SYLLABUS

1. Information regarding the programme

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

2. Information regarding the discipline

2.1 Name of the discipline			Topics in Mathematical Analysis III				
2.2 Course coordinator			Prof. Nicolae Popovici, Ph.D. habil.				
2.3 Seminar coordinator			Prof. Nicolae Popovici, Ph.D. habil.				
2.4. Year of study	2	2.5 Semester	4	2.6. Type of evaluation	Exam	2.7 Type of discipline	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/laboratory	12
Time allotment:					hours
Learning using manual, course support, bibliography, course notes					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) • Mathematical Analysis 2 (Calculus on R^n)
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 blackboard and beamer
5.2. for the seminar /lab activities	• Classroom equipped with blackboard

6. Specific competencies acquired

Professional 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.

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 in-depth study of key notions and fundamental theoretical results.

8. Content

8.1 Course	Teaching methods	Remarks
1. Sequences of (extended) real numbers; limit points; limit inferior and limit superior.	Direct instruction, mathematical proof, exemplification	
2. Sequences defined by linear recurrences with constant coefficients; special classes of sequences defined by nonlinear recurrences.	Direct instruction, mathematical proof, exemplification	
3. Toeplitz theorem and some of its consequences (Stolz-Cesaro and Cauchy theorems).	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. Semi-continuous functions; characterizations of semi-continuity by means of the epigraph/hypograph, level sets, and sequences.	Direct instruction, mathematical proof, exemplification	
7. Uniformly continuous functions and their sequential characterization; Lipschitz and Hölder continuous functions.	Direct instruction, mathematical proof, exemplification	
8. The Darboux property and antiderivability.	Direct instruction, mathematical proof, exemplification	
9. Riemann integrable functions.	Direct instruction, mathematical proof, exemplification	
10. Convex functions (one variable);	Direct instruction, mathematical	

characterizations and regularity properties (one sided derivability, continuity).	proof, exemplification	
11. Characterizations of convexity by means of tangent lines, first and second order derivatives.	Direct instruction, mathematical proof, exemplification	
12. Convex functions (several variables) and their characterizations; subdifferențiability of convex 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. COBZAŞ, Şt.: Analiză matematică (Calcul diferenţial). Presa Universitară Clujeană, Cluj-Napoca, 1997.
4. MARUŞCIAC, I: Analiză matematică. Partea II. Universitatea "Babeş-Bolyai" Cluj-Napoca, 1983.
5. MEGAN, M.: Bazele analizei matematice. Vol. I şi II, Editura EUROBIT, Timişoara, 1997. Vol. III, Editura EUROBIT, Timişoara, 1998.
6. NICOLESCU, M.: Analiză matematică. Vol. II, Editura Tehnică, Bucureşti, 1958.
7. ROBERTS, A.W., VARBERG, D.E.: Convex Functions. Academic Press, 1973.
8. RUDIN, W.: Principles of Mathematical Analysis. 2nd Edition, McGraw-Hill, New York, 1964.
9. SIREŢCHI, Gh.: Calcul diferenţial şi integral. Vol. 1: Noţiuni fundamentale. Editura Ştiinţifică şi Enciclopedică, Bucureşti, 1985.

8.2 Seminar / laboratory	Teaching methods	Remarks
1. Sequences: limit points; limit inferior and limit superior; convergence.	Problem-based instruction, debate, mathematical proofs	
2. Sequence for which the set of limit points is an interval	Problem-based instruction, debate, mathematical proofs	
3. Sequences defined by linear recurrences.	Problem-based instruction, debate, mathematical proofs	
4. Sequences defined by nonlinear recurrences.	Problem-based instruction, debate, mathematical proofs	
5. Applications of Toeplitz and Stolz-Cesaro theorems.	Problem-based instruction, debate, mathematical proofs	
6. Remarkable series of real numbers.	Problem-based instruction, debate, mathematical proofs	
7. Wallis and Stirling formulae.	Problem-based instruction, debate, mathematical proofs	
8. Taylor series.	Problem-based instruction, debate, mathematical proofs	
9. Semicontinous functions.	Problem-based instruction, debate, mathematical proofs	
10. Uniform continuity; Lipschitz continuous functions.	Problem-based instruction, debate, mathematical proofs	
11. The Darboux property and antiderivability.	Problem-based instruction, debate, mathematical proofs	
12. Convex functions; applications to inequalities.	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 R^n. Casa Cărţii de Ştiinţă, Cluj-Napoca, 2003.
4. BUCUR, G., CÂMPU, E., GĂINĂ, S.: Culegere de probleme de calcul diferenţial şi integral. Vol. II, Editura Tehnică, Bucureşti, 1966. Vol. III, Editura Tehnică, Bucureşti, 1967.
5. COBZAŞ, Şt.: Analiză matematică (Calcul diferenţial). Presa Universitară Clujeană, Cluj-Napoca, 1997.
6. RĂDULESCU, S., RĂDULESCU, M.: Teoreme şi probleme de analiză matematică. Editura Didactică şi Pedagogică, Bucureşti, 1982.
7. SIREŢCHI, Gh.: Calcul diferenţial şi integral. Vol. 2: Exerciţii, Editura Ştiinţifică şi Enciclopedică, Bucureşti, 1985
8. TRIF, T.: Probleme de calcul diferenţial şi integral în R^n. Casa Cărţii de Ştiinţă, Cluj-Napoca, 2003.

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

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course	- Knowledge of theoretical concepts and theoretical results; - Ability to solve practical exercises and theoretical problems	Written exam	75%
10.5 Seminar/lab activities	Active participation to tutorials (problem solving).	Continuous evaluation	25%
10.6 Minimum performance standards			
The final grade should be greater than or equal to 5.			

Date	Signature of course coordinator	Signature of seminar coordinator
29.04.2022	Prof. Nicolae Popovici, Ph.D. Habil.	Prof. Nicolae Popovici, Ph.D. Habil.

Date of approval	Signature of the head of department
29.04.2022	Prof. Octavian Agratini, Ph.D.