

## COURSE DESCRIPTION

Calculus 1(Calculus on R)

Academic year 2026-2027

### 1. Programme-related data

1.1. Higher Education Institution	<b>Babeş-Bolyai University</b>
1.2. Faculty	<b>Mathematics and Computer Science</b>
1.3. Department	<b>Mathematics</b>
1.4. Field	<b>Computer Science</b>
1.5. Level of study	<b>Bachelor</b>
1.6. Degree programme / Qualification	<b>Artificial Intelligence</b>
1.7. Form of education	<b>Full-time</b>

### 2. Course-related data

2.1. Course title	<b>Calculus 1 (Calculus on R)</b>			Course code	<b>MLE0001</b>
2.2. Course coordinator	Lect. dr. Grad Anca				
2.3. Seminar coordinator	Lect. dr. Grad Anca				
2.4. Year of study	1	2.5. Semester	1	2.6. Type of assessment	<b>Exam</b>
2.7. Course status	<b>Compulsory</b>			2.8. Course type	<b>Core subject</b>

### 3. Total estimated time (hours per semester of teaching activities)

3.1. Number of hours per week	<b>5</b>	of which: 3.2. course	<b>3</b>	3.3. seminar/ laboratory/ project	<b>2</b>
3.4. Total of hours in the curriculum	70	of which: 3.5. course	42	3.6. seminar/ laboratory	<b>28</b>
<b>Time allocation for individual study (IS) and self-taught activities (ST)</b>					<b>hours</b>
Learning from textbooks, course materials, bibliography, and notes (IS)					25
Additional research in the library, on subject-specific electronic platforms, and on-site					10
Preparing seminars/ laboratories/ projects, assignments, reports, portfolios, and essays					25
Tutoring (professional guidance)					10
Examinations					10
Other activities					0
<b>3.7. Total hours of individual study (IS) and self-taught activities (ST)</b>				<b>80</b>	
<b>3.8. Total hours per semester</b>				<b>150</b>	
<b>3.9. Number of credits</b>				<b>6</b>	

### 4. Prerequisites (where applicable)

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

### 5. Specific conditions (where applicable)

5.1. course-related	Lecture hall with large board and beamer
5.2. seminar/laboratory-related	Seminar hall with large board

### 6.1. Competencies resulting from the completion of the degree programme (as referred to in the curriculum)<sup>1</sup>

<sup>1</sup> The professional and/or transversal skills targeted by the subject for which the course description is prepared will be copied from the curriculum of the degree programme. For each competency, the complete entry, including the competency code, will be copied with the exact wording that appears in the curriculum, without any changes.

Professional competencies	
Competency code	Competency
PC5	Define technical requirements
PC17	Create data models
Transversal competencies	
Competency code	Competency
TC1	Work independently
TC2	Solve problems
TC3	Think analytically
TC4	Schedule and organize
TC5	Master the English language

## 6.2. Learning outcomes relevant to the degree programme (as referred to in the curriculum)<sup>2</sup>

Learning outcomes targeted by the subject		
Competency code	Knowledge and comprehension	Specific academic skills
PC5	The student/graduate selects, explains and specifies the mathematical foundations applied in computer science, including formal logic, algebra, probability and statistics.	The student/graduate applies, evaluates, and proposes mathematical methods for modeling, simulating and solving computer science problems.
TC1, TC2, TC3, TC4	The student/graduate has the knowledge necessary to understand and solve complex problems, and to plan and organize advanced processes in various fields.	The graduate is able to identify complex problems and examine related issues to develop solving options and implement solutions. The graduate has the ability to apply general rules to specific problems and produce relevant solutions. The graduate is able to combine diverse information to formulate solutions and generate ideas for developing new products and applications.

## 7. Subject-specific learning outcomes

Knowledge and comprehension
<p>1.The student:</p> <ul style="list-style-type: none"> <li>- has acquired the specific skills of mathematics-related disciplines necessary for completing assignments.</li> <li>- 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.</li> </ul>

If no competency is copied from either of the two categories, the row corresponding to that category is deleted from the table.

<sup>2</sup> The learning outcomes relevant for the degree programme and targeted by the subject for which the course description is prepared will be listed. The entries, copied without any changes from the Curriculum by subject type (Core Subject/Specialisation Subject/Complementary Subject), are listed under the corresponding competency.

2. 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.
<b>Specific academic skills</b>
The student has the ability to:
1. independently explore certain mathematical contents, based on the ideas and tools already acquired, in order to expand his knowledge.
2. independently extend the mathematical ideas and arguments already acquired, to a mathematical topic that has not been studied previously.

## 8. Contents

8.1. Course	Teaching and learning methods	Remarks <sup>3</sup>
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

<sup>3</sup> For example, organisational aspects, recommendations for students, specific aspects relating to the course/seminar, such as inviting experts in the field, etc.

<b>9.</b> Sequences of functions (convergence and uniform convergence; properties of the sum function).	Lecture, discussion, didactic proofs	[4], pp. 427 – 441
<b>10.</b> Series of functions (convergence and uniform convergence; properties of the sum function).	Lecture, discussion, didactic proofs	[4], pp. 361 – 365
<b>11.</b> Power series. Taylor's theorem	Lecture, discussion, didactic proofs	[4],pp. 441 – 445
<b>12.</b> The Riemann integral (definition, characterizations of inerrability; properties of the Riemann integral)	Lecture, discussion, didactic proofs	[4], pp. 365 – 384
<b>13</b> Primitives, the Leibniz-Newton formula.	Lecture, discussion, didactic proofs	[1] pp. 314-388
<b>14.</b> Improper integrals	Lecture, discussions, didactic proofs	[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
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

<b>8.2. Seminar/ laboratory</b>	<b>Teaching and learning methods</b>	<b>Remarks</b>
<b>1.</b> 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
<b>2.</b> . 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
<b>3.</b> Fundamental sequences. Series of real numbers.	Discussions, problematisation, self-thinking, team-work	List of problems edited by the lecturer
<b>4.</b> Series of real numbers.	Discussions, problematisation, self-thinking, team-work	List of problems edited by the lecturer
<b>5.</b> 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		
<ol style="list-style-type: none"> <li>1. D. Andrica, D.I. Duca, I. Purdea, I. Pop: Matematica de baza, Editura Studium, Cluj-Napoca, 2004</li> <li>2. W.W. Breckner: Analiza matematica. Topologia spatiului <math>R^n</math>, Universitatea din Cluj-Napoca, Cluj-Napoca, 1985</li> <li>3. S. Cobzas: Analiza matematica (Calcul diferential), Presa Universitara Clujeana, Cluj-Napoca, 1997</li> <li>4. D.I. Duca: Analiza matematica (vol. I), Casa Cartii de Stiinta, Cluj-Napoca, 2013</li> <li>5. D.I. Duca, E. Duca: Exercitii si probleme de analiza matematica (vol. I), Editura Casa Cartii de Stiinta, Cluj-Napoca, 2007</li> <li>6. D.I. Duca, E. Duca: Exercitii si probleme de analiza matematica (vol II), Editura Casa Cartii de Stiinta, Cluj-Napoca, 2009</li> <li>7. M. Megan: Bazele Analizei matematice, vol. 1,2,3, Editura Eurobit, 1997, 1997, 1998</li> <li>8. Gh. Siretchi: Calcul diferential si integral, vol. I si II, Editura Stiintifica si Enciclopedica, Bucuresti, 1985</li> <li>9. V.A. Zorich: Mathematical Analysis, Springer, Berlin, 2004</li> </ol>		

## 9. Evaluation



















Type of activity	9.1 Evaluation criteria <sup>4</sup>	9.2 Evaluation methods <sup>5</sup>	9.3 Percentage in the final grade
9.4. Course	knowledge of the basic notions and results	Final written exam	60%
	knowledge of the proofs for the main theoretical results		
9.5. Seminar/ laboratory	Homework including problems based on the theory presented at the lecture	Continuous evaluation during the seminar	20%

<sup>4</sup> The evaluation criteria must directly reflect the learning outcomes targeted at the level of the degree programme respectively at the level of the subject. More specifically, the learning outcomes set out in the expected learning outcomes are assessed.

<sup>5</sup> Both final evaluation methods and ongoing evaluation strategies should be established.

	application of the theoretical results to practical problems	quizzes during the lecture or the seminar	20%
9.6 Minimum standard for passing			
<ul style="list-style-type: none"> <li>- Minimum 7% out of 20% from the Continuous evaluation during the seminary</li> <li>- Minimum 20% out of 60% from the final written exam</li> </ul>			

## 10. SDG labels (Sustainable Development Goals)<sup>6</sup>

	<input type="radio"/>	Sustainable Development Generic Label						
								
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								No label applies
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Date of entry:  
06.04.2026

Signature of course coordinator

Lect. dr. Grad Anca

Signature of seminar coordinator

Lect. dr. Grad Anca

Date of approval in the department:  
24,04,2026

Signature of the head of department

Prof. dr. Andrei Mărcuș

<sup>6</sup> Select a single label which, according to the [Implementation of SDG labels in the academic process](#), best matches the subject. If the subject addresses sustainable development in a generic manner (i.e. by presenting/introducing the general framework of sustainable development, etc.), then the Sustainable Development generic label may be applied. If none of the labels describe the subject, select the last option: "No label applies."