MATHEMATICAL ANALYSIS

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| Course code | *FUN101* |
| Compulsory in the programmes | *Economics and Politics, Finance* |
| Level of studies | *Undergraduate* |
| Number of credits | *6 ECTS (48 in-class hours + 2 hours of consultations + 2 hours of examination, 108 individual work hours)* |
| Course coordinator (title and name) | *Kristina Aldošina* |
| Prerequisites | *-* |
| Language of instruction | *English* |

**THE AIM OF THE COURSE**

This course 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**

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| 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, individual work | Lectures, 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, individual work | Lectures, tutorials, 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, individual work | Lectures, tutorials, 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**

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| **Topic** | **in-class hours** | **Readings** |
| *Introduction to the course.*  **1. Linear functions and models.** Cartesian coordinate system. Equations of a straight line (point-slope, point-point, general). Simultaneous equations. Applications: linear depreciation, equilibrium point of supply and demand, break-even point, budget line, choice of the means of production. | 4 | [1] 68-72, 74-79, 111-116, 134, lecture notes |
| **2. Mathematics of finance.** Number sequences and limit of a sequence. Geometric series. Sigma notation. Applications: compound interest, double declining-balance method of depreciation, present value, annuity etc. | 4 | [1] 4.1, 4.2, 4.4  [2] 3.1 |
| **3. Limit of a function.** Rational functions. Asymptote as geometrical representation of a limit. Limit laws. One-sided limits. Continuity of a function. Applications: forecasting. | 4 | [1] 9.1, 9.2  [2] 6.5 |
| **4. Limit calculation techniques.** Unboundedly increasing and vanishing functions. Number e. Natural logarithm. Applications: continuous compounding. | 4 | [2] 4.9; 4.10; 7.9; 10.2 |
| **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. Applications: profit maximization and cost minimization problems, L’Hospital’s rule. | 4 | [1] 9.3-9.8  [1] 10.1, 10.4, 10.5  [2] 7.7; 7.12 |
| **6. Higher order derivatives of a function.** Concavity, inflection points. Second derivative test. Taylor’s approximation. Applications: law of diminishing returns, optimization. | 4 | [1] 9.5, 10.2, lecture notes |
| CONSULTATION | 2 |  |
| MIDTERM EXAM | 2 |  |
| **7. Functions of several variables.** Graphs and level curves. Partial differentiation. Higher order partial derivatives. Differentials. Implicit differentiation. Applications: Cobb–Douglas production function, utility function, indifference curves, substitute and complementary commodities, marginal analysis, marginal rate of substitution. | 4 | [1] 12.1, 12.2  [2] 11.8; 12.3; 12.5; 12.9 |
| **8. Extrema of functions of several variables.** The Lagrange problem. The least squares method. Applications: profit maximization (cost minimization) in case of several products, constrained optimization,forecasting by curve fitting. | 4 | [1] 12.3  [2] 13.4; 14.1 – 14.4 |
| 9. Indefinite integral. Antiderivative. Integration rules. Integration by substitution. Integration by parts. Applications: marginal analysis. | 4 | [1] 11.1; 11.2  [2] 9.5 |
| **10. Definite integral.** Properties. Newton – Leibniz formula. Area between two curves. Integration by substitution. Integration by parts. Applications: producer and consumer surplus, Lorentz curve and Gini index, mean value over time interval, growth and decay. | 4 | [1] 11.3–11.7 |
| **11. Improper integrals.** Applications: economic growth theory, area under unbounded function, evaluation of investment (total discounted value). | 4 | [2] 9.7 |
|  | **Total: 48 hours** |  |
| CONSULTATION | 2 |  |
| FINAL EXAM | 2 |  |

**FINAL GRADE COMPOSITION**

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| --- | --- |
| **Type of assignment** | **%** |
| *Individual Components 100%* |  |
| Midterm exam (topics 1 – 6) | 40 |
| Final exam (topics 7 – 11) | 50 |
| Individual work and active learning (homework) | 10 |
| **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 3 tasks (midterm and final exams, homework), which are described as follows:

1. Two academic hours long written closed book midterm exam will count for the 40% of the final evaluation. Only non-text (non-graphical, non-solving) calculators and provided sheet with formulas will be allowed. Exam will include applied problems on the topics 1 – 6.
2. Two academic hours long written closed book exam will count for the 50% of the final evaluation. Only non-text (non-graphical, non-solving) calculators and provided sheet with formulas will be allowed. Exam will include applied problems on the topics 7 – 11.
3. When the course starts, each student already has 10% of the final grade for individual work and active learning. This percentage may be reduced during the semester in case a student fails to upload homework until deadlines (see “Additional remarks”).

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 arithmetics;
* 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 **90%** of the final mark. Marks earned during the semester (except additional grade) will be annulled. Structure of the retake is the same as of exam.

**ADDITIONAL REMARKS**

1. There will be 10 homework given during the semester. A student has to solve them **in full extent** and upload on e-learning solutions of each homework until the prescribed date. Each not uploaded homework or not fully solved homework reduces final grade by 1%. Final grade will not be reduced for mistakes in homework.
2. Practices 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.
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.
4. In case of pure online studies, examination form will be changed to an open book written exam or an oral examination (depending on the number of students in the group). These changes will be presented to students directly via email without change of the syllabus.

**REQUIRED READINGS**

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

**ADDITIONAL READINGS**

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

**ANNEX I**

**DEGREE LEVEL LEARNING OBJECTIVES**

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

*Programmes:*

*Economics and Data Analytics,*

*Economics and Politics*

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| --- | --- | --- |
| **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**

