COURSE DESCRIPTION

Theorem proving in Lean

Academic year 2026-2027

1. Programme-related data

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

2. Course-related data

2.1. Course title	**Theorem proving in Lean**			Course code	**MLE0104**
2.2. Course coordinator		Lect. dr. Iulian Simion			
2.3. Seminar coordinator		Lect. dr. Iulian Simion			
2.4. Year of study	3	2.5. Semester	1	2.6. Type of assessment	C
2.7. Course status		Opțional		2.8. Course type	DS

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

3.1. Number of hours per week	3	of which: 3.2. course	2	3.3. seminar/ laboratory/ project	1
3.4. Total of hours in the curriculum	42	of which: 3.5. course	28	3.6. seminar/ laboratory	14
Time allocation for individual study (IS) and self-taught activities (ST)					**hours**
Learning from textbooks, course materials, bibliography, and notes (IS)					8
Additional research in the library, on subject-specific electronic platforms, and on-site					14
Preparing seminars/ laboratories/ projects, assignments, reports, portfolios, and essays					14
Tutoring (professional guidance)					14
Examinations					8
Other activities					
3.7. Total hours of individual study (IS) and self-taught activities (ST)				**58**	
3.8. Total hours per semester				**100**	
3.9. Number of credits				**4**	

4. Prerequisites (where applicable)

4.1. curriculum-related	A first course in algebra and programming.
4.2 skills-related	Competencies of using the above mentioned courses.

5. Specific conditions (where applicable)

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

6.1. Competencies resulting from the completion of the degree programme *(as referred to in the curriculum)*[1]

Professional competencies

[1] 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.

Competency code	Competency
PC10	use software libraries
PC19	create data models
Transversal competencies	
Competency code	**Competency**
TC2	Solve problems
TC3	Think analytically

6.2. Learning outcomes relevant to the degree programme (as referred to in the curriculum)[2]

Learning outcomes targeted by the subject		
Competency code	**Knowledge and comprehension**	**Specific academic skills**
CP2, CP3	The student/graduate names, gives examples, concludes, specifies, recognizes and critically argues the methods of designing and managing complex IT projects using modern strategies.	The student/graduate initiates, prepares, implements, and proposes methods for developing complex IT projects. The student/graduate produces specific professional reports.

7. Subject-specific learning outcomes

Knowledge and comprehension
The student has acquired the basic concepts specific to formal proofs.
Specific academic skills
The student is able to use the ecosystem needed for Lean.

8. Contents

8.1. Course	Teaching and learning methods	Remarks[3]
Weeks 1-2. Proofs by calculation • Types and terms • Equalities and inequalities • Numerical Tactics • Organizing code • Theorems and proofs	Exposition, proofs, examples	
Weeks 3-5. Logic • Operators and quantifiers • Excluded middle • Proofs with structure	Exposition, proofs, examples	
Week 6. Examples • Cases tactic • Divisibility • Functions	Exposition, proofs, examples	
Weeks 7-8. Induction • Inductive types • Induction and recursion • Match tactic • Induction types	Exposition, proofs, examples	
Week 9. Examples: Number Theory • Modular arithmetic	Exposition, proofs, examples	

[2] 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.

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

• Bézout's identity • Irrationality of √2 • Infinitely many primes		
Week 10. Examples: Set Theory • Operations on sets • Finite sets • Sets with properties • Dependent types	Exposition, proofs, examples	
Week 11. Type classes • Structures • Hierarchies • Algebraic structures	Exposition, proofs, examples	
Week 12. Metaprogramming • Macros • Tactics • LeanBlueprint	Exposition, proofs, examples	
Weeks 13-14. Examples • Linear algebra • Topology • Group theory	Exposition, proofs, examples	
Bibliography [1] Jeremy Avigad, Patrick Massot - Mathematics in Lean, 2020 [2] Heather Macbeth - The Mechanics of Proof, 2024 [3] Jeremy Avigad, Leonardo de Moura, Soonho Kong and Sebastian Ullrich, with contributions from the Lean Community - Theorem Proving in Lean 4, 2024 [4] Anne Baanen, Alexander Bentkamp, Jasmin Blanchette, Johannes Hölzl, Jannis Limperg - The Hitchhiker's Guide to Logical Verification, 2023		
8.2. Seminar/ laboratory	**Teaching and learning methods**	**Remarks**
Weeks 1-2. Proofs by calculation • Types and terms • Equalities and inequalities • Numerical Tactics • Organizing code • Theorems and proofs	Dialog, problem solving	
Weeks 3-5. Logic • Operators and quantifiers • Excluded middle • Structure of proofs	Dialog, problem solving	
Week 6. Examples • Cases tactic • Divisibility • Functions	Dialog, problem solving	
Weeks 7-8. Induction • Inductive types • Induction and recursion • Match tactic • Induction types • Examples: prime numbers	Dialog, problem solving	
Week 9. Examples: Number Theory • Modular arithmetic • Bézout's identity • Irrationality of √2 • Infinitely many primes	Dialog, problem solving	
Week 10. Examples: Set Theory • Operations on sets • Finite sets • Sets with properties • Dependent types	Dialog, problem solving	
Week 11. Type classes • Structures	Dialog, problem solving	

• Hierarchies • Algebraic structures		
Week 12. Metaprogramming • Macros • Tactics • LeanBlueprint	Dialog, problem solving	
Week 13-14. Advanced examples • Linear algebra • Topology • Group theory	Dialog, problem solving	
Bibliography [1] Jeremy Avigad, Patrick Massot - Mathematics in Lean, 2020 [2] Heather Macbeth - The Mechanics of Proof, 2024 [3] Jeremy Avigad, Leonardo de Moura, Soonho Kong and Sebastian Ullrich, with contributions from the Lean Community - Theorem Proving in Lean 4, 2024		

9. Evaluation

Type of activity	9.1 Evaluation criteria[4]	9.2 Evaluation methods[5]	9.3 Percentage in the final grade
9.4. Course	Critical grasp of the learned material, ability to use what was learned	Two written partial exams at the middle and at the end of the semester (20% and 20% respectively)	40%
9.5. Seminar / laboratory	Ability to solve relevant problems	Homework	60%
9.6 Minimum standard for passing			
1. 75% attendance at the seminar. 2. Final grade greater of 5 or greater.			

10. SDG labels (Sustainable Development Goals)[6]

	○	Sustainable Development Generic Label

1 FĂRĂ SĂRĂCIE	2 FOAMETE „ZERO"	3 SĂNĂTATE ȘI BUNĂSTARE	4 EDUCAȚIE DE CALITATE	5 EGALITATE DE GEN	6 APĂ CURATĂ ȘI SANITAȚIE	7 ENERGIE CURATĂ ȘI LA PREȚURI ACCESIBILE	8 MUNCĂ DECENTĂ ȘI CREȘTERE ECONOMICĂ	9 INDUSTRIE, INOVAȚIE ȘI INFRASTRUCTURĂ
○	○	○	○	○	○	○	○	◉

[4] 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.

[5] Both final evaluation methods and ongoing evaluation strategies should be established.

[6] 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."*

								No label applies
○	○	○	○	○	○	○	○	○

Date of entry:
11.04.2026

Signature of course coordinator

Lect. dr. Iulian-Ion Simion

Signature of seminar coordinator

Lect. dr. Iulian-Ion Simion

Date of approval in the department:
24.04.2026

Signature of the head of department

Prof. dr. Andrei Mărcuș