SYLLABUS

Geometry 2 (Affine Geometry)

University year 2025-2026

1. Information regarding the programme

1.1. Higher education institution	Babeș-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
1.7. Form of education	Full-time

2. Information regarding the discipline

2.1. Name of the discipline	**Geometry 2 (Affine Geometry)**					Discipline code	**MLE0015**
2.2. Course coordinator	Lect. dr. Iulian Simion						
2.3. Seminar coordinator	Lect. dr. Iulian Simion						
2.4. Year of study	**1**	2.5. Semester	**2**	2.6. Type of evaluation	**VP**	2.7. Discipline regime	**Compulsory**

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

3.1. Hours per week	**4**	of which: 3.2 course	**2**	3.3 seminar/laboratory	**2**
3.4. Total hours in the curriculum	**56**	of which: 3.5 course	**28**	3.6 seminar/laborator	**28**
Time allotment for individual study (ID) and self-study activities (SA)					**hours**
Learning using manual, course support, bibliography, course notes (SA)					23
Additional documentation (in libraries, on electronic platforms, field documentation)					23
Preparation for seminars/labs, homework, papers, portfolios and essays					23
Tutorship					14
Evaluations					11
Other activities:					
3.7. Total individual study hours	**94**				
3.8. Total hours per semester	**150**				
3.9. Number of ECTS credits	**6**				

4. Prerequisites (if necessary)

4.1. curriculum	A first course in linear algebra and geometry respectively.
4.2. competencies	Competencies of using the above mentioned courses.

5. Conditions (if necessary)

5.1. for the course	blackboard and chalk or whiteboard and whiteboard marker, video projector
5.2. for the seminar /lab activities	blackboard and chalk or whiteboard and whiteboard marker

6.1. Specific competencies acquired [1]

Professional/essential competencies	• C1.1 Identifying specific concepts, describing specific theories and using domain specific language. • C2.3 Applying suitable analytical methods to specific problems and contexts.
Transversal competencies	• CT1. Applying the principles of rigorous and efficient work while demonstrating a responsible attitude toward science and education, in compliance with ethical and professional standards.

6.2. Learning outcomes

Knowledge	The student knows: - The specific language, methods, and algorithms required to solve specific problems. - How to derive mathematical proofs for specific statements and formulas.
Skills	The student is able to: - Apply appropriate methods and algorithms to solve specific problems. - Derive mathematical proofs for specific statements and formulas.
Responsibility and autonomy:	The student is capable of working independently to: - Expand acquired knowledge. - Critically engage with the relevant literature.

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

7.1 General objective of the discipline	• Basic concepts, methods, and algorithms in the context of affine geometry.
7.2 Specific objective of the discipline	• Interfacing with linear algebra and a first geometry course through affine subspaces, quadratic forms, classification of isometries, different perspectives on curves and surfaces, and classification of quadrics.

[1] One can choose either competences or learning outcomes, or both. If only one option is chosen, the row related to the other option will be deleted, and the kept one will be numbered 6.

8. Content

8.1 Course	**Teaching methods**	**Remarks**
Weeks 1-2. Affine Space • Geometric vectors • Vector space structure • Cartesian coordinate frames • Changing coordinate frames • Orientation • Affine subspaces in dimension n	Exposition, proofs, examples	Two lectures
Weeks 3-4. Affine Subspaces • Parametrizations • Linear systems of equations • Relative positions • Changing coordinate frames	Exposition, proofs, examples	Two lectures
Week 5. Classical theorems in dimension 2 • Thales, Pappus, Desargue, Menelaus, Ceva,etc.	Exposition, proofs, examples	
Week 6. Euclidean Space • Symmetric bilinear forms • Diagonalization	Exposition, proofs, examples	
Week 7. Affine Maps • Properties of affine transformations • Parallel projections and reflections • Orthogonal projections and reflections	Exposition, proofs, examples	
Weeks 8-9. Isometries • Rotations in dimension 2 and 3 • Displacements • Classification of isometries	Exposition, proofs, examples	Two lectures
Week 10. Classification of Quadrics • Reduction to canonical form • Isometric classification of quadrics • Affine classification of quadrics	Exposition, proofs, examples	
Weeks 11-12. Quadratic surfaces • Ellipsoid, Cone, Hyperboloid, Paraboloid • Canonical equation • Tangent planes	Exposition, proofs, examples	Two lectures
Weeks 13-14. Projective Space • Homogeneous coordinates • Projective transformations • Classical theorems in dimension 2	Exposition, proofs, examples	Two lectures

Bibliography
[1] I. Simion, Geometry – course material, 2025.
[2] P.A. Blaga, Geometrie liniară, Cluj-Napoca, 2022.
[3] M. Troyanov, Cours de géométrie, Lausanne, 2011.
[4] E. Sernesi, Linear Algebra. A geometric Approach (Translated by J. Montaldi), 2009.

8.2 Seminar / laboratory	**Teaching methods**	**Remarks**
Weeks 1-2. Affine Space • Geometric vectors • Vector space structure • Cartesian coordinate frames • Changing coordinate frames • Orientation • Affine subspaces in dimension n	Dialog, problem solving	
Weeks 3-4. Affine Subspaces • Parametrizations	Dialog, problem solving	

• Linear systems of equations • Relative positions • Changing coordinate frames		
Week 5. Classical theorems in dimension 2 • Thales, Pappus, Desargue, Menelaus, Ceva,etc.	Dialog, problem solving	
Week 6. Euclidean Space • Symmetric bilinear forms • Diagonalization	Dialog, problem solving	
Week 7. Affine Maps • Properties of affine transformations • Parallel projections and reflections • Orthogonal projections and reflections	Dialog, problem solving	
Weeks 8-9. Isometries • Rotations in dimension 2 and 3 • Displacements • Classification of isometries	Dialog, problem solving	
Week 10. Classification of Quadrics • Reduction to canonical form • Isometric classification of quadrics • Affine classification of quadrics	Dialog, problem solving	
Weeks 11-12. Quadratic surfaces • Ellipsoid, Cone, Hyperboloid, Paraboloid • Canonical equation • Tangent planes	Dialog, problem solving	
Weeks 13-14. Projective Space • Homogeneous coordinates • Projective transformations • Classical theorems in dimension 2	Dialog, problem solving	

Bibliography
[1] I. Simion, Geometry – course material, 2025.
[2] P.A. Blaga, Geometrie liniară, Cluj-Napoca, 2022.
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[4] E. Sernesi, Linear Algebra. A geometric Approach (Translated by J. Montaldi), 2009.

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

- A solid understanding of geometry is a prerequisite for any job involving geometric modeling.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of final grade
10.4 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	40% and 60% respectively
10.5 Seminar/laboratory	Ability to use the theory for solving problems	Points during the tutorial for active participation	Can lead up to one extra point for the final grade
10.6 Minimum standard of performance			
• 75% attendance at the Seminar. • At least grade 5 for the final grade (excluding the bonus points obtained during the tutorials).			

11. Labels ODD (Sustainable Development Goals)[2]

	General label for Sustainable Development							
								

Date:
11.04.2025

Signature of course coordinator

Lect. dr. Iulian Simion

Signature of seminar coordinator

Lect. dr. Iulian Simion

Date of approval:
25.04.2025

Signature of the head of department

Prof. dr. Andrei Mărcuș

[2] Keep only the labels that, according to the *Procedure for applying ODD labels in the academic process*, suit the discipline and delete the others, including the general one for *Sustainable Development* – if not applicable. If no label describes the discipline, delete them all and write „*Not applicable.*”.