МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ

ХАРКІВСЬКИЙ НАЦІОНАЛЬНИЙ ЕКОНОМІЧНИЙ УНІВЕРСИТЕТ ІМЕНІ СЕМЕНА КУЗНЕЦЯ

"ЗАТВЕРДЖУЮ"
Заступник керівника
(проректор з науково-педагогічної роботи)
М.В. Афанасьєв

ВИЩА МАТЕМАТИКА

робоча програма навчальної дисципліни

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Завідувач кафедри вищої математики та економіко-математичних методів — Малярець Л.М.

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ЗАТВЕРДЖЕНО
на засіданні кафедри вищої математики та економіко-математичних методів
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Лист оновлення та перезатвердження
робочої програми навчальної дисципліни

Навчальний рік	Дата засідання кафедри – розробника РПНД	Номер протоколу	Підпис завідувача кафедри

1. 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 specialities 051 “Economics” and 073 “Management”.

The basic problems of teaching the academic discipline is giving students knowledge of the basic parts of mathematical analysis and linear algebra; a rising of the level of the fundamental mathematical training of students with intensification of its applied direction, mastering the fundamentals of mathematical analysis and linear algebra and application of this knowledge to the economic investigations for solving economic problems, forming skills in application of elements of mathematical analysis and linear algebra in investigations where higher mathematics is applied as instrument of investigation and solving optimization economic problems for forming models of economic processes and developments, acquiring the necessary theoretical and practical knowledge for solving specific problems, which are set in the process of forming economic and mathematical models, and the obtaining the required mathematical knowledge for the study of other disciplines.

The annotation of the academic discipline:

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 service sphere, 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 and linear 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 algorithmical thinking; obtaining primary skills in independent-learning of mathematical and applied library sources by students.

The subject of the academic discipline "Higher Mathematics" is the fundamentals of mathematical analysis, linear and vector algebra.

In the process of learning the academic discipline "Higher Mathematics" a student receives analytic and investigatory competences which are necessary for a modern economist in any sphere of his activity.

The syllabus of the academic discipline "Higher Mathematics" is compiled according to the statements of the field standard of the higher education of Ministry of Education and Science of Ukraine based on the educational professional program of bachelor training, which is made by the Scientific Methodical Committee of Economics and Enterprise of the Ministry of Education and Science of Ukraine.

A student starts studying the academic discipline "Higher Mathematics" in the first term of the first year of studies.

In the process of learning the students obtain the required theoretical knowledge during lectures and acquire practical skills at the practical and laboratory studies and during independent work and fulfillment of individual tasks. Independent and individual work of students has a great value in the process of mastering material and fixing knowledge. All of these types of studies were devised according to the statements of the Bolognese declaration.

As a result of studying the academic discipline a student **must know**: the elements of the limits theory: a limit of a sequence and a limit of a function; the limit of a function in a point, their equivalence; equivalent functions, their applications to finding the limit of a ratio of functions; the first and second noteworthy limits, the table of basic limits, finding the limits of power-exponential functions; the bases of limiting (marginal) analysis; the differential calculus: a function of one variable and several variables; ways to define a function and its illustration; some special classes of functions; monotone, even and odd, convex and concave, bounded and unbounded functions; a continuity of a function at the same point; one-sided continuity of a function of one variable at the same point, necessary and sufficient conditions of continuity; classification of points of discontinuity; a differentiable function, its differential; the derivative of a function of one variable, partial derivatives, a gradient of a function of several variables; the derivative of a function of several variables in the direction, its relationship with a gradient; the elasticity of a function; higher-order derivatives and differentials, higher-order derivatives of some elementary functions; investigation of functions with the help of the differential calculus; the notion of a differential of a function and its application to approximate calculation; the notion of an elasticity of a function; the integral calculus: the notion of an antiderivative, indefinite and definite integrals; methods of integration; Newton–Leibnitz formula; the notion of an improper integrals; the elements of economic dynamics; the first-order ordinary differential equation, Cauchy problem; the particular and general solutions; types of the differential equations; the higher-order differential equations and systems of differential equations; solution of the second-order linear differential equations with constant coefficients; numerical series, necessary and sufficient conditions of a convergence of numerical series with positive terms and alternating numerical series; absolute and conditional convergence; power series, the convergence radius and the interval of power series; functional series, trigonometric Fourier series; the bases of linear algebra: matrices and determinants, (facilities, possibilities) of their application to making a mathematical model of economic problems; methods of solving the system with n linear algebraic equations with m unknowns; the conditions of compatibility of the system of linear algebraic equations; the notion of the basic solution; the bases of vector algebra: the basis of space; linear dependence and linear independence of vectors; the notions of subspace; the linear vector space, a rank of finite systems of vectors, rules of its calculation;

***be able to*:** learn mathematical literature by oneself; calculate the mean values; carry out the operations with vectors, matrices, calculation of the determinants; solve the systems of linear equations; investigate the forms and properties of the straight lines and planes, second-order curves and quadratic surfaces; classify the functions, numerical sequences; find the limit of power-exponential functions; investigate the function with the help of differential calculus; carry out the integral calculus; carry out calculation of numerical and power series; solve first-order and higher-order differential equations, systems of differential equations; form and use economic mathematical models; broaden the knowledge, develop logical and algorithmic thinking by oneself.

A modern tendency in higher education is a reorientation of students of higher educational institutions from the process of education to a result, from knowledge to skills, forming definite competences.

The purpose of the academic discipline:

Academic year	**1st**	
Term	**1st**	
Number of credits	**5**	
The form of studies	**lectures**	**32**
	practical studies	**16**
	laboratory studies	**16**
Independent work		**86**
Form of final control	**exam**	

Structural and logical scheme of studying the academic discipline:

Previous academic disciplines	Next academic disciplines
Algebra (Mathematics)	Probability theory and mathematical statistics
Geometry (Mathematics)	Econometrics

2. Competences and result of mastering the academic discipline:

Competences	Results of mastering the academic discipline
Forming analytic thinking, the ability to explain the importance of complicated expressions with the help of mathematical symbols and operations. Development of the abilities to solve problems with the help of calculation of limits and methods of differential calculus using mathematical symbolic variables, i.e. forming the initial skills in economic modelling	A student must 1) be able to define the type of a function by its analytic recording; 2) calculate derivatives of elementary and composite functions and use a differential of a function for approximate calculus; 5) investigate a function with the help of differential calculus; 6) carry out the simplest calculations by an optimization of production; 7) make corresponding conclusions and independently analyze the obtained solution; 8) find partial and mixed derivatives of a function of several variables, 9) be able to investigate a local extremum of a function
Understanding a possibility to use the integral calculus for solving applied problems. Forming skills in independently formation of mathematical models for a description of different processes. Forming the skill in independent work. Analysis and understanding of the importance of a relationship between the definite and an indefinite integral	A student must 1) calculate definite and indefinite integrals; 2) be able to use definite integrals for independent calculation of areas and volumes of figures; 3) draw corresponding conclusions and independently analyze the obtained results

Competences	Results of mastering the academic discipline
Forming inclinations to independent search of different ways of solving problems and understanding the necessity to use knowledge of other themes (a function, a derivative, an integral)	A student must 1) be able to calculate the type of a differential equation, the method of further solving independently; 2) be able to use the knowledge for solving the simplest economic problems
Forming the ability to do analytic calculations	A student must 1) calculate the type of series; 2) be able to investigate the convergence of series independently; 3) find the convergence radius of power series
Forming the ability to prove independently the simplest statements with the help of elementary mathematical knowledge. Forming skills in the use of the instrument of the matrix calculus for modelling the simplest economic problems and situations. The ability to analyze the results of calculations	A student must 1) know the basic proofs and theorems of the theme; 2) give examples of using determinants, matrices and systems of linear equations in economics; 3) be able to use the instrument of matrix algebra for economic problems; 4) be able to model the simplest situations with the help of knowledge of the theme
Forming analytic thinking, the ability to explain the importance of complicated expressions with the help of mathematical symbols and operations	A student must be able to use vector algebra for calculation of the simplest problems of applied character (finding the area, the volume)

3. The syllabus of the academic discipline

Thematic module 1. The elements of mathematical analysis

Theme 1. The limit of a function and continuity

1.1. Sets, functions, their classification.

Basic notions. Numerical sets. Operations with sets. Numerical intervals, the neighborhood of a point. The notion of a function of one variable. Ways to define a function. The domain of a definition and a range of values of a function. A geometrical illustration of a function. Elementary functions and their graphs. Properties of a function: the boundedness and the unboundedness, an increasing and decreasing function, the oddness and the evenness, the periodicity. Classification of elementary functions. The notion of an inverse function. Inverse trigonometric functions. The superposition of a function.

1.2. Numerical sequences and their limits.

A numerical sequence. The definition of the limit of a sequence. Infinitesimals. Infinitely large values. The relationship between infinitesimals and infinitely large values.

1.3. A limit of a function.

The definition of the limit of a function. One-sided limits. Properties of functions which have finite limits. Limiting processes in equalities and inequalities. Lemmas about infinitesimals. Arithmetical operations with functions which have finite limits. The limit of a function $\frac{\sin x}{x}$ at $x \to 0$. Indefinite expressions. The limit of a monotonic function. The number *e*. Natural logarithms.

1.4. A function continuity.

The definition of a function continuity at a point. Continuity of a function on a segment. Arithmetical operations with continuous functions. Classification of breaks. Properties of continuous functions. Continuity of elementary functions.

Theme 2. Differential calculus of the function of one variable

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

Application of a derivative to economic accounts. Limiting characteristics in microeconomics. Maximization of profit and marginal analysis. Optimization of a taxation of enterprises. The definition of a derivative. The geometric, mechanical and economic meanings of a derivative. Derivatives of elementary functions. A derivative of an inverse function. A table of derivatives. The rules of calculation of derivatives. A derivative of a composite function. One-sided derivatives. Derivatives of higher orders. The definition of a differential. The differential of a sum, a product and a quotient. The invariance of the form of the first differential. Differentials of the higher orders. Application of a differential to approximate calculations.

2.2. The main theorems of differential calculus and using them.

Fermat theorem. Rolle theorem. Lagrange theorem. Cauchy theorem. L'Hospital rule.

2.3. Application of derivatives to the investigation of functions.

The condition of a monotony of a function. The condition of increasing and decreasing of a function on an interval. The maximum and the minimum of a function. Necessary and sufficient conditions of an extremum of a function. Convexity and concavity of a graph of a function, inflection points, asymptotes of a graph of a function. A general scheme of a plot of the graph of a function.

2.4. Application of a derivative to economics.

Marginal analysis. Elasticity of economic indicators. The economic meaning of Fermat theorem. Application of a derivative to economic calculations.

Theme 3. Analysis of the function of several variables

3.1. Basic notions.

The function of two variables, the domain of their definition. A graphical illustration of a function of two variables.

3.2. Partial derivatives. The differential.

A partial and a total increments of a function of two variables. Partial derivatives. A total differential. Derivatives of the higher orders. The theorem about the equality of mixed derivatives. Differentials of the higher orders.

3.3. The extremum of a function of several variables.

The necessary conditions of a function of two variables. The sufficient conditions of an extremum of a function of two variables. The conditions of an absence of the extremum. The notion of a conditional extremum. The method
of Lagrange multipliers. The least-squares method.

3.4. Application of a function of several variables to economics.

The function of several variables in problems of economics (the utility function, the expenditure function, the multifactor production function of Cobb and Douglas). Some problems of optimization (an optimal profit from production of goods of different types; the problem of price discrimination, an optimal distribution of resources; optimization of the choice of a consumer). The functional dependence between variables.

Theme 4. The indefinite integral

4.1. An antiderivative and an indefinite integral.

The notion of an antiderivative of a function and an indefinite integral. The geometrical and mechanical meanings of an integral. The table of basic integrals.

4.2. Basic methods of integration.

The simplest rules of an integration. Direct integration. A change of a variable in an indefinite integral. Integration by parts.

4.3. Integration of some classes of functions.

Integration of rational fractions. Integration of irrational expressions and expressions which have trigonometric functions. Trigonometric substitutions.

Theme 5. The definite integral and its application

5.1. The notion and properties of a definite integral.

Integral sums. Conditions of the existence of a definite integral. Properties of a definite integral.

5.2. Calculation of a definite integral.

Newton–Leibnitz formula. A change of a variable in a definite integral. Integration by parts.

5.3. Improper integrals of the first and the second kinds.

The notion of an improper integral. Conditions of convergence of improper integrals. Euler-Poisson integral and its application.

5.4. Application of a definite integral.

The geometrical application of a definite integral: calculation of areas, volumes of the solid of a revolution, arc lengths of curves. An approximate calculus of a definite integral: formulas of rectangles, trapezoids, Simpson**.** Finding the volume of a productive production; a consumer surplus, an analysis of a nonuniformity in the distribution of income from population with the
help of Lorenz curve.

Theme 6. Differential equations

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

The notion of a differential equation and its solutions. Application of differential equations to problems of economic dynamics. A model of increasing for a constant rate of an increment; a model of increasing under the conditions of a competition; a dynamic model of Keynes; a neoclassic model of increasing; a marketing model with predicted prices. The order of a differential equation. Differential equations of the first order. A general solution and a general integral of a differential equation of the first order. Initial conditions. A particular solution and a particular integral of a differential equation of the first order with separable variables. Homogeneous equations of the first order. Linear differential equations of the first order. Differential equations of Bernoulli**.**

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

The second-order linear differential equations with constant coefficients. Homogeneous and inhomogeneous differential equations. The notion of linearly independent solutions of a homogeneous differential equation of the second order. Initial conditions. The structure of a general solution of an inhomogeneous differential equation of the second order. Linear inhomogeneous differential equations of the second order with the right parts of a special form. The notion of the differential equation. The notion of a system of differential equations. The notion of an equilibrium of a solution.

6.3. Application of differential equations to economics.

Using differential equations for a construct of production functions. Models of economic dynamics. Solow model. A model of a natural increasing output. The dynamics of market prices. Application of differential equations to economics.

Theme 7. Series

7.1. Numerical series and their convergence.

Partial sums of series. The necessary condition of series convergence. Series with

positive terms. The theorem of a comparison of series. Sufficient conditions of series convergence with positive terms: D'Alembert criterion, Cauchy's criterion, Maclaurin – Cauchy integral criterion.

7.2. Alternating series and their convergence

The notion of alternating series. Absolute and a conditional convergence of series. Alternating series. Leibnitz theorem. A sign of a remainder of alternating series.

7.3. Power series.

Abel theorem. The convergence radius of power series. A differentiation and an integration of power series. Taylor and Maclaurin series. Decomposition of elementary functions in Taylor and Maclaurin series. Application of power series to an approximate calculus.

Thematic module 2. Linear algebra and analytical geometry

Theme 8. The elements of the theory of matrices and determinants

8.1. Matrices.

The definition, types of matrices, basic matrices (square, triangular, diagonal, unit). Comparison of matrices. Basic operations with matrices: addition, multiplication of a matrix by a scalar, a vector, a matrix; properties of these operations. Transposition of a matrix. The notion of an inverse matrix, properties of a matrix inversion operation.

8.2. Determinants.

The definition of the determinant, rules of calculation of determinants of lower orders (schematic) and higher-orders (expansion by Laplace formulas). Properties of determinants. Calculation of some special determinants (triangular, diagonal, identity matrices, Vandermonde matrix). Calculation of an inverse matrix with the help of the determinants (algebraic cofactors).

8.3. The inverse matrix

Calculation of an inverse matrix by two ways: with the help of a definition (as a transposed matrix of algebraic cofactors) and elementary row transformations with a given and unit matrices. A matrix rank and ways to define it.

Theme 9. The general theory of the system of linear algebraic equations

9.1. Systems of linear algebraic equations.

The definition of the system of linear algebraic equations, the augmented and matrix forms of its entry. Definitions of a solution, consistent or inconsistent, determined or undetermined system.

9.2. Methods of solving systems of linear algebraic equations.

A solution of square systems of linear algebraic equations with the help of an inverse matrix, by Cramer formulas. Equivalent transformations, Gauss - Jordan method of sequential exclusion of unknowns for a solution of systems of linear algebraic equations, its realization with the help of tables. Finding an inverse matrix by Gauss - Jordan method. The notion of a matrix rank and its calculation. Kronecker - Capelli theorem, the particular and the general solutions of the system of linear algebraic equations.

9.3. Homogeneous systems of linear algebraic equations

The notion of a homogeneous system of linear algebraic equations. The space of solutions of a homogeneous system, a relationship of its dimension and a matrix rank. A fundamental system of solutions of a homogeneous system of linear algebraic equations. Economic problems.

Theme 10. The elements of vector algebra

10.1. The basic notions of vector algebra.

The 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 colinearity of two vectors. A sign of a complanarity of three vectors. Properties of a scalar product of two vectors. The 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. The expression of a mixed product through coordinates of vectors-factors.

10.2. The elements of the theory of linear spaces.

The definition of linear space. The definitions and main theorems of linear dependence and linear independence of linear space elements. A basis of linear space. The main theorems about the basis: uniqueness of expansion, linear dependence of $(n+1)$ elements, the number of basic elements. The dimension of linear space. Coordinates of space elements in a given basis. The notion of subspace. The notion of linear vector space. The rank of finite systems of vectors, rules of its calculation.

10.3. Eigenvectors.

Eigenvalues and eigenvectors of a matrix. A characteristic equation. Methods of finding eigenvalues and eigenvectors for matrices of the second and the third orders. Economic examples.

10.4. Quadratic forms.

The notion of a quadratic form. Conditions of a determinacy of quadratic forms. The matrix of a quadratic form. Reducing quadratic forms to a canonical form. The curves of the second-order on a plane. A general equation of the second-order curve. Reducing the second-order curve to a canonical form.

Theme 11. Elements of analytical geometry

11.1. A straight line on a plane

A straight line as a line of the first order. The general equation of a straight line. Types of an equation of a straight line. The equation of a straight line with intercepts on the coordinate axes. Parametric and canonical equations of a straight line. The equation of a straight line which passes through two given points. The equation of a straight line with an angular coefficient. An angle between two straight lines. Conditions of parallelity and perpendicularity for two straight lines. The normal equation of a straight line. A distance from the point to the straight line.

11.2. A plane in a space

A plane as a surface of the first order. The general equation of a plane. The equation of a plane with intercepts on the coordinate axes. The equation of a plane which passes through three given points. An angle between two planes. Conditions of parallelity and perpendicularity for two planes. The normal equation of a plane. A distance from the point to the plane.

11.3. A straight line in a space

Canonical equations of a straight line which passes through two given points. An angle between two straight lines. Conditions of parallelity and perpendicularity for two straight lines. An angle between a straight line and a plane. Conditions of parallelity and perpendicularity a straight line and a plane.

11.4. Second-order curves

A definition of a second-order curve. Its the general equation. An ellipse. Investigation of a form of an ellipse. A hyperbola. Asymptotes of a hyperbola. Investigation of a form of a hyperbola. A parabola. Investigation of a form of a parabola. An eccentricity of the second-order curve. Directrices of the second-order curve.

4. The order of assessment of studying results

The system of assessment of competences which were formulated for a student during the learning of the academic discipline, takes into consideration the forms of studies which according to the syllabus of the academic discipline provide lectures, practical studies, laboratory works, fulfillment of students' independent work. The assessment of the formed competences of students is carried out on the accumulative 100-point system. According to the temporary provision "About the Order of Assessment of Students Academic performance on the Accumulative Point Rating System" of Simon Kuznets Kharkiv National University of Economics control ways include:

current control which is carried out within a term during lectures, practical studies and laboratory works and it is assessed as a sum of accumulative points (the maximum equals 60 points; the minimum which makes it possible for a student to pass an exam, equals 35 points);

module control which is carried out in the form of a colloquium with taking into account the current control according to a corresponding thematic module, provides an integral assessment of student's results after learning the material of a logically completed part of the discipline (or a thematic module);

final/term control, which is carried out as a terminal exam, according to the schedule of the educational process.

Current control on the given academic discipline is carried out in the following forms: active in-class work (lecture); active in-class work (practical study); active in-class work (laboratory study); homework; competence oriented tasks (defence of laboratory works); an independent test; a written test; independent creative work.

Final/term control is conducted in the form of a term exam. **Term exams** are a form of assessment of students' final mastery of the theoretical and practical material of a particular module of the academic discipline or the academic discipline on the whole, which is conducted as a test.

Assessment of student's knowledge during practical studies and carrying out laboratory works is conducted on the accumulative system according to the following criteria: understanding, the degree of the mastery of the theory and methodology of problems which are considered; the degree of the mastery of the factual material of the academic discipline; familiarizing with the recommended literary sources and modern literature on the questions which are considered; the ability to connect theory and practice in the consideration of particular examples, solving problems, carrying out laboratory works, carrying out calculations in the process of doing homework and tasks which are considered in class; the logic, structure, style of presenting the material in written works and in oral answers in class, the ability to ground one's position, carry out generalization of the information and draw conclusions.

The general criteria for the assessment of ***independent work*** of students are profound and deep of knowledge, the level of thinking, skills in systematization knowledge on particular themes, skills in drawing conclusions, attainments and techniques of carrying out practical tasks, the ability to find necessary information, carry out its classification and processing, self-realization in practical and laboratory studies.

The criteria for assessment of independent creative work and independent tests are: the ability to carry out a critical and an independent estimation of the defined problem questions; skills in the explanation of alternative views and availability of a students' own point of view, position on the defined problem question; using the analytical approach; the quality and accuracy of expressing the thought; the logic, structure and explanation of conclusions about a particular problem; independence of carrying out of the work;

grammatical correctness of the presentation of the material; using the methods of comparison, generalization of the concepts and facts; the design of the work; the quality of presentation.

The final control of knowledge and competences of students on the academic discipline is carried out on the base of the term exam. The examination paper includes the syllabus of the discipline and provides for assessment of the knowledge level and a degree of the mastery of corresponding competences of students.

The purpose of ***the exam*** is to test student's understanding of the syllabus material on the whole, the logic and relations between its particular parts, the skills in the creative use of the stored knowledge, the ability to formulate one's attitude to a particular problem of the academic discipline and so on. The competent approach to the assessment of the exam implies measuring the level of the student's mastery of the competences provided by the qualifying requirements.

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 assessment of the exam is carried out according to the temporary provision "About the Order of Assessment of Students' Academic Performance on the Accumulative Point Rating System" of Simon Kuznets Kharkiv National University of Economics.

In the case of irreproachable fulfillment of all the examination tasks with the demonstration of deep knowledge of the academic discipline, skills in the practical use of the formed competences which are based on the ability to analyze and solve a wide range of tasks, a high level of completing the written work the student obtains 40 points.

A student can't be allowed to take the exam, if the number of points, obtained during the current and module control according to the thematic module during the term, does not make 35 points. After the examination period the dean of the department gives a notice about sitting the failed exams. In a given period the student adds the required points.

The final mark on the academic discipline is calculated according to points, obtained during an exam, and points, obtained during a current control by an accumulative system.

It should be assessed student's progress, if a sum of points, obtained as the total result of an assessment by all forms of a control, equals or exceeds 60. Accordingly the minimal possible quantity of points by a current and a module control during a term equals 35 and the minimal possible quantity of points, obtained on an exam, equals 25.

The result of a terminal exam is assessed in points (the maximum is 40 points, the minimum of a quantity, which is passed, equals 25 points) and it is entered into the corresponding column of an *examination «Mark sheet»*.

The final mark of the academic discipline is calculated according to the points obtained during the exam and points obtained during the current control on the accumulative system.

The total result in points during the term is "*60 and more points mean passed*", "*59 and less points mean failed*" and it is entered into the "*Mark sheet*" on the academic discipline.

The distribution of points by weeks
The distribution of points by weeks

Themes of the thematic module			Lectures	Practical study	Laboratory study	Homework	Competence oriented task	Independent test	Written test	Independent creative work	Colloquium	Total
Thematic module 1 Elements of mathematical analysis	Theme 1	week 2	0.3	0.3	–	–	–	–	–	–	–	0.6
	Theme 2	week 3	0.3	–	0.3	–	–	–	–	–	–	0.6
	Theme 3	week 4	0.3	0.3	–	0.4	–	–	–	–	–	1.0
	Theme 4	week 5	0.3	–	0.3	–	–	–	–	–	–	0.6
		week 6	0.3	0.3	–	0.5	–	4	–	–	–	5.1
	Theme 5	week 7	0.3	–	0.3	–	5	–	–	–	–	5.6
	Theme 6	week 8	0.3	0.3	–	0.5	–	–	6	–	–	7.1
		week 9	0.3	–	0.3	–	–	–	–	–	5	5.6
	Theme 7	week 10	0.3	0.3	–	0.5	–	–	–	–	–	1.1
Thematic module 2 Linear algebra	Theme 8	week 11	0.3	–	0.3	–	–	–	–	–	–	0.6
	Theme 9	week 12	0.3	0.3	–	0.5	–	4	–	–	–	5.1
		week 13	0.3	–	0.3	–	–	–	–	–	–	0.6
	Theme 10	week 14	0.3	0.3	–	0.5	–	–	6	–	–	7.1
		week 15	0.3	–	0.3	–	5	–	–	–	–	5.6
	Theme 11	week 16	0.3	0.3	–	0.5	–	–	–	–	5	6.1
		week 17	0.3	–	0.3	–	–	–	–	7	–	7.6
	Exam											40
Total			4.8	2.4	2.4	3.4	10	8	12	7	10	100

The scales of assessment: national and ECTS

Sum of points including all forms of study	Mark on the ECTS scale	Mark on the national scale	
		for an exam, a term paper, practice	for a test
90 – 100	A	excellent	passed
82 – 89	B	very good	
74 – 81	C	good	
64 – 73	D	satisfactory	
60 – 63	E		
35 – 59	FX	unsatisfactory	failed
1 – 34	F		

5. Recommended reading

5.1. Main

1. Вища математика : базовий підручник для вузів / під ред. В. С. Пономаренка. – Харків : Фоліо, 2014. – 669 с.

2. Guidelines for practical tasks in analytic geometry of the academic discipline "Higher and Applied Mathematics" for foreign and English-learning full-time students of the preparatory direction "Management" / compiled by Ie. Iu. Misiura. – Kh. : Publishing House of KhNUE, 2011. – 76 p. (English, Ukrainian)

3. Higher mathematics : handbook Vol. 1 / under edition of Kurpa L. V. – Kh. : NTU "KhPI", 2006. – 344 p.

4. Higher mathematics : handbook Vol. 2 / under edition of Kurpa L. V. – Kh. : NTU "KhPI", 2006. – 540 p.

5. Higher mathematics : handbook Vol. 3 / under edition of Kurpa L. V. – Kh. : NTU "KhPI", 2006. – 364 p.

6. Higher mathematics: handbook Vol. 4 / under edition of Kurpa L. V. – Kh. : NTU "KhPI", 2006. – 328 p.

7. Methodical recommendations for the conduct of the practical studies in the academic discipline "Higher mathematics" for foreign and English-learning students of the preparatory direction "Management" of the full-time education / complied by Ie. Iu. Misiura. – Kh. : Publishing House of KhNUE, 2010. – 44 p. (English, Ukrainian)

5.2. Additional

8. Англо-русский словарь математических терминов / под ред. П. С. Александрова. – М. : Мир, 1994. – 416 с.

9. Малярець Л. М. Математика для економістів : навч. посіб. У 2-х ч. Ч. 1 / Л. М. Малярець, Л. М. Афанасьєва, А. В. Ігначкова. – Харків : Вид. ХНЕУ, 2011. – 393 с.

10. Малярець Л. М. Математика для економістів : навч. посіб. У 2-х ч. Ч. 2 / Л. М. Малярець, Л. М. Афанасьєва, А. В. Ігначкова. – Харків : Вид. ХНЕУ, 2011. – 368 с.

11. Borakovskiy A. B. Handbook for problem solving in higher mathematics / A. B. Borakovskiy, A. I. Ropavka. – Kh. : KNMA, 2008. – 195 p.

12. Handbook of mathematics / I. N. Bronshtein, K. A. Semendyaev, G. Musiol et. al. – Berlin : Springer, 2007. – 1097 p.

5.3. Methodical support

13. Сайт персональних навчальних систем:
https://pns.hneu.edu.ua/course/view.php?id=3612