COURSE DESCRIPTION

Category theory

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 of study	Mathematics
1.5. Study cycle	Bachelor
1.6. Study programme/Qualification	Mathematics Computer Science
1.7. Form of education	Full-time education

2. Course-related data

2.1. Course title	**Category theory**			Course code	**MME3123**
2.2. Course coordinator	Prof. PhD. Septimiu Crivei				
2.3. Seminar coordinator	Prof. PhD. Septimiu Crivei				
2.4. Year of study	1	2.5. Semester	1	2.6. Type of assessment	Exam
2.7. Course status	Compulsory			2.8. Course type	Core subject

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)					28
Additional research in the library, on subject-specific electronic platforms, and on-site					28
Preparing seminars/ laboratories/ projects, assignments, reports, portfolios, and essays					42
Tutoring (professional guidance)					28
Examinations					32
Other activities					0
3.7. Total hours of individual study (IS) and self-taught activities (ST)				**158**	
3.8. Total hours per semester				**200**	
3.9. Number of credits				**8**	

4. Prerequisites (where applicable)

4.1. curriculum-related	
4.2 skills-related	

5. Specific conditions (where applicable)

5.1. course-related	
5.2. seminar/laboratory-related	

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

Professional competencies	
Competency code	**Competency**
CP3	perform analytical mathematical calculations
CP1	develop problem-solving strategies
CP6	disseminate results among the scientific community
Transversal competencies	
Competency code	**Competency**
CT3	work independently
CT6	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**
CP3	5. The graduate formulates observations and differentiates notions, properties and assertions from advanced disciplines of mathematics through examples and counterexamples.	5. The graduate verifies, on particular cases or by constructing examples or counterexamples, the validity of mathematical statements. The graduate translates a practical situation into mathematical language, solves the problem obtained and interprets the results obtained.
CP1	1. The graduate analyses the hypotheses and conclusions from mathematical assertions and links them within the demonstration.	1. The graduate demonstrates the acquisition and use of effective research methods and techniques.
CP7, CT3	3. The graduate compares and distinguishes related notions and their properties from advanced mathematics disciplines in the curriculum.	3. The graduate is able to identify and formulate significant problems which form the basis for further research.
CT6	4. The graduate critically studies the specialized literature, including by using international databases, identifying fundamental concepts.	4. The graduate applies appropriate techniques for solving advanced problems.

7. Subject-specific learning outcomes

Knowledge and comprehension
1. The student is able to ensure the formation of skills specific to the Mathematics-related disciplines needed to complete the assignments.
2. The student knows fundamental notions related to Category theory, and methods of applying them to areas of science related to Mathematics.
3. The student is able to define/identify/understand research problems in Mathematics.
Specific academic skills

[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.

[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.

1. The student will construct clear and well-supported mathematical arguments to explain mathematical problems, topics, and ideas in writing.
2. The student will prove theorems using the language of mathematics in theoretical junior/senior level courses and present those results both orally and in writing.
3. The student will interpret articles or books from the mathematical literature and incorporate ideas and results from the literature in their written and oral presentations.

8. Contents

8.1. Course	**Teaching and learning methods**	**Remarks[3]**
1. Categories - definition and examples	Exposition, proof, examples	
2. Special objects and morphisms	Exposition, proof, examples	
3. Constructions on categories	Exposition, proof, examples	
4. Products and coproducts	Exposition, proof, examples	
5. Equalizers and coequalizers	Exposition, proof, examples	
6. Pullbacks and pushouts	Exposition, proof, examples	
7. Limits and colimits	Exposition, proof, examples	
8. Natural transformations	Exposition, proof, examples	
9. Equivalence of categories	Exposition, proof, examples	
10. Yoneda Lemma	Exposition, proof, examples	
11. Adjoint functors	Exposition, proof, examples	
12. Grothendieck categories	Exposition, proof, examples	
13. Abelian categories	Exposition, proof, examples	
14. Exact categories	Exposition, proof, examples	

Bibliography

1. S. Awodey, *Category theory*, Oxford University Press, 2010.
2. S. Mac Lane, *Categories for the working mathematician*, Springer, 1998.
3. B. Mitchell, *Theory of categories*, Academic Press, New York, London, 1965.
4. C. Nastasescu, *Inele, module, categorii* (in Romanian), Editura Academiei, Bucuresti, 1976.
5. I. Purdea, *Tratat de algebra moderna*, vol. II (in Romanian), Editura Academiei, Bucuresti, 1982.

8.2. Seminar/ laboratory	**Teaching and learning methods**	**Remarks**
1. Categories - definition and examples	Explanation, problematization, examples	
2. Special objects and morphisms	Explanation, problematization, examples	
3. Constructions on categories	Explanation, problematization, examples	
4. Products and coproducts	Explanation, problematization, examples	
5. Equalizers and coequalizers	Explanation, problematization, examples	
6. Pullbacks and pushouts	Explanation, problematization, examples	
7. Limits and colimits	Explanation, problematization, examples	

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

8. Natural transformations	Explanation, problematization, examples	
9. Equivalence of categories	Explanation, problematization, examples	
10. Yoneda Lemma	Explanation, problematization, examples	
11. Adjoint functors	Explanation, problematization, examples	
12. Grothendieck categories	Explanation, problematization, examples	
13. Abelian categories	Explanation, problematization, examples	
14. Exact categories	Explanation, problematization, examples	

Bibliography

1. S. Awodey, *Category theory*, Oxford University Press, 2010.
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1. I. Purdea, *Tratat de algebra moderna*, vol. II (in Romanian), Editura Academiei, Bucuresti, 1982.

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	Use of basic concepts, examples	Project, presentation.	1/2 of the grade
9.5. Seminar/ laboratory	Problem solving	Assignments, presentation	1/2 of the grade
9.6 Minimum standard for passing			
The final grade must be at least 5.			

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

	○	Sustainable Development Generic Label

[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."*

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

Date of entry:
15.04.2026

Signature of course coordinator

Prof. PhD. Septimiu Crivei

Signature of seminar coordinator

Prof. PhD. Septimiu Crivei

Date of approval in the department:
23.04.2026

Signature of the head of department

Prof. PhD. Andrei Mărcuş