COURSE DESCRIPTION

Linear algebra, analitical and differential geometry 1

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	**Computers and Information Technology**
1.5. Level of study	**Bachelor**
1.6. Degree programme / Qualification	**Information Engineering**
1.7. Form of education	**Full-time**

2. Course-related data

2.1. Course title	**Linear algebra, analitical and differential geometry 1**			Course code	**MLE0088**
2.2. Course coordinator	Assist. Prof. PhD. Cosmin Pelea				
2.3. Seminar coordinator	Assist. Prof. PhD. Cosmin Pelea				
2.4. Year of study	**1**	2.5. Semester	**1**	2.6. Type of assessment	Exam
2.7. Course status	Compulso			2.8. Course type	D

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

3.1. Number of hours per week	**4**	of which: 3.2. course	**3**	3.3. seminar/ laboratory/ project	**1**
3.4. Total of hours in the curriculum	**56**	of which: 3.5. course	**42**	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)					28
Additional research in the library, on subject-specific electronic platforms, and on-site					20
Preparing seminars/ laboratories/ projects, assignments, reports, portfolios, and essays					28
Tutoring (professional guidance)					14
Examinations					4
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	Basic notions and results from the 11th and 12th grades: • determinants, proprerties; • rank, the inverse of a matrix; • sistem of linear equations; • group, ring, field.
4.2 skills-related	• Basic computation skills. • Managing abstract concepts and performing logical reasonings. • The ability to use the knowledge aquired in problem solving.

5. Specific conditions (where applicable)

5.1. course-related	Blackboard, chalk, sponge
5.2. seminar/laboratory-related	Blackboard, chalk, sponge

6.1. Competencies resulting from the completion of the degree programme *(as referred to in the curriculum)*[1]

Professional competencies	
Competency code	**Competency**
PC5	design information system
Transversal competencies	
Competency code	**Competency**
TC1	Work independently
TC2	Solve problems
TC3	Think analytically
TC4	Schedule and organize

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	The graduate has adequate knowledge of the use of integrated development environments in order to create large-scale complex applications. The graduate has knowledge of programming, mathematics, engineering and technology and has the skills to use them in creating complex computer systems.	The graduate has the ability to develop, design and create new applications, systems or products using best practices in the field of computer science.
TC1, TC2, TC3, TC4	The student/graduate has the knowledge necessary to understand and solve complex problems, and to plan and organize advanced processes in various fields.	The graduate is able to identify complex problems and examine related issues to develop solving options and implement solutions. The graduate has the ability to apply general rules to specific problems and produce relevant solutions. The graduate is able to combine diverse information to formulate solutions and generate ideas for developing new products and applications.

[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.

7. Subject-specific learning outcomes

Knowledge and comprehension
1. The student aquired the notions and results required to compute determinants, the rank and the inverse of a matrix and to solve linear systems, and basics on vector spaces.
2. The student knows the necessary tools and properties to perform determinant and matrix rank computations, linear systems solving, a basic study of vector spaces and she/he can realize connections between them.
3. The student understands the course topics, its ideas and the provided tools.
Specific academic skills
1. The student is able to construct clear and well-supported mathematical arguments to explain mathematical problems, topics, and ideas presented in the course.
2. The student is able to prove theorems and solve exercises by using the appropriate mathematical tools and can present these results both orally and in writing.
3. The student has the ability to work independently to explore some new mathematical content, using previous coursework ideas and tools, to extend their understanding and to extend mathematical ideas and tools to mathematical topics not previously studied.

8. Contents

8.1. Course	**Teaching and learning methods**	**Remarks[3]**
1. Groups. Rings. Fields.	Interactive exposure; explanation; conversation; didactical demonstration	
2. Polynomial rings. Matrix rings	Interactive exposure; explanation; conversation; didactical demonstration	
3. Determinants. The inverse of a matrix	Interactive exposure; explanation; conversation; didactical demonstration	
4. The rank of a matrix.	Interactive exposure; explanation; conversation; didactical demonstration	
5. Systems of linear equations	Interactive exposure; explanation; conversation; didactical demonstration	
6. Elementary operations on a matrix. Applications	Interactive exposure; explanation; conversation; didactical demonstration	
7. Vector spaces. Subspaces.The generated subspace	Interactive exposure; explanation; conversation; didactical demonstration	
8. Linear maps	Interactive exposure; explanation; conversation; didactical demonstration	
9. Bases	Interactive exposure; explanation; conversation; didactical demonstration	
10. Dimension	Interactive exposure; explanation; conversation; didactical demonstration	
11. Matrices and linear maps	Interactive exposure; explanation; conversation; didactical demonstration	
12. Eigenvectors and eigenvalues	Interactive exposure; explanation;	

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

	conversation; didactical demonstration	
13. Diagonalisable matrices. Hamilton-Cayley Theorem	Interactive exposure; explanation; conversation; didactical demonstration	
14. Bilinear and quadratic forms.	Interactive exposure; explanation; conversation; didactical demonstration	

Bibliografie

1. R. COVACI, Algebra si programare liniara, Litografia UBB, Cluj-Napoca, 1986.
2. S. CRIVEI, Basic Abstract Algebra, Ed. Casa Cartii de Stiinta, Cluj-Napoca, 2002, 2003.
3. C. NASTASESCU, I. STANESCU, C. NITA, Matematica, Elemente de algebra superioara, Editura Didactica si Pedagogica, Bucuresti, 1995.
4. W. K. NICHOLSON, Linear Algebra and Applications, Lyryx Version, https://lila1.lyryx.com/textbooks/OPEN_LAWA_1/marketing/Nicholson-OpenLAWA-2021A.pdf
5. I. PURDEA, I. POP, Algebra, Editura GIL, Zalau, 2003.

8.2. Seminar/ laboratory	**Teaching and learning methods**	**Remarks**
1. Groups. Rings. Fields. Review.	Interactive exposure; explanation; conversation; didactical demonstration	
2. Determinants.	Interactive exposure; explanation; conversation; didactical demonstration	
3. The rank of a matrix	Interactive exposure; explanation; conversation; didactical demonstration	
4. The inverse of a matrix	Interactive exposure; explanation; conversation; didactical demonstration	
5. Systems of linear equations	Interactive exposure; explanation; conversation; didactical demonstration	
6. Vector spaces.	Interactive exposure; explanation; conversation; didactical demonstration	
7. Subspaces. Generated subspace	Interactive exposure; explanation; conversation; didactical demonstration	
8. Linear maps	Interactive exposure; explanation; conversation; didactical demonstration	
9. Bases	Interactive exposure; explanation; conversation; didactical demonstration	
10. Dimension formulas.	Interactive exposure; explanation; conversation; didactical demonstration	
11. Dimension and generated subspaces.	Interactive exposure; explanation; conversation; didactical demonstration	
12. Matrices and linear maps	Interactive exposure; explanation; conversation; didactical demonstration	
13. Eigenvectors and eigenvalues. Diagonalisable matrices. Hamilton-Cayley Theorem	Interactive exposure; explanation; conversation; didactical demonstration	
14. Bilinear and quadratic forms.	Interactive exposure; explanation; conversation; didactical demonstration	

Bibliografie

1. I.D. ION, N. RADU, Algebra (ed.4), Editura Didactica si Pedagogica, 1990.
2. I.D. ION, C. NITA, D. POPESCU, N. RADU: Probleme de algebra, Editura Didactica si Pedagogica, Bucuresti, 1981.
3. C. NASTASESCU, I. STANESCU, C. NITA, Matematica, Elemente de algebra superioara, Editura Didactica si Pedagogica, Bucuresti, 1995.
4. W. K. NICHOLSON, Linear Algebra and Applications, Lyryx Version,

https://lila1.lyryx.com/textbooks/OPEN_LAWA_1/marketing/Nicholson-OpenLAWA-2021A.pdf
5. I. PURDEA, C. PELEA, Probleme de algebra, EIKON, Cluj-Napoca, 2008.Bibliography

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	Knowledge of basics concerning matrices and linear systems and using them in solving exercises	Test	25%
	Knowledge of course basic notions and results (ststements and proofs)	Final exam	25%
9.5. Seminar/ laboratory	Examples, counterexamples and problem solving	Final exam	50%
9.6 Minimum standard for passing			

- The final grade must be at least 5.
- The required background for receiving the degree 5 contains:
  - all the course notions;
  - the statements of all the results presented in the course;
  - the possibility to compute (any size) determinants, the inverse of a matrix, the rank of a matrix using all the algorithms discussed during the semester;
  - the possibility to discuss the consistency and to solve systems of linear equations using all the algorithms discussed during the semester.

[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.

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

	○	Sustainable Development Generic Label

								
○	○	○	○	○	○	○	○	X
								No label applies
○	○	○	○	○	○	○	○	○

Date of entry:
10.04.2026

Signature of course coordinator

Assist. Prof. PhD. Cosmin Pelea

Signature of seminar coordinator

Assist. Prof. PhD. Cosmin Pelea

Date of approval in the department:
24.04.2026

Signature of the head of department

Prof. PhD. Andrei Mărcuș

[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."*