SYLLABUS

1. Program Information

1.1 Higher education institution	Technical University of Cluj-Napoca
1.2 Faculty	Faculty of Automation and Computer Science
1.3 Department	Department of Automation
1.4 Field of study	Automation, Applied Informatics and Intelligent Systems
1.5 Cycle of studies	Bachelor
1.6 Study Programme/Qualification	Intelligent Automation Systems (dual, in English language)
1.7 Form of education	IF – full-time education
1.8 Course code	3.00

2. Course information

2.1 Course title	**Linear Algebra**				
2.2 Course Lecturer	*Associate Prof. Math. Diana Otrocol, PhD, Diana.Otrocol@math.utcluj.ro*				
2.3 Seminar Lecturer	*Associate Prof. Math. Diana Otrocol, PhD, Diana.Otrocol@math.utcluj.ro*				
2.4 Year of study	1	2.5 Semester	1	2.6 Type of assessment	E
2.7 Course status	Formative category *(DF, DS, DC)*				DF
	Optionality *(DOB, DOP, DFac)*				DOB

3.Total estimated time

3.1 Number of hours per week	4	of which:	HEI	Lecture	2	Seminar	2	Laboratory	0	Project	0
			CO		0		0		0		0
3.2 Number of hours per semester	56	of which:	HEI	Lecture	28	Seminar	28	Laboratory	0	Project	0
			CO		0		0		0		0

3.3 Distribution of time allocation (hours per semester) for:	HEI	CO
(a) Study based on textbook, course support, bibliography, and notes	10	-
(b) Additional documentation in library, specialized electronic platforms, and fieldwork	7	-
(c) Preparation of seminars/laboratories, assignments, papers, portfolios and essays	24	-
(d) Tutoring	0	-
(e) Examinations	3	-
(f) Other activities:	0	-
3.4 Total individual study hours (sum (3.3(a)... 3.3(f)))	44	-
3.5 Total hours per semester (3.2+3.4)	100	-
3.6 Number of credits per semester	4	-

(HEI = Higher Education Institution, CO = Company)

4. Prerequisites (where applicable)

4.1 Curriculum Prerequisites	Basic knowledge of linear algebra
4.2 Competency Prerequisites	Competencies in linear algebra: matrices, determinants, linear systems

5. Conditions (where applicable)

5.1. Course Organization Conditions	Blackboard, Video Projector
5.2. Seminar / Laboratory / Project organization conditions	Blackboard, Video Projector

6. Specific Competencies Acquired

Professional Competencies	• PC02 Analyze test data • PC24 Think abstractly • PC27 Execute analytical mathematical calculations
Transversal Competencies	• TC02 Think analytically • TC05 Interpret mathematical information

7. Learning outcomes

Knowledge	• Understand the structure of linear spaces, subspaces, and bases. • Grasp the theory and properties of inner product spaces, eigenvalues, and eigenvectors. • Know how linear transformations operate and how they relate to matrix representations. • Be familiar with diagonalization, Jordan canonical forms, adjoint/self-adjoint operators, and matrix functions. • Understand the mathematical significance and applications of bilinear forms, quadratic forms, and singular value decomposition.
Skills	• Compute matrix representations of linear transformations in different bases. • Perform eigenvalue and eigenvector analysis for diagonalization and Jordan form construction. • Use linear algebra tools such as SVD in applied contexts (e.g., data compression, numerical stability). • Implement matrix functions such as exponentials and powers in solving system dynamics or iterative processes.
Responsibility and autonomy	• Collaborate effectively to interpret, transform, and analyze mathematical and engineering systems. • Demonstrate autonomy in exploring and generalizing results across abstract spaces and coordinate systems. • Evaluate the suitability of linear models and interpret results in engineering, physics, or computer science contexts.

8. Course Objectives

8.1 General objective of the course	A presentation of the concepts, notions, methods and fundamental techniques used in linear algebra.
8.2 Specific objectives	Use of the matriceal calculus (in the general context of linear algebra) to solve problems in engineering.

9. Contents

9.1 Lectures	No. of hours	Teaching methods	Obs.
C1. Linear spaces. Definition. Linear subspaces. Examples.	2	Explanation Demonstration Collaboration Interactive activities	-
C2. Linear independence. Basis. Dimension. Change of basis.	2		
C3. Inner - product spaces. Definition, properties, Schwarz' inequality. Examples	2		

C4. Linear transformations: definition, elementary properties, kernel and image.	2		
C5. The matrix associated to a linear transformation. The standard construction. Expresions in terms of coordinates.	2		
C6. Eigenvalues and eigenvectors. Definitions, invariant subspaces, characteristic polynomials.	2		
C7. The diagonal form. Canonical forms, diagonalizability.	2		
C8. The Jordan canonical form. Construction of a Jordan basis and a Jordan matrix.	2		
C9. Functions of a matrix. The n-th power of a matrix. Elementary functions of a matrix.	2		
C10. The adjoint operator. Definition, properties, examples.	2		
C11. Self-adjoint operators, unitary operators, properties of the eigenvalues and eigenvectors.	2		
C12. Bilinear forms, quadratic forms. The associated matrix.	2		
C13. The canonical form. Reduction to a canonical form. The method of eigenvalues and Jacobi's method.	2		
C14. Singular Values. Singular Value Decomposition.	2		

Bibliography
[1]. D. Cimpean, D. Inoan, I. Rasa, An invitation to Linear Algebra and Analytic Geometry, Ed. Mediamira, 2012 (in TUCN library)
[2]. V. Pop, I. Rasa, Linear Algebra with Applications to Markov Chains, Ed. Mediamira, 2005 [3]. D. Robinson, A Course in Linear Algebra with Applications, World Scientific Publishing, 2nd Edition, 2006.

9.2 Seminar	Hours HEI	Hours CO	Teaching methods	Obs.
S1. Linear spaces and subspaces. Applications.	2	-	Explanation Demonstration Collaboration Interactive activities	-
S2. Linear independence. Basis. Dimension. Change of basis. Applications.	2	-		
S3. Inner - product spaces. Applications.	2	-		
S4. Linear transformations (kernel and image). Injective and surjective transformations. Applications.	2	-		
S5. The matrix associated to a linear transformation. The standard construction. Expresions in terms of coordinates. Applications.	2	-		
S6. Eigenvalues and eigenvectors. Characteristic polynomials. Applications.	2	-		
S7. The diagonal form. Canonical forms, diagonalizability. Applications.	2	-		
S8. The Jordan canonical form. Construction of a Jordan basis and a Jordan matrix. Applications.	2	-		
S9. Functions of a matrix. The n-th power of a matrix. Elementary functions of a matrix. Applications.	2	-		
S10. The adjoint operator. Applications.	2	-		
S11. Self-adjoint operators, unitary operators. Applications.	2	-		
S12. Bilinear forms, quadratic forms. The associated matrix. Applications.	2	-		
S13. The canonical form. Reduction to a canonical form. The method of eigenvalues and Jacobi's method. Applications.	2	-		
S14. Singular Values. Applications.	2	-		

Bibliography
[1]. D. Cimpean, D. Inoan, I. Rasa, An invitation to Linear Algebra and Analytic Geometry, Ed. Mediamira, 2024 (in TUCN library)
[2]. V. Pop, I. Corovei, Algebra pentru ingineri. Culegere de probleme, Ed. Mediamira, 2003 (in Romanian).
[3]. S. Axler, Linear Algebra Done Right, Springer, 2-nd edition, 2004.

10. Correlation of course content with the expectations of the epistemic community representatives, professional associations, and major employers in the field related to the program

The course content is aligned with the expectations of academic and professional communities by providing foundational and advanced linear algebra competencies essential for modern engineering, data science, and applied research, as recognized by leading industry standards and employer requirements.

11. Evaluation

Activity Type	**Evaluation criteria**	**Evaluation methods**	**Weight in final grade**
11.1 Lecture	Written Exam	-	70%
11.2 Seminar/ Project	Seminar Activity Project	-	30%
11.3 Minimum Performance Standard			
Grade = 70% Written Exam + 20% Project + 10% Seminar Activity; Minimum Performance Standard: Grade≥5			

Date of completion: 15.05.2025	Lecturers		Signature
	Course	Assoc. Prof. PhD Math. Diana Ioana OTROCOL	
	Applications	Assoc. Prof. PhD Math. Diana Ioana OTROCOL	

Date of approval by the Department of Automation Council 24.11.2025	Director of the Department of Automation Prof.dr.ing. Honoriu VĂLEAN
Date of approval by the Faculty of Automation and Computer Science Council 28.11.2025	Dean Prof.dr.ing. Vlad MUREȘAN