

## MATHEMATICAL FINANCE

<b>Course code</b>	<i>GRAE017</i>
<b>Compulsory in the programmes</b>	<i>Financial Economics</i>
<b>Level of studies</b>	<i>Graduate</i>
<b>Number of credits</b>	<i>6 ECTS (36 contact hours + 2 consultation hours, 124 individual work hours)</i>
<b>Course coordinator (title and name)</b>	<i>Benjamin N. Emmich</i>
<b>Prerequisites</b>	<i>None</i>
<b>Language of instruction</b>	<i>English</i>

### 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' in greater depth in other courses. This course serves dual purposes: ensuring students have the mathematical preparation needed to further study financial economics and introducing them to the rigorous mathematical models used in modern academic and professional financial modeling. The first part of the course will ensure students have appropriate knowledge of set theory, relations, linear algebra, probability, and optimization. The course will quickly transition to the study of stochastic asset pricing using modern theory that applies to stocks, bonds, and options. The course will conclude with analysis of modern financial markets from around the globe. Emphasis will be not only on problem solving, but also on intuitive understanding of theory and application, history, and communication of ideas.

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

<b>Course level learning outcomes (objectives)</b>	<b>Degree level learning objectives (Number of LO)</b>	<b>Assessment methods</b>	<b>Teaching methods</b>
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.

Topic	In-class hours	Readings	Lecture
<b>1. Introductory discussion.</b> Introduction to the Instructor, the nature and purpose of the course, the history and empirics of financial mathematics.	1	NA	1
<b>2: Set Theory, Relations, and Preferences</b> Introductory set theory, equivalence and order relations, rational preferences.	1.5	S&B A1	1
<b>3. Matrices and Linear Algebra</b> Matrices, Vectors, Linear Transformations, Inversion	1.5	S&B Ch. 7,8,9	1
<b>4. Probability, Lotteries and Risk</b> Probability Axioms, Basic Properties, Distributions, Stochastic Dominance and Risk Preferences	3	S&B A5	2
<b>5. Optimization</b> Unconstrained and Constrained Optimization of functions of multiple variables, Karush-Kuhn-Tucker Theorem, Utility Maximation.	2.5	S&B Ch. 17&18	2/3
<b>6. Intertemporal Choice Under Uncertainty</b> Two period, N-period, and infinite savings problems.	2.5	Cochrane Ch.1	3
<b>7. Asset Pricing: Introduction</b> Consumption-Based Model, Stochastic Discount Factors, Rational Pricing, Mean Variance Frontier.	4	Cochrane Ch. 1	4
<b>Midterm Examination</b> The examination will occur at the beginning of the fifth lecture and will cover Lectures 1-4, Topics 1-7.	1.5	NA	5
<b>8. Asset Pricing: Applications</b> Assumptions, General Equilibrium, Consumption-Based Model in Practice, Utility, Alternative Asset Pricing Models	3.5	Cochrane Ch. 2	5/6
<b>9. The Discount Factor</b> Law of One Price, Existence, Empirical Discount Factors, No Arbitrage Conditions and Positive Discount Factors	3	Cochrane Ch. 4	6
<b>10: Factor Pricing Models</b> Capital Asset Pricing Model, Intertemporal Capital Asset Pricing, Arbitrage Pricing Theory	4	Cochrane Ch. 9	7

<b>11: Econometric Estimation of Models</b> Generalized Method of Moments, Multinomial Models, Delta Method, Simple Programming Implementations in R.	1.5	Cochrane 10&11	8
<b>11: Option Pricing</b> Black-Scholes, Modifications	3.5	Cochrane Ch. 17	8/9
<b>12: Financial Markets Around the World</b> USA, Europe, China, India, other markets.	3	NA	9
	<b>Total: 36 hours</b>		

### 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. The midterm examination will be given in-class and will be allotted 90 minutes.
2. The Final examination will be given after the final lecture in-person. Solutions will be scanned and sent to the instructor for grading.
3. 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. Students are not to confer with each other, but they may ask questions of the instructor. Students may use a four-function or scientific calculator if they so choose.

### 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. It will be held in-person and is also open-book, open notes. A four-function or scientific calculator is again permitted.

### ADDITIONAL REMARKS

Regular attendance is strongly encouraged as all exams are open book.

Questions are welcomed and encouraged during class.

Office hours can be scheduled at the request of the student via email.

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

## READINGS

- Simon, C. P., & Blume, L. E. (1994). *Mathematics for Economists*. Norton.
- Cochrane, J. H. (2005). *Asset Pricing*. Princeton University Press.

(Last updated: 2023 08 21)

## ANNEX

### 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> .