

## MATHEMATICAL FINANCE

<b>Course code</b>	GRAE017
<b>Compulsory in the programmes</b>	Financial Economics
<b>Level of studies</b>	Graduate
<b>Number of credits</b>	6 ECTS (36 contact hours + 2 consultation hours, 124 individual work hours)
<b>Course coordinator (title and name)</b>	Prof. Dr. Tom Hashimoto <a href="mailto:tomhas@ism.lt">tomhas@ism.lt</a>
<b>Prerequisites</b>	None
<b>Language of instruction</b>	English

### THE AIM OF THE COURSE:

This introductory course surveys various mathematical concepts utilised in financial economics. Together with Financial Econometrics, it constitutes the foundation of the 'research' pillar in MSc Financial Economics at ISM. As such, some of the topics will be 'repeated', but more in depth, in other courses. As clients' profiles and objectives have become increasingly global and complex over the past few decades, financial institutions have come up with more sophisticated and more structured products, alternatives, and approaches, some of which are reviewed in this course from a pricing and mathematical perspective. Given the current political environments (e.g. transpacific trade war, COVID), we pay significant attention to the assumptions behind formulae and models, while we practice not only calculations but also explanations to prepare ourselves for the contemporary regulatory environment, most notably characterised by the MiFID II and SFDR.

### MAPPING OF COURSE LEVEL LEARNING OUTCOMES (OBJECTIVES) WITH DEGREE LEVEL LEARNING OBJECTIVES (See Annex), ASSESMENT AND TEACHING METHODS

Course level learning outcomes (objectives)	Degree level learning objectives (Number of LO)	Assessment methods	Teaching methods
CLO1. Illustrate and utilise the axioms of rationality in pricing.	LO1.1.	Midterm, Final exam	Lectures
CLO2. Define and explain interest rates as they are applied to different types of debt instruments.	LO1.1.	Midterm, Final exam	Lectures, seminars
CLO3. Define and explain the structuring considerations for various derivative products.	LO1.1.	Midterm, Final exam	Lectures, seminars
CLO4. Identify issues and projects surrounding the rapidly changing world such as hybrid securities, financial engineering, and blockchain.	LO1.1., LO1.2.	Final exam	Seminars

### ACADEMIC HONESTY AND INTEGRITY

The ISM University of Management and Economics Code of Ethics, including cheating and plagiarism are fully applicable and will be strictly enforced in the course. Academic dishonesty, and cheating can and will lead to a report to the ISM Committee of Ethics. With regard to remote learning, ISM remind students that they are expected to adhere and maintain the same academic honesty and integrity that they would in a classroom setting.

## COURSE OUTLINE

Topic	In-class hours	Readings
<b>1. Introductory discussion.</b> Overview of MSc Financial Economics. Overview of financial instruments and markets. Concept of risk.	4	
2. Mathematics of compounding. Simple, compound, and varying interest rates. Bootstrapping.	4	Chs. 1.1 & 1.2
3. Mathematics of compounding (cont.). Bootstrapping (cont.). Annuities, bonds, yield rates.	4	Chs. 1.3 – 1.5
4. Basic price models. Binomial model, log-normal model, Law of One Price.	4	Chs. 2.2 & 2.3
<b>5. Review.</b> <b>Midterm.</b>	4	
6. Price models and discrete time market models. Tri- and quadrinomial models. Option pricing (bid-ask). Cox-Ross-Rubinstein model.	4	Chs. 7.1 & 15.2
7. Concept of utility and risk. Cox-Ross-Rubinstein model (cont.).	4	
8. Basics of Ito calculus and stochastic analysis. Brownian motion, Diffusion Markov processes, Black-Sholes model.	4	Chs. 6.3 & 11.4
9. Topics in contemporary financial economics from a mathematical perspective. <b>Review</b>	4	
	<b>Total: 36 hours</b>	
CONSULTATIONS	2	
FINAL EXAM	2	

## FINAL GRADE COMPOSITION

Type of assignment	%
<i>Individual Components 100%</i>	
• Midterm	40%
• Final exam	60%
<b>Total:</b>	<b>100</b>

## DESCRIPTION AND GRADING CRITERIA OF EACH ASSIGNMENT

1. Both the midterm and final exams are open book. Students can refer to their notes and textbooks during the exam as long as they are paper based.
2. The midterm exam will cover the topics from the first four lectures. The final exam will cover all topics discussed during the course with more weight on the topics covered after the midterm. The retake exam will cover all topics without such preferences.

## RETAKE POLICY

The retake exam for the students who did not meet the passing score is normally scheduled 1-2 weeks after the announcement of the final grades. It covers 100% of the total grade.

## ADDITIONAL REMARKS

Regular attendance is strongly encouraged as both exams are open book. If for some reasons you need to miss a class, please notify the lecturer *beforehand*.

Please note, due to the travel/health regulations in place, some meetings may be held via MS Teams.

Students are expected to be acquainted with the undergraduate level of mathematics and statistics. Therefore, if a student feels shortage of knowledge and wants to improve his/her understanding in quantitative methods, the lecturer is available for further consultation by appointment.

## REQUIRED READINGS

Please utilise them as encyclopaedia rather than core reading. The chapters indicated in the table above are for core materials. There may be other chapters relevant to the given topic – the connection of each chapters are relatively clear from the chapter titles.

- Campolieti, G. & Makarov R.N. (2014) *Financial Mathematics*. London: CRC Press.

## ADDITIONAL READINGS

For those who are looking for additional challenge:

- Dokuhcaev, N. (2007) *Mathematical Finance*. London: Routledge.

(Last updated: 2022 08 16)

## DEGREE LEVEL LEARNING OBJECTIVES

### Learning objectives for Master of Social Science

Programme:

*Financial Economics*

Learning Goals	Learning Objectives
Students will be critical thinkers	LO1.1. Students will be able to identify underlying assumptions, limitations of previous research; evaluate managerial solution alternatives.
	LO1.2. Students will become <b>independent learners</b> and develop their own comprehension of scientific theories, models, and concepts.
Students will be socially responsible leaders	LO2.1. Students will be able to evaluate past and current practices in their discipline from an <b>ethical perspective</b> .
Students will be effective communicators	LO3.1. Students will develop and deliver a <b>coherent oral presentation</b> .
	LO3.2. Students will develop and deliver a <b>coherent written research paper</b> .