МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ
ХАРКІВСЬКИЙ НАЦІОНАЛЬНИЙ ЕКОНОМІЧНИЙ УНІВЕРСИТЕТ
ІМЕНІ СЕМЕНА КУЗНЕЦЯ

ЗАТВЕРДЖЕНО
на засіданні кафедри
вищої математики та економіко-
математичних методів
Протокол № 1 від 21.08.2023 р.

ПОГОДЖЕНО
Проректор з навчально-методичної роботи
_____ Каріна НЕМАШКАЛО

ВИЩА МАТЕМАТИКА
робоча програма навчальної дисципліни (РПНД)

Галузь знань	**07 «Управління та адміністрування»**
Спеціальність	**073 «Менеджмент»**
Освітній рівень	**перший (бакалаврський)**
Освітня програма	**«Бізнес-адміністрування»**

Статус дисципліни	**обов'язкова**
Мова викладання, навчання та оцінювання	**англійська**

Розробник:
канд. фіз.-мат. наук, доцент Євгенія МІСЮРА

Завідувач кафедри
вищої математики та
економіко-математичних методів Людмила МАЛЯРЕЦЬ

Гарант програми Ольга МИРОНОВА

Харків
2023

MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
SIMON KUZNETS KHARKIV NATIONAL UNIVERSITY OF ECONOMICS

APPROVED
at the meeting of higher mathematics
and economic mathematical methods
Protocol № 1 of 21.08.2023

AGREED
Vice-rector for educational and methodical work

Karina NEMASHKALO

Higher Mathematics

Program of the course

Field of knowledge	**07 Management and administration**
Specialty	**073 Management**
Study cycle	**first (bachelor)**
Study programme	**Business administration**

Course status	**mandatory**
Language	**English**

Developers:
PhD (Technics),
Associate Professor _____ Ievgeniia MISIURA

Head of Higher mathematics
and economic mathematical
methods _____ Lyudmyla MALYRETS

Head of Study Programme _____ Olga MYRONOVA

Kharkiv
2023

INTRODUCTION

The fundamental base in the mathematical preparation of economists and managers is the academic discipline "Higher Mathematics" which is a compulsory discipline of the natural scientific series and the component of the structural logical scheme which is provided for the educational professional program of bachelors of speciality 073 “Management”.

The main purpose of teaching is to form future specialists' basic mathematical knowledge for solving theoretical and practical problems in professional activity of a competent specialist in the sphere of international economic relations, skills in analytical thinking and skills in using mathematical knowledge for formation of real processes and developments, and for solving economic problems.

The main tasks that should be carried out in the process of teaching the discipline are: giving students knowledge of the basic parts of mathematical analysis, linear algebra and vector algebra; definitions, theorems, rules; proving the main theorems; mastering the fundamentals of the methodology of mathematical investigation of the applied economic problems; independent broadening of knowledge, development of logical and algorithmic thinking; obtaining primary skills in independent-learning of mathematical and applied library sources by students.

The object of study of the discipline is the process of formation of theoretical knowledge and practical skills necessary for mastering professional disciplines.

The subject of the academic discipline "Higher mathematics" is the basics of linear algebra and analytic geometry, mathematical concepts and methods of differential and integral calculus of functions of one and several variables, mathematical concepts and methods of series theory, mathematical concepts and methods of differential equations.

The learning outcomes and competencies formed by the course are defined in Table 1.

Table 1

Learning outcomes and competencies formed by the course

Competencies	Learning outcomes
GC3, GC4, GC8, SC2	LO6
GC3, GC4, GC8	LO19

where GC3. An ability to abstract thinking, analysis, and synthesis.
GC4. An ability to apply knowledge in practical situations.
GC8. Skills in the use of information and communication technologies.
SC2. An ability to analyze the results of an activity of a company, compare them with the factors of external and internal environment
LO6. Demonstrate skills of a search, a collection and an analysis of information, a calculation of indicators to interpret management decisions.
LO19. Demonstrate skills of an analysis and a synthesis of information, adapting them to analyze and solve problems in different areas of business and management

COURSE CONTENT

Content module 1: Linear algebra and analytical geometry.

Topic 1. The elements of the theory of matrices and determinants.

1.1. Matrices.

The definition of a matrix, its types. Operations with matrices: addition, multiplication of a matrix by a scalar, by a matrix. Transposition of a matrix. Equivalent transformations of matrices. Examples of using matrices.

1.2. Determinants.

The definition of the determinant, the rules of calculation of determinants of lower orders (schematic), higher orders (expansion by Laplace formulas). Properties of determinants. Calculation of some special determinants (triangular, diagonal, identity matrices).

1.3. The inverse matrix.

The notion of an inverse matrix, the properties of operation of a matrix inversion. Calculation of an inverse matrix by definition (as a transposed matrix of algebraic cofactors) and with the help of equivalent transformations of an adjoined unit matrix. The definition of a rank of a matrix and methods of definition.

Topic 2. The general theory of the system of linear algebraic equations.

2.1. Systems of linear algebraic equations.

The definition of the system of linear algebraic equations, the augmented and matrix forms of entry. Definitions of a solution to linear algebraic equations. The notion of a consistent or inconsistent system of linear algebraic equations. Determined or undetermined systems of linear algebraic equations.

2.2. Methods of solving systems of linear algebraic equations.

Solving the system of linear algebraic equations with the help of an inverse matrix and Cramer′s formulas. Kronecker – Capelli theorem. Investigation of compatibility of the system of linear algebraic equations.

General, particular and support solutions to the system of n algebraic equations with m unknowns. A fundamental system of solutions.

Solving the system of linear algebraic equations with the help of the method of sequential elimination of unknowns (the Gauss method). Application of the method to complete elimination of unknowns (the Gauss – Jordan method) for solving the system of linear algebraic equations, its realization with the help of tables.

Topic 3. The elements of vector algebra. Elements of analytical geometry

3.1. The basic notions of vector algebra.

Cartesian coordinates of a vector and a point. Examples of economic problems, which are connected with using vector algebra and analytic geometry. Coordinates on a straight line. Coordinates on a plane. Coordinates in a space. Linear operations with vectors in coordinates. Coordinates of a point of division of a segment. Coordinates

of a vector which is given by two points. A sign of a collinearity of two vectors. A sign of a coplanarity of three vectors. Properties of a scalar product of two vectors. An expression of a scalar product through coordinates. A cross product of two vectors, its properties. An expression of a cross product through coordinates. A mixed product of three vectors, its properties. An expression of a mixed product through coordinates of vectors-factors.

3.2. Straight line on a plane.

A geometrical locus of points. A concept of an equation of a straight line on a plane. Current coordinates of points of a line. Basic problems of analytical geometry. Forms of equations of a straight line on a plane: a canonical equation, a parametric equation, an equation passing through two given points, an equation passing through a given point in a given direction, an equation with an angular coefficient, an equation with intercepts on axes, a normal equation, an equation with a given normal vector, a general equation. Basic problems with a straight line, a mutual arrangement of two and three straight lines in R^2. An angle between two straight lines. A distance from a point to a straight line. Equations of a bisectrix of angles, which are formed two straight lines. A model of "supply-and-demand".

3.3. Curves of the second order.

A general equation of CO2: a definition, conditions of a belonging to elliptical, hyperbolical, parabolic type. Central (non-central) CO2. A circle, an ellipse, a hyperbola, a parabola: a definition, a canonical equation, a parametric equation, an eccentricity, a construction.

3.4. Analytical geometry in a space (in R^3)

A concept about an equation of a surface in R^3. A normal vector of a plane. Forms of equations of planes in a space: an equation passing through three given points, an equation with intercepts on axes, a normal equation, an equation passing through a given point with a given normal vector, a general equation, a parametric equation. A condition of an intersection, a collinearity, an orthogonality, a coincidence of two planes. An angle between two planes. A condition of a belonging of three points of one straight line in R^3. A distance from a point to a plane. Equations of bisector planes. A directed vector of a straight line. Forms of equations of a straight line in R^3: a canonical equation, a parametric equation, an equation passing through two given points, a general equation. Conditions of a collinearity, a perpendicularity, a coincidence, an intersection, a crossing of two straight lines. An angle between two straight lines in R^3. A distance between a parallel straight line. An analysis of a mutual arrangement of a straight line and a plane in space. An angle between a straight line and a plane. Coupling of planes.

Content module 2: The elements of mathematical analysis.

Topic 4. The limit of a function and continuity. Differential calculus of the function of one variable.

4.1. Limits of functions

The notion of the function of one variable. Ways to define the function. The domain of the definition and the range of values of a function. A graph of a function. Basic elementary functions, their properties and graphs. Classification of elementary functions. The notion of a numerical sequence. The limit of a sequence, its geometrical meaning. Infinitesimals and infinitely large sequences, their properties. Basic theorems for limits of sequences. The definition of the limit of a function at a point, its geometrical meaning. Infinite limits and limits if a limiting value approaches infinity. One-sided limits at a point. Basic theorems for limits of functions. The notions of indeterminate forms, their types. Methods of elimination of indeterminations. The first and the second remarkable limits, their consequences. Equivalent infinitesimals. Calculation of limits with the help of comparison of infinitesimals. Application of limits to solving economic problems.

4.2. The continuity of functions.

The definition of the function continuity at a point and on an interval. One-sided continuity. Continuity of elementary functions. Break points of functions and their classification. Basic properties of continuous functions.

4.3. A derivative and a differential. Techniques of differentiation.

The definition of a derivative, its economic and geometric meanings. The notion of differentiation of a function at a point. The relationship between the differentiation and continuity of a function. A table of derivatives of basic elementary functions. Basic rules of differentiation. The theorem of a derivative of a composite function. Calculation of a derivative of a parametric function. Differentiation of implicit functions. The notion of a differential of a function, its geometric meaning and properties. L′Hospital′s rule for calculation of limits of functions.

4.4. Application of derivatives to the investigation of functions.

The condition of monotony of a function, finding local extremums of a function. The greatest and the least values of a function on a segment. Conditions of convexity and concavity of a graph of a function, finding inflection points. Vertical, horizontal and inclined asymptotes of a curve. A general scheme of investigation of a one-variable function and a plot of its graph. Application of a derivative to economics. Marginal analysis. Elasticity of economic indicators.

Topic 5. Analysis of the function of several variables.

5.1. Basic notions. Partial derivatives. A gradient and a directional derivative.

The definition of a function of several variables. The domain of the definition of the function of two variables and its graph. Lines and surfaces of a level. The continuity and the limit of the function of two variables. Partial derivatives of a function, its geometrical and economic meaning. Partial derivatives and differentials of higher orders. The derivative of the function of several variables. The gradient of the function and its properties. The relationship between the gradient and level lines for the function of two variables.

5.2. The extremum of the function of two variables.

Basic notions. A local extremum of the function of two variables, the necessary and the sufficient conditions of an extremum. The greatest and the least values of a function in a closed domain. A conditional extremum of the function of two variables. Reducing the problem of a conditional extremum of the function of two variables to the problem of the local extremum of the function of one variable. The method of Lagrange multipliers.

5.3. Application of the function of several variables to economics.

Application of the function of several variables to economic models: production functions, the function of Cobb and Douglas, the expenditure function, the demand function. Elasticity of the function of several variables.

Topic 6. Integral calculus.

6.1. Indefinite integral

An antiderivative and an indefinite integral. A notion of an antiderivative of a function and an indefinite integral. A geometrical and a mechanical meaning of an integral. A table of basic integrals. Basic methods of integration. The simplest rules of an integration. A direct integration. A change of a variable in an indefinite integral. Integration by parts. Integration of some classes of functions. Integration of rational fractions. Integration of irrational expressions and expressions which have trigonometric functions. Trigonometric substitutions.

6.2. Definite integral and its application

A notion and properties of a definite integral. Integral sums. Conditions of an existence of a definite integral. Properties of a definite integral. Calculation of a definite integral. Newton–Leibnitz formula. A change of a variable in a definite integral. Integration by parts. Improper integrals of the first and the second kinds.

A notion of an improper integral. Conditions of a convergence of improper integrals. Euler-Poisson integral and its application. Application of a definite integral. A geometrical application of a definite integral: a calculation of areas, volumes of a solid of a revolution, arc lengths of curves. An approximate calculus of a definite integral: formulas of rectangles, trapezoids, Simpson**.** Finding a volume of a productive production; a consumer surplus, an analysis of a nonuniformity in a distribution of income from a population with the help of Lorenz curve.

Topic 7. Differential equations.

7.1. The basic notions of the theory of differential equations. Solving the first-order differential equations.

The general notions of the theory of ordinary differential equations. The first-order differential equations: basic definitions, the notions of general and particular solutions. The Cauchy problem, the theorem of existence and uniqueness of solution to it. Differential equations with separable variables, homogeneous equations of the first order, linear differential equations of the first order, Bernoulli′s equation.

7.2. Differential equations of higher orders. Methods of solving the second-order differential equation.

The basic notions and definitions, general and particular solutions, the Cauchy problem. Differential equations of the second order. Equations, which reduce the order, methods of integration. Linear differential equations of the second order, the structure of a general solution. Homogeneous linear differential equations of the second order with constant coefficients.

Topic 8: Series.

8.1. Numerical series and their convergence.

The definition of series, its sums. Numerical series and its convergence. The properties of convergent series. The necessary condition of convergence. The harmonic series, its divergence. The generalized harmonic series. Sufficient criteria of a convergence of series with positive terms: comparison criterion, D′Alembert criterion, Cauchy's radical criterion and Maclaurin – Cauchy integral criterion.

8.2. Alternating series and their convergence.

The notion of alternating series. Alternating numerical series. The sufficient sign of convergence. Absolute and conditional convergences. The Leibnitz criterion. Application of the Leibnitz theorem to finding an error of calculation of a sum of series.

8.3. Functional series.

The notion of functional series. The radius and the convergence domain of power series, formulas of calculation.

The list of practical (seminar) studies in the course is given in Table 2.

Table 2

The list of practical (seminar) studies

Name of the topic and/or task	Content
1	2
Topic 1 Task 1	Operations on matrices. Calculation of determinants of the second and third orders.
Topic 2 Task 2	An investigation of a system of equations for compatibility. Solving systems of linear algebraic equations.
Topic 3 Task 3	Using elements of vector algebra and analytic geometry to solve applied problems
Topic 4 Task 4	Calculation of limits of functions. The application of the derivative to the investigation of functions and in economic problems.
Topic 5 Task 5	Finding the domain of a function of two variables. Partial and mixed derivatives. An investigation of an extremum.
Topic 6 Task 6	Methods of a calculation of the indefinite integral of a function of one variable. An application of the definite integral to solving applied problems.
Topic 7 Task 7	Methods of solving differential equations of the first and second orders.
Topic 8 Task 8	An investigation of numerical series for a convergence. Finding

	the radius of convergence of a power series.

The list of laboratory studies in the course is given in table 3.

Table 3

List of laboratory studies

Name of the topic and/or task	Content
Topic 1	Solving tasks of matrix algebra using software GNU Octave.
Topic 2	An investigation of the compatibility and solving systems of linear algebraic equations by the Cramer's method and the inverse matrix method using software GNU Octave.
Topic 3	Basic operations and functions, which are used to solve problems of vector algebra and analytic geometry using software GNU Octave.
Topic 4	Basic rules for calculation of limits and derivatives of functions in software GNU Octave. An investigation of the function and constructing its graph using software GNU Octave.
Topic 5	A construction of a graph of a function of two variables, calculating partial derivatives of the first and second orders, finding the gradient of a function at a point and the derivative along the direction of a vector, finding the local extremum of a function of two variables using software GNU Octave.
Topic 6	Finding indefinite and definite integrals of a function of one variable, an investigation of improper integrals, calculation of the area of a figure bounded by lines, calculation of the volume of a body formed by rotation about the corresponding axis of a figure bounded by lines using software GNU Octave.
Topic 7	Solving differential equations of the first and second orders and solving applied problems using differential equations in software GNU Octave.
Topic 8	Investigation of numerical and power series for convergence in software GNU Octave.

The list of self-studies in the course is given in Table 4.

Table 4

List of self-studies

Name of the topic and/or task	Content
Topic 1-8	Search, selection and review of literature on a given topic
Topic 1-8	Preparation for practical classes
Topic 1-8	Preparation for laboratory classes
Topic 1-8	Performing a creative task
Topic 1-8	Preparing for the final exam

The number of hours of lectures, practical (seminar) and laboratory studies and hours of self-study is given in the technological card of the course.

TEACHING METHODS

In the process of teaching the course, in order to acquire certain learning outcomes, to activate the educational process, it is envisaged to use such teaching methods as:

Verbal (problem lectures (Topic 1, Topic 2, Topic 4–7), lecture-discussion (Topic 1–8), brainstorming (Topic 1, Topic 2, Topic 5).

Visual (demonstration (Topic 1–8)).

Practical (individual research work (Topic 1–8)).

FORMS AND METHODS OF ASSESSMENT

The University uses a 100-point cumulative system for assessing the learning outcomes of students.

Current control is carried out during lectures, practical, laboratory and seminar classes and is aimed at checking the level of readiness of the student to perform a specific job and is evaluated by the amount of points scored:

− for courses with a form of semester control as an exam: maximum amount is 60 points; minimum amount required is 35 points.

The final control includes current control and an exam.

Semester control is carried out in the form of a semester exam or grading.

The final grade in the course is determined:

− for disciplines with a form of exam, the final grade is the amount of all points received during the current control and the exam grade.

During the teaching of the course, the following control measures are used:

Current control: colloquiums (estimated at 6 points (two colloquiums during the semester – the total maximum number of points – 12)); written tests (maximum score – 6 points (two written tests during the semester, total maximum number of points – 12)); homework (maximum score – 2 points (seven homework during the semester, total maximum number of points – 14 points)); laboratory work (maximum score – 2 points (eight laboratory work during the semester, total maximum number of points – 16 points)); an independent creative task (maximum score – 6 points).

Semester control: Grading including Exam (40 points).

More detailed information on the assessment system is provided in the technological card of the course.

An example of an exam card and assessment criteria.

An example of examination paper

SIMON KUZNETS KHARKIV NATIONAL UNIVERSITY OF ECONOMICS

Study cycle: first (bachelor)

Term 1

Educational discipline: "Higher mathematics"

Examination paper (EXAMPLE)

Task 1. a) Find this definite integral:

$$\int_0^1 \frac{arctg^5 x dx}{1+x^2}$$

b) Find the derivative of the function:

$$y = ctg(4x+5) - \ln(4x^3 - 9)$$

Task 2. a) Find the limit:

$$\lim_{x \to 7} \frac{\sqrt{2+x}-3}{x^2-6x-7}$$

b) Investigate the convergence of the numerical series:

$$\sum_{n=1}^{\infty} \frac{n^4}{(n+2)!}$$

Task 3. Solve the systems using Jordan-Gauss method and check its solution using a substitution:

$$\begin{cases} x_1 + 2x_2 - x_3 = 6 \\ -x_1 + x_2 - x_3 = 0 \\ -x_1 - x_2 + x_3 = -4 \end{cases}$$

Define rank A, rank A|B and n. What is a type of this system?

Task 4. Solve the differential equation and find its particular solution:

$$y' - \frac{1}{x} y = x \sin x; \; y(\pi) = 0.$$

Task 5. The laws of supply and demand have the form:

$$f(x) = \frac{120}{x+2} \quad g(x) = 10 + \frac{5}{2} x$$

a) Find the point of market equilibrium.

b) Find consumers' surplus under the condition of establishment of market equilibrium.

c) Find suppliers' surplus under the condition of establishment of market equilibrium.

d) Make an analysis of the obtained values in the problem.

It was approved at the meeting of the department of higher mathematics and economic mathematical methods

Protocol № _ from____, 20___

The head of the department L. Malyarets

The lecturer Ie. Misiura

An assessment criteria

Each examination paper contains 5 practical tasks, including two first-level (diagnostic) tasks, two second level (situational) tasks and one third level (diagnostic and heuristic) task.

The structure of the examination paper is given in Table 5.

Table 5

The structure of the examination paper

Task level	The content of tasks after the themes
First	Task 1. A calculation of a definite (an indefinite) integral using the method of a substitution or the method by parts. Finding a general equation of a straight line that passes through two points. Finding a general equation of the straight line perpendicular (parallel) to the line and passing through the point. Solving the problems of vector algebra. Calculation of scalar, cross and mixed products, checking the coplanarity and collinearity of vectors Task 2. Finding the limits of functions using methods of eliminating various types of uncertainty, finding the derivative. Sufficient signs of convergence of positive numerical series: comparison sign, D'Alembert's sign, Cauchy's radical sign, and Cauchy–Maclauren's integral sign. Variable number series. A sufficient sign of convergence. Absolute and conditional convergence. Interspersed rows. Leibniz's sign. The region of convergence of the power series.
Second	Task 3. Solving the systems of linear algebraic equations by Cramer's method, the inverse matrix method and Jordan − Gauss method. Task 4. Differential equations with separated variables. Homogeneous differential equations of the first order. Linear differential equations of the first order. Cauchy's problem.
Third	Task 5. Application of the knowledge according to the themes: "Analysis of the function of several variables"; "The definite integral and its application"; "Differential equations".

The task of the first level is assessed as follows (7 points):

7 points, in the case of the exact use of the scientific terminology and symbols in the necessary logical sequence; a creative approach to solving original problems which require a high level of knowledge;

6 points, in the case of the exact use of the mathematical terminology and symbols; irreproachable mastery of mathematical instruments; correct use of mathematical methods, facts, formulas and relations for solving the task of the third level;

5 points, if a logically right sequence of steps of solution has been made. All the key moments of the solution have been grounded. 1–2 slight mistakes or slips are possible in the calculations which don't influence the correctness of the further solution;

4 points, if mastery of a small part of obligatory skills and attainments which are intended for the syllabus of the academic discipline has been demonstrated; in solving the tasks, the conclusions, reproduction of the syllabus material of the discipline has not been always shown;

3 points, if the task has been solved only partially with initial right considerations, but there are mistakes, which considerably influenced the process of the right solution of the task;

2 points, if the task fulfillment has been begun, there are separate correct considerations, but a logical mistake has been made, which resulted in an incorrect solution.

1 point, if the condition has been written;

0 point, if no task has been fulfilled.

The task of the second level is assessed as follows (8 points):

8 points, if solving the assigned tasks is characterized by a creative use of the theoretical instrument, logical correctness, precision, explanation of conclusions, rationality or using original approaches to solving the tasks;

7 points, if perfect mastery of the skill in the use of mathematical instruments application of information from the other educational courses and discipline has been demonstrated; one slight mistake has been made; a high level of standards of carrying out the tasks;

6 points, if a logically right sequence of steps of solution has been chosen. All the key points of solution have been grounded. 1–2 slight mistakes or slips are possible in the calculations, which don't influence the correctness of the further solution;

5 points, in the case of correct using the terminology of the discipline and the basic methods for solving standard problems; showing the ability to use theoretical knowledge for solving standard (multistep) tasks, availability of some mistakes or deficiencies on the calculating stage of presentation of the solution, the ability to conclude;

4 points, in the case of more than one mistake and one or two deficiencies in the calculations, the graphs, the choice of the method of solution, which have caused a wrong final result in the individual cases;

3 points, if task fulfillment has been begun, there are separate correct considerations, but a logical mistake has been made, which resulted in an incorrect solution;

2 points, if numerical gross mistakes have been made in the process of using the concepts of the discipline in the formulas which prove the absence of a minimally necessary part of the compulsory skills and the practical attainments provided for the discipline syllabus;

1 point, if no task fulfillment has been begun, but the condition has been written;

0 point, if no task fulfillment has been begun.

The task of the third level is assessed as follows (10 points):

10 points, if the ability for scientific investigative developments on the problems of the discipline has been shown; perfect skills in the use of mathematical instruments using modern scientific theoretical approaches; a high level of standards of carrying out tasks has been demonstrated;

9 points, in the case of using scientific terminology and symbols in the necessary logical sequence; solving the assigned tasks is characterized by precision, explanation, a creative approach, rationality of the choice of method of solution, correct necessary calculations and transformations;

8 points, if systematic, deep and full knowledge of all the parts of the academic discipline and the basic questions which go beyond the discipline has been shown; a high level of standards of carrying out the tasks has been demonstrated;

7 points, in the case of solitary slight deficiencies which don't influence the final result; correct use of mathematical methods, facts, formulas and relations for solving the task of different level of complexity;

6 points, if the ability to conclude and compare the theoretical and practical material has been demonstrated; correct (but not always rational) use of mathematical methods of solution, facts, formulas and relations has been shown;

5 points, if half of the tasks have been done, the interpretation of the obtained results is absent; level of standards of carrying out tasks is acceptable;

4 points, if the tasks have been carried out without any logical relationship of the mathematical concepts and practical solutions have not been given sufficient theoretical explanation;

3 points, if acceptable volume of knowledge has been shown within the educational standard; the use of mathematical symbols and terminology has been insufficient and in exact, the knowledge of the basic formulas and concepts on the discipline has not been demonstrated;

2 points, in the case of solving tasks with the theoretical material used only on the level of concepts; the inability to understand the connection of the theoretical material with the practical tasks;

1 point, if the condition has been written;

0 point, if no task fulfillment has been begun.

RECOMMENDED LITERATURE

Main

1. Вища математика: математичний аналіз, лінійна алгебра, аналітична геометрія [електронний ресурс]: підручник / [авт. кол. : Пономаренко В. С., Малярець Л. М., Афанасьєва Л. М. та ін. ; за ред. В. С. Пономаренка]. – Мультимедійне інтерактивне електрон. вид. комбінованого використ. (412 Мб). – Х.: ХНЕУ ім. С. Кузнеця, 2015. – Назва з тит. екрана. – ISBN 978-966-676-568-3.

2. Вища математика : підручник / Л. М. Малярець, Л. М. Афанасьєва, Т. В. Денисова та ін. – Харків : ХНЕУ, 2012. – 772 с. Режим доступу :

http://repository.hneu.edu.ua/handle/123456789/28721
3. Вища математика : базовий підручник для вузів / під ред. В. С. Пономаренка. – Харків : Фоліо, 2014. – 669 с.
4. Коваленко Л. Б. Вища математика для менеджерів : підручник. – Харків : ХНУМГ ім. О. М. Бекетова, 2019. – 341 с.
5. Лебедєва І. Л. Вища та прикладна математика. Лабораторний практикум для студентів напряму підготовки 6.030601 "Менеджмент" / І. Л. Лебедєва, Л. О. Норік. – Х. : ХНЕУ ім. С. Кузнеця, 2014. – 200 с. (Укр. мов.) http://www.repository.hneu.edu.ua/jspui/handle/123456789/9557

Additional

6. Вища математика : мультимедійні методичні рекомендації до самостійної роботи з теми «Невизначені інтеграли» [Електронний ресурс] / Л. М. Афанасьева, А. В. Воронін, О. В. Гунько. – Мультимедійне інтерактивне електрон. вид комбінованого використ. (89 Мб). – Харків : ХНЕУ ім. С. Кузнеця, 2019. – Режим доступу : http://library.hneu.edu.ua/departments/kafedra-vishoyi-matematiki-ta-ekonomiko-matematichnih-metodiv/81
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Information resources

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http://www.philender.com/courses/multivariate/notes/matoctave.html