Syllabus
Course Program

Mathematical analysis. Part 1.

Specialty
113 - Applied mathematics

Institute
Institute of Computer Modelling, Applied Physics and Mathematics

Educational program
Computer and mathematical modelling

Department
Applied mathematics (170)

Level of education
Bachelor's degree

Course type
General, mandatory

Semester
1

Language of instruction
English

Lecturers and course developers

Hanna Linnyk
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author of more than 60 scientific articles and methodical developments, main courses: mathematical analysis, computer science, linear algebra, mathematical physics

More about the lecturer on the department's website

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senior lecturer

More about the lecturer on the department's website

General information

Summary

The course in mathematical analysis provides the knowledge necessary for theoretical and practical training of engineers in this speciality in the acquisition of mathematical methods in the basics of boundary theory, differential and integral calculus of a function of one variable.

Course objectives and goals

Acquaintance and mastery of mathematical theories and methods necessary for solving problems in the field of mechanics of solid deformable bodies, dynamic processes, other engineering and information systems that provide an opportunity to analyse and model processes and phenomena.

Format of classes

Lectures, practical classes, independent work, consultations. The final control is an exam.

Competencies

GC06. Ability to think abstractly, analyse and synthesise.
PC01. Ability to use and adapt mathematical theories, methods and techniques to prove mathematical statements and theorems.
PC03. Ability to choose and apply mathematical methods for solving applied problems, modelling, analysis, design, management, forecasting, decision-making.

Learning outcomes

PO02. To know 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.

Student workload

The total volume of the discipline is 150 hours (5 ECTS credits): lectures - 48 hours, practical classes - 32 hours, independent work - 70 hours, calculation task, exam

Course prerequisites

Knowledge of the school mathematics course, the basics of algebra and trigonometry, a basic understanding of logic and abstract thinking, and skills in solving mathematical problems.

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

Lectures are conducted interactively with the use of multimedia technologies. Lectures use explanatory and illustrative, reproductive, problem-based and critical thinking methods. Practical classes use a partially search method and a discussion method, with an emphasis on the application of practical tasks in the field of computer science. Learning materials are available to students through OneNote Class Notebook.

Program of the course

Topics of the lectures

Topic 1: Theory of boundaries.
Logical signs. Basic definitions of set theory. Actions on sets. Sets on the number line. Supremum and infimum of a numerical set. Bounded and unbounded sets. Points of convergence. Properties of elementary functions. Numerical sequences. Basic definitions. The concept of the limit of a sequence. Bounded, unbounded, infinitely large and infinitely small sequences. Properties of convergent sequences. Signs of convergence of numerical sequences. Definition of the Cauchy and Heine limits of a function. Infinitely large and infinitesimal functions. Properties of functions that have a limit at a point. Signs of the existence of a limit. Outstanding limits. Comparison of infinitely large and infinitesimal functions. Continuity of a function at a point, its various definitions. Properties of a function that is continuous at a point. Continuity of basic elementary functions. Classification of discontinuity points. Properties of a function continuous on a segment. The concept of uniform continuity. Cantor's theorem.

Topic 2. Differential calculus of a function of one variable
The concept of a derivative. Geometric and physical meaning. Differentiability. Rules for calculating the derivative. Table of derivatives. First differential: definition, geometric sense, form invariance, applications. Derivatives and differentials of higher orders. Rules of calculation, lack of form invariance. Basic theorems of differential calculus. Lopital's rule. Taylor's formula. Different forms of the residual term. Increasing and decreasing functions in the interval. Extremum. Necessary and sufficient conditions of extremum. Conditions of convexity and concavity. Points of inflection. Necessary and sufficient

conditions for inflection points. Asymptotes of the graph of a function. The scheme of a complete study of the function and the construction of its graph.

Topic 3: Integral calculus of a function of one variable.
Primary and indefinite integral, the relationship between them. Indefinite integral and its properties. Table of indefinite integrals. Methods of integration (signing the differential, replacing the variable and integrating by parts). Trigonometric and hyperbolic substitutions.
Rational fractions and their properties. Decomposition of regular rational fractions into the simplest terms. Integration of elementary rational fractions. Integration of linear and small-linear irrationalities. Integrate functions that rationally depend on trigonometric functions.

Topics of the workshops

Topic 1: Theory of boundaries.
Numerical sets and operations with them. Calculating the limits of functions. The first great limit. Comparison of infinitesimal and infinitely large functions. The second great limit. Investigating functions for continuity.

Topic 2. Differential calculus of a function of one variable.
The concept of a derivative. Geometric and physical meaning. Differentiability. Rules for calculating the derivative. Table of derivatives. First differential: definition, geometric sense, form invariance, applications. Derivatives and differentials of higher orders. Calculation rules, lack of form invariance. Application of Lopital's rule. Investigation of the growth and decay of a function in the interval. Finding extremes. Application of necessary and sufficient conditions for an extremum. Investigation of convexity and concavity of a function. Finding the points of inflection. Asymptotes of the graph of a function. The scheme of a complete study of a function and the construction of its graph.

Topic 3: Integral calculus of a function of one variable.
Primary and indefinite integral, the relationship between them. Indefinite integral and its properties. Methods of integration (differential sign, variable replacement and integration by parts). Trigonometric and hyperbolic substitutions.
Rational fractions and their properties. Decomposition of regular rational fractions into the simplest terms. Integration of elementary rational fractions. Integration of linear and small-linear irrationalities. Integrate functions that rationally depend on trigonometric functions.

Topics of the laboratory classes

It is not provided for in the curriculum.

Self-study

The calculation task consists of three parts: limits (10 marks), derivative (10 marks), integral (10 marks). Study the lecture material. Preparation for practical classes. Preparation for tests.

Course materials and recommended reading

1. Mathematics in a technical university [Electronic resource] : textbook / I. V. Alekseeva, V. O. Haidei, O. O. Dykhovychnyi, L. B. Fedorova ; edited by O. I. Klesov ; Igor Sikorsky Kyiv Polytechnic Institute.
2. Mathematics at a Technical University: Textbook / I. V. Alekseeva, V. O. Haidei, O. O. Dykhovychnyi, L. B. Fedorova ; edited by O. I. Klesov ; Igor Sikorsky Kyiv Polytechnic Institute. - Kyiv : Condor Publishing House, 2021. - Vol. 3. - 456 p.
3. A short course of higher mathematics: a textbook. Ч. 2. Mathematical analysis. Theory of limits. Differential calculus of a function of one variable / H. M. Timchenko [et al: FOP Ivanchenko I. S., 2023. 232 p.
4. Methodical instructions for independent work in the course "Higher Mathematics" on the topic "Limits and derivative of the function of one variable" for students of technical specialities of part-time and reduced forms of education / compiled by. G.B. Linnik, I.O. Morachkovska, G.V. Rudneva - Kharkiv: NTU "KhPI", 2021. 40 p.

5. Methodical instructions "Limits of function" for students of technical specialities of correspondence and accelerated forms of study / G. B. Linnik, I. O. Morachkovska - Kharkiv: NTU "KhPI", 2019. 36 p.

Assessment and grading

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

Independent work (30 points)
Test papers (30 points)
Colloquium (20 points)
Exam (20 points)
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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	Head of the department Vyacheslav BURLAENKO
	Date, signature	Guarantor of the educational program Gennadiy LVOV