SYLLABUS

Complements of Mathematical Analysis

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	Bachelor
1.6. Study programme/Qualification	Mathematics and Computer Science
1.7. Form of education	full-time

2. Information regarding the discipline

2.1. Name of the discipline	Complements of Mathematical Analysis					Discipline code	**MLE0033**
2.2. Course coordinator			Lect. dr. Stefan Berinde				
2.3. Seminar coordinator			Lect. dr. Stefan Berinde				
2.4. Year of study	**2**	2.5. Semester	**4**	2.6. Type of evaluation	**VP**	2.7. Discipline regime	Optional

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/laborator	**28**
Time allotment for individual study (ID) and self-study activities (SA)					**hours**
Learning using manual, course support, bibliography, course notes (SA)					30
Additional documentation (in libraries, on electronic platforms, field documentation)					10
Preparation for seminars/labs, homework, papers, portfolios and essays					20
Tutorship					14
Evaluations					20
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	Mathematical Analysis I
4.2. competencies	Understanding calculus on the real axis

5. Conditions (if necessary)

5.1. for the course	Class room with an overhead projector and a blackboard
5.2. for the seminar /lab activities	Class room with an overhead projector, computer and a 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	• C1.5 Elaborarea unor proiecte si lucrari de prezentare a unor rezultate si metode matematice • C5.4 Evaluarea comparativa si utilizarea eficienta a diferitelor metode de demonstratie
Transversal competencies	• CT2. Desfasurarea eficienta si eficace a activitatilor organizate in echipa

6.2. Learning outcomes

Knowledge	The student knows fundamental notions to ensure the formation of skills specific to the Mathematics-related disciplines needed to complete the assignments
Skills	The student is able to: - explain theoretical notions, problem-solving methods, paradigms, etc. used in various branches of Mathematics related to secondary education - explore some mathematical content independently, drawing on ideas and tools from previous coursework to extend their understanding
Responsibility and autonomy:	The student has the ability to work independently to: - communicate mathematics in both oral and written form with precision, clarity, and organization - construct clear and well-supported mathematical arguments to explain mathematical problems, topics, and ideas in writing - give clear and well-organized presentations about mathematical topics that communicate mathematical arguments - prove theorems using the language of mathematics in theoretical junior/senior level courses and present those results both orally and in writing

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

7.1 General objective of the discipline	• Complementary results from the field of classical analysis on the real axis
7.2 Specific objective of the discipline	• Introduction to theory of continued fractions • Solving linear recurrences by methods of characteristic equation and generating function • Computational techniques based on operations with power series • Study of some notable series and products, and their connection with Riemann zeta function • Applications to number theory and combinatorics

8. Content

8.1 Course	**Teaching methods**	**Remarks**
1. A short history of mathematical analysis	interactive exposure, explanation, examples	
2. Real numbers – irrationality and transcendence	interactive exposure, explanation, examples	
3. Real numbers – continued fractions	interactive exposure, explanation, examples	
4. Applications of continued fractions	interactive exposure, explanation, examples	
5. Linear recurrent sequences	interactive exposure, explanation, examples	
6. Nonlinear recurrent sequences	interactive exposure, explanation, examples	
7. Notable recurrent sequences and applications	interactive exposure, explanation, examples	
8. Limit points of a sequence	interactive exposure, explanation, examples	
9. Operations with power series	interactive exposure, explanation, examples	
10. Formal series	interactive exposure, explanation, examples	
11. Generating functions	interactive exposure, explanation, examples	
12. Applications to combinatorics	interactive exposure, explanation, examples	
13. Various applications	interactive exposure, explanation, examples	
14. *Due examination*		

Bibliography

1. Hardy G.H. et al.: An introduction to the theory of numbers, Oxford University Press, 2008

2. Mickens R.E.: Difference equations. Theory, applications and advanced topics, CRC Press, 2015

3. Wilf H.S.: generatingfunctionology, A.K. Peters Ltd., Massachusetts, 2006

4. Zorich V.A.: Mathematical Analysis I, Springer, 2004

5. ***: Pagina cursului Complemente de analiza matematica (notite de curs ale titularului), *http://math.ubbcluj.ro/~sberinde/comp/*

8.2 Seminar / laboratory	**Teaching methods**	**Remarks**
1. Classic inequalities	project exposure by student team	2-3 students
2. Important numbers as limits of sequences	project exposure by student team	2-3 students
3. Irrationality and transcendence of some important numbers	project exposure by student team	2-3 students
4. Toeplitz theorem and applications	project exposure by student team	2-3 students
5. Arithmetic-geometric mean. Gauss formula	project exposure by student team	2-3 students
6. Stirling formula	project exposure by student team	2-3 students
7. Notable recurrences and applications	project exposure by student team	2-3 students
8. Infinite products	project exposure by student team	2-3 students
9. Bernoulli polynomials and numbers	project exposure by student team	2-3 students
10. Riemann Zeta function	project exposure by student team	2-3 students

11. Euler Gamma function	project exposure by student team	2-3 students
12. *Proofs from the lists I*	conversation, exercise and didactic proof	selection
13. *Proofs from the lists II*	conversation, exercise and didactic proof	selection
14. *Due examination*		

Bibliography

1. Cobzas S.: Analiza matematica (Calcul diferential), Presa Universitara Clujeana, 1997

2. Duren P.: Invitation to Classical Analysis, AMS, 2012

3. Kaczor W.J., Nowak M.T.: Problems in Mathematical Analysis, vol. I si II, AMS, 2001

4. Mercer P.R.: More calculus of a single variable, Springer, 2014

5. Siretchi, Gh.: Calcul diferential si integral, vol. I si II, Editura Stiintifica si Enciclopedica, 1985

*6. ***: Pagina cursului Complemente de analiza matematica (notite de curs ale titularului), http://math.ubbcluj.ro/~sberinde/comp/*

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

- This lecture is useful for teacher and research candidates in mathematics, enriching their knowledge in classical mathematical analysis. More specifically, we address new methods and results which might be useful later for a master degree preparation in mathematics or a related field.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of final grade
10.4 Course	Knowledge of basic concepts and results, problem solving	Written exam	50%
10.5 Seminar/laboratory	Individual project evaluation	Continous observation, dialogue	50%
10.6 Minimum standard of performance			
• Grade 5 (on a scale from 1 to 10)			

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

	General label for Sustainable Development							
								

[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*.".

Date:
11.04.2025

Signature of course coordinator

Lect. dr. Stefan Berinde

Signature of seminar coordinator

Lect. dr. Stefan Berinde

Date of approval:
25.04.2025

Signature of the head of department

Prof. dr. Andrei Mărcuș