SYLLABUS

1. Information regarding the programme

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

2. Information regarding the discipline

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

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	2
3.4 Total hours in the curriculum	56	Of which: 3.5 course	28	3.6 seminar/laboratory	28

Time allotment:	hours
Learning using manual, course support, bibliography, course notes	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 blackboard and projector
5.2. for the seminar /lab activities	• Classroom with blackboard

6. Specific competencies acquired

Professional 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 didactic-scientific domains. • Methods and techniques for research and for presenting one's work.

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 extremum points	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, 2023.
[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-based instruction, debate, mathematical proofs	
2. Sequences of real numbers	Problem-based instruction, debate, mathematical proofs	
3. Series of real numbers (I)	Problem-based instruction, debate, mathematical proofs	
4. Series of real numbers (II). Power series	Problem-based instruction, debate, mathematical proofs	
5. Functions of one variable: limits, continuity, differentiability.	Problem-based instruction, debate, mathematical proofs	
6. Higher order derivatives. Taylor series	Problem-based instruction, debate, mathematical proofs	
7. Riemann integrals. Improper integrals	Problem-based instruction, debate, mathematical proofs	
8. The n-dimensional Euclidean space	Problem-based instruction, debate, mathematical proofs	
9. Functions of several variables: limits and continuity	Problem-based instruction, debate, mathematical proofs	
10. Partial derivatives and differentiability. Gradient descent	Problem-based instruction, debate, mathematical proofs	
11. Higher order derivatives. Hessian matrix. Local extremum points	Problem-based instruction, debate, mathematical proofs	
12. Optimization with constraints. Lagrange multipliers	Problem-based instruction, debate, mathematical proofs	
13. Double integrals. Change of variables	Problem-based instruction, debate, mathematical proofs	
14. Triple integrals. Change of variables	Problem-based instruction, debate, 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

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course	Knowledge of fundamental theoretical results. Problem solving	Exam	50%
		Midterm test	30%
10.5 Seminar/lab activities	Problem solving	Seminar activity	10%
		Homework	10%
		Extra homework	10%
10.6 Minimum performance standards			
➢ Attendance at 75% of the seminars. ➢ Final grade should be greater or equal to 5.			

Date Signature of course coordinator Signature of seminar coordinator

....

Date of approval Signature of the head of department

....….....