

## COURSE DESCRIPTION

### Mathematical Logic and Set Theory

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>Mathematics</b>
1.5. Level of study	<b>Bachelor</b>
1.6. Degree programme / Qualification	<b>Mathematics Computer Science (English)</b>
1.7. Form of education	<b>Full-time</b>

#### 2. Course-related data

2.1. Course title	<b>Mathematical Logic and Set Theory</b>			Course code	<b>MLE0070</b>
2.2. Course coordinator	Prof. dr. Andrei Mărcuş				
2.3. Seminar coordinator	Prof. dr. Andrei Mărcuş				
2.4. Year of study	1	2.5. Semester	1	2.6. Type of assessment	<a href="#">Exam</a>
2.7. Course status	<a href="#">Compulsory</a>		2.8. Course type	<a href="#">Core subject</a>	

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

3.1. Number of hours per week	<b>4</b>	of which: 3.2. course	<b>2</b>	3.3. seminar/ laboratory/ project	<b>2</b>
3.4. Total of hours in the curriculum	<b>56</b>	of which: 3.5. course	<b>28</b>	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)					30
Additional research in the library, on subject-specific electronic platforms, and on-site					15
Preparing seminars/ laboratories/ projects, assignments, reports, portfolios, and essays					30
Tutoring (professional guidance)					9
Examinations					10
Other activities					
<b>3.7. Total hours of individual study (IS) and self-taught activities (ST)</b>				<b>94</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	<p>Profound knowledge of high school math, especially of the following topics:</p> <ul style="list-style-type: none"> <li>- elements of propositional and predicate calculus</li> <li>- operations with sets</li> <li>- functions;</li> <li>- injectivity, surjectivity, bijectivity</li> <li>- number sets</li> <li>- divisibility in <math>\mathbb{Z}</math>; primes;</li> <li>- modular arithmetic</li> <li>- counting arguments</li> </ul>
4.2 skills-related	<ul style="list-style-type: none"> <li>- ability to perform symbolic calculations</li> <li>- ability to operate with abstract concepts</li> <li>- ability to do logical deductions</li> <li>- ability to solve math problems based on acquired notions</li> </ul>

#### 5. Specific conditions (where applicable)

5.1. course-related	<b>blackboard, projector</b>
5.2. seminar/laboratory-related	<b>blackboard</b>

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

Professional competencies	
Competency code	Competency
CP2	perform analytical mathematical calculations
CP6	think abstractly
CP8	study relationships between quantities
Transversal competencies	
Competency code	Competency
CT4	Soluționează probleme
CT5	Gândește analitic

### 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
CP2	7. The student/graduate selects, explains, and specifies the mathematical foundations applied in computer science, including formal logic, algebra, probability, and statistics.	7. The student/graduate applies, evaluates, and proposes mathematical methods for modeling, simulating, and solving computer science problems.
CP6	4. The student/graduate defines the basic concepts from advanced mathematics disciplines in the curriculum.	4. The student/graduate answers questions and correctly and rigorously formulates the statements of mathematical assertions (lemmas, propositions, theorems) from the disciplines in the curriculum.
CP8	3. The student/graduate formulates observations and differentiates notions, properties, and assertions from the core disciplines of mathematics through examples and counterexamples.	3. The student/graduate identifies and describes the essential elements in the construction of proofs of mathematical assertions (lemmas, propositions, theorems), recognizes errors in reasoning, and corrects them.
CT4, CT5	2. The student/graduate compares and distinguishes related notions and their properties from the core disciplines of mathematics.	2. The student/graduate recognizes and analyzes the necessary and/or sufficient conditions in the statements of mathematical assertions and specifies their role in the proof.

### 7. Subject-specific learning outcomes

Knowledge and comprehension
1. The student has acquired the basic concepts specific to the discipline: propositional logic, first-order logic, sets, relations, functions, equivalence relations and order relations, cardinal and ordinal numbers, sets of numbers, algebras and Boolean rings, with applications in computer science and electrical circuits.

<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. 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 knows fundamental notions related to logic and set theory as well as methods of applying them in fields of science related to mathematics and computer science.
<b>Specific academic skills</b>
1. The student is able to construct clear and well-supported mathematical arguments to explain mathematical problems, topics, and ideas in writing.
2. The student is able to prove theorems using mathematical language in theoretical courses and will be able to present these results both orally and in writing.

## 8. Contents

8.1. Course	Teaching and learning methods	Remarks <sup>3</sup>
Week 1. Propositional Logic. Formulas, truth values, tautologies.	Explanation, dialogue, examples, proofs	
Week 2. Normal forms in propositional logic. First order Logic. Predicates, quantifiers.	Explanation, dialogue, examples, proofs	
Week 3. Methods of mathematical proof. Sets and operations with sets.	Explanation, dialogue, examples, proofs	
Week 4. Binary relations. Functions. Injective, surjective, bijective functions.	Explanation, dialogue, examples, proofs	
Week 5. Equivalence relations and partitions, factor sets, kernel of a function.	Explanation, dialogue, examples, proofs	
Week 6. Factorization of functions	Explanation, dialogue, examples, proofs	
Week 7. Ordered sets, lattices.	Explanation, dialogue, examples, proofs	
Week 8. Boole algebras and Boole rings.	Explanation, dialogue, examples, proofs	
Week 9. Axiomatic number theory. The Frege-Russell constructions and the Peano axioms	Explanation, dialogue, examples, proofs	
Week 10. Construction of integers and rationals.	Explanation, dialogue, examples, proofs	
Week 11. Cardinal numbers. Operations with cardinal numbers.	Explanation, dialogue, examples, proofs	
Week 12. Ordering cardinal numbers. Finite, countable, infinite sets.	Explanation, dialogue, examples, proofs	
Week 13. Elements of Combinatorics. Counting arguments.	Explanation, dialogue, examples, proofs	
Week 14. Ordinal Numbers.	Explanation, dialogue, examples, proofs	

### Bibliography

- Lorinczi A; Marcus, A.: *Mathematical Logic and Set Theory*, Prese Universitară Clujeană, Cluj-Napoca, 2025.
- Breaz, S.; Covaci, R.: *Elemente de logica, teoria mulțimilor si aritmetica*, Editura Fundației pentru Studii Europene, Cluj-Napoca, 2006.

8.2. Seminar/ laboratory	Teaching and learning methods	Remarks
Week 1. Propositional Logic. Formulas, truth values, tautologies.	Explanation, dialogue, examples, proofs	
Week 2. Normal forms in propositional logic. First order Logic. Predicates, quantifiers.	Explanation, dialogue, examples, proofs	

<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.

Week 3. Methods of mathematical proof. Sets and operations with sets.	Explanation, dialogue, examples, proofs	
Week 4. Binary relations. Functions. Injective, surjective, bijective functions.	Explanation, dialogue, examples, proofs	
Week 5. Equivalence relations and partitions, factor sets, kernel of a function.	Explanation, dialogue, examples, proofs	
Week 6. Factorization of functions	Explanation, dialogue, examples, proofs	
Week 7. Ordered sets, lattices.	Explanation, dialogue, examples, proofs	
Week 8. Boole algebras and Boole rings.	Explanation, dialogue, examples, proofs	
Week 9. Axiomatic number theory. The Frege-Russell constructions and the Peano axioms	Explanation, dialogue, examples, proofs	
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Week 12. Ordering cardinal numbers. Finite, countable, infinite sets.	Explanation, dialogue, examples, proofs	
Week 13. Elements of Combinatorics. Counting arguments.	Explanation, dialogue, examples, proofs	
Week 14. Ordinal Numbers.	Explanation, dialogue, examples, proofs	



















### Bibliography

1. Adamson, I.: A Set Theory Workbook. Birkha"user, Boston, 1998.
2. Epp, S.: Discrete Mathematics with Applications. 4th ed. Brooks/Cole, Boston, 2011.
3. Levy, A.: Basic Set Theory. Dover Publications, New York, 1979.
4. Lidl, R., Pilz, G.: Applied Abstract Algebra. Springer-Verlag, Berlin, 1998.
5. Ross, K. A., Wright Ch., Discrete Mathematics. Pearson Education, New Jersey, 2003.

## 9. Evaluation

Activity type	9.1 Evaluation criteria	9.2 Evaluation methods	9.3 Percentage of final grade
9.4 Course	- know the basic principles of the field. - apply the new concepts.	- Written exam	80%
9.5 Seminar/laboratory	- problem solving	- homeworks	20%
9.6 Minimum standard of performance			
<ul style="list-style-type: none"> <li>• to aquire minimum 5 (out of 10) points to pass the exam</li> </ul>			

## 10. SDG labels (Sustainable Development Goals)<sup>4</sup>

		<input type="radio"/> Sustainable Development Generic Label						
<b>1</b> FĂRĂ SĂRĂCIE 	<b>2</b> FOAMETE 'ZERO' 	<b>3</b> SĂNĂTATE ȘI BUNĂSTĂRE 	<b>4</b> EDUCĂȚIE DE CALITATE 	<b>5</b> EGALITATE DE GEN 	<b>6</b> APĂ CURĂȚĂ ȘI SĂNĂTATE 	<b>7</b> ENERGIE CURĂȚĂ ȘI LA PREȚURI ACCESIBILE 	<b>8</b> MUNCĂ DECENTĂ ȘI CREȘTERE ECONOMICĂ 	<b>9</b> INDUSTRIE, INOVAȚIE ȘI INFRASTRUCTURĂ 
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	X
<b>10</b> INEGALITĂȚI REDUSE 	<b>11</b> ORAȘE ȘI COMUNITĂȚI DURABILE 	<b>12</b> CONSUM ȘI PRODUCȚIE RESPONSABILE 	<b>13</b> ACȚIUNE CLIMATICĂ 	<b>14</b> VIAȚĂ ACVATICĂ 	<b>15</b> VIAȚĂ TERESTRĂ 	<b>16</b> PACE, JUSTIȚIE ȘI INSTITUȚII EFICIENTE 	<b>17</b> PARTENERIATE PENTRU REALIZAREA OBIECTIVELOR 	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:  
10.04.2026

Signature of course coordinator

Prof. dr. Andrei Mărcuș

Signature of seminar coordinator

Prof. dr. Andrei Mărcuș

Date of approval in the department:  
24.04.2026

Signature of the head of department

Prof. dr. Andrei Mărcuș

<sup>4</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."