SYLLABUS

Mathematical Analysis

University year 2025-2026

1. Information regarding the programme

1.1. Higher education institution	Babeş-Bolyai University
1.2. Faculty	Faculty of Mathematics and Computer Science
1.3. Department	Department of Mathematics
1.4. Field of study	Computer Science
1.5. Study cycle	Bachelor
1.6. Study programme/Qualification	Computer Science
1.7. Form of education	

2. Information regarding the discipline

2.1. Name of the discipline	**Mathematical Analysis**					Discipline code	**MLE0002**
2.2. Course coordinator				Lect. PhD. Mihai Nechita			
2.3. Seminar coordinator				Lect. PhD. Mihai Nechita			
2.4. Year of study	1	2.5. Semester	1	2.6. Type of evaluation	E	2.7. Discipline regime	DC

3. Total estimated time (hours/semester of didactic activities)

3.1. Hours per week	**4**	of which: 3.2 course	**2**	3.3 seminar/laboratory/project	**2**
3.4. Total hours in the curriculum	56	of which: 3.5 course	28	3.6 seminar/laboratory/project	**28**
Time allotment for individual study (ID) and self-study activities (SA)					**hours**
Learning using manual, course support, bibliography, course notes (SA)					28
Additional documentation (in libraries, on electronic platforms, field documentation)					8
Preparation for seminars/labs, homework, papers, portfolios and essays					42
Tutorship					10
Evaluations					6
Other activities					-
3.7. Total individual study hours	**94**				
3.8. Total hours per semester	**150**				
3.9. Number of ECTS credits	**6**				

4. Prerequisites (if necessary)

4.1. curriculum	Basic knowledge of high school calculus
4.2. competencies	Computing limits (sequences and functions), derivatives, antiderivatives

5. Conditions (if necessary)

5.1. for the course	Lecture room with whiteboard/blackboard and projector
5.2. for the seminar /lab activities	Classroom with whiteboard/blackboard

6.1. Specific competencies acquired [1]

[1] One can choose either competences or learning outcomes, or both. If only one option is chosen, the row related to the other option will be deleted, and the kept one will be numbered 6.

Professional/essential competencies	• Understanding fundamental concepts and results in mathematical analysis. • Applying calculus methods to problems in optimization, statistics, machine learning.
Transversal competencies	• Efficient and productive work rules applied in scientific and educational domains. • Methods and techniques for doing research and for presenting one's work.

6.2. Learning outcomes

Knowledge	The student knows: ...
Skills	The student is able to ...
Responsibility and autonomy:	The student has the ability to work independently to obtain ...

7. Objectives of the discipline (outcome of the acquired competencies)

7.1 General objective of the discipline	• To acquire elementary knowledge about differential and integral calculus for real-valued functions of one or several real variables.
7.2 Specific objective of the discipline	• Sequences and series of real numbers • Power series • Taylor series • Riemann integrals, improper integrals • Partial derivatives. Gradient. Higher order derivatives. • Extremum points • Gradient descent methods • Constrained optimization • Double integrals and triple integrals

8. Content

8.1 Course	Teaching methods	Remarks
1. Real numbers: basic concepts	Exposition, proofs, examples	
2. Sequences of real numbers	Exposition, proofs, examples	
3. Series of real numbers (I)	Exposition, proofs, examples	
4. Series of real numbers (II). Power series	Exposition, proofs, examples	
5. Functions of one variable: limits, continuity, differentiability	Exposition, proofs, examples	
6. Higher order derivatives. Taylor series	Exposition, proofs, examples	
7. Riemann integrals. Improper integrals	Exposition, proofs, examples	
8. The n-dimensional Euclidean space	Exposition, proofs, examples	
9. Functions of several variables: limits and continuity	Exposition, proofs, examples	
10. Partial derivatives and differentiability. Gradient descent	Exposition, proofs, examples	
11. Higher order derivatives. Hessian matrix. Local extrema	Exposition, proofs, examples	
12. Optimization with constraints. Lagrange multipliers	Exposition, proofs, examples	
13. Double integrals. Change of variables	Exposition, proofs, examples	
14. Triple integrals. Change of variables	Exposition, proofs, examples	

Bibliography

[1] M. Nechita, Lecture notes for mathematical analysis, 2025.
[2] W. Rudin, Principles of Mathematical Analysis 3rd ed, McGraw-Hill, 1976.
[3] T. Tao, Analysis I, Springer, 2016.
[4] J.E. Marsden, A. Tromba, Vector Calculus 6th ed, W.H. Freeman and Company, 2012.
[5] M. Oberguggenberger, A. Ostermann, Analysis for Computer Scientists, Springer, 2018.
[6] G. Strang, Linear Algebra and Learning from Data, Wellesley Cambridge Press, 2019.

8.2 Seminar / laboratory	Teaching methods	Remarks
1. Real numbers	Problem solving, discussions, mathematical proofs	
2. Sequences of real numbers	Problem solving, discussions, mathematical proofs	
3. Series of real numbers (I)	Problem solving, discussions, mathematical proofs	
4. Series of real numbers (II). Power series	Problem solving, discussions, mathematical proofs	
5. Functions of one variable: limits, continuity, differentiability	Problem solving, discussions, mathematical proofs	
6. Higher order derivatives. Taylor series	Problem solving, discussions, mathematical proofs	
7. Riemann integrals. Improper integrals	Problem solving, discussions, mathematical proofs	
8. The n-dimensional Euclidean space	Problem solving, discussions, mathematical proofs	
9. Functions of several variables: limits and continuity	Problem solving, discussions, mathematical proofs	
10. Partial derivatives and differentiability. Gradient descent	Problem solving, discussions, mathematical proofs	
11. Higher order derivatives. Hessian matrix. Local extrema	Problem solving, discussions, mathematical proofs	
12. Optimization with constraints. Lagrange multipliers	Problem solving, discussions, mathematical proofs	
13. Double integrals. Change of variables	Problem solving, discussions, mathematical proofs	
14. Triple integrals. Change of variables	Problem solving, discussions, mathematical proofs	

Bibliography

[1] W.J. Kaczor, M.T. Nowak, Problems in Mathematical Analysis, AMS, 2000, 2001, 2003.
[2] P.D. Lax, M.S. Terrell, Calculus with Applications, Springer, 2014.
[3] J.E. Marsden, A. Tromba, Vector Calculus 6th ed, W.H. Freeman and Company, 2012

[4] G. Procopiuc, Probleme de analiză matematică, 2009.

9. Corroborating the content of the discipline with the expectations of the epistemic community, professional associations and representative employers within the field of the program

- The course provides a fundamental background in mathematical analysis that is essential for applications in optimization, statistics, machine learning and data science. It is similar to introductory courses at top universities worldwide.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of final grade
10.4 Course	Knowledge of fundamental theoretical results.	Exam	50%
	Problem solving	Midterm test	30%
10.5 Seminar/laboratory	Knowledge of fundamental theoretical results.	Seminar activity	10%
	Problem solving	Homework	10%
10.6 Minimum standard of performance			
• Attendance at 75% of the seminars. • Final grade greater or equal to 5.			

11. Labels ODD (Sustainable Development Goals)[2]

Not applicable.

Date:	Signature of course coordinator	Signature of seminar coordinator
29.09.2025	Lect. PhD Mihai Nechita	Lect. PhD Mihai Nechita

Date of approval:
29.09.2025

Signature of the head of department

Prof. PhD Andrei Mărcuș

[2] Keep only the labels that, according to the *Procedure for applying ODD labels in the academic process*, suit the discipline and delete the others, including the general one for *Sustainable Development* – if not applicable. If no label describes the discipline, delete them all and write „*Not applicable*.”.