COURSE DESCRIPTION

1. Program identification information

1.1 Higher education institution	**National University of Science and Technology Politehnica Bucharest**
1.2 Faculty	**Electronics, Telecommunications and Information Technology**
1.3 Department	**Electronic Devices, Circuits and Architectures**
1.4 Domain of studies	Electronic Engineering, Telecommunications and Information Technology
1.5 Cycle of studies	Bachelor/Undergraduate
1.6 Programme of studies	Microelectronics, Optoelectronics and Nanotechnologies

2. Date despre disciplină

2.1 Course name (ro) (en)				Algebră liniară, geometrie analitică și diferențială Linear Algebra, Analitic and Differential Geometry			
2.2 Course Lecturer				Slesar Vladimir			
2.3 Instructor for practical activities				Slesar Vladimir			
2.4 Year of studies	1	2.5 Semester	I	2.6. Evaluation type	E	2.7 Course regime	Ob
2.8 Course type		F	2.9 Course code	04.F.01.O.002		2.10 Tipul de notare	Nota

3. Total estimated time (hours per semester for academic activities)

3.1 Number of hours per week	4	Out of which: 3.2 course	3	3.3 seminary/laboratory	1
3.4 Total hours in the curricula	56	Out of which: 3.5 course	42	3.6 seminary/laboratory	14
Distribution of time:					hours
Study according to the manual, course support, bibliography and hand notes Supplemental documentation (library, electronic access resources, in the field, etc) Preparation for practical activities, homework, essays, portfolios, etc.					54
Tutoring					10
Examinations					5
Other activities (if any):					0

3.7 Total hours of individual study	69.00
3.8 Total hours per semester	125
3.9 Number of ECTS credit points	5

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	Knowledge of algebra, mathematical analysis, and geometry, according to the baccalaureate syllabus and the faculty admission syllabus.
4.2 Results of learning	-

5. Necessary conditions for the optimal development of teaching activities (where applicable)

5.1 Course	Lecture hall for approx. 150 seats, equipped with a board and video projector.
5.2 Seminary/ Laboratory/Project	Seminar room for approx. 30 seats, equipped with a board.

6. General objective *(Reffering to the teachers' intentions for students and to what the students will be thought during the course. It offers an idea on the position of course in the scientific domain, as well as the role it has for the study programme. The course topics, the justification of including the course in the currcula of the study programme, etc. will be described in a general manner)*

The acquisition of knowledge in linear algebra, analytic geometry, and differential geometry is an essential stage in training future engineers in electronics, telecommunications, and information technologies. The course provides the mathematical tools needed for the analysis, design, and optimization of electronic and communication systems, as well as for developing algorithms and numerical models used in research and industry. Emphasis is placed on understanding vector spaces, linear transformations, and matrix representations—fundamental concepts in signal processing, communication theory, and circuit design.

The content provides the theoretical basis indispensable for studying linear and nonlinear systems, numerical methods for solving equations, function optimization and data analysis, as well as algorithms used in the simulation and control of electronic systems.

The material supports understanding of processes involved in signal and systems theory, digital signal processing, neural networks, coding and information compression, data transmission, and performance optimization of communication systems. It also develops the capacity for abstract thinking, rigorous reasoning, geometric intuition, and the analytical skills necessary for designing and evaluating hardware and software solutions in complex, interdisciplinary contexts.

7. Competences *(Proven capacity to use knowledge, aptitudes and personal, social and/or methodological abilities in work or study situations and for personal and proffesional growth. They refflect the empolyers requirements.)*

Specific Competences	• Understanding fundamental concepts of linear algebra and analytic geometry needed for modeling and analyzing electronic and communication systems. • Applying algebraic and analytical methods in signal representation, circuit analysis, data processing, and the study of linear systems. • Using matrices, vectors, and vector spaces in formulating and solving problems specific to electronics, telecommunications, and information technologies. • Geometric and analytical modeling of physical phenomena and electromagnetic fields, applicable to the design and optimization of transmission systems. • Understanding concepts of differentiation and vector differentiation used in variational analysis, function optimization, and the study of continuous signals. • Developing abstraction, analytical thinking, and synthesis skills needed to interpret and implement mathematical models in electronic and communication engineering.

Transversal (General) Competences	• Mastering optimal learning methods, combining theoretical results, and developing the habit of teamwork. • Learning how to support an idea and conduct a scientific debate. • Honorable, responsible, ethical behavior, in the spirit of the law, to ensure the profession's reputation. • Awareness of the need for continuous training; efficient use of resources and learning techniques for personal and professional development.

8. Learning outcomes *(Synthetic descriptions for what a student will be capable of doing or showing at the completion of a course. The learning outcomes reflect the student's acomplishments and to a lesser extent the teachers' intentions. The learning outcomes inform the students of what is expected from them with respect to performance and to obtain the desired grades and ECTS points. They are defined in concise terms, using verbs similar to the examples below and indicate what will be required for evaluation. The learning outcomes will be formulated so that the correlation with the competences defined in section 7 is highlighted.)*

Knowledge	*The result of knowledge aquisition through learning. The knowledge represents the totality of facts, priciples, theories and practices for a given work or study field. They can be theoretical and/or factual.* • Explains domain-specific concepts. • Gives examples for the studied notions. • Correlates the studied notions within and across disciplines. • Recognizes the studied notions in processes within the specialty courses. • Compares certain studied notions, highlighting similarities and differences.
Skills	*The capacity to apply the knowledge and use the know-how for completing tasks and solving problems. The skills are described as being cognitive (requiring the use of logical, intuitive and creative thinking) or practical (implying manual dexterity and the use of methods, materials, tools and intrumentation).* • Selects and groups relevant information in a given context. • Applies the studied theory in solving applications. • Uses specific results, with justification, to solve problems. • Combines various methods and arguments to solve problems. • Creates a scientific text. • Interprets a practical problem from a mathematical point of view. • Interprets a mathematical problem from a practical point of view, where applicable. • Identifies multiple approaches to solving a problem, where applicable, and proposes solution plans. • Formulates conclusions after applying the studied notions. • Anticipates stages/modes of solving.

Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* • Selects appropriate bibliographic sources and analyzes them. • Respects academic ethics, correctly citing the bibliographic sources used. • Demonstrates receptiveness to new learning contexts. • Shows collaboration with other colleagues and teaching staff in carrying out teaching activities. • Demonstrates autonomy in organizing the learning situation/context or the problem situation to be solved. • Promotes/contributes with new solutions in the field to improve the quality of social life. • Analyzes and interprets business/entrepreneurial development opportunities in the field. • Demonstrates management skills for real-life situations (time management, collaboration vs. conflict).

9. Teaching techniques *(Student centric techniques will be considered. The means for students to participate in defining their own study path, the identification of eventual fallbacks and the remedial measures that will be adopted in those cases will be described.)*

Starting from the analysis of students' learning characteristics and their specific needs, the teaching process will explore both expository methods (lecture, presentation) and conversational–interactive methods, based on discovery learning models facilitated by direct and indirect exploration of reality (demonstration, modeling), as well as action-based methods such as exercises and problem solving. Each lecture will begin with a recap of the notions covered in the previous class. This discipline includes information and practical activities designed to support students in their learning efforts and in developing optimal collaboration and communication relationships in a climate favorable to discovery learning. Emphasis will be placed on practicing active listening and assertive communication skills, as well as mechanisms for constructing feedback as ways of regulating behavior in various situations and adapting the pedagogical approach to students' learning needs.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	Linear systems, matrices, algebraic structures (review of fundamental high-school notions). Gauss method. Gauss–Jordan method. LU decomposition	3
2	Analytic and vector geometry in the plane and in space	6
3	Vector spaces: linear independence, generating set, basis, dimension. Subspaces. Sum and intersection. Direct sum. Applications	6
4	Linear mappings. Kernel and image of a linear mapping. Matrix associated to a linear mapping. Change of basis. Examples and applications	4
5	Inner product. Orthogonal complement of a subspace. Gram–Schmidt orthogonalization. QR decomposition. Applications	5
6	Eigenvalues and eigenvectors. Canonical forms. Diagonalization of symmetric matrices. Applications	6
7	Quadratic forms. Reduction to canonical form. Conics and quadrics. Applications	6
8	Parametrized curves. Torsion and curvature	3

9	Parametrized surfaces. First fundamental form	3
	Total:	42

Bibliography:

1. Course page on the platform https://curs.upb.ro/.
2. Adriana Balan, Radu F. Constantin, *Algebră liniară și geometrie. Teorie și probleme*, Editura Printech, București, 2005.
3. Silvia Balea, Ana Niță, Alina Niță, Radu Ursianu, *Algebră liniară și geometrie*, Editura Printech, București, 2004.
4. Mircea Cimpoeaş, *Capitole de algebră liniară, geometrie şi ecuaţii diferenţiale pentru ingineri*, Editura Politehnica Press, București, 2021.
5. Irina Meghea, *Lecţii de algebră şi geometrie*, Editura Politehnica Press, Bucureşti, 2010.
6. Alexandru Negrescu, *Algebră liniară. O abordare prietenoasă*, Editura Politehnica Press, București, 2023.
7. Alina Petrescu-Niță, *Algebră liniară aplicativă*, Editura Politehnica Press, București, 2021.
8. Gilbert Strang, *Introduction to Linear Algebra*, Fourth Edition, Wellesley-Cambridge Press, 2009.
9. https://ocw.mit.edu/courses/18-06-linear-algebra-spring-2010/

SEMINARY

Crt. no.	Content	No. hours
1	Linear systems, matrices, algebraic structures (review of fundamental high-school notions). Gauss method. Gauss–Jordan method. LU decomposition	1
2	Analytic and vector geometry in the plane and in space	2
3	Vector spaces: linear independence, generating set, basis, dimension. Subspaces. Sum and intersection. Direct sum. Applications	2
4	Linear mappings. Kernel and image of a linear mapping. Matrix associated to a linear mapping. Change of basis. Examples and applications	2
5	Inner product. Orthogonal complement of a subspace. Gram–Schmidt orthogonalization. QR decomposition. Applications	2
6	Eigenvalues and eigenvectors. Canonical forms. Diagonalization of symmetric matrices. Applications	2
7	Quadratic forms. Reduction to canonical form. Conics and quadrics. Applications	1
8	Parametrized curves. Torsion and curvature	1
9	Parametrized surfaces. First fundamental form	1
	Total:	14

Bibliography:

1. Course page on the platform https://curs.upb.ro/.
2. Adriana Balan, Radu F. Constantin, *Algebră liniară și geometrie. Teorie și probleme*, Editura Printech, București, 2005.
3. Mircea Cimpoeaş, *Capitole de algebră liniară, geometrie şi ecuaţii diferenţiale pentru ingineri*, Editura Politehnica Press, București, 2021.
4. Marius Marinel Stănescu, Florin Munteanu, Vladimir Slesar, *Probleme de algebră liniară, geometrie analitică și geometrie diferenţială*, Editura Universitaria, Craiova, 2001.
5. Alexandru Negrescu, *Algebră liniară. O abordare prietenoasă*, Editura Politehnica Press, București, 2023.
6. Alina Petrescu-Niță, *Algebră liniară aplicativă*, Editura Politehnica Press, București, 2021.
7. Teodor Stihi, Roxana Vidican, *Algebră liniară. Geometrie analitică și diferențială. Ecuații diferențiale. Teoria câmpurilor*, Editura Fair Partners, București, 2006.

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade
11.4 Course	Knowledge of fundamental theoretical notions. Ability to apply theoretical knowledge to problem solving.	Verification test	40%
	Knowledge of fundamental theoretical notions. Ability to apply theoretical knowledge to problem solving.	Final exam	50%
11.5 Seminary/laboratory/project	Applying the theoretical notions presented in the course to exercises and problems.	Systematic observation of students' activity during the seminar.	10%
11.6 Passing conditions			
• Participation in the final exam, face to face, during the scheduled time window. • Obtaining 50% of the total score.			

12. Corroborate the content of the course with the expectations of representatives of employers and representative professional associations in the field of the program, as well as with the current state of knowledge in the scientific field approached and practices in higher education institutions in the European Higher Education Area (EHEA)

The course “Linear Algebra, Analytic and Differential Geometry” plays an essential role in developing students’ analytical, logical, and modeling skills, addressing current labor-market demands that value the ability to mathematically represent data, solve complex systems, and develop efficient algorithms.

The content is aligned with employer expectations in fields such as IT, software, artificial intelligence, computer graphics, and digital signal and image processing, where algebraic and geometric methods are indispensable for system design, process optimization, and analysis of algorithmic performance. Such courses are also supported by international organizations and professional associations (e.g., IEEE, ACM) that promote the integration of applied mathematics into modern engineering education.

The course is aligned with the practices and standards of study programs in SEIS institutions, emphasizing the development of applied mathematical competencies, understanding vector spaces, linear transformations, matrices, eigenvalues, and differential equations, as well as their application to concrete problems in IT, numerical simulations, artificial intelligence, and computer graphics.

By completing this course, students acquire the ability to analyze and solve linear and nonlinear systems, apply algebraic and geometric methods in algorithm development, interpret mathematical models, and integrate this knowledge into software projects and complex applications. This preparation supports careers in research, the IT industry, software development, artificial intelligence, or applied/scientific master's programs.

Date	Course lecturer	Instructor(s) for practical activities
25.09.2025	Slesar Vladimir	Slesar Vladimir

Date of department approval	Head of department
	Prof. Dr. Claudius Dan

Date of approval in the Faculty Council	Dean
	Prof. Eng. Dr. Radu Mihnea Udrea