Higher Mathematics

Specialty 073 – Management	**Institute** Educational and Scientific Institute of MECHANICAL ENGINEERING AND TRANSPORT
Educational program Management of organization and administration / Business administration	**Department** Higher Mathematics (155)
Level of education Bachelor's level	**Course type** Fundamental. Mandatory
Term 1	**Language** English

Lecturers and course developers

Tetyana SHMATKO

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Doctor of Technical Science, Associate Professor of Higher Mathematics
Department

Experience is 25 years. Author and co-author of more than 100 scientific and
methodological works. Leading lecturer in the discipline "Higher
Mathematics"

General information, number of publications, main courses, etc
 More about the lecturer on the department's website
http://web.kpi.kharkov.ua/vm/pro-
kafedru/personaliyi/shmatko-ukr/

General information

Summary

The course covers the basic concepts of linear algebra, analytical geometry and mathematical analysis,
it is the basis of special mathematical disciplines of economic-mathematical modeling. This provides
all aspects of students' formation of a system of basic theoretical and practical mathematical knowledge
and competences that are necessary for solving complex specialized tasks and problems in the fields of
business, trade and stock exchange activities, development of skills in mathematical research of applied
problems, formation of logical thinking.

Course objectives and goals

The goal of mathematical training of students is to teach research methods and solve mathematically
formalized problems, search for optimal solutions, develop the ability to analyze results, give skills for
successful independent work.

Format of classes

Lectures, practical classes, self-study, consultations. A final exam is an estimation of the course.

Competencies

GC03 - Ability to abstract thinking, analysis, synthesis.
GC09 - Ability to learn and master modern knowledge.

Learning outcomes

LO16. Demonstrate the skills of independent work, flexible thinking, openness to new knowledge, be critical and self-critical.

Student workload

The total volume of the course is 180 hours (6 ECTS credits): lectures - 32 hours, practical classes - 32 hours, self-study- 116 hours

Course prerequisites

To successfully complete the course, you must have knowledge and practical skills in the following basic disciplines: algebra, geometry (planimetry, stereometry), mathematical analysis (school course)

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

Lectures are conducted interactively using multimedia technologies. Active forms of classes are used: lecture, lecture survey, practical classes, joint solution of practical tasks, discussion of solutions to homework exercises, intercommunication, consultation.

Program of the course

Topics of the lectures	Hours
Topic 1. Elements of linear algebra Matrices. Determinants. Solution of the systems of linear algebraic equations by Kramer's rule, by method of an inverse matrix and the Gauss method.	4
Topic 2. Elements of vector algebra and analytic geometry Coordinates of the vector. Scalar, vector, mixed products of vectors and their application. Plane. Straight line in plane and space. Curves of the second order.	4
Topic 3. Limits. Continuity of functions Number set. Actions on sets. Elementary functions. Function definition and its basic properties. The limit of a numerical sequence. The limit of a function. Calculation of limits using the first and second remarkable limits. Continuity of the functions. Discontinuity points of a function and their classification.	4
Topic 4. Derivative. Differentiation technique Definition of the derivative, its mechanical and geometric applications. Differentiation rules. Derivatives of basic elementary functions. Differential of the function. Application of the derivative in economic analysis. Derivatives and differentials of the higher orders.	4
Topic 5. Investigation of the function using the differential calculus of one variable function Basic theorems of differential calculus: theorems of Rolle, Cauchy and Lagrange. Monotonicity intervals, extremum points of a function. Convexity, concavity of the function graph, inflection points: necessary and sufficient conditions. Asymptotes of the function graph.	4
Topic 6. Indefinite integral Concept of indefinite integral. Table of integrals. The simplest methods of integration. Basic integration methods.	4
Topic 7. The definite integral and its application	4

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Properties of the definite integral. Newton-Leibniz formula. Integration by parts and replacement of the variable in the definite integral. Calculation of the area of the flat figures. Improper integrals.

Topic 8. Functions of several variables Domain definition of a function of several variables. Partial derivatives of functions of several variables. Differentiation of implicit functions. Extrema of a function of two variables. Equations of normal and tangent plane using the partial derivatives.	4
Total number of hours	**32**

Practical classes

Topics of the classes	Hours	Weighting factors a
Topic 1. Elements of linear algebra Operations on matrices. Calculation of determinants of arbitrary order by various methods. Solution of SLAE by means of Kramer's formulas, inverse matrix and the Gauss method.	4	2
Topic 2. Elements of vector algebra and analytic geometry Arithmetic operations with vectors. Solving problems using the concept of the scalar, vector and mixed products. Solving the problem about straight line and plane in space. Solution of problems for the curves of the second order: ellipse, circle, parabola, hyperbola.	4	2
Topic 3. Limits. Continuity of functions Basic elementary functions, their properties and graphs. The simplest rules for calculating limits. Application of the first and second remarkable limits to calculate the limits. Properties of continuous functions. Discontinuity points of the function.	4	2
Topic 4. Derivative. Differentiation technique The derivative, its geometric and economic meaning. Table of derivatives, rules for calculating derivatives. Differentiation of the complicate, implicit and parametrically defined function.	4	2
Topic 5. Investigation of the function using the differential calculus of one variable function Investigation on extremum and monotonicity intervals of the function. Investigation and constructing the graph of the function using the main concepts of differential calculus.	4	2
Topic 6. Indefinite integral The simplest methods of integration. Integration by the method of variable substitution. Integration by parts.	4	2
Topic 7. The definite integral and its application Application of the Newton-Leibniz formula. Integration by parts and replacement of the variable in the definite integral. Calculation of the area of flat figures by means of the definite integral.	4	2
Topic 8. Functions of several variables Problems with domain definition of a function of several variables. Partial derivatives of functions with two or three variables. Mixed partial derivatives. Extrema of a function of two variables.	4	2
Total number of hours	**32**	$\sum_{i=1}^{n} a_i = 16$

Topic of control works	Weighting factors b
Topic 1. Elements of linear, vector algebra and analytic geometry Operations with matrices. Calculating determinants. Solving SLAE. Scalar, vector, mixed vector products. Surfaces and lines of the first order	1
Topic 2. Limits of a function. Differential calculus of functions of one variable. Indefinite and definite integrals Calculation of limits: disclosure of indetermination of the kinds $\left\|\dfrac{\infty}{\infty}\right\|, \left\|\dfrac{0}{0}\right\|, \|0\cdot\infty\|, \|1^{\infty}\|$. Calculating limits using the first and second remarkable limits. Differentiation techniques. Investigation on monotonicity and extrema. Calculation of indefinite and definite integrals.	1

Self-study

Students' independent work consists of studying lecture material and completing individual tasks (IT).

Studying the theoretical material

Topics for self-study	Hours
Topic 1. Solving SLAE using the inverse matrix Inverse matrix. Theorem of existence of the inverse matrix. Calculating the inverse matrix. Matrix equations. Solving SLAE.	6
Topic 2. Solving homogeneous SLAEs by the Gauss method. Homogeneous SLAEs. Properties of solutions of homogeneous SLAEs, fundamental solution system (FSR). Solving inhomogeneous and homogeneous SLAEs by the Gauss method. Construction of FSRs of homogeneous SLAEs.	8
Topic 3. Elements of vector algebra and analytic geometry Application of the scalar, vector, mixed products of vectors. Straight line in plane and space. Curves of the second order.	8
Topic 4. Infinitesimals small and infinitely large functions. Infinitesimals and infinitely large functions, relationship between them. Properties of infinitesimals, their comparison. Properties of equivalent infinitesimals**.**	6
Topic 5. Differentiation of parametrically and implicitly defined functions. Logarithmic derivative. The concept of a parametrically and implicitly defined function. Calculating derivatives of a parametrically defined function and an implicit function. Logarithmic derivative.	8
Topic 6. L'Hôpital's Rule. Calculating limits using L'Hôpital's rule. Disclosure of indetermination $\left\|1^{\infty}\right\|, \left\|\infty^{0}\right\|, \left\|0^{0}\right\|$.	8
Topic 7. Application of differential and derivative. Application of differential to calculate approximate values of a function to solve geometric problems.	8
Topic 8. Functions of several variables Problems with domain definition of a function of several variables. Mixed partial derivatives. Extrema of a function of two variables	8
Total number of hours	**60**

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Subject of individual tasks

An individual task involves the performance of individual tasks for each student, which are aimed at consolidating theoretical knowledge and developing practical skills and demonstrate the ability to analyze mathematical methods, build graphic illustrations and competently present results. Calculations are recorded in a written report. The task is performed during the academic weeks and submitted for verification before the exam.

Topic of individual tasks

Topic 1. Elements of linear and vector algebra. Analytical geometry.
Operations with matrices. Calculation of determinants. Solution of SLAR. Scalar, vector, mixed products of vectors. Surfaces and lines of the first order

Topic 2. Limits of a function. Differential calculus of functions of one variable. Indefinite and definite integrals

Calculation of limits: disclosure of indetermination of the kinds $\left\|\frac{\infty}{\infty}\right\|, \left\|\frac{0}{0}\right\|, \|0\cdot\infty\|, \|1^\infty\|$. Calculating limits using the first and second remarkable limits. Differentiation techniques. Investigation on monotonicity and extrema. Calculation of indefinite and definite integrals.

Total number of hours	56

Informal education

The applicant has the opportunity to re-enroll individual topics or courses by: completing professional courses or trainings, online education, professional internships, in a field that meets the educational goals of the discipline.

For enrollment, it is necessary to provide: a certificate (electronic or printed) of completion of the course/internship, a description of the training program indicating the content of the topics, scope and duration.

Course materials and recommended reading

1. Kurpa L. V. Higher mathematics: Problems solving and variants of typical calculation. Volume 1. Kharkiv: NTU KhPI - 316 p.

2. Kurpa L.V., Shmatko T.V. Differential and Integral Calculus for One Variable Functions – Kharkiv: NTU KhPI: 2017. – 324 p.

3. Kurpa L.V., Linnik A.B., Shmatko T.V. Mathematical analysis in examples and problems. – Volume 1. – Харків: НТУ «ХПІ», 2024. – 209с.

4. Mulyk O. Calculus: part I. Differential calculus of function of one variable - Kyiv : Igor Sikorsky Kyiv Polytechnic Institute, 2022. – 117 p.

5. Zhuravska G.V. Higher Mathematics. Differential Calculus of a Function of One Variable. Elements of Theory – Kyiv : Igor Sikorsky Kyiv Polytechnic Institute, 2019. – 81 p.

Evaluation system

The final grade for the educational component is determined by the lecturer responsible according to topics, types of classes, etc. in accordance with the syllabus and is an integral assessment of the results of all types of educational activities of the higher education applicant. The final grade should reflect all grades for the components of the educational process, considering their weighting factors.

Поточний контроль (практичні, семінарські, лабораторні заняття), k_1	Контрольні роботи (за наявності), k_2	Індивідуальне завдання (за наявності), k_3	Підсумковий контроль (для ОК з іспитом), k_4
0,2	0,3	0,3	0,2

Сума коефіцієнтів повинна складати одиницю: $k_1 + k_2 + k_3 + k_4 = 1$. Підбір вагових коефіцієнтів підсумкової оцінки здійснює розробник курсу.

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Розрахунок підсумкової оцінки проводиться за формулою:

$$O = \Pi \cdot k_1 + K \cdot k_2 + I \cdot k_3 + \Pi\text{к} \cdot k_4$$

де: Π– середньозважена середня оцінка за поточний контроль

        I– оцінка за виконання індивідуального завдання

        K– середньозважена оцінка за контрольні роботи

        $\Pi\text{к}$– оцінка за підсумковий контроль

$$\Pi = \frac{\Pi_1 \cdot a_1 + \Pi_2 \cdot a_2 + \ldots + \Pi_n \cdot a_n}{\sum_{i=1}^{n} a_i}$$

де: a_i - ваговий коефіцієнт за кожне практичне (семінарське) або лабораторне заняття.

$$K = \frac{K_1 \cdot b_1 + K_2 \cdot b_2 + \ldots + K_m \cdot b_m}{\sum_{i=1}^{m} b_i}$$

де: b_i - ваговий коефіцієнт за кожну контрольну роботу.

Evaluation and grading

Criteria for evaluation of student study, and the final score structure

In each term, 100% of the final grade consists of evaluating results in the form of an exam (20%) and current evaluation (80%).
Exam: writing task and oral presentation.
Current evaluation: independent works, control works and individual home tasks.

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	29.08.2025	Head of the department Iuliia PERSHYNA
	29.08.2025	Guarantor of the educational program Olena PROKHORENKO

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