



Syllabus

Course Program



Mathematical Analysis Part 2

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

Course type

General, Mandatory

Language of instruction

Ukrainian

Lecturers and course developers



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Candidate of Technical Sciences, Associate Professor of the Department of Computer Mathematics and Mathematical Modeling, Head of Computer Mathematics and Data Analysis Department.

Work experience – more than 30 years. The author of many scientific, educational, and methodological works. Leading lecturer in the courses: "Mathematical Analysis", "Differential Equations and Complex Analysis", "Functional Analysis", "Higher Mathematics", etc.

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

General information

Summary

The course is aimed at mastering the theoretical foundations of mathematical analysis. The course covers the basic concepts of set theory, numerical sequences, limit theory functions of one variable, continuous functions of one variable, differential calculus of a function of one variable

Course objectives and goals

Development of abilities to logical thinking, research and solution of mathematically formalized tasks. Teaching the basic mathematical methods necessary for the analysis and modeling of processes, phenomena, devices. Developing the ability to analyze the results obtained, skills of independent study of literature on mathematics and its applications

Format of classes

Lectures, laboratory classes, consultations, 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 5. Ability to conduct research at the appropriate level. GC 6. Ability to abstract thinking, analysis and synthesis.
 GC 7. Ability to search, process and analyze information from various sources.
 GC 8. Knowledge and understanding of the subject area and understanding of professional activities.
 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 select and apply mathematical methods for solving applied problems, modeling, analysis, design, management, forecasting, decision-making.
 GC 15. Ability to formulate a mathematical statement of the problem, based on the statement in the language of the subject area, and choose a method of solving it that provides the required accuracy and reliability of the result.

Learning outcomes

ELO 1. Demonstrate knowledge and understanding of the basic concepts, principles, theories of applied mathematics and apply them in practice.
 PLO 2. To master the basic principles and methods of mathematical, complex and functional analysis, linear algebra and number theory, analytical geometry, theory of differential equations, including partial differential equations, probability theory, mathematical statistics and random processes, numerical methods.
 ELO 3. Formalize problems formulated in the language of a particular subject area; formulate their mathematical formulation and choose a rational method of solution; solve the obtained problems by analytical and numerical methods, evaluate the accuracy and reliability of the results.
 ELO 12. Solve individual engineering problems and/or problems arising in at least one subject area: sociology, economics, ecology and medicine.
 ELO 14. Show the ability to self-learn and continue professional development. |

Student workload

|The total volume of the course is 180 hours (6 ECTS credits): lectures – 42 hours, practical classes – 48 hours, self-study – 90 hours. |

Course prerequisites

|Students should have the basics of mathematical knowledge gained earlier at school or other educational institutions, “Mathematical Analysis. Part 1”, ‘Linear Algebra’, ‘Mathematical Logic’..... |

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

Lectures are conducted interactively with the use of multimedia technologies. Practical classes use a project-based learning approach. Teaching materials are available to students through OneNote Class Notebook.

Program of the course

Topics of the lectures

Topic 1: Indefinite integral and its properties. Table of indefinite integrals.
 Topic 2. Integration by summation under the sign of the differential. Integration by substitution and by parts.
 Topic 3: Integration of elementary fractions. Extraction of the rational part of the integral.
 Topic 4. Integration of a rational function of $\sin x$, $\cos x$. Universal trigonometric substitution.
 Topic 5. Integration of some classes of irrational functions, which can be reduced to the integration of a rational function.
 Topic 6: The Riemann integral. Basic definitions. Darbu sums and their properties. Conditions for the existence of the Riemann integral. Classes of integrated functions.
 Topic 7. Properties of the Riemann integral. Inequalities and the mean value theorem. Evaluation of the value of the integral.

Topic 8 Properties of the integral as an upper bound function. Existence of the original. Newton's formula - Leibniz's formula. The second theorem of the mean. Formula for variable replacement and integration by parts.

Topic 9: Examples of geometric and physical applications of the Riemann integral. The area of a curved trapezoid and a curved sector.

Topic 10. The length of the arc of the curve and the area of the surface of rotation. The volume of bodies of revolution.

Topic 11. Non-proper integrals. Definition of integrals over unbounded intervals. Elementary properties of non-proper integrals of the first kind. Convergence of integrals of nonnegative functions.

Topic 12: Non-proper integrals of unbounded functions. Convergence of integrals of nonnegative functions.

Topic 13 Absolute and conditionally convergent integrals. Approximate calculation.

Topic 14: The space R^n . Definition of metrics and sets in R^n . Open and closed sets. Functions on R^n . Limits and continuity of functions.

Topic 15: Repeated limits. Elementary properties of continuous functions.

Topic 16. Partial derivatives and their properties. Geometric meaning for a function of two variables. Total increment of a function and total differential.

Topic 17. Derivative of a complex function. Derivative of an implicitly defined function. First differential. Application to approximate calculations.

Topic 18: Derivatives and differentials of higher orders. Theorem of mixed derivatives. Geometric applications of the differential calculus of a function of many variables.

Topic 19: Extremum of a function of many variables

Topic 20: Conditional extremum. The method of Lagrange multipliers.

Topic 21. Level surfaces of a scalar field. Derivative of a scalar field in a given direction. Gradient of a scalar field. |

Topics of the workshops

Topic 1: Table of indefinite integrals. Integration by summation under the sign of the differential.

Topic 2. Integration by substitution and parts.

Topic 3: Integration of elementary fractions. Integration of rational functions.

Topic 4. Integration of the rational function from $\sin x$, $\cos x$. Universal trigonometric substitution.

Topic 5. Integration of irrationalities.

Topic 6: Thematic control "Indefinite integral"

Topic 7. Definition of an integral. Darboux sums and their properties.

Topic 8 Newton's formula - Leibniz. Integration by substitution and parts.

Topic 9: Replacing a variable in the Riemann integral. Special means of integration.

Topic 10. Examples of application of a certain integral. Area of a curved trapezoid.

Topic 11. The length of the arc of a curve. The area of the surface of rotation.

Topic 12: Volume of a body by cross-sectional area. Volume of a body of revolution

Topic 13. Improper integrals of the first kind

Topic 14: Improper integral of the second kind

Topic 15: Thematic control "Defined integral and its application. Non-proper integrals".

Topic 16. The domain of definition of a function of many variables. Limits and continuity of a function of many variables.

Topic 17. Partial derivatives and their properties. Geometric meaning for a function of two variables. Total increment of a function and total differential.

Topic 18: Calculating the derivatives of complex functions and functions that are implicitly defined.

Topic 19: Calculating derivatives of higher orders.

Topic 20 Taylor's formula for a function of many variables. Topic 21. Normal to the surface and tangent plane.

Topic 22. Extremum of a function of many variables.

Topic 23. Level surfaces of a scalar field. Derivative of a scalar field in a given direction. Gradient of a scalar field.

Topic 24 Thematic control "Differential calculus of a function of many variables" |

Topics of the laboratory classes

Laboratory work is not included in the course |

Self-study

... The course involves completing an individual calculation task. It is formalized in written form. Independent work involves studying lecture material, solving problems, preparing for module tests, performing calculations, and preparing for the exam. Independent work with the possibility of consultations with the teacher.

Students are also recommended additional materials (videos, articles, books) for self-study. |

Non-formal education

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Course materials and recommended reading

Basic literature

1. Ляшко І. І. Математичний аналіз : підручник : у 2 ч. / І. І. Ляшко, В. Ф. Ємельянов, О. К. Боярчук. – Київ : Вища школа, 1992. – Ч. 1. – 495 с.

https://chtyvo.org.ua/authors/Yemelianov_Vladyslav/Matematychnyi_analiz_Chastyna_1/

2. Ляшко І. І. Математичний аналіз : підручник : у 2 ч. / І. І. Ляшко, В. Ф. Ємельянов, О. К. Боярчук. – Київ : Вища школа, 1993. – Ч. 2. – 375 с.

https://chtyvo.org.ua/authors/Liashko_Ivan/Matematychnyi_analiz_Chastyna_2/

3. Дороговцев А. Я. Математичний аналіз : підручник у двох частинах. — Київ : Либідь, 1993. – 320 с. ISBN 5-325-00380-1

https://pdf.lib.vntu.edu.ua/books/2015/Dorogovtsev_P1_1993_320.pdf

4. Курченко О. О. Диференціальне числення функції однієї змінної: підручник. – Київ, 2014.– 238 с

<https://mechmat.knu.ua/wp-content/uploads/2018/03/merged.pdf>

5. Збірник задач з математичного аналізу. Функції однієї змінної / Денисьєвський М. О., Курченко О. О., Нагорний В. Н., Нестеренко О. Н., Петрова Т. О., Чайковський А. В. – Київ : ВПЦ «Київський університет», 2005. — 257 с.

<https://www.mechmat.univ.kiev.ua/wp-content/uploads/2018/03/all.pdf>

6. Математичний аналіз: навчальні завдання до практичних занять для студентів освітньої програми "комп'ютерна механіка" механікоматематичного факультету (1 семестр першого курсу) / Упорядн. М. О. Назаренко, О. Н. Нестеренко, Т. О. Петрова, А. В. Чайковський. – Електронне видання. – 2020. – 90 с

<https://www.mechmat.univ.kiev.ua/wp-content/uploads/2020/04/mathankomp-1sem.pdf>

7. Практикум з курсу "Математичний аналіз". Диференціальне числення : навч.-метод. посібник / О. В. Костюк [та ін.] ; Нац. техн. ун-т "Харків. політехн. ін-т". – Харків : Друкарня Мадрид, 2022. – 291 с.

<https://repository.kpi.kharkov.ua/handle/KhPI-Press/62939>

8. Нестандартні та олімпіадні задачі з алгебри та аналізу: практикум для підготовки студентів 1-го курсу [Електронний ресурс] : навчальний посібник для студентів ступеня бакалавра / КПІ ім. Ігоря Сікорського ; уклад.: С. В. Боднарчук, М. К. Ільєнко, Т. В. Маловічко, В. В. Павленков, А. В. Сиротенко – Електронні текстові дані (1 файл: 1,33 Мбайт). – Київ: КПІ ім. Ігоря Сікорського, 2020.– 183 с.

https://ela.kpi.ua/bitstream/123456789/39002/1/Olimp_metodychka_for_students.pdf

9. Математика в технічному університеті : Підручник / І. В. Алексеева, В. О. Гайдей, О. О. Диховичний, Л. Б. Федорова ; за ред. О. І. Клесова ; КПІ ім. Ігоря Сікорського. — Київ : Видавничий дім «Кондор», 2019. — Т. 2. — 504 с. ISBN 978-617-7841-40-0

<https://core.ac.uk/download/pdf/323525525.pdf>

10. Вища математика у прикладах і задачах : навч.-метод. посібник : у 2-х ч. Ч. 2. Теорія границь. Диференціальне та інтегральне числення / Т. Л. Корніль [та ін.] ; Нац. техн. ун-т "Харків. політехн. ін-т". – Харків : Друкарня Мадрид, 2022. – 188 с.

<https://repository.kpi.kharkov.ua/handle/KhPI-Press/62938>

11. Вища математика : навч. посібник : у 2 ч. / О. П. Олійник, Н. П. Тупко, О. М. Гришко, В. О. Варивода. – Ч. 1. – К. : НАУ, 2021. – 217 с.

<https://er.nau.edu.ua/handle/NAU/58038>

12. Дудкін М. Є. Вища математика [Електронний ресурс] : підручник для здобувачів ступеня бакалавра за інженерними спеціальностями / М. Є. Дудкін, О. Ю. Дюженкова, І. В. Степахо ; КПІ ім. Ігоря Сікорського. – Електронні текстові дані (1 файл: 10,96 Мбайт). – Київ : КПІ ім. Ігоря Сікорського, 2022. – 449 с. – Назва з екрана.

<https://ela.kpi.ua/handle/123456789/51064>

13. Невизначений та визначений інтеграли : навч.-метод. посібник / Ю. І. Першина [та ін.] ; Нац. техн. ун-т "Харків. політехн. ін-т". – Харків : Друкарня Мадрид, 2022. – 188 с.

<https://repository.kpi.kharkov.ua/handle/KhPI-Press/58324>

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