SYLLABUS

CALCULUS (ON R)

University year 2025-2026

1. Information regarding the programme

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

2. Information regarding the discipline

2.1. Name of the discipline	**Calculus 1 (Calculus on R)**					Discipline code	**MLE0001**
2.2. Course coordinator				Lect. dr. Anca Grad			
2.3. Seminar coordinator				Lect. dr. Anca Grad			
2.4. Year of study	1	2.5. Semester	1	2.6. Type of evaluation	E	2.7. Discipline regime	Mandatory

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

3.1. Hours per week	**5**	of which: 3.2 course	**3**	3.3 seminar/laboratory	**2**
3.4. Total hours in the curriculum	70	of which: 3.5 course	42	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)					25
Additional documentation (in libraries, on electronic platforms, field documentation)					10
Preparation for seminars/labs, homework, papers, portfolios and essays					25
Tutorship					10
Evaluations					10
Other activities:					
3.7. Total individual study hours	**80**				
3.8. Total hours per semester	**150**				
3.9. Number of ECTS credits	**6**				

4. Prerequisites (if necessary)

4.1. curriculum	High-school calculus
4.2. competencies	Mathematical thinking, logical thinking

5. Conditions (if necessary)

5.1. for the course	Lecture hall with large board and beamer	
5.2. for the seminar /lab activities	Seminar hall with large 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	C4.1. Defining basic concepts, theory and mathematical models C4.2 Interpretation of mathematical models C4.3 Identifying the appropriate models and methods for solving real-life problems C4.5 Embedding formal models in applications from various areas
Transversal competencies	CT1 Application of efficient and rigorous working rules, manifest responsible attitudes towards the scientific and didactic field, respecting the professional and ethical principles. CT3 Use of efficient methods and techniques for learning, information, research and development of abilities for knowledge acquiring, for adapting to the needs of dynamic society and for communication in Romanian as well as in a widely used foreign language.

6.2. Learning outcomes

Knowledge	The student: - has acquired the specific skills of mathematics-related disciplines necessary for completing assignments. - knows fundamental notions related to the topology of real numbers as well as to strings, series, differentiable functions and Riemann integrable functions, as well as methods for applying them in areas of science related to mathematics and computer science.
Skills	The student is able to: - build clear and well-supported mathematical arguments to explain mathematical problems, topics and ideas in writing. - prove theorems using mathematical language in theoretical courses and will be able to present these results both orally and in writing.
Responsibility and autonomy:	The student has the ability to: - independently explore certain mathematical contents, based on the ideas and tools already acquired, in order to expand his knowledge. - independently extend the mathematical ideas and arguments already acquired, to a mathematical topic that has not been studied previously.

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

7.1 General objective of the discipline	• Acquiring knowledge about the algebraic and topological structure of the space R, differential and integral calculus
7.2 Specific objective of the discipline	• Presentation of the basic notions and concepts connected to the topology of R • Presentation of the basic notions and results concerning sequences and series of real numbers • Presentation of the basic notions and results concerning the differential and integral calculus of real functions of one real variable

8. Content

8.1 Course	**Teaching methods**	**Remarks**

1. The system of real numbers (upper and lower bound of a set; minimum and maximum of a set; infimum and supremum of a set; the infimum principle, the supremum principle and its consequences; the sets of natural numbers, the set integer numbers, the set of rational numbers, and the set of irrational numbers; the extended set of real numbers). Topology of the real axis (neighbourhoods, open sets, interior set, exterior set, boundary set, closure, accumulation points)	Lecture, discussion, didactic proofs	[1] pp. 125-157 or [4] pp. 80-97
2. Sequences of real numbers (existence of the limit for monotone sequences; applications: the irrational number e)	Lecture, discussion, didactic proofs	[4] pp. 159-195, 259-263
3. Fundamental sequences. Series of real numbers (convergence/divergence criteria for series: Cauchy's general criterion, Cauchy's condensation criterion, comparison criteria, the root criterion, Kummer's, D'Alembert's and Raabe-Duhamel's criteria)	Lecture, discussion, didactic proofs	[4] pp. 313-346
4. Series of real numbers; comparison criteria.	Lecture, discussion, didactic proofs	[4] pp. 367-396
5. Series of real numbers (Abel-Dirichlet criterion; absolutely convergent series; the Leibniz criterion for alternant series; convolutive product of series).	Lecture, discussion, didactic proofs	[2], pp. 193 – 204 pp. 232 – 244 [6], pp. 290 – 298 pp. 348 – 353
6. Limits of real-valued functions, characterization theorems. Continuous functions, characterization theorems.	Lecture, discussion, didactic proofs	[4] pp.
7. Differential calculus. Mean theorems	Lecture, discussion, didactic proofs	[1] pp. 195-232 or [4] pp. 409-420, 459-472, 486-507
8. Higher order derivatives; Taylor's theorem and applications.	Lecture, discussion, didactic proofs	[1] pp. 233-263 or [4] pag. 579-594
9. Sequences of functions (convergence and uniform convergence; properties of the sum function).	Lecture, discussion, didactic proofs	[4], pp. 427 – 441
10. Series of functions (convergence and uniform convergence; properties of the sum function).	Lecture, discussion, didactic proofs	[4], pp. 361 – 365
11. Power series. Taylor's theorem	Lecture, discussion, didactic proofs	[4],pp. 441 – 445
12. The Riemann integral (definition, characterizations of inerrability; properties of the Riemann integral)	Lecture, discussion, didactic proofs	[4], pp. 365 – 384
13 Primitives, the Leibniz-Newton formula.	Lecture, discussion, didactic proofs	[1] pp. 314-388
14. Improper integrals	Lecture, discussion, didactic proofs	[4], pp. 379-391

Bibliography

1. D. Andrica, D.I. Duca, I. Purdea, I. Pop: Matematica de baza, Editura Studium, Cluj-Napoca, 2004

2. W.W. Breckner: Analiza matematica. Topologia spatiului R^n, Universitatea din Cluj-Napoca, Cluj -Napoca, 1985

3. S. Cobzas: Analiza matematica (Calcul diferential), Presa Universitara Clujeana, Cluj-Napoca, 1997

4. D.I. Duca: Analiza matematica (vol. I), Casa Cartii de Stiinta, Cluj-Napoca, 2013

5. D.I. Duca, E. Duca: Exercitii si probleme de analiza matematica (vol. I), Editura Casa Cartii de Stiinta, Cluj-Napoca, 2007

6. D.I. Duca, E. Duca: Exercitii si probleme de analiza matematica (vol II), Editura Casa Cartii de Stiinta, Cluj -Napoca, 2009
7. M. Megan: Bazele Analizei matematice, vol. 1,2,3, Editura Eurobit, 1997, 1997, 1998
8. Gh. Siretchi: Calcul diferential si integral, vol. I si II, Editura Stiintifica si Enciclopedica, Bucuresti,1985
9. V.A. Zorich: Mathematical Analysis, Springer, Berlin, 2004

8.2 Seminar / laboratory	**Teaching methods**	**Remarks**
1. The set of real numbers. Topology of the set of real numbers.	Discussions, problematisation, self-tanking, team-work	[5] 1.2-1.4; 1.7-1.10; 1.12-1.16; 2.2; 2.4-2.6; 2. 8-2.9; 2.11-2.32
2. . Real number sequences; convergence of the monotone sequences.	Discussions, problematisation, self-tanking, team-work	[5] 3.24; 3.26; 3.33; 3.39; 3. 43; 3.47; 3.54; 3.59; 3.67-3.73; 3.85; 3.90; 3.95; 3.99-3.108
3. Fundamental sequences. Series of real numbers.	Discussions, problematisation, self-thinking, team-work	List of problems edited by the lecturer
4. Series of real numbers.	Discussions, problematisation, self-thinking, team-work	List of problems edited by the lecturer
5. Limits of functions. Continuous functions	Discussions, problematisation, self-thinking, team-work	[5] 4.2-4.3; 4.7; 4.12; 4.16; 4.18; 4.22; 4.24-4.26; 4.41; 4.45; 4.47; 4.50; 4.56; 4.73-4.75; 4.79; 4.80; 4.84; 4.94 5.2; 5.8; 5.11; 5.15-5.19; 5.22; 5.26; 5.29; 5.31; 5.35; 5.40; 5.41
6. Limits of real-valued functions, characterization theorems. Continuous functions, characterization theorems.	Discussions, problematisation, self-thinking, team-work	[3] 6.2; 6.14-6.17; 6.21; 6.26-6.32; 6.92-6.95; 7.10; 7.12-7.17; 7.24-7.36; 7.48; 7.52; 7.57-7.63
7. Differential calculus. Mean theorems	Discussions, problematisation, self-thinking, team-work	[3] 6.68-6.90; 6.169-6.187
8. Higher order derivatives; Taylor's theorem and applications.	Discussions, problematisation, self-thinking, team-work	[4] 1.2; 1.14; 1.20; 1.22; 1.32; 1.39-1.40; 1.65-1.66; 1.126; 2.6-2.42; 2.46-2.51; 2.60; 2.68; 2.72-2.74; 2.78; 2.82-2.89; 2.130-2.131; 2.139; 2.147; 2.171; 2.224; 2.262; 2.303; 2.307; 2.314
9. Sequences of functions (convergence and uniform convergence; properties of the sum function).	Discussions, problematisation, self-thinking, team-work	[1] pp. 339-352
10. Series of functions (convergence and uniform convergence; properties of the sum function). Power series. Taylor's theorem	Discussions, problematisation, self-thinking, team-work	List of problems edited by the lecturer
11. Power series.	Discussions, problematisation, self-thinking, team-work	List of problems edited by the lecturer
12. The Riemann integral (definition, characterizations of inerrability; properties of the Riemann integral)	Discussions, problematisation, self-thinking, team-work	[1] pag. 277-313
13. Primitives, the Leibniz-Newton formula.	Discussions, problematisation, self-thinking, team-work	[1] pag. 314-338
14. Improper integrals	Discussions, problematisation, self-thinking, team-work	[8] pag. 379-391

Bibliography

1. D. Andrica, D.I. Duca, I. Purdea, I. Pop: Matematica de baza, Editura Studium, Cluj-Napoca, 2004
2. W.W. Breckner: Analiza matematica. Topologia spatiului R^n, Universitatea din Cluj-Napoca, Cluj

-Napoca, 1985
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4. D.I. Duca: Analiza matematica (vol. I), Casa Cartii de Stiinta, Cluj-Napoca, 2013
5. D.I. Duca, E. Duca: Exercitii si probleme de analiza matematica (vol. I), Editura Casa Cartii de Stiinta, Cluj-Napoca, 2007
6. D.I. Duca, E. Duca: Exercitii si probleme de analiza matematica (vol II), Editura Casa Cartii de Stiinta, Cluj
-Napoca, 2009
7. M. Megan: Bazele Analizei matematice, vol. 1,2,3, Editura Eurobit, 1997, 1997, 1998
8. Gh. Siretchi: Calcul diferential si integral, vol. I si II, Editura Stiintifica si Enciclopedica, Bucuresti,1985
9. V.A. Zorich: Mathematical Analysis, Springer, Berlin, 2004

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 content of this course can be encountered in the syllabus of every respected university in land or abroad. It represents a basic part not only for mathematics teachers but also for researchers.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of final grade
10.4 Course	knowledge of the basic notions and results	Final written exam	60%
	knowledge of the proofs for the main theoretical results		
10.5 Seminar/laboratory	Homework including problems based on the theory presented at the lecture	Continuous evaluation during the seminar	20%
	application of the theoretical results to practical problems	quizzes during the lecture or the seminar	20%
10.6 Minimum standard of performance			
• The definitions, the statement of the theoretical results and straight-forward applications • Identification and proper selection of the solving methods for various practical problems			

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. Anca Grad

Signature of seminar coordinator

Lect. dr. Anca Grad

Date of approval:
25.04.2025

Signature of the head of department

Prof. dr. Andrei Mărcuș