# COURSE DESCRIPTION

## Geometry 2 (Affine Geometry)

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 | Mathematics |
| 1.5. Level of study | Bachelor |
| 1.6. Degree programme / Qualification | Mathematics Computer Science (English) |
| 1.7. Form of education | Full-time |

**2. Course-related data**

| | | | | | |
|---|---|---|---|---|---|
| 2.1. Course title | **Geometry 2 (Affine Geometry)** | | | Course 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 assessment | VP |
| 2.7. Course status | | Compulsory | | 2.8. Course type | DF |

**3. Total estimated time** (hours per semester of teaching activities)

| | | | | | |
|---|---|---|---|---|---|
| 3.1. Number of hours per week | 4 | of which: 3.2. course | 2 | 3.3. seminar/ laboratory/ project | 2 |
| 3.4. Total of hours in the curriculum | 56 | of which: 3.5. course | 28 | 3.6. seminar/ laboratory | 28 |
| **Time allocation for individual study (IS) and self-taught activities (ST)** | | | | | **hours** |
| Learning from textbooks, course materials, bibliography, and notes (IS) | | | | | 23 |
| Additional research in the library, on subject-specific electronic platforms, and on-site | | | | | 23 |
| Preparing seminars/ laboratories/ projects, assignments, reports, portfolios, and essays | | | | | 23 |
| Tutoring (professional guidance) | | | | | 14 |
| Examinations | | | | | 11 |
| Other activities | | | | | |
| **3.7. Total hours of individual study (IS) and self-taught activities (ST)** | | | | **94** | |
| **3.8. Total hours per semester** | | | | **150** | |
| **3.9. Number of credits** | | | | **6** | |

**4. Prerequisites** (where applicable)

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

**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** |
|---|

[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.

| Competency code | Competency |
|---|---|
| PC1 | develop problem-solving strategies |
| PC2 | perform analytical mathematical calculations |
| PC6 | think abstractly |
| **Transversal competencies** | |
| **Competency code** | **Competency** |
| TC4 | Solve problems |
| TC5 | 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** |
| PC5, PC6, PC7 | 1. The student/graduate defines the fundamental concepts from the core disciplines of mathematics. | 1. The student/graduate provides examples of how fundamental concepts and theoretical results are used in solving exercises and problems related to the topics covered in the curriculum disciplines. |
| PC1, CT4, CT5 | 2. The student/graduate compares and distinguishes related notions and their properties from the core disciplines of mathematics. | 2. The student/graduate recognizes and analyzes the necessary and/or sufficient conditions in the statements of mathematical assertions and specifies their role in the proof. |

**7. Subject-specific learning outcomes**

| **Knowledge and comprehension** |
|---|
| The student has acquired the basic concepts specific to affine geometry. |
| **Specific academic skills** |
| The student is able to model basic geometric requirements. |

**8. Contents**

| **8.1. Course** | **Teaching and learning methods** | **Remarks[3]** |
|---|---|---|
| Weeks 1-2. Affine Space<br>• Geometric vectors<br>• Vector space structure<br>• Cartesian coordinate frames<br>• Changing coordinate frames<br>• Orientation<br>• Affine subspaces in dimension n | Exposition, proofs, examples | Two lectures |
| Weeks 3-4. Affine Subspaces<br>• Parametrizations<br>• Linear systems of equations<br>• Relative positions<br>• Changing coordinate frames | Exposition, proofs, examples | Two lectures |
| Week 5. Classical theorems in dimension 2<br>• Thales, Pappus, Desargue, Menelaus, | Exposition, proofs, examples | |

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

| | | |
|---|---|---|
| Ceva,etc. | | |
| Week 6. Euclidean Space<br>• Symmetric bilinear forms<br>• Diagonalization | Exposition, proofs, examples | |
| Week 7. Affine Maps<br>• Properties of affine transformations<br>• Parallel projections and reflections<br>• Orthogonal projections and reflections | Exposition, proofs, examples | |
| Weeks 8-9. Isometries<br>• Rotations in dimension 2 and 3<br>• Displacements<br>• Classification of isometries | Exposition, proofs, examples | Two lectures |
| Week 10. Classification of Quadrics<br>• Reduction to canonical form<br>• Isometric classification of quadrics<br>• Affine classification of quadrics | Exposition, proofs, examples | |
| Weeks 11-12. Quadratic surfaces<br>• Ellipsoid, Cone, Hyperboloid, Paraboloid<br>• Canonical equation<br>• Tangent planes | Exposition, proofs, examples | Two lectures |
| Weeks 13-14. Projective Space<br>• Homogeneous coordinates<br>• Projective transformations<br>• Classical theorems in dimension 2 | Exposition, proofs, examples | Two lectures |
| Bibliography<br>[1] I. Simion, Geometry – course material, 2026.<br>[2] P.A. Blaga, Geometrie liniară, Cluj-Napoca, 2022.<br>[3] M. Troyanov, Cours de géométrie, Lausanne, 2011.<br>[4] E. Sernesi, Linear Algebra. A geometric Approach (Translated by J. Montaldi), 2009. | | |
| | | |
| **8.2. Seminar/ laboratory** | **Teaching and learning methods** | **Remarks** |
| Weeks 1-2. Affine Space<br>• Geometric vectors<br>• Vector space structure<br>• Cartesian coordinate frames<br>• Changing coordinate frames<br>• Orientation<br>• Affine subspaces in dimension n | Dialog, problem solving | |
| Weeks 3-4. Affine Subspaces<br>• Parametrizations<br>• Linear systems of equations<br>• Relative positions<br>• Changing coordinate frames | Dialog, problem solving | |
| Week 5. Classical theorems in dimension 2<br>• Thales, Pappus, Desargue, Menelaus, Ceva,etc. | Dialog, problem solving | |
| Week 6. Euclidean Space<br>• Symmetric bilinear forms<br>• Diagonalization | Dialog, problem solving | |
| Week 7. Affine Maps<br>• Properties of affine transformations<br>• Parallel projections and reflections<br>• Orthogonal projections and reflections | Dialog, problem solving | |
| Weeks 8-9. Isometries<br>• Rotations in dimension 2 and 3<br>• Displacements<br>• Classification of isometries | Dialog, problem solving | |
| Week 10. Classification of Quadrics<br>• Reduction to canonical form<br>• Isometric classification of quadrics | Dialog, problem solving | |

| | | |
|---|---|---|
| • Affine classification of quadrics | | |
| Weeks 11-12. Quadratic surfaces<br>• Ellipsoid, Cone, Hyperboloid, Paraboloid<br>• Canonical equation<br>• Tangent planes | Dialog, problem solving | |
| Weeks 13-14. Projective Space<br>• Homogeneous coordinates<br>• Projective transformations<br>• Classical theorems in dimension 2 | Dialog, problem solving | |
| Bibliography<br>[1] I. Simion, Geometry – course material, 2026.<br>[2] P.A. Blaga, Geometrie liniară, Cluj-Napoca, 2022.<br>[3] M. Troyanov, Cours de géométrie, Lausanne, 2011.<br>[4] E. Sernesi, Linear Algebra. A geometric Approach (Translated by J. Montaldi), 2009. | | |

**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 | 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) | 30% |
| | | | |
| 9.5. Seminar/ laboratory | Ability to use the theory for solving problems | included in the above | 70% |
| | | | |
| 9.6 Minimum standard for passing | | | |
| 75% attendance at the seminar.<br>The weighted average of the grades for the two partial exams needs to be at least 5 | | | |

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

| | | |
|---|---|---|
|  | ○ | Sustainable Development Generic Label |

| 1 FĂRĂ SĂRĂCIE | 2 FOAMETE „ZERO" | 3 SĂNĂTATE ȘI BUNĂSTARE | 4 EDUCAȚIE DE CALITATE | 5 EGALITATE DE GEN | 6 APĂ CURATĂ ȘI SANITAȚIE | 7 ENERGIE CURATĂ ȘI LA PREȚURI ACCESIBILE | 8 MUNCĂ DECENTĂ ȘI CREȘTERE ECONOMICĂ | 9 INDUSTRIE, INOVAȚIE ȘI INFRASTRUCTURĂ |
|---|---|---|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ◉ |

[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."*

|  |  |  |  |  |  |  |  | No label applies |
|---|---|---|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

Date of entry:
11.04.2026

Signature of course coordinator

Lect. dr. Iulian-Ion Simion

Signature of seminar coordinator

Lect. dr. Iulian-Ion Simion

Date of approval in the department:
24.04.2026

Signature of the head of department

Prof. dr. Andrei Mărcuș