



Syllabus Course Program



Linear Algebra

Specialty

113 Applied mathematics

Educational program

Intelligent Data Analysis

Level of education

Bachelor's level

Semester

2

Institute

Educational and Scientific Institute of Computer Science and Information Technology

Department

Computer Mathematics and Data Analysis (324)

Course type

General, Mandatory

Language of instruction

Ukrainian

Lecturers and course developers



Iryna Serdiuk

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Associate professor of the Department of Computer Mathematics and Data Analysis

Work experience - more than 25 years. The author of many scientific, educational, and methodological works. Leading lecturer in the courses: "Linear Algebra", "Functional Analysis", "Analytic Geometry", etc.

[More about the lecturer on the department's website](#)

General information

Summary

The educational discipline "Linear Algebra" is one of the fundamental disciplines in the preparation of bachelors under the educational program "Intellectual data analysis". The discipline is aimed at mastering the theoretical foundations of linear algebra. The course covers the basic concepts of linear algebra: matrices, systems of linear algebraic equations, linear spaces, linear operators, quadratic forms. The knowledge that the student should acquire as a result of studying this course will play an important role in the process of his further education; they lay the foundations for studying other general theoretical and special disciplines.

Course objectives and goals

The purpose of studying the discipline is for the student to master the principles of modern algebra, understand its place in the general system of mathematical knowledge, and be able to apply the acquired knowledge in practice. Formation of students' basic theoretical knowledge and practical problem-solving skills.

To develop in students the skills of mathematical research of applied questions and the ability to reduce the problem to mathematical models of the theory of linear algebra .

Format of classes

Lectures, practical classes, consultations, distance and blended learning in the Office 365 system, self-study. Final control in the form of an exam.

Competencies

GC 1. Ability to learn and master modern knowledge.

GC 2. Ability to apply knowledge in practical situations.

GC 3. Ability to generate new ideas (creativity).

GC 4. Ability to be critical and self-critical.

GC 6. Capability of abstract thinking, analysis and synthesis.

GC 7. Ability to search, process and analyse information from various sources.

GC 12. Determination and perseverance in relation to tasks and responsibilities.

GC 13. Skills of interpersonal interaction.

GC 14. The ability to exercise their rights and responsibilities as a member of society, to realize the values of civil (free democratic) society and the need for its sustainable development, the rule of law, human and civil rights and freedoms in Ukraine.

GC 15. The ability to preserve and enhance moral, cultural, scientific values and achievements of society based on an understanding of the history and patterns of development of the subject area, its place in the general system of knowledge about nature and society and in the development of society, technique and technology, to use various types and forms of physical activity for active recreation and healthy lifestyle.

Learning outcomes

LO 1. Demonstrate knowledge and understanding of basic concepts, principles, theories of applied mathematics and use them on practice.

LO 2. To know the basic principles and methods of mathematical, complex and functional analysis, linear algebra and theory numbers, analytic geometry, theory of differential equations, in particular partial differential equations, probability theory, mathematical statistics and random processes, and numerical methods.

LO 14. Demonstrate the ability to self-learn and continue professional development.

LO 15. Be able to organize your own activities and get results within a limited time frame.

LO 16. Demonstrate skills of interaction with other people, ability to work in a team.

LO 17. To be able to collect, process, analyse, systematize scientific and technical information, while avoiding academic dishonesty.

LO 19. Gather and interpret relevant data and analyse complexities within their area of specialization to make judgments that reflect relevant social and ethical issues.

LO 20. Demonstrate professional communication skills, including oral and written communication in Ukrainian and at least one of the official EU languages.

Student workload

The total volume of the course is 120 hours (4 ECTS credits): lectures - 28 hours, practical classes - 32 hours, self-study - 60 hours.

Course prerequisites

Students must possess the basics of mathematical knowledge obtained earlier at school or other educational institutions .

Features of the course, teaching and learning methods, and technologies

When teaching this discipline, such teaching and learning methods as gamification and peer-to-peer are used. LMS (learning management systems) systems are used in the learning process.

Program of the course

Topics of the lectures

- Topic 1. Vector Spaces and Subspaces
- Topic 2. Linearly Independent Sets; Column Spaces and Linear Transformations; Bases; Rank
- Topic 3. Coordinate Systems. The Dimension of a Vector Space. Examples of vector spaces
- Topic 4. Change of Basis
- Topic 5. Subspaces. Linear combinations, linear spans. Row space of a matrix. Sums and direct sums
- Topic 6. Euclidean spaces. Inner Product, Length, Orthogonality
- Topic 7. Orthogonal Sets; Orthogonal Projections
- Topic 8. The Gram - Schmidt Process
- Topic 9. Unitary spaces
- Topic 10. Linear Mappings. Kernel and Image of a linear mapping. Operations with linear mappings. Algebra of linear operators. Invertible operators
- Topic 11. The Characteristic Equation. Eigenvectors and Eigenvalues. Diagonalization
- Topic 12. Linear and Adjoint operators. Orthogonal and Unitary operators. Orthogonal and Unitary matrices
- Topic 13. Symmetric bilinear forms, Quadratic forms. Real Symmetric Bilinear forms. Law of inertia. Hermitian forms
- Topic 14. Positive operators. Diagonalization and canonical forms in Euclidean spaces. Spectral theorem

Topics of the practical classes

- Topic 1. Vector Spaces. Linear combination. Rank
- Topic 2. Linearly Independent Sets; Column Spaces and Linear Transformations; Bases; Rank
- Topic 3. Coordinate Systems. Change of Basis
- Topic 4. Subspaces. Row space of a matrix. Sums and direct sums
- Topic 5. Vector addition and scalar multiplication.
- Topic 6. Orthogonal Projections
- Topic 7. The Gram - Schmidt Process
- Topic 8. Vectors in the Unitary space
- Topic 9. Modular control work: "Linear spaces"
- Topic 10. The Characteristic Equation. Eigenvectors and Eigenvalues
- Topic 11. Minimum polynomial
- Topic 12. Functions from matrices
- Topic 13. Linear Mappings. Kernel and Image of a linear mapping. Operations with linear mappings
- Topic 14. Modular control work: "Linear operators"
- Topic 15. Orthogonal matrices. Diagonalization and canonical forms in Euclidean spaces
- Topic 16. Modular control work: "Quadratic Forms"

Topics of the workshops

Workshops are not provided within the discipline.

Topics of the laboratory classes

Workshops are not provided within the discipline .

Self-study

The course involves the completion of individual tasks, the results of which are monitored and assessed by teachers. Students are also recommended additional materials (videos, articles) for self-study.

Course materials and recommended reading

1. Корніль Т. Л. Вища математика у прикладах і задачах : навч.-метод. посібник : у 2-х ч. Ч. 1. Елементи лінійної алгебри. Аналітична геометрія на площині / Т. Л. Корніль, Г. О. Голотайстрова,

- С. Є. Гардер ; Нац. техн. ун-т "Харків. політехн. ін-т". – Харків : Мадрид, 2020. – 80 с
<https://repository.kpi.kharkov.ua/handle/KhPI-Press/>
2. Seymour Lipschutz. Theory and problems of linear algebra. – New York, 1968. - 170p.
3. Цубербіллер О.М. Задачі і вправи з аналітичної геометрії. – Київ, Державне видавництво технічної літератури, 1965, – 290с.
https://shron1.chtyvo.org.ua/Tsuberbiller_Olha/Zadachi_i_vpravy_z_analitychnoi_heometrii.pdf
4. Практикум з курсу “Алгебра і геометрія”. Визначники та матриці. Системи лінійних алгебраїчних рівнянь: навчальний посібник для студентів напрямів підготовки “Прикладна математика” та “Системний аналіз” / І. В.Сердюк, О. Б.Ахієзер, О. І.Дунаєвська, А. О.Нікульченко, А. Ю.Стрельнікова. – Харків: “НТМТ”, 2022. - 112с.
<https://repository.kpi.kharkov.ua/handle/KhPI-Press/64558>
5. Сердюк І. В. Використання методу рекурентних співвідношень для обчислення визначників N-го порядку /І. В. Сердюк, О. Б. Ахієзер, О. І. Дунаєвська. Під. ред. Мітіна В. М, // Навчальний посібник – Харків: видавництво «ДРУКАРНЯ МРІЯ», 2019 – 173 с.(Рекомендовано вченою радою НТУ «ХПІ» протокол № 10 від 22.12.2018)
 ISBN 978-617-7683-52-9
<https://repository.kpi.kharkov.ua/handle/KhPI-Press/41206>
6. Сердюк І. В. Теорія визначників. Обчислення визначників N- го порядку /І. В. Сердюк, О. Б. Ахієзер, О. І. Дунаєвська. Під. ред. Мітіна В. М. // Навчальний посібник – Харків: видавництво «ДРУКАРНЯ МРІЯ», 2019 – 255 с.(Рекомендовано вченою радою НТУ «ХПІ» протокол № 10 від 22.12.2018)
 ISBN 978-617-7683-51-2
<https://repository.kpi.kharkov.ua/handle/KhPI-Press/41204>
7. Чарін В. С. Лінійна алгебра. – 2-ге вид., стер. – К., Техніка, 2005. – 416 с.
https://pdf.lib.vntu.edu.ua/books/2015/Charin_2005_416.pdf
8. Lay, David C. Linear algebra and its applications/ David C. Lay, University of Maryland, College Park, Steven R. Lay, Lee University, Judi J. McDonald, Washington State University. - Pearson Education, 2016. - 580 p.
 ISBN 978-0-321-98238-4

Assessment and grading

Criteria for assessment of student performance, and the final score structure

Description of the final score structure, course requirements, and necessary steps to earn points, especially paying attention to self-study and individual assignments.

Grading scale

Total points	National	ECTS
90–100	Excellent	A
82–89	Good	B
75–81	Good	C
64–74	Satisfactory	D
60–63	Satisfactory	E
35–59	Unsatisfactory (requires additional learning)	FX
1–34	Unsatisfactory (requires repetition of the course)	F

Norms of academic integrity and course policy

The student must adhere to the Code of Ethics of Academic Relations and Integrity of NTU "KhPI": to demonstrate discipline, good manners, kindness, honesty, and responsibility. Conflict situations should be openly discussed in academic groups with a lecturer, and if it is impossible to resolve the conflict, they should be brought to the attention of the Institute's management.

Regulatory and legal documents related to the implementation of the principles of academic integrity at NTU "KhPI" are available on the website: <http://blogs.kpi.kharkov.ua/v2/nv/akademichna-dobrochesnist/>

Approval

Approved by

Date, signature
29.08.2024



Head of the department
Olena AKHIEZER

Date, signature
29.08.2024



Guarantor of the educational
program
Olena AKHIEZER