COURSE DESCRIPTION

Representation theory of finite groups

Academic year 2026-2027

1. Programme-related data

1.1. Higher Education Institution	Babeș-Bolyai University of Cluj-Napoca
1.2. Faculty	Faculty of Mathematics and Computer Science
1.3. Doctoral Shool	Doctoral School in Mathematics and Computer Science
1.4. Field of study	Mathematics
1.5. Level of study	Doctoral studies

2. Course-related data

2.1. Course title	Representation theory of finite groups			Course code	**MDE3145**
2.2. Course coordinator	Prof. dr. Andrei Mărcuș				
2.3. Seminar coordinator	Prof. dr. Andrei Mărcuș				
2.4. Year of study		2.5. Semester		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)					54
Additional research in the library, on subject-specific electronic platforms, and on-site					50
Preparing seminars/ laboratories/ projects, assignments, reports, portfolios, and essays					54
Tutoring (professional guidance)					10
Examinations					10
Other activities					30
3.7. Total hours of individual study (IS) and self-taught activities (ST)				**208**	
3.8. Total hours per semester				**250**	
3.9. Number of credits				**10**	

4. Prerequisites (where applicable)

4.1. curriculum-related	Deep knowledge of bachelor and master 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 bases on aquired notions

5. Specific conditions (where applicable)

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

6. Subject-specific learning outcomes

Knowledge
1. The student/graduate defines the concepts in the discipline studied.
2. The student/graduate compares and distinguishes related notions and their properties in the discipline studied.

3. The student/graduate formulates observations and differentiates notions, properties, and assertions from the basic disciplines of computer science and/or applied mathematics through examples and counterexamples.
4. The student/graduate indicates and recognizes the concepts involved in the requirements of the formulated problems.
Skills
1. The student/graduate identifies and applies appropriate techniques for solving problems in the discipline studied.
2. The student/graduate identifies and applies appropriate techniques for solving advanced problems in the discipline studied.
3. The student/graduate describes real-world problems in mathematical terms related to the discipline studied, identifies working hypotheses, constructs appropriate mathematical models, and explains the limitations of the models thus obtained.
4. The student/graduate uses numerical methods and software packages to solve the constructed mathematical models and interprets the mathematical results thus obtained from the perspective of the modeled practical problem.
Responsibility and autonomy
1. The student/graduate identifies and correlates connections between concepts in the discipline studied. Approaches problem solving from different angles and directions, including based on non-traditional methodologies, in order to use them in applications of the discipline studied.
2. The student/graduate summarizes, classifies and presents the conclusions of problems in the studied topic and communicates mathematical concepts and reasoning in English to specialists through written reports and oral presentations.
3. Studentul/absolventul rezolvă prin metode analitice şi/sau numerice şi foloseşte pachete software dedicate sau scrie coduri elaborate în vederea rezolvării unor probleme practice şi analizării modelelor matematice construite pe baza temelor studiate.
4. The student/graduate uses independent information and documentation methods, uses international academic research databases, which provides him/her with openness to continuous learning, develops scientific communications or scientific reports and makes complete bibliographic references by respecting ethical norms when citing the documentation sources used.

7. Contents

7.1. Course	**Teaching and learning methods**	**Remarks**[1]
Week 1. Algebras, subalgebras, homomorphisms, ideals, factor algebras. Examples. Group algebra.	Explanation, dialogue, examples, proofs	
Week 2. Representations and modules. Simple modules (irreducible representations) and indecomposable modules.	Explanation, dialogue, examples, proofs	
Week 3. Tensor products. Hopf algebras.	Explanation, dialogue, examples, proofs	
Week 4. Semisimple algebras and modules. The theorems of Jordan-Holder, Krull-Schmidt, Wedderburn-Artin and Maschke.	Explanation, dialogue, examples, proofs	
Week 5. Representations of finite groups. Characters. Orthogonality.	Explanation, dialogue, examples, proofs	
Week 6. Products of characters. Induced characters. Frobenius reciprocity.	Explanation, dialogue, examples, proofs	
Week 7. Burnside's Theorem.	Explanation, dialogue, examples, proofs	
Week 8. Character table computations.	Explanation, dialogue, examples, proofs	
Week 9. Representations of the symmetric group.	Explanation, dialogue, examples, proofs	

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

Week 10. Group algebras over fields of characteristic $p>0$ and over discrete valuation rings. Blocks.	Explanation, dialogue, examples, proofs	
Week 11. Clifford's Theorems. Projective representations	Explanation, dialogue, examples, proofs	
Week 12. G-algebras and crossed products	Explanation, dialogue, examples, proofs	
Week 13. Relative projectivity and the Green correspondence	Explanation, dialogue, examples, proofs	
Week 14. Defect group of a block and Brauer's Main Theorems.	Explanation, dialogue, examples, proofs	
Bibliography		

7.2. Seminar/ laboratory	**Teaching and learning methods**	**Remarks**
Week 1. Algebras, subalgebras, homomorphisms, ideals, factor algebras. Examples. Group algebra.	dialogue, examples, proofs	
Week 2. Representations and modules. Simple modules (irreducible representations) and indecomposable modules.	dialogue, examples, proofs	
Week 3. Tensor products. Hopf algebras.	dialogue, examples, proofs	
Week 4. Semisimple algebras and modules. The theorems of Jordan-Holder, Krull-Schmidt, Wedderburn-Artin and Maschke.	dialogue, examples, proofs	
Week 5. Representations of finite groups. Characters. Orthogonality.	dialogue, examples, proofs	
Week 6. Products of characters. Induced characters. Frobenius reciprocity.	dialogue, examples, proofs	
Week 7. Burnside's Theorem.	dialogue, examples, proofs	
Week 8. Character table computations.	dialogue, examples, proofs	
Week 9. Representations of the symmetric group.	dialogue, examples, proofs	
Week 10. Group algebras over fields of characteristic $p>0$ and over discrete valuation rings. Blocks.	dialogue, examples, proofs	
Week 11. Clifford's Theorems. Projective representations	dialogue, examples, proofs	
Week 12. G-algebras and crossed products	dialogue, examples, proofs	
Week 13. Relative projectivity and the Green correspondence	dialogue, examples, proofs	
Week 14. Defect group of a block and Brauer's Main Theorems	dialogue, examples, proofs	
Bibliography		

8. Evaluation

Type of activity	8.1 Evaluation criteria[2]	8.2 Evaluation methods[3]	8.3 Percentage in the final grade
8.4. Course	- know the basic principles of the field; - apply the new concepts	written exam	75%
8.5. Seminar/ laboratory	- problem solving	- homeworks	25%
8.6 Minimum standard for passing			
• to aquire 5 points to pass the exam			

9. SDG labels (Sustainable Development Goals)[4]

	○	Sustainable Development Generic Label						
								
○	○	○	○	○	○	○	○	x
								No label applies
○	○	○	○	○	○	○	○	○

Date of entry:
12.02.2026

Signature of course coordinator

Prof. dr. Andrei Mărcuș

Signature of seminar coordinator

Prof. dr. Andrei Mărcuș

Date of approval in the department:
20.02.2026

Signature of the head of department

[2] 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.

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

[4] 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."*