SYLLABUS

1. Information regarding the programme

1.1 Higher education institution	**Babeş Bolyai University**
1.2 Faculty	**Faculty of Mathematics and Computer Science**
1.3 Department	**Department of Mathematics**
1.4 Field of study	**Mathematics**
1.5 Study cycle	**Master**
1.6 Study programme / Qualification	**Advanced Mathematics**

2. Information regarding the discipline

2.1 Name of the discipline	**MME3103 Group Theory and applications**							
2.2 Course coordinator	prof. dr. Andrei Marcus							
2.3 Seminar coordinator	prof. dr. Andrei Marcus							
2.4. Year of study	**1**	2.5 Semester	**2**	2.6. Type of evaluation	**E**	2.7 Type of discipline	**Compulsory**	

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/~~laboratory~~	14
Time allotment:					hours
Learning using manual, course support, bibliography, course notes					36
Additional documentation (in libraries, on electronic platforms, field documentation)					36
Preparation for seminars/labs, homework, papers, portfolios and essays					36
Tutorship					20
Evaluations					30
Other activities:					

3.7 Total individual study hours	158
3.8 Total hours per semester	200
3.9 Number of ECTS credits	8

4. Prerequisites (if necessary)

4.1. curriculum	- deep knowledge of bachelor level algebra, especially of the following subjects: - algebraic structures - linear algebra
4.2. competencies	- 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. Conditions (if necessary)

5.1. for the course	• blackboard, projector
5.2. for the seminar /lab activities	• blackboard

6. Specific competencies acquired

Professional competencies	• C1.1 Identifying the notions, describing the theories and using the specific language. • C2.3 Applying the adequate analytical theoretical methods to a given problem.
Transversal competencies	• CT1. Applying some rules of precise and efficient work, showing a responsible attitude regarding the scientific domain and teaching training for an optimal and creative development of the personal potential in specific situations, respecting the deontological norms.

7. Objectives of the discipline (outcome of the acquired competencies)

7.1 General objective of the discipline	• Advanced knowledge on group theory. Ability to solve more difficult problems
7.2 Specific objective of the discipline	• students will operate with fundamental concepts of group theory • students will aquire knowlegde regarding the structure of groups from various important classes. • students solve problems, theoretical and practical, using instruments of modern algebra, regarding symmetry groups.

8. Content

8.1 Course	Teaching methods	Remarks
1. Revision: groups, subgroups, factor group, isomorphism theorems. Symmetry groups.	Explanation, dialogue, examples, proofs	
2. The symmetric group. Group actions on sets.	Explanation, dialogue, examples, proofs	
3. p-groups and Sylow theorems	Explanation, dialogue, examples, proofs	
4. Direct and semidirect products. Finitely generated abelian groups. Dihedral groups.	Explanation, dialogue, examples, proofs	
5. Group extensions. The Schur-Zassenhaus theorem.	Explanation, dialogue, examples, proofs	
6. Classification of groups of given order.	Explanation, dialogue, examples, proofs	
7. The general linear group.	Explanation, dialogue, examples, proofs	
8. Algebras, subalgebras, homomorphisms, ideals, factor algebras.	Explanation, dialogue, examples, proofs	
9. Examples. Group algebra.	Explanation, dialogue, examples, proofs	

10. Representations and modules. Simple modules (irreducible representations) and indecomposable modules.	Explanation, dialogue, examples, proofs	
11. Semisimple algebras and modules.	Explanation, dialogue, examples, proofs	
12. Representations of finite groups. Characters.	Explanation, dialogue, examples, proofs	
13. Orthogonality of characters.	Explanation, dialogue, examples, proofs	
14. The character table of a finite group.	Explanation, dialogue, examples, proofs	

Bibliography

[1] M.A. Armstrong. *Groups and symmetry*. Springer-Verlag 1988.
[2] J.J. Rotman. *An introduction to the theory of groups*. Springer-Verlag. 1995.

8.2 Seminar / laboratory	Teaching methods	Remarks
15. Revision: groups, subgroups, factor group, isomorphism theorems. Symmetry groups.	dialogue, examples, proofs	
16. The symmetric group. Group actions on sets.	dialogue, examples, proofs	
17. p-groups and Sylow theorems	dialogue, examples, proofs	
18. Direct and semidirect products. Finitely generated abelian groups. Dihedral groups.	dialogue, examples, proofs	
19. Group extensions. The Schur-Zassenhaus theorem.	dialogue, examples, proofs	
20. Classification of groups of given order.	dialogue, examples, proofs	
21. The general linear group.	dialogue, examples, proofs	
22. Algebras, subalgebras, homomorphisms, ideals, factor algebras.	dialogue, examples, proofs	
23. Examples. Group algebra.	dialogue, examples, proofs	
24. Representations and modules. Simple modules (irreducible representations) and indecomposable modules.	dialogue, examples, proofs	
25. Semisimple algebras and modules.	dialogue, examples, proofs	
26. Representations of finite groups. Characters.	dialogue, examples, proofs	
27. Orthogonality of characters.	dialogue, examples, proofs	
28. The character table of a finite group.	dialogue, examples, proofs	

Bibliography

3. J.L. Alperin and R.B. Bell. *Groups and representatons*. Springer-Verlag. 1995.
4. D.J.S. Robinson. *An introduction to the theory of groups*. 2nd Ed. Springer-Verlag. 1996.
5. B.E. Sagan. *The symmetric group*. Springer-Verlag. 2001.
6. John B. Fraleigh. *A First course in abstract algebra*. 6th edition, Addison Wesley.
7. Michael Artin. *Algebra*. Prentice Hall 1991.
8. D.S. Dummit and R.M. Foote. *Abstract Algebra*. 2nd edition. John Wiley & Sons, 1999.
9. J.A. Gallian. *Contemporary Abstract Algebra*. 7th Edition.

9. Corroborating the content of the discipline with the expectations of the epistemic community, professional associations and representative employers within the field of the program

- Such a course exists in the curricula of all major universities in Romania and abroad;
- Groups are fundamental mathematical structures and have multiple applications in geometry,

number theory, cryptography, chemistry and physics, as they measure symmetry.

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course	- know the basic principles of the field; - apply the new concepts	- written exam	75%
10.5 Seminar/lab activities	- problem solving	- homeworks	25%
10.6 Minimum performance standards			
➢ to aquire 5 points to pass the exam			

Date	Signature of course coordinator	Signature of seminar coordinator
17.04.2024	Prof.dr. Andrei Mărcuș	Prof.dr. Andrei Mărcuș

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