

## MATHEMATICAL METHODS IN ECONOMICS

<b>Course code</b>	<i>FUN105</i>
<b>Compulsory in the programmes</b>	<i>Economics and Politics</i>
<b>Level of studies</b>	<i>Undergraduate</i>
<b>Number of credits</b>	<i>6 ECTS (44 in-class hours + 2 hours of consultations + 4 hours of examination, 112 individual work hours)</i>
<b>Course coordinator (title and name)</b>	<i>Marius Kušlys</i>
<b>Prerequisites</b>	<i>Mathematical Analysis, Finite Mathematics</i>
<b>Language of instruction</b>	<i>English</i>

### THE AIM OF THE COURSE

This course aims to broaden the knowledge and skills in advanced mathematical analysis, which is usually applied in solution of various economic problems.

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

Course level learning outcomes (objectives)	Learning objectives for BSc in Social Science	Assessment methods	Teaching methods
CLO1. To be acquainted with concepts and principles of advanced mathematical analysis	ELO1.1, ELO1.2	Practice assignments, midterm exam, final exam	Lectures, seminars
CLO2. Be able to formulate, model, and solve static optimization problems	ELO1.1, ELO1.2	Practice assignments, midterm exam	Lectures, seminars, individual work
CLO3. Be able to formulate, model, and solve dynamic optimization problems	ELO1.1, ELO1.2	Practice assignments, final exam	Lectures, seminars, individual work
CLO4. Be able to analyze solved problems and make conclusions	ELO1.1, ELO4.1	Midterm exam, final exam	Lectures, seminars, individual work
CLO5. Be able to convey information sequentially, logically, accurately, and clearly, both in written and oral form	ELO4.3	Midterm exam, final exam	Seminars, individual work

### 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 [1]
<i>Introduction to the course.</i>		
1. <b>Linear algebra.</b> Vectors, linear independence. The rank of a matrix. Eigenvalues and eigenvectors.	4	1.1-1.3; 1.5
2. <b>Multivariable calculus.</b> Gradient. Convex sets. Concavity of a function.	4	2.1-2.5
3. <b>Static optimization.</b> Global and local extrema of a multivariable function. Lagrange problem: equality constraints.	4	3.2-3.4
4. <b>Static optimization.</b> Lagrange problem: inequality constraints.	4	3.5-3.6
5. <b>Static optimization.</b> Lagrange problem: non-negativity constraints.	4	3.8
<b>MIDTERM EXAM</b>	2	
6. <b>First-order differential equations.</b> Introduction. Separable equations.	4	5.1; 5.3
7. <b>First-order differential equations.</b> Linear equations.	4	5.4
8. <b>Second-order differential equations in the plane.</b> Introduction. Equations where $x$ or $t$ is missing. Homogeneous linear equations with constant coefficients. Nonhomogeneous linear equations with constant coefficients. Euler's equation. Stability for linear equations.	4	6.1-6.4
9. <b>Simultaneous equations in the plane.</b> Solution methods. Equilibrium points for linear systems, stability.	4	6.5-6.7
10. <b>Calculus of variations.</b> Problem formulation. Terminal conditions.	4	8
11. <b>Control theory.</b> Problem formulation. Terminal conditions. Variable final time.	4	9.1-9.2; 9.3-9.8
	<b>Total: 46 hours</b>	
CONSULTATION	2	
FINAL EXAM	2	

## FINAL GRADE COMPOSITION

Type of assignment	%
<i>Individual Components 100%</i>	
Practice assignments	10
Midterm exam (topics 1-5)	40
Final exam (topics 6-11)	50
<b>Total:</b>	<b>100</b>

## DESCRIPTION AND GRADING CRITERIA OF EACH ASSIGNMENT

1. **Practice assignments** will contribute 10% to the final evaluation. Students are required to complete the designated practice exercises, submit their solutions on the eLearning system by the specified deadline, and present them during

the seminar if invited by the lecturer. The evaluation of practice assignments is based on the number of assignments completed by a student. The maximum score will be awarded when all practice assignments have been completed. A deduction of 1 point will be applied for each incomplete assignment. Furthermore, the grade will be reduced if a student declines to present their solutions or fails to attend the seminar.

2. The **midterm exam** will contribute 40% to the final evaluation and will cover topics 1-5. Only non-text calculators and provided formulas will be permitted during the exam. The duration of the exam is 120 minutes.
3. The **final exam** will contribute 50% to the final evaluation and will cover topics 6-11. Only non-text calculators and provided formulas will be permitted during the exam. The duration of the exam is 120 minutes.

The precision of composite evaluations is left intact (up to 2 decimal places) until the end of the course and only the final evaluation will be subject to rounding.

### RETAKES POLICY

In case of a failing final grade, students will have a right to the **retake exam**, which will account for 90% of the final grade and will consist of all topics covered throughout the course. Midterm exam and final exam results will be annulled. Only non-text calculators and provided formulas will be permitted during the exam. The duration of the exam is 120 minutes.

### REQUIRED READINGS

1. K. Sydsæter, P. Hammond, A. Seierstad, A. Strøm (2008). Further mathematics for economic analysis. Prentice Hall.

### ADDITIONAL READINGS

2. K. Aldošina, M. Kušlys. Statinio ir dinaminio optimizavimo ekonomikoje. Vilnius: ISM Vadybos ir ekonomikos universitetas, 2021.
3. Turckington, D.A. (2007). Mathematical Tools for Economics. Blackwell Publishing.
4. K. Sydsæter, P. Hammond, A. Seierstad, A. Strøm (2008). Essential mathematics for economic analysis. Prentice Hall.
5. Chiang, A. C. & Wainwright, K. (2005). *Fundamental methods of mathematical economics*. McGraw-Hill/Irwin.
6. Hoy, M., Livernois, J., McKenna, C., Rees, R. & Stengos, T. (2022). *Mathematics for economics*. The MIT Press.
7. Shone, R. (2001). *An introduction to economic dynamics*. Cambridge: Cambridge Univ. Press.

**ANNEX**

**DEGREE LEVEL LEARNING OBJECTIVES**

**Learning objectives for the Bachelor of Social Science**

*Programmes:*

*Economics and Data Analytics,*

*Economics and Politics*

Learning Goals	Number of LO	Learning Objectives
Students will be critical thinkers	ELO1.1.	Students will be able to understand core concepts and methods in the key economics disciplines
	ELO1.2.	Students will be able to identify underlying assumptions and logical consistency of causal statements
Students will have skills to employ economic thought for the common good	ELO2.1.	Students will have a keen sense of ethical criteria for practical problem-solving
Students will be technology agile	ELO3.1.	Students will demonstrate proficiency in common business software packages
	ELO3.2.	Students will be able to make decisions using appropriate IT tools
Students will be effective communicators	ELO4.1.	Students will be able to communicate reasonably in different settings according to target audience tasks and situations
	ELO4.2.	Students will be able to convey their ideas effectively through an oral presentation
	ELO4.3.	Students will be able to convey their ideas effectively in a written paper