

MATHEMATICAL ANALYSIS

Course code	<i>FUN101</i>
Compulsory in the programmes	<i>Economics and Politics, Finance</i>
Level of studies	<i>Undergraduate</i>
Number of credits	<i>6 ECTS (48 in-class hours + 4 hours of consultations + 5,4 hours of examination, 104,6 individual work hours)</i>
Course coordinator (title and name)	<i>Kristina Aldošina</i>
Prerequisites	-
Language of instruction	<i>English</i>

THE AIM OF THE COURSE

This course is based on the flipped classroom method and aims to develop skills for mathematical modeling of basic economical, financial, and managerial 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 Sciences	Assessment methods	Teaching methods
CLO1. Ability to operate the main concepts, laws, and techniques of differential and integral calculus	ELO1.1	Midterm exam, final exam, tests	Lectures, video tutorials, exercises, examples, practical sessions in small groups, individual work
CLO2. Ability to apply these concepts, laws and techniques in economic, financial, and managerial analysis	ELO4.1, ELO4.3	Midterm exam, final exam	Lectures, exercises, examples, development and analysis of mathematical models; practical sessions in small groups, individual work
CLO3. Analytical thinking, active learning and learning strategies, complex problem-solving, critical thinking and analysis, initiative (see Annex II)	ELO1.1, ELO1.2	Midterm exam, final exam	Lectures, exercises, examples, development and analysis of mathematical models; practical sessions in small groups, 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
<p>1. Linear functions and models. Cartesian coordinate system. Equations of a straight line (point-slope, point-point, general). Simultaneous equations. Test 1. Applications: linear depreciation, equilibrium point of supply and demand, break-even point, budget line, choice of the means of production.</p>	4	[1] 68-72, 74-79, 111-116, 134, lecture notes
<p>2. Mathematics of finance. Number sequences and limit of a sequence. Geometric series. Sigma notation. Test 2. Applications: compound interest, double declining-balance method of depreciation, present value, annuity etc.</p>	4	[1] 4.1, 4.2, 4.4 [2] 3.1
<p>3. Limit of a function. Rational functions. Asymptote as geometrical representation of a limit. Limit laws. One-sided limits. Continuity of a function. Test 3. Applications: forecasting.</p>	4	[1] 9.1, 9.2 [2] 6.5
<p>4. Limit calculation techniques. Unboundedly increasing and vanishing functions. Number e. Natural logarithm. Test 4. Applications: continuous compounding, forecasting.</p>	4	[2] 4.9; 4.10; 7.9; 10.2
<p>5. First order derivative of a function. Definition. The main rules of differentiation. The chain rule. Applications: slope of a function, tangent line, marginal analysis, velocity. Increasing and decreasing functions. Monotony, relative and absolute extrema of a function. Test 5. Applications: profit maximization and cost minimization problems, L'Hospital's rule for forecasting.</p>	4	[1] 9.3-9.8 [1] 10.1, 10.4, 10.5 [2] 7.7; 7.12
<p>6. Higher order derivatives of a function. Concavity, inflection points. Second derivative test. Taylor's approximation. Test 6. Applications: law of diminishing returns, optimization.</p>	4	[1] 9.5, 10.2, lecture notes
CONSULTATION	2	
MIDTERM EXAM	2,7	
<p>7. Functions of several variables. Graphs and level curves. Partial differentiation. Higher order partial derivatives. Differentials. Implicit differentiation. Test 7. Applications: Cobb–Douglas production function, utility function, indifference curves, substitute and complementary commodities, marginal analysis, marginal rate of substitution.</p>	4	[1] 12.1, 12.2 [2] 11.8; 12.3; 12.5; 12.9
<p>8. Extrema of functions of several variables. Unconstrained optimization. The Lagrange problem. The least squares method. Test 8. Applications: profit maximization (cost minimization) in case of several products, constrained optimization, forecasting by curve fitting.</p>	4	[1] 12.3 [2] 13.4; 14.1 – 14.4
<p>9. Indefinite integral. Antiderivative. Integration rules. Integration by substitution. Integration by parts. Test 9. Applications: marginal analysis, rates of change.</p>	4	[1] 11.1; 11.2 [2] 9.5
<p>10. Definite integral. Properties. Newton – Leibniz formula. Area between two curves. Integration by substitution. Integration by parts. Test 10.</p>	4	[1] 11.3–11.7

Applications: producer and consumer surplus, Lorentz curve and Gini index, mean value over time interval, growth and decay.		
11. Improper integrals. Integration with infinite limits. Integration of discontinuous functions. Test 11. Applications: economic growth theory, area under unbounded function, evaluation of investment (total discounted value).	4	[2] 9.7
	Total: 48,7 hours	
CONSULTATION	2	
FINAL EXAM	2,7	

FINAL GRADE COMPOSITION

Type of assignment	%
<i>Individual Components 100%</i>	
Tests 1 – 11	22 (11*2%)
Midterm exam (topics 1 – 6)	39
Final exam (topics 7 – 11)	39
Total:	100

DESCRIPTION AND GRADING CRITERIA OF EACH ASSIGNMENT

(Provide short descriptions and grading criteria of each assignment)

The overall assessment of the course (total maximum of 100% is possible) will be composed from evaluations of multiple tasks (midterm and final exams, tests), which are described as follows:

- Tests are held at the beginning of each theory lecture and consist of 10 multiple-choice pure mathematical questions that cover material from video tutorials, which students must watch prior each theory lecture. Each test values 2% of the final grade.
- Two astronomic hours long written closed book midterm exam will count for the 39% of the final evaluation and will require to solve several applied problems. Only non-text (non-graphical, non-solving) calculators, dictionaries, and provided sheet with formulas will be allowed. Exam will include applied problems on the topics 1 – 6.
- Two astronomic hours long written closed book exam will count for the 39% of the final evaluation and will require to solve several applied problems. Only non-text (non-graphical, non-solving) calculators, dictionaries, and provided sheet with formulas will be allowed. Exam will include applied problems on the topics 7 – 11.

Grading guidelines:

- a task is divided into several steps, each values 0,25 or 0,5 (it depends);
- final grade is sum of evaluations for the right steps;
- modeling and explanations (interpretations) value more than arithmetic;
- if model is wrong but later calculations are right, you get some points (depends on the task);
- you lose some points for mistakes (0,25 for arithmetical, 0,5 or more for methodical, it depends on the task);
- wrong answer doesn't mean zero evaluation;
- all components of the solution are important: model, appropriate solution method, calculations, presentation of information (clear, logical), substantiation, conclusions, explanations, interpretations.

RETAKE POLICY

(Provide short description and percentage of the final grade)

In case of the negative final evaluation, retake is possible. It will cover material of the whole course and will comprise **100%** of the final mark. Marks earned for tests, midterm and final exams will be annulled. Retake is two astronomic hours long written closed book examination and will require to solve several applied problems. Only non-text (non-graphical, non-solving) calculators, dictionaries, and provided sheet with formulas will be allowed.

ADDITIONAL REMARKS

1. Practices (seminars) will be organized in form of consultations (workshops). Students will have possibility to solve both skill-forming and applied problems (individually or in groups), ask questions, discuss.
2. Duration of midterm exam, final exam, and retake may be prolonged depending on the group's performance.
3. Precision of composite evaluations is left intact (up to 2 decimal places) until the end of semester and only the final evaluation will be subject to rounding.

REQUIRED READINGS

1. S.T. Tan. Applied Mathematics for the Managerial, Life, and Social Sciences. 3rd ed. Thomson, 2004, p.969.

ADDITIONAL READINGS

2. K.Sydsaeter, P.Hammond. Essential Mathematics for Economic Analysis. 2nd ed. Prentice Hall, 2006, p.714.
3. V. Būda. Matematiniai ekonominės analizės pagrindai. Vilnius, TEV, 2008. P. 359.
4. Solodovnikov A.C. et.al. Matematika v ekonomike. Moskva, Finansy i statistika, parts 1–2. 2000.

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

ANNEX II



Top 10 skills of 2025

-  Analytical thinking and innovation
-  Active learning and learning strategies
-  Complex problem-solving
-  Critical thinking and analysis
-  Creativity, originality and initiative
-  Leadership and social influence
-  Technology use, monitoring and control
-  Technology design and programming
-  Resilience, stress tolerance and flexibility
-  Reasoning, problem-solving and ideation

- Type of skill**
-  Problem-solving
 -  Self-management
 -  Working with people
 -  Technology use and development

Source: Future of Jobs Report 2020, World Economic Forum.