

SYLLABUS

TOPICS IN MATHERMATICAL ANALYSIS III

University year 2025-2026

1. Information regarding the programme

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

2. Information regarding the discipline

2.1. Name of the discipline		Topics in Mathematical Analysis III					Discipline code		MME3010
2.2. Course coordinator					Prof. Octavian Agratini, PhD				
2.3. Seminar coordinator					Prof. Octavian Agratini, PhD				
2.4. Year of study	2	2.5. Semester	4	2.6. Type of evaluation	E	2.7. Discipline regime		Optional	

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

3.1. Hours per week	3	of which: 3.2 course	2	3.3 seminar/laboratory	1
3.4. Total hours in the curriculum	36	of which: 3.5 course	24	3.6 seminar/laborator	12
Time allotment for individual study (ID) and self-study activities (SA)					hours
Learning using manual, course support, bibliography, course notes (SA)					56
Additional documentation (in libraries, on electronic platforms, field documentation)					48
Preparation for seminars/labs, homework, papers, portfolios and essays					40
Tutorship					10
Evaluations					35
Other activities:					-
3.7. Total individual study hours	189				
3.8. Total hours per semester	225				
3.9. Number of ECTS credits	9				

4. Prerequisites (if necessary)

4.1. curriculum	• Mathematical Analysis 1 (on R)
4.2. competencies	Ability to use abstract notions, theoretical results and practical methods of Mathematical Analysis

5. Conditions (if necessary)

5.1. for the course	• Lecture hall equipped with smartboard and video projector.
5.2. for the seminar /lab activities	• Classroom equipped with smart board.

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	To use appropriate theoretical results and methods for solving different classes of mathematical analysis problems.
Transversal competencies	To apply rigorous and efficient work rules, by adopting a responsible attitude towards the scientific and didactic activities. To develop the own creative potential in specific areas, following the professional ethical norms and principles.

6.2. Learning outcomes

Knowledge	The student knows: to identify the appropriate method in solving analysis problems.
Skills	The student is able to apply the mathematical apparatus by making connections between different types of problem approaches.
Responsibility and autonomy:	The student has the ability to work independently to obtain problem solving and create new statements by composing similar requirements.

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

7.1 General objective of the discipline	Enhanced understanding of some special topics in Mathematical Analysis useful to high-school teachers.
7.2 Specific objective of the discipline	Students should acquire solving skills for challenging problems, by an indepth study of key notions and fundamental theoretical results.

8. Content

8.1 Course	Teaching methods	Remarks
1. Sequences defined by linear recurrences with constant coefficients.	Direct instruction, mathematical proof, exemplification	

2. Special classes of sequences defined by nonlinear recurrences	Direct instruction, mathematical proof, exemplification	
3. Techniques to solve equations	Direct instruction, mathematical proof, exemplification	
4. Series of real numbers: Cauchy and Riemann theorems concerning the permutations of absolutely convergent and of conditionally convergent series, respectively	Direct instruction, mathematical proof, exemplification	
5. Abel, Cauchy and Mertens theorems concerning the product of two series	Direct instruction, mathematical proof, exemplification	
6. The Darboux property. Applications	Direct instruction, mathematical proof, exemplification	
7. Uniformly continuous functions and their sequential characterization; Lipschitz and Hölder continuous functions	Direct instruction, mathematical proof, exemplification	
8. Computing methods for the primitives	Direct instruction, mathematical proof, exemplification	
9. Riemann integrable functions	Direct instruction, mathematical proof, exemplification	
10. Convex functions (one variable); characterizations and regularity properties (continuity, one sided derivability)	Direct instruction, mathematical proof, exemplification	
11. Characterizations of convexity by means of tangent lines, first and second order derivatives	Direct instruction, mathematical proof, exemplification	
12. Approximation of functions	Direct instruction, mathematical proof, exemplification	

Bibliography

1. BRECKNER, B.E., POPOVICI, N.: Convexity and Optimization. An Introduction. Editura EFES, Cluj-Napoca, 2006.
2. BRECKNER, W.W., TRIF, T.: Convex Functions and Related Functional Equations. Selected Topics. Presa Universitară Clujeană, 2008.
3. COBZAȘ, Șt.: Analiză matematică (Calcul diferențial). Presa Universitară Clujeană, Cluj-Napoca, 1997.
4. ROBERTS, A.W., VARBERG, D.E.: Convex Functions. Academic Press, 1973.
5. RUDIN, W.: Principles of Mathematical Analysis. 2nd Edition, McGraw-Hill, New York, 1964.
6. SIREȚCHI, Gh.: Calcul diferențial și integral. Vol. 1. Editura Științifică și Enciclopedică, București, 1985.

8.2 Seminar / laboratory	Teaching methods	Remarks
1. Sequences defined by linear recurrences. Examples	Problem-based instruction, debate, mathematical proofs	
2. Sequences defined by nonlinear recurrences. Examples	Problem-based instruction, debate, mathematical proofs	
3. The chord and tangent method for solving equations	Problem-based instruction, debate, mathematical proofs	
4. The fixed point method for solving equations	Problem-based instruction, debate, mathematical proofs	
5. Remarkable series of real numbers	Problem-based instruction, debate, mathematical proofs	
6. Mean values theorems. Applications	Problem-based instruction, debate, mathematical proofs	
7. Wallis and Stirling formulas	Problem-based instruction, debate, mathematical proofs	
8. Taylor series	Problem-based instruction, debate, mathematical proofs	
9. Uniform continuity; Lipschitz continuous functions	Problem-based instruction, debate, mathematical proofs	
10. The Darboux property and antiderivability	Problem-based instruction, debate, mathematical proofs	
11. Applications of convexity. Inequalities	Problem-based instruction, debate, mathematical proofs	
12. Classes of linear approximation operators	Problem-based instruction, debate, mathematical proofs	

Bibliography

1. APOSTOL, T. M.: Modular functions and Dirichlet series in number theory. Springer-Verlag, New York, 1990.
2. BORWEIN, J.M., LEWIS, A.S.: Convex Analysis and Nonlinear Optimization. Theory and Examples. CMS Books in Mathematics, Springer, 2000.
3. BRECKNER, B.E., POPOVICI, N.: Probleme de analiză convexă în $\mathbb{R}^n$. Casa Cărții de Știință, Cluj-Napoca, 2003.
4. SIREȚCHI, Gh.: Calcul diferențial și integral. Vol. 2: Exerciții, Editura Științifică și Enciclopedică, București, 1985.

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 ensures a solid theoretical background, according to national and international standards.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of final grade
10.4 Course	Knowledge of theoretical concepts and theoretical results	Written exam	70%
	Ability to solve practical exercises and theoretical problems		
10.5 Seminar/laboratory	Active participation to tutorials (problem solving).	Continuous evaluation	15%
	The manner of presentation the report with a theme imposed by the coordinator	Evaluation	15%
10.6 Minimum standard of performance			
• The final grade should be greater than or equal to 5.			

11. Labels ODD (Sustainable Development Goals)²

Not applicable

Date: 11.04.2025

Signature of course coordinator

Signature of seminar coordinator



Date of approval:
25.04.2025

Signature of the head of department

Prof. dr. 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.”