

SYLLABUS

Homological Algebra

University 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	Mathematics
1.5. Level of study	Master
1.6. Degree programme / Qualification	Advanced Mathematics
1.7. Form of education	Full-time

2. Course-related data

2.1. Course title	Homological Algebra			Course code	MME3112
2.2. Course coordinator	Prof. dr. Simion-Sorin Breaz				
2.3. Seminar coordinator	Prof. dr. Simion-Sorin Breaz				
2.4. Year of study	2	2.5. Semester	3	2.6. Type of assessment	Exam
2.7. Course status	Compulsory		2.8. Course type	Core subject	

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

3.1. Hours per week	3	of which: 3.2 course	2	3.3 seminar/laboratory	1
3.4. Total hours in the curriculum	42	of which: 3.5 course	28	3.6 seminar/laborator	14
Time allotment for individual study (ID) and self-study activities (SA)					hours
Learning using manual, course support, bibliography, course notes (SA)					46
Additional documentation (in libraries, on electronic platforms, field documentation)					36
Preparation for seminars/labs, homework, papers, portfolios and essays					32
Tutorship					24
Evaluations					20
Other activities:					
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	Deep knowledge of bachelor level algebra, especially of the following subjects: - algebraic structures - linear algebra
4.2 skills-related	- ability to perform symbolic calculations - ability to operate with abstract concepts - ability to do logical deductions - ability to solve mathematics problems based on the aquired notions

5. Specific conditions (where applicable)

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

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/graduate has acquired the knowledge specific to the discipline studied necessary for solving problems.
2. The student/graduate knows fundamental notions of algebra as well as methods of applying them in fields of science related to mathematics and computer science.
Specific academic skills
1. The student/graduate is able to construct clear and well-supported mathematical arguments to explain mathematical problems, topics, and ideas in writing.
2. The student/graduate is able to prove theorems using mathematical language in theoretical courses and will be able to use them in other fields.

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.

8. Content



















8.1 Course	Teaching methods	Remarks
1. Preliminaries	Lectures, didactical demonstration, conversation.	
2. Modules	Lectures, didactical demonstration, conversation.	
3. Categories	Lectures, didactical demonstration, conversation.	
4. Limits and colimits	Lectures, didactical demonstration, conversation.	
5. Functors	Lectures, didactical demonstration, conversation.	
6. Injective and projective modules	Lectures, didactical demonstration, conversation.	
7. Flat modules	Lectures, didactical demonstration, conversation.	
8. Complexes	Lectures, didactical demonstration, conversation.	
9. Homology functors	Lectures, didactical demonstration, conversation.	
10. Derived functors	Lectures, didactical demonstration, conversation.	
11. Ext	Lectures, didactical demonstration, conversation.	
12. Tor	Lectures, didactical demonstration, conversation.	
13. Ext for Abelian Groups	Lectures, didactical demonstration, conversation.	
14. Tensor and Tor for Abelian Groups	Lectures, didactical demonstration, conversation.	
Bibliography		
<ol style="list-style-type: none">1. I. Moerdijk: Notes on Homological Algebra, course notes, www.math.ru.nl/topology/Notes%20on%20Homological%20Algebra.pdf2. J.J. Rotman: An Introduction to Homological Algebra, Springer, 20093. Osborne, M. Scott: Basic homological algebra. Graduate Texts in Mathematics. 196. New York, NY: Springer. x, 395 p. (2000).		
8.2 Seminar / laboratory	Teaching methods	Remarks
1. Preliminaries	problematization, exercises, problem solving,	
2. Modules	problematization, exercises, problem solving,	
3. Categories	problematization, exercises, problem solving,	

4. Limits and colimits	problematization, exercises, problem solving,	
5. Functors	problematization, exercises, problem solving,	
6. Injective and projective modules	problematization, exercises, problem solving,	
7. Flat modules	problematization, exercises, problem solving,	
8. Complexes	problematization, exercises, problem solving,	
9. Homology functors	problematization, exercises, problem solving,	
10. Derived functors	problematization, exercises, problem solving,	
11. Ext	problematization, exercises, problem solving,	
12. Tor	problematization, exercises, problem solving,	
13. Ext for Abelian Groups	problematization, exercises, problem solving,	
14. Tensor and Tor for Abelian Groups	problematization, exercises, problem solving,	
Bibliography		
<ol style="list-style-type: none"> 1. S. Breaz, G. Calugareanu, G. Modoi, D. Valcan: Exercices in Abelian Group Theory, Kluwer 2003. 2. J. Cigler, V. Losert, P. Michor: Banach Modules and Functors on Cateories of Banach Specaes, Marcel Dekker, 1979. 3. A. Hatcher: Algebraic Topology, Cambridge University Press, 2001, http://www.math.cornell.edu/~hatcher/AT/AT.pdf 4. C. Schochet: A Pext primer: Pure extensions and \lim^1 for infinite abelian groups, NYJM Monographs, 2003, http://nyjm.albany.edu/m/2003/1v.pdf 		

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	50%
9.5 Seminar/laboratory	Ability to use the concepts in order to solve problems	Final exam and activity during the semester.	25%+25%
9.6 Minimum standard of performance			
<ol style="list-style-type: none"> 1. to aquire 5 points to pass the exam. 			

10. SDG labels (Sustainable Development Goals)³

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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:
11.04.2026

Signature of course coordinator
Prof. dr. Simion-Sorin Breaz

Signature of seminar coordinator
Prof. dr. Simion-Sorin

Date of approval in the department:
25.04.2026

Signature of the head of department
Prof. dr. Andrei Mărcuș

³ 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."