Appendix 2
To the order of 23.05 2023 No. 144

NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCES OF UKRAINE

Department of Higher and Applied Mathematics

"APPROVE"
Dean of the Faculty of Agricultural Management
_____ Ostapchuk A.D.
18.05 2023

"APPROVED"
at the meeting of the Department of Higher and Applied Mathematics
protocol No. 14 of 1.05.2023
Acting Head of Department
_____ Pantalienko L.A.

"CONSIDERED"
Guarantor OP
_____

WORKING PROGRAM OF EDUCATIONAL DISCIPLINE HIGHER MATHEMATICS

For the training of ES "Bachelor" specialists
Educational and professional program: 075 "Marketing"
Field of knowledge: 07 "Management and administration"
Faculty of Agricultural Management
Developers: Candidate of Pedagogy, Associate Professor Artemchuk L.M.,
Dr.Sc., Professor Shydlich A.L.

Kyiv - 2023

Form No. H - 3.04

1. Description of the academic discipline

Higher mathematics

Field of knowledge, direction of training, specialty, educational degree		
Educational degree	Bachelor	
Branch of knowledge	07 "Management and administration"	
Specialty	075 "Marketing"	
Educational program	Marketing. Bachelor	
Characteristics of the academic discipline		
Kind	Mandatory	
Total hours	120	
Number of credits ECTS	4	
Number of content modules	2	
Course project (work)	-	
Form of control	Examination	
Indicators of academic discipline for full-time and part-time forms of education		
	Full-time form	Part-time form
Year of preparation	1	1
Semester	1	1
Lecture classes	15 hours	4 hours
Practical, seminar classes	45 hours	8 hours
Laboratory classes	-	-
Individual work	60 hours	108 hours
Individual tasks	-	-
Number of weekly hours for full-time education: classrooms: independent work of the student	 4 hours 4 hours	-

2. The purpose and tasks of the educational discipline

The **goal** of the educational discipline "Higher Mathematics" is the formation of students' personalities, the development of their intelligence and abilities for logical and algorithmic thinking, assimilation of mathematical methods for solving managerial problems in the economic sphere.

The **main tasks** of studying the discipline "Higher Mathematics" are: acquisition by students of knowledge on the main sections of higher mathematics, proving the main theorems, the formation of initial skills: performing actions on vectors, matrices, calculating determinants; solution of systems of linear equations; study of forms and properties of straight lines and planes, curves and surfaces of the second order; finding the boundary of step exponential functions.

As a result of studying the academic discipline, the student must master the following competencies:

general:

GC3. Ability to abstract thinking, analysis and synthesis.
GC4. Ability to learn and master modern knowledge.
GC5. Determination and persistence in relation to assigned tasks and assumed responsibilities.
GC8. Ability to conduct research at an appropriate level.

professional:

…

Program learning outcomes:

Knowledges:

1. Basic provisions of higher mathematics.
2. The content of basic concepts from higher mathematics and their application to the construction of management models.
3. Principles and methods of organization and service technology.
4. Technologies of development, promotion and sale of products.
5. Principles, processes and technology of organizing the work of managers (administrative-managerial, social-psychological, economic, technical-technological)
6. To know the peculiarities of the organization of activities in nature conservation areas, in the field of agriculture.
7. Peculiarities of enterprise management.
8. Methods and forms of marketing activity in management.

Skills:

1. To formulate the simplest applied problems and build mathematical models of real objects and processes occurring in them.
2. To develop rational methods of researching the created models, conduct their qualitative and quantitative research.
3. To develop models of inter-industry balance, analyze the factors used.
4. To develop an adequate mathematical model of an applied problem and find its solution using methods of mathematical analysis.
5. Arguably defend your views in solving professional tasks.
6. To make informed decisions and bear responsibility for the results of one's professional activity.

7. To demonstrate performance of professional tasks in standard and uncertain situations
8. To present the obtained results as succinctly and clearly as possible and, based on them, develop practical recommendations regarding the choice of the optimal economic strategy for the development of a specific agro-industrial complex.
9. Independently master new mathematical methods and apply them to solving practical problems.
10. To show respect for individual and cultural diversity.
11. To show professional tolerance for identifying alternative principles.
12. Act in accordance with the principles of social responsibility and civic consciousness.
13. To manage your studies with the aim of self-realization in the professional sphere.

3. Program of educational discipline

Content module 1. Linear and vector algebra.

Topic 1. Determinants.

Determinant of the second order. Determinant of the third order. Basic properties of determinants. Layout of the determinant by row (or column) elements. The determinant of the n^{th} order.

Topic 2. Matrices.

Linear operations on matrices. Elementary matrix transformations. Matrix multiplication. Inverse matrix. Matrix rank.

Topic 3. Systems of linear equations, their application in solving economic and management tasks.

Basic concepts. Solving systems of linear equations by the matrix method. Solving systems of linear equations by Kramer's method. Solving systems of linear equations by the Gaussian method. Solvability of systems of linear equations. The Kronecker-Capelli theorem. Systems of linear homogeneous equations.

Topic 4. Linear economic models.

Linear economic models:

- Leontiev model (balance analysis).
- Model of equilibrium prices.
- Linear model of equilibrium trade.

Content module 2. Differential and integral calculus.

Topic 5. Application of functions in economic theory.

Function: definition, domain of definition. Concept of function. Ways to define a function. Functions given implicitly. Inverse functions. Functions specified parametrically. The simplest properties of functions. Basic elementary functions, their properties and graphs. Inverse, composite, even, odd, periodic functions.

Topic 6. The limit of a function. Continuity of function.

The limit of a function at a point. The limit of the function is at infinity. Infinitely large and infinitely small quantities, their properties. Basic theorems about limits.

Types of uncertainties and methods of their disclosure. The first and second wonderful borders. Comparison of infinitesimal quantities. Unilateral borders. Argument and function increments. Continuity of function. Basic theorems about continuous functions. Breakpoints and their classification. Asymptotes of the function graph. Local and global properties of functions.

Topic 7. Derivative of functions. Differential function.

Table of derivatives. Geometric, economic and mechanical content of the derivative. The derivative of a composite, inverse, implicitly given function. Logarithmic differentiation.

Topic 8. The use of the derivative for the study of a function when solving problems of an economic and managerial nature.

Study of the function on monotonicity. Extrema of functions. The largest and smallest value of the function on the interval. The direction of the convexity and the inflection point of the graph of the function. Scheme of research of the function and construction of its graph. Equilibrium price. Elasticity of supply and demand. The relationship of elasticity with income. Optimal price, marginal costs, optimal volume of production.

Topic 9. Indefinite integral.

Concept of antiderivative and indefinite integral. Properties of the indefinite integral. Table of basic integrals. Basic methods of integration. Integration of fractional and rational functions. Integration of expressions containing trigonometric functions. Integration of some irrational functions. Cauchy's theorem. The concept of integrals that "do not take".

Topic 10. The definite integral. Application of the definite integral to geometric and economic problems.

Problems that lead to the concept of a definite integral. Definition of the definite integral. Conditions for the existence of a definite integral. Properties of the definite integral. Evaluation of the definite integral. Evaluation theorems. Theorem about the mean value of a function. A definite integral with a variable upper bound. Newton-Leibniz formula. Methods of calculating definite integrals. Application in dynamic processes. Total production costs. Coefficient of uneven distribution of income tax. Types of positioning.

4. The structure of the academic discipline

Titles of content modules and topics	Number of hours											
	Full-time form						Part-time form					
	Total	including					Total	including				
		Lec	P	Lab	I	I.w.		Lec	P	Lab	I	I.w.
1	2	3	4	5	6	7	8	9	10	11	12	13
Content module 1. Linear and vector algebra.												
Topic 1. Determinants.	9	1	2			5	9		1			8
Topic 2. Matrices.	9	1	4			5	9	1				8

Topic 3. Systems of linear equations, their application in solving economic and management tasks.	9	2	4			5	9					9
Topic 4. Linear economic models	13	42	4			5	13	1	1			11
Total according to content module 1	**40**	**6**	**14**			**20**	**40**	2	2			36
Content module 2. Differential and integral calculus.												
Topic 1. Application of functions in economic theory.	**4**	1	1			2	-	-	-	-	-	4
Topic 2. The limit of a function. Continuity of function.	**12**	3	3			6	-	-	2	-	-	10-
Topic 3. The derivative of a function. Differential function.	**8**	2	2			4	-	1	1	-	-	6
Topic 4. Application of the derivative for the study of the function when solving problems of an economic and managerial nature.	**8**	**2**	**2**			**4**	-	-	1	-	-	7
Topic 5. Definition of antiderivative and indefinite integral.	**16**	**2**	**4**			**8**						16
Topic 6. The definite integral. Application of the definite integral to geometric and economic problems.	16	**4**	**4**			**8**			2			12
Topic 7. Definition of DE of the 1st order.	8	**2**	**2**			**4**						8
Topic 8. Linear DEs of the 2nd order with constant coefficients.	8	**2**	**2**			**4**		1				7
Total according to content module 2	**80**	**9**	**31**			**40**	**80**	2	6			72
Total	**120**	**15**	**45**			**60**	-	4	8	-	-	108

5. Topics of practical (seminar) classes

No.	Topic name	Number of hours
1	**Topic 1**. Determinants.	2
2	**Topic 2**. Matrices.	4
3	**Topic 3**. Systems of linear equations, their application in solving economic and management tasks.	2
4	**Topic 4.** Linear economic models.	4
5	**Topic 5**. Application of functions in economic theory.	1
6	**Topic 6**. The limit of a function. Continuity of function.	3

7	**Topic 7**. The derivative of a function. Differential function.	2
8	**Topic 8**. Application of the derivative for the study of the function when solving problems of an economic and managerial nature.	6
9	**Topic 9**. Definition of antiderivative and indefinite integral.	4
10	**Topic 10**. The definite integral. Application of the definite integral to geometric and economic problems.	4
11	**Topic 11**. Definition of DE of the 1st order.	4
12	**Topic 12**. Linear DEs of the 2nd order with constant coefficients.	4

6. Topics for independent work

No.	The title of the topic	Number of hours
1	**Topic 1.** Determinants. Determinants of the nth order.	10
2	**Topic 2.** Matrices. Matrix rank. Inverse matrix.	10
3	**Topic 3.** Systems of linear algebraic equations, their application in solving economic and managerial problems. Gauss method. SLAE of compatibility. Homogeneous SLAE.	10
4	**Topic 4.** Linear economic models. Leontiev's model of p-branches.	10
5	**Topic 5.** Application of functions in economic theory. Graphs of functions.	4
6	**Topic 6**. The limit of a function. Continuity of function.	6
7	**Topic 7.** The derivative of a function. Differential of a function Derivatives of higher orders	4
8	**Topic 8.** The use of the derivative for the study of the function when solving problems of an economic and managerial nature. A complete study of a function.	6
9	**Topic 9.** Definition of the primitive and indefinite integral. Integration methods.	8
10	**Topic 10.** The definite integral. Application of the definite integral	8
11	**Topic 11.** Linear DEs of the 1st order.	8
12	**Topic 12.** Linear DEs of the 2nd order with constant coefficients.	6

7. Tasks for individual work of students.

I. During the learning of the discipline, students perform individual works on the following topics:

1. Application of linear algebra in management.
2. Study of the function
3. Integral

II. Each student receives a set of test tasks in a variant, a sample is given.

Content module 1. Elements of linear algebra in marketing

1. Обчислити визначник третього порядку / Find the determinant of the third order $A = \begin{vmatrix} 1 & 2 & 0 \\ 0 & 1 & 3 \\ 5 & 0 & -1 \end{vmatrix}$				
5	4	0	27	29

2. Розв'язати систему лінійних рівнянь методом Крамера / Solve the system of linear equations by the Cramer method $\begin{cases} 3x - 5y = 13; \\ 2x + 7y = 81. \end{cases}$				
$\Delta = 31, \Delta_x = 496,$ $\Delta_y = 217;$ $x = 16; y = 7$	$\Delta = 21, \Delta_x = 496,$ $\Delta_y = 217;$ $x = 16; y = 7$	$\Delta = 31, \Delta_x = 0,$ $\Delta_y = 217;$ $x = 0; y = 7$	$\Delta = 5, \Delta_x = 25,$ $\Delta_y = 35;$ $x = 16; y = 7$	$\Delta = -1, \Delta_x = 9,$ $\Delta_y = 5;$ $x = -9; y = -5$

3. Знайти обернену матрицю для матриці A, якщо / Find the inverse matrix for the matrix A, if $A = \begin{pmatrix} 2 & 2 & 3 \\ 1 & -1 & 0 \\ -1 & 2 & 1 \end{pmatrix}$.				
$\begin{pmatrix} 2 & 2 & 3 \\ 1 & -1 & 0 \\ -1 & 2 & 1 \end{pmatrix}$	$\begin{pmatrix} 1 & -4 & -3 \\ 1 & -5 & -3 \\ -1 & 6 & 4 \end{pmatrix}$	$\begin{pmatrix} 2 & 2 & 3 \\ 1 & 1 & 0 \\ 1 & 2 & 1 \end{pmatrix}$	$\begin{pmatrix} 1 & 0 & 0 \\ 1 & -1 & 0 \\ -1 & 2 & 1 \end{pmatrix}$	$\begin{pmatrix} 1 & 2 & 3 \\ 1 & 2 & 0 \\ 1 & 2 & 1 \end{pmatrix}$

4. Знайти матрицю A^2, якщо / Find the matrix A^2, if $A = \begin{pmatrix} 2 & 3 & 1 \\ -1 & 1 & 0 \\ 1 & 2 & -1 \end{pmatrix}$.				
$\begin{pmatrix} 2 & 11 & 1 \\ -3 & -2 & -1 \\ -1 & 3 & 2 \end{pmatrix}$	$\begin{pmatrix} 2 & 3 & 1 \\ -1 & 1 & 0 \\ 1 & 2 & -1 \end{pmatrix}$	$\begin{pmatrix} 2 & 2 & 3 \\ 1 & 1 & 0 \\ 1 & 2 & 1 \end{pmatrix}$	$\begin{pmatrix} 2 & 11 & 1 \\ -3 & 2 & 1 \\ 1 & 3 & -2 \end{pmatrix}$	$\begin{pmatrix} 2 & 11 & 1 \\ -3 & 2 & 1 \\ -1 & 3 & 2 \end{pmatrix}$

5. Розв'язати систему лінійних рівнянь методом Гаусса / Solve the system of linear equations by the Gauss method $\begin{cases} 2x - y + z = 5; \\ 3x + 4y - 2z = -3; \\ x - 3y + z = 4. \end{cases}$				
$x = 1; y = 2;$ $z = 3$	$x = 1; y = 2;$ $z = 3$	$x = 1; y = 1;$ $z = 0$	$x = 1; y = -2;$ $z = 1$	$x = 1; y = 0;$ $z = 3$

6. Матриця A^{-1} називається оберненою до матриці A, якщо / The matrix A^{-1} is called the inverse matrix of the matrix A, if				
$A \times A^{-1} = E,$ E – одинична матриця / identity matrix	$A \times A^{-1} = E,$ $A^{-1} \times A = E,$ E – одинична матриця / identity matrix	$A^{-1} \times A = E,$ E – квадратна матриця / square matrix	$A^{-1} + A = E,$ E – одинична матриця / identity matrix	$A^{-1} \times A = E,$ $A^{-1} + A = E,$ E – одинична матриця / identity matrix

7. Розв'язати систему лінійних рівнянь методом оберненої матриці / Solve the system of linear equations using the inverse matrix method $\begin{cases} 2x - y + z = 5; \\ 3x + 4y - 2z = -3; \\ x - 3y + z = 4. \end{cases}$				
$x = 1; y = 2;$ $z = 3$	$x = 1; y = 2;$ $z = 3$	$x = 1; y = 1;$ $z = 0$	$x = 1; y = -2;$ $z = 1$	$x = 1; y = 0;$ $z = 3$

Content module 2. Differential and integral calculus.

8. Знайти область визначення функції / Find the domain of a function $y = \frac{3x}{x^2-4x}$			
$(-\infty, 0) \cup (0,4) \cup (4, +\infty)$;	[0;-4];	$(-\infty, 0) \cap (0,4) \cap (4, +\infty)$;	Інша відповідь. / Another answer.

9. Знайти границю послідовності / Find the limit of the sequence: $\lim\limits_{n\to\infty} \frac{2n^2-3n-3}{2n-3n^2}$.			
1;	$-\frac{2}{3}$;	$-\frac{1}{3}$;	Інша відповідь / Another answer.

10. Знайти границю функції / Find the limit of the function: $\lim\limits_{x\to 3} \frac{x^2-2x-3}{x^2-9}$.			
1;	$\frac{2}{3}$;	$-\frac{1}{3}$;	Інша відповідь / Another answer.

11. Знайти похідну функції / Find the derivative of a function: $y = (2x^3 - 3)^2$.			
$y' = 12\,x^2(2x^3 - 3)$;	$y' = 6x^2(2x^3 - 3)$;	$y' = 4x^3 - 6$;	Інша відповідь / Another answer.

12. Знайти похідну неявно заданої функції / Find the derivative of the implicitly given function: $x + \ln y + y = 0$.			
$y' = -(1 + \frac{1}{y})$;	$y' = -2y$;	$y' = -\frac{y}{y+1}$;	Інша відповідь / Another answer.

13. Знайти похідну показниково-степеневої функції / Find the derivative of exponential-power function: $y = (\sin x)^x$.			
$y' = (\sin x)^{x-1} \cdot x$;	$y' = (\sin x)^{x-1} \cdot \ln(\sin x)$;	$y' = (\sin x)^x$;	Інша відповідь / Another answer.

14. Знайти інтеграл / Find the integral: $\int (4x^3 - sinx)\,dx$.			
$\frac{x^4}{4} - cosx + C$;	$x^4 + cosx + C$;	$x^4 + cosx + C$;	Інша відповідь / Another answer.

15. Визначений інтеграл $\int_0^2 (3x^2 - 1)\,dx$ дорівнює: / The defined integral $\int_0^1 (3x^2 - 1)\,dx$ is equal to			
1;	4;	6;	Інша відповідь / Another answer.

8. Methods of training

To learn the material, the following types of classes are provided: lectures with dialogue elements, practical (seminar), individual work, group work. In order to consolidate the material, the work of students on individual tasks, independent work of students with educational and special literature, preparation of reports and essays is expected.

9. Forms of control

The program provides for constant monitoring of students' knowledge during practical classes, surveys, their performance of complex control tasks, the use of a modular rating system of learning and knowledge assessment, and passing an exam) after studying the course of the discipline.

10. Distribution of points received by students

Distribution of points by individual elements of the content modules and methods of current control of the success of students' academic work (form of final control - exam)

No.	Elements of the content module	Number of points		Current monitoring of students' academic work	
		minimal	maximal	control methods	week of the semester
Content module 1.					
1.	Lecture course (4 lecture topics)	30	40	written module work	1-5
	Practical lesson 1. Determinants	6	10	**Control work** Determinant of the order IV	1
	Practical lesson 2. Matrices.	6	10	**Control work** Matrix multiplication	2
	Practical lesson 3. Systems of linear equations, their application in solving economic and management tasks.	6	10	**Control work** Inverse matrix	3
	Practical lesson 4.-5 Leontiev's model. Study of consumer behavior	12	30	Application of elements of linear algebra for solving economic problems.	4-5
	Total points for the content module	60	100		
Content module 2.					
2.	Lecture course (8 lecture topics)	15	30	written module work	6-15
	Practical lesson 6. Application of functions in economic theory.	1	3	discussions, presentations	6
	Practical lesson 7. The derivative of a function. Differential function.	4	7	**Control work**	7
	Practical lesson 8. Limit of a function. Continuity of function.	5	10	**Control work**	8

	Practical lesson 9. Application of the derivative for the study of a function when solving problems of an economic and managerial nature.	10	10	**I.W.** Application of the derivative	9
	Practical lesson 10. Definition of the antiderivative and the indefinite integral.	5	10	**Control work** Integral	10-11
	Practical lesson 11. Definite integral. Application of the definite integral to geometric and economic problems	20	20	**I.W.** Integral	12-13
	Practical lesson 12. Definition of DE of the 1st order.	2	5	discussions, presentations	14
	Practical lesson 13. Linear DEs of the 2nd order with constant coefficients	2	5	discussions, presentations	15
	Total points for the content module	*60*	*100*		
	Rating of the student in the academic discipline	42	70		
	Examination	**18**	**30**		
	Total number of points	**60**	**100**		

Current control		Academic work rating R_{AW}	Rating from additional work R_{ADW}	Penalty rating R_{PR}	Final certification (exam or test)	Total points
Content module 1	Content module 2					
0-100	0-100	0-70	0-20	0-5	0-30	0-100

Notes. 1. In accordance with the "Regulations on the credit-module system of education at NULES of Ukraine", approved by the Rector of the university on 27.02.2019, the rating of a student on the academic work R_{AW} in relation to the study of a certain discipline is determined by the formula

$$R_{AW} = \frac{0{,}7 \cdot (R^{(1)}_{CM} \cdot N^{(1)}_{CM} + \ldots + R^{(n)}_{CM} \cdot N^{(n)}_{CM})}{N_D} + R_{ADW} - R_{PR},$$

where $R^{(1)}_{CM}, \ldots R^{(n)}_{CM}$ are ratings of content modules on a 100-point scale; **n** is a number of content moduli; $N^{(1)}_{CM}, \ldots N^{(n)}_{CM}$ are the numbers of ECTS credits, transferred by the working initial plan for the secondary module; $N_D = N^{(1)}_{CM} + \ldots + N^{(n)}_{CM}$ is a number of ECTS credits transferred to a working initial plan for discipline in a full-time semester; R_{ADW} is rating for supplementary work; R_{PR} is the penalty rating.

The given formula can be simplified if we take $R^{(1)}_{CM} = \ldots = R^{(n)}_{CM}$. Then it will look like

$$R_{AW} = \frac{0{,}7 \cdot (R^{(1)}_{CM} + \ldots + R^{(n)}_{CM})}{} + R_{ADW} - R_{PR}.$$

The **rating from additional work R_{ADW}** is added to R_{AW} and cannot exceed 20 points. It is determined by the lecturer and given to students by the decision of the department for performing works that are not provided for in the curriculum, but contribute to increasing the level of students' knowledge of the discipline.

The **penalty rating R_{PR}** does not exceed 5 points and is subtracted from R_{AW}. It is determined by the lecturer and introduced by the decision of the department for students who learned the material of the content module late, did not follow the work schedule, missed classes, etc.

2. In accordance with the mentioned Regulation, **the preparation and defense of the course project (thesis)** is evaluated on a 100-point scale and is further translated into evaluations on the national scale and the ECTS scale.

Evaluation scale: national and ECTS

National assessment	Rating of a higher education applicant, points
Excellent	90-100
Good	74-89
Satisfactorily	60-73
Unsatisfactorily	0-59

11. FINAL QUESTIONS

1. Determinants of small orders, their geometric interpretation and connection with systems of linear equations. 2. Properties of determinants. Algebraic complements and minors. 3. Layout of the determinant by row or column elements. 4. Matrices. Basic definitions. Operations on matrices. Inverse matrix. 5. Systems of linear equations. Basic definitions. 6. Solving systems of linear equations using Kramer's formulas. 7. Matrix notation of the system of linear equations and its solution. 8. Rank of the matrix, calculation methods. 9. Solving systems of linear equations by the Gaussian method. 10. Set of real numbers. Sets on the number line. 11. Numerical sequences. The limit of a numerical sequence. 12. Properties of convergent sequences. 13. Concept of function. Ways of assigning functions. 14. Classification of elementary functions. 15. The limit of a function at a point. 16. The limit of a function at infinity. Properties of functions that have a limit. 17. Infinitesimal functions and their properties. 18. Basic theorems about the limits of functions. The first important border. 19. Comparison of infinitesimal functions. Equivalent infinitely small . Their application in the calculation of boundaries. 20. Continuity of a function. Continuity of basic elementary functions. 21. Infinitely large functions and their properties. The connection between infinitely large and infinitely small functions. 22. Properties of functions continuous at a point. Continuity of sum, product and quotient. Limit and continuity of a complex function. 23. Unilateral borders. Unilateral continuity. Breakpoints and their classification. 24. Properties of functions continuous on a segment: limitation, existence of the largest and smallest values, existence of intermediate values. 25. Definition of derivative function. Mechanical and geometric content of the derivative. 26. Derived sums, products and shares. 27. The derivative of a composite function. Differentiation of the inverse function. 28. Derivatives and differentials of higher orders. 29. Theorems of Fermat and Rolle. Lagrange's and Cauchy's theorems and their use. 30. Lopital's rule. 31. Conditions of growth and decline of the function. Extreme points. 32. Necessary

conditions for extremum. Sufficient signs of the existence of an extremum. Finding the largest and smallest value of a function on a segment. 33. Study of functions at extremum using derivatives of higher order. Research of convexity and concavity functions. Inflection points. 34. Asymptotes of curves. The general scheme of constructing graphs of functions. 35. Antiderivative. The indefinite integral, its properties. Table of basic integration formulas. 36. Direct integration. Integration by parts and substitution. 37. The definite integral and its properties.

12. Methodological support

1. Legeza V.P., Martynenko M.A., Ivanova Yu.I. Higher mathematics. Textbook for university students, Part I. K.: "The Fourth Wave", 2012. – 368 p.
2. Legeza V.P., Martynenko M.A., Ivanova Yu.I. Higher mathematics. Textbook for university students, Part II. K.: "The Fourth Wave", 2014. – 368 p.

13. Recommended literature

Basic literature:

1. Dubovik V.P., Yurik I.I. Higher mathematics. - K.: Higher school. 2004. – 647p.
2. Legeza V.P., Martynenko M.A., Ivanova Yu.I. Higher mathematics. Textbook for university students, Part I. K.: "The Fourth Wave", 2012. – 368 p.
3. Legeza V.P., Martynenko M.A., Ivanova Yu.I. Higher mathematics. Textbook for university students, Part II. K.: "The Fourth Wave", 2014. – 368 p.
4. Legeza V.P., Martynenko M.A., Ivanova Yu.I. Higher mathematics. Study guide for university students. K.: "The Fourth Wave", 2011. – 664 p.
5. Legeza V.P., Ivanova Y.I. Higher mathematics. Elements of linear and vector algebra. Synopsis of lectures. – K.: NULES, 2014. – 51 p.
6. Legeza V.P., Ivanova Yu.I. Higher mathematics. Elements of analytical geometry. Synopsis of lectures. – K.: NULES, 2014. – 42 p.
7. Legeza V.P., Ivanova Y.I. Higher mathematics. Introduction to mathematical analysis. Synopsis of lectures. – K.: NULES, 2014. – 48 p.
8. Legeza V.P., Ivanova Y.I. Higher mathematics. Differential calculus of functions of one variable. Synopsis of lectures. – K.: NULES, 2014. – 64 p.
9. Legeza V.P., Ivanova Y.I. Higher mathematics. Integral calculus of functions of one variable. Synopsis of lectures. – K.: NULES, 2014. – 75 p.
10. Sulima I.M., Kovtun I.I., Radchyk I.A. Higher mathematics, part 1. Elements of linear and vector algebra. Analytical geometry. – K.: NAU, 2003. - 216 p.
11. Sulima I.M., Kovtun I.I., Yakovenko V.M. Higher mathematics, Part 2. Introduction to mathematical analysis. Differential and integral calculus of functions of one variable. – K.: NAU, 2003. – 297 p.

12. Sulima I.M., Kovtun I.I., Batechko N.G., Nikitina I.A., Yakovenko V.M. Higher mathematics. Collection of problems. – K.: NAU, 2003, – 218 p.

Auxiliary literature:

1. Borysyuk M.M. Methodical recommendations and individual tasks "Definitions. Matrices. Systems". – K.: NAU, 2004. – 73 p.
2. Borysyuk M.M., Skorokhod T.A. derivative Application of the derivative. Educational and methodical guide for students of NNI business of NAU. – K.: NAU, 2004 – 87 p.
3. Sulima I.M., Kovtun I.I., Yakovenko V.M., Vechoryk A.M., Ruzhilo M.Ya. Educational and methodological guide for studying the discipline "Higher Mathematics". Section "Rows". – K.: NAU, 2003. – 77 p.
4. Borysyuk M.M. Ordinary differential equations. Educational and methodical guide for students of NNI business of NAU. – K.: NAU, 2004. – 39 p.
5. Sulima I.M., Kovtun I.I., Skorokhod T.A., Ovchar R.F., Osypova T.Yu. Educational and methodological guide for studying the discipline. Section "Differential equations". – K.: NAU, 2003. – 64 p.
6. Kovtun I.I., Nikitina I.A. Application of differential calculus of functions of one variable. – K.: NAU, 1999. – 26 p.
7. Borysyuk M.M., Dyshleva N.O., Nikitina I.A. Indefinite integral. Individual tasks for students of engineering faculties. – K.: NAU, 1998. – 30 p.
8. Sulima I.M., Kovtun I.I. TR. Application of the definite integral. – K.: NAU, 1998. – 28 p.

CONTENT