



Syllabus Course Program



Functional analysis

Specialty

113 Applied mathematics

Educational program

Intelligent Data Analysis

Level of education

Bachelor's level

Semester

5

Institute

Educational and Scientific Institute of Computer Science and Information Technology

Department

Computer Mathematics and Data Analysis

Course type

Special (professional), 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](http://web.kpi.kharkov.ua/kmmm/uk)

<http://web.kpi.kharkov.ua/kmmm/uk>

General information

Summary

Functional analysis is one of the central sections of modern mathematics. It studies infinite-dimensional spaces and operators in them. Concepts and methods of functional analysis make it possible to formulate statements of both classical and modern mathematical problems at a rigorous mathematical level and build their solutions. Functional analysis finds its applications in such related areas as differential and integral equations, equations of mathematical physics, computational mathematics, probability theory, etc..

Course objectives and goals

The purpose of studying the discipline is to master the necessary competencies in the field of functional analysis. Formation of students' basic theoretical knowledge and practical problem-solving skills. To develop in students the skills of mathematical theoretical research of applied issues and the ability to reduce the problem to mathematical models of the theory of functional analysis.

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.
- SC 1. Ability to use and adapt mathematical theories, methods and techniques to prove mathematical statements and theorems.
- SC 2. Ability to perform tasks formulated in mathematical form.
- SC 3. Ability to choose and apply mathematical methods for solving applied problems, modelling, analysis, design, management, forecasting, decision-making.

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.
- LO 22. To know and understand the methods of solving mathematical problems of intellectual information retrieval and knowledge extraction.

Student workload

The total volume of the course is 90 hours (3 ECTS credits): lectures - 22 hours, practical classes - 22 hours, self-study - 46 hours.

Course prerequisites

To successfully complete the course, you must have knowledge and practical skills in the following disciplines: "Mathematical analysis", "Analytic geometry", "Linear algebra", "Numerical methods"..

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. Recurrent relations and their classification. Solving first-order recurrence relations with constant and variable coefficients

Topic 2. Solving recurrence relations of the second order with constant and variable coefficients

Topic 3. Metric spaces. Complete metric spaces. The Principle of contraction mappings and its applications

Topic 4. Normed linear spaces

Topic 5. Rows in normalized spaces. Theorem on the convergence of a series in a Banach space. Linear independence of vectors. Basis

Topic 6. Linear subsets and linear subspaces of normed spaces. Finite-dimensional normalized spaces. 1,2,3 vector norms. Theorem on the subordination of norms

Topic 7. Hilbert spaces. The space $L_2[a, b]$. Subspaces. Orthogonal complements. Linear and bilinear functionals in Hilbert space

Topic 8. Orthogonal Sets of functions. Orthogonal Projections. The Gram - Schmidt Process. Fourier series over orthogonal sets

Topic 9. The space of Linear Operators. The theory of Fredholm operators

Topic 10. Functions of Bounded Variation and the Lebesgue - Stieltjes integral

Topic 11. Function spaces and Generalized functions

Topics of the practical classes

Topic 1. Solving first-order recurrence relations with constant and variable coefficients

Topic 2. Solving recurrence relations of the second order with constant and variable coefficients

Topic 3. Metric spaces

Topic 4. Rows in normalized spaces

Topic 5. The Lebesgue integral.

Topic 6. Fourier series over orthogonal sets

Topic 7. Calculation the norms of linear operators

Topic 8. Functions of Bounded Variation and the Lebesgue - Stieltjes integral

Topic 9. Linear functional equations

Topic 10. Invertible linear operator

Topic 11. Modular control work: "Metric and Normed spaces "

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. Мокін, Борис Іванович.

Функціональний аналіз, адаптований до прикладних задач в галузі інформаційних технологій [Текст] : навч. посіб. / Б. І. Мокін, В. Б. Мокін, О. Б. Мокін ; Вінниц. нац. техн. ун-т. - Вінниця : ВНТУ, 2020. - 191 с. : рис., табл. - Бібліогр.: с. 190-191. - 50 (1-й запуск 1-21) прим. - ISBN 978-966-641-796-4

<https://ir.lib.vntu.edu.ua/bitstream/handle/123456789/34634/86392.pdf?sequence=2&isAllowed=y>

2. Ніколаєв, Олексій Георгійович.

Функціональний аналіз [Текст] : підручник / О. Г. Ніколаєв ; Нац. аерокосм. ун-т ім. М. Є. Жуковського "Харків. авіац. ін-т". – Харків : ХАІ, 2021. – 231 с. : рис. – Бібліогр.: с. 229. – 100 прим. – ISBN 978-966-662-832-2

3. Кадець, Володимир Михайлович.

Курс функціонального аналізу та теорії міри [Текст] : підручник / В. М. Кадець ; пер. з рос. Я. С. Магола, д-р фіз.-мат. наук І. Е. Чижиков ; за наук. ред. проф. О. Б. Скаскіна. – Л. : І. Е. Чижиков [вид.], 2012. – 589 с. – (Університетська бібліотека ; т. 1). – Бібліогр.: с. 571-575. – 500 прим. - ISBN 978-966-2645-03-3.

4. Березанський, Юрій Макарович.

Функціональний аналіз [Текст] : підручник / Ю. М. Березанський, Г. Ф. Ус, З. Г. Шефтель ; пер. з англ. канд. фіз.-мат. наук Т. С. Кудрик, д-р фіз.-мат. наук О. Б. Скасків ; за наук. ред. проф. В. А. Михайлеця та проф. О. Б. Скасківа. – Львів : І. Е. Чижиков [вид.], 2014. – 558 с. – м (Серія "Університетська бібліотека" ; т. 3). – Бібліогр.: с. 545-549. – Пер. изд. : Functional analysis / Yu. M. Berezansky, Z. G. Sheftel, G. F. Us. – 2010. - 500 прим.

ISBN 978-966-2645-12-5.

5. Функціональний аналіз : навч. посіб. для студентів спеціальності «Системний аналіз» усіх форм навчання / Г. С. Буланов, О. Г. Ровенська, В. М. Астахов. – Краматорськ : ДДМА, 2017. – 63 с. – ISBN 978-966-379-788-5.

http://www.dgma.donetsk.ua/metod/vm/BM_Ровенская_укр.pdf

[Mokin B.I. Functional analysis in information technologies: textbook/B.I. Mokin, V.B. Mokin, O.B. Mokin, Vinnytsia:VNTU, 2024, 130p.](#)

ISBN 978-966-641-955-5

<https://press.vntu.edu.ua/index.php/vntu/catalog/view/825/1439/2710-1>

[A.N. Kolmogorov, S.V. Fomin. Elements of the Theory of Functions and Functional Analysis. Volume 1. - Rochester, N.Y.: Graylock Press, 1961, 129 pp.](#)

https://drive.google.com/drive/folders/1jkd39q5TQbP821u73gE1dh_o3pLidutY?usp=sharing

[A.N. Kolmogorov, S.V. Fomin. Elements of the Theory of Functions and Functional Analysis. Volume 2. - Albany, N.Y.: Graylock Press, 1961, 128 pp.](#)

https://drive.google.com/drive/folders/1jkd39q5TQbP821u73gE1dh_o3pLidutY?usp=sharing

[A.A. Kirillov, A.D. Gvishiani. Theorems and Problems in Functional Analysis. - Springer, New York, 1982, 347pp.](#)

https://drive.google.com/drive/folders/1jkd39q5TQbP821u73gE1dh_o3pLidutY?usp=sharing

Assessment and grading

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

The student is recommended to attend both lecture classes and practical classes. Completion of calculation works is a necessary condition for obtaining an estimate. Completion of tests and passing the exam are mandatory.

100% of the final grade consists of the results of the test assessment (40%) and the ongoing assessment (60%).

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