SYLLABUS

Linear algebra, analitical and differential geometry 1

University year 2025-2026

1. Information regarding the programme

1.1. Higher education institution	Babeş-Bolyai University
1.2. Faculty	Mathematics and Computer Science
1.3. Department	Mathematics
1.4. Field of study	Computers and Information Technology
1.5. Study cycle	Bachelor
1.6. Study programme/Qualification	Information Engineering
1.7. Form of education	Full time

2. Information regarding the discipline

2.1. Name of the discipline	**Linear algebra, analitical and differential geometry 1**					Discipline 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 evaluation	**E**	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	**3**	3.3 seminar/laboratory	**1**
3.4. Total hours in the curriculum	**56**	of which: 3.5 course	**42**	3.6 seminar/laborator	**14**
Time allotment for individual study (ID) and self-study activities (SA)					**hours**
Learning using manual, course support, bibliography, course notes (SA)					28
Additional documentation (in libraries, on electronic platforms, field documentation)					20
Preparation for seminars/labs, homework, papers, portfolios and essays					28
Tutorship					14
Evaluations					4
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	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. competencies	• Basic computation skills. • Managing abstract concepts and performing logical reasonings. • The ability to use the knowledge aquired in problem solving.A

5. Conditions (if necessary

5.1. for the course	Blackboard, chalk, sponge
5.2. for the seminar /lab activities	Blackboard, chalk, sponge

6.1. Specific competencies acquired [1]

Professional/essential 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.

6.2. Learning outcomes

Knowledge	The student knows how to compute determinants, the rank and the inverse of a matrix, basics of linear systems, vector spaces, matrices and linear maps.
Skills	The student is able to construct clear and well-supported mathematical arguments to explain mathematical problems, topics, and ideas in writing, to explain theoretical notions, problem-solving methods using the appropriate mathemaical tools and can present these results both orally and in writing.
Responsibility and autonomy:	The student has the ability to work independently to explore some mathematical content, drawing on ideas and tools from previous coursework to extend their understanding and to extend mathematical ideas and arguments from previous coursework to a mathematical topic not previously studied.

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

[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.

7.1 General objective of the discipline	To introduce the basic notions of linear algebra.
7.2 Specific objective of the discipline	To introduce some basic results on vector spaces, matrices, systems of linear equations, eigenvalues, eigenvectors and quadratic forms.

8. Content

8.1 Course	**Teaching methods**	**Remarks**
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; 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	

Bibliography

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 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	

Bibliography

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.

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

- The course presents notions which often appear in other undergraduate courses.
- The course offers a sufficiently general background for some highschool algebra topics and the opportunity to develop some problem solving skills useful for further teaching activities.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of final grade
10.4 Course	Knowledge of basic concepts	Test	25%
	Knowledge of basic results	Final exam.	25%
10.5 Seminar/laboratory	Examples and problem solving	Final exam.	50%
10.6 Minimum standard of performance			
• 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.

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

	General label for Sustainable Development							
								

Date:
11.04.2025

Signature of course coordinator

Assist. Prof. PhD. Cosmin Pelea

Signature of seminar coordinator

Assist. Prof. PhD. Cosmin Pelea

Date of approval:
25.04.2025

Signature of the head of department

Prof. PhD. 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.”*.