and an overview of the instruments offered and a distinction will be drawn between Exchange-based and off-exchange instruments. The course will examine some of the applications to which stock and index equity futures and options can be put and will also

examine single and multi-period hedging of interest rates. Towards the end of the course participants will be introduced to asset swaps, total return swaps, credit default swaps and financially engineered equity products.

Learning objectives and outcomes

At the conclusion of the course, the students are expected to acquire the following skills:

1. Ability to create new theories, invent new ways and tools of professional activity.
2. Ability to analyze, verify, evaluate the completeness of information in the course of professional activities, if necessary, to fill and synthesize the missing information.
3. Ability to develop strategies for the behavior of economic agents in different markets
4. Ability to present the results of the study to the scientific community in the form of an article or report
5. Ability to carry out applied and / or fundamental research, using advanced methods of economic analysis, including instrumental

Methods of instruction

The following methods and forms of study are used in the course

- Lectures
- Seminars. They serve mainly to solve the homework assignments.
- Written homework assignments, containing paper-and-pencil exercises and applications in Matlab.
- Self-study: read the corresponding sections in the lecture notes, the chapters in the textbooks as indicated in the course outline below and journal papers as announced in class.

Reading list

- 1) Hull, J., *Options, Futures, and Other Derivatives*, Prentice-Hall (the edition does not matter) (H)
- 2) Willmott, P., *Paul Willmott on Quantitative Finance*, Wiley (the edition does not matter)
- 3) Eales, B. A. & Choudhry, M. (2003), *Derivative Instruments: a Guide to Theory and Practice*, Elsevier (E)

Supplementary Readings

- 1) Kat, H. M (2001), *Structured Equity Derivatives*, Wiley Finance (K)
- 2) Kolb, R. W. & Overdahl, J. A. (2007), *Futures, Options and Swaps* 5th edition, Blackwell (K)
- 3) Das, S. (2006), *Structured Products Volume 2*. Wiley (D).

Grading System and Examination Type

- The total grade for the course is

$$TotalGrade=0.7*Part1+0.3*Part2$$

- *Part1* is the grade for Part 1 of the course. It is computed as

$$Part1=0.25*HA+0.75*Exam$$

where *HA* is the grade for home assignments, and *Exam* is the grade for the final exam. The exam is in written form, and includes problems based on only Part 1 of the course

- *Part2* is the grade for a written Test that takes place after Part 2 of the course.

All grades are given initially out of 100. The final grades are also transferred to 10 and 5 points grades in accordance with the ICEF Grading Regulations (par.3) available at https://icef-info.hse.ru/goto_icef_file_29837_download.html

Retakes are organized in accordance with the [HSE Interim and Ongoing Assessment Regulations](#) (incl. Annex 8 for ICEF). Grade determination after retakes is done in accordance with ICEF Grading Regulations (par. 5) available at https://icef-info.hse.ru/goto_icef_file_29837_download.html

Course plan

Part 1: Fundamentals of derivative pricing

1) Overview:

Historical background and milestones in the development of derivative markets

Key concepts: replication, underlying security, no arbitrage, relative versus absolute pricing

Popular derivative instruments: forwards, futures, options

2) Option pricing: static and discrete-time analysis

No arbitrage bounds on option prices.

Types of options: European, American, Bermudan, Asian, etc.

Binomial option pricing models: building binomial trees, pricing on the tree, risk neutral tree probabilities

3) Option pricing in continuous time

Mathematics of option pricing: Brownian motion, Ito's processes, Ito's lemma, partial differential equations, martingale approach

Pricing and replication in continuous time, Black-Scholes formula, option greeks,

Empirical evaluation of Black-Scholes formula, volatility smile

4) Pricing with multiple sources of uncertainty

Traded and non-traded risks, stochastic volatility and stochastic interest rate models, market price of risk, pricing convertible bonds

5) Structural and reduced-form models of credit risk

Defaultable bonds, bond as an option, credit rating, risky yield curve

Part II: Applications of Derivative Securities

Day 1. Exchange-based and OTC derivatives

Exchange-based derivatives (ETDs): Futures and options – contract specifications, operational characteristics.

Over-the-counter (OTC) derivatives: Forwards, Options.

Hedging an equity portfolio with futures.

Exchange Trade Funds (ETFs), Universal Stock futures (USFs and SSFs), speculation, arbitrage, ‘Chasing alpha’. Portfolio engineering using exchange-traded futures. OTC short term equity swaps (Contracts for Difference (CFD)).

Option review.

Workshop 1: Using the web familiarise yourself with the products offered by the following derivative exchanges:

Eurex www.eurexchange.com

NYSE THEICE www.theice.com

CME Group www.cmegroup.com

Workshop 2: Checking available contracts on the web. Hedging an equity portfolio using ETD futures.

Readings: (E) Chapter 8, 10, (H) Chapter 2, 3, 14, (K) Chapters 2 – 4 and 7 and 8.

Day 2: Options and an introduction to Structured Certificates:

Market links between options and futures. Structuring certificates using options. The impact of time on officially recognised strategies.

Workshop 3: Hedging with ETD equity options.

Readings: (E) Chapter 10 (H) Chapter 9, 10 and 16 (K) Chapters 10 and 11. See also the major websites for more on option strategies and simulated trading.
for option strategies.

Day 3: Short Term interest Rates and Bonds:

Comparing FRAs and STIRs.

Using STIR options and Interest Rate Guarantees to hedge single and multiple period exposures.
Hedging using bond futures.

Workshop 4: Hedging a bond portfolio.

Readings: (E) Chapter 6, (H) Chapters 2, 4 and 6. (NB Pricing methodologies are covered in chapters 28 – 31). (K) Chapters 5, 6

Day 4: Swaps:

Review of plain vanilla interest rate swaps. Some variations on the basic interest rate swap. Asset swaps. Total return swaps. Credit default swaps.

Workshop 5: Structuring a special interest rate swap.

Readings: (E) Chapter 6, (H) Chapter 7, 24 and 32.

Day 5: Structured Equity Products:

Constructing guaranteed principal products (GPP).

Workshop: Testing the feasibility of a GPP.

Readings: (E) Chapter 12, (K) Chapter 1, 3 & 9. (D) Chapter 4 & 5.

#	Topic	Total Hours	Lectures	Seminars	Self-study
	Part I				
1	Overview				
2	Option pricing: static and discrete-time analysis				
3	Option pricing in continuous time				
4	Pricing with multiple sources of uncertainty				
5	Structural and reduced-form models of credit risk				
	Part II				
1	Exchange-based and OTC derivatives				
2	Options and an introduction to Structured Certificates				
3	Short Term interest Rates and Bonds				
4	Swaps				
5	Structured Equity Products				
	Total	114	22	26	66