MATHEMATICAL METHODS IN ECONOMICS

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| Course code | *FUN105* |
| Compulsory in the programmes | *Economics and Politics* |
| 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 | *Mathematical Analysis, Finite Mathematics* |
| Language of instruction | *English* |

**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**

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| 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 | Midterm exam, final exam | Lectures, tutorials, examples |
| CLO2. Be able to formulate, model, and solve static optimization problems | ELO1.1, ELO1.2 | Midterm exam | Lectures, examples, practical sessions in small groups, individual work |
| CLO3. Be able to formulate, model, and solve dynamic optimization problems | ELO1.1, ELO1.2 | Final exam | Lectures, examples, practical sessions in small groups, individual work |
| CLO4. Be able to analyze solved problems and make conclusions | ELO1.1, ELO4.1 | Midterm exam, final exam | Lectures, examples, practical sessions in small groups, 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 | Lectures, examples, 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**  (pages of the main book) |
| *Introduction to the course.*  **1. Linear algebra.** Vectors, linear independence. Rank of a matrix. Eigenvalues and eigenvectors. | 4 | 7-13, 19-23 |
| **2. Multivariable calculus.** Gradient. Convex sets. Concavity of a function. | 4 | 44-46, 50-64, 68-76 |
| **3. Static optimization.** Global and local extrema of multivariable function. Lagrange problem: equality constraints. | 6 | 110-114, 115-126 |
| **4. Static optimization.** Lagrange problem: inequality constraints. | 4 | 129-139 |
| **5. Static optimization.** Lagrange problem: non-negativity constraints. | 4 | 143-146 |
| **MIDTERM EXAM** | 2 |  |
| **6. First order differential equations.** Introduction. Separable equations. Linear equations. | 6 | 190-191, 194-204 |
| **7. Second order differential equations in the plane.** 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. | 6 | 223-236 |
| **8. Simultaneous equations in the plane.** Solution methods. Equilibrium points for linear systems, stability. | 4 | 237-246 |
| **9. Calculus of variations.** Problem formulation. Terminal conditions. | 4 | 288-304 |
| **10. Control theory.** Problem formulation. Terminal conditions. Variable final time. | 4 | 306-311, 314-319, 324-327, 336-338 |
|  | **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 – 5) | 50 |
| Final exam (topics 6 – 10) | 50 |
| **Total:** | **100** |

**DESCRIPTION AND GRADING CRITERIA OF EACH ASSIGNMENT**

*(Provide short descriptions and grading criteria of each assignment)*

Each of exams is two academic hours long closed-book written examination. Only non-text, non-graphical calculators (without solving functions), provided sheet with formulas and language dictionary will be allowed.

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, exam retake is possible, topics will cover the material of the whole course and will comprise 100**%** of the final mark. Structure of retake is the same as structure of exam.

**ADDITIONAL REMARKS**

1. 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.
2. 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**

K. Syds**æ**ter, P. Hammond, A. Seierstad, A. Str**ø**m (2008). Further mathematics for economic analysis. Prentice Hall.

**ADDITIONAL READINGS**

1. Turckington, D.A. (2007). Mathematical Tools for Economics. Blackwell Publishing.
2. K. Syds**æ**ter, P. Hammond, A. Seierstad, A. Str**ø**m (2008). Essential mathematics for economic analysis. Prentice Hall.

**ANNEX**

**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 |