MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE

SIMON KUZNETS KHARKIV NATIONAL UNIVERSITY OF ECONOMICS

"APPROVED"

Deputy Rector

(Vice-Rector on Scientific and Pedagogical work)

M. V. Afanasiev

HIGHER MATHEMATICS

syllabus of the academic discipline

Training direction	**29 International relations**
Speciality	**291 «International relations, public communications and regional studies», 292 «International economic relations»**
Academic degree	**first (bachelor)**
Academic program	**International relations, public communications and regional studies** **International business**

Type of the academic discipline	**basic**
Language of teaching, training and assessment	**foreign (english)**

Chief of the department of higher mathematics,
economical and mathematical methods — Malyrets L.M.

Kharkiv
S. Kuznets KhNUE
2018

ЗАТВЕРДЖЕНО
на засіданні кафедри вищої математики та економіко-математичних методів
Протокол № 1 від 27.08.2018 р.

Розробник:
Місюра Євгенія Юріївна (Misiura Ie.Iu.), к.т.н.,
доц. кафедри вищої математики та економіко-математичних методів

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 training of economists and managers is the academic discipline "Higher Mathematics" which is a normative discipline of the natural science series and the component of the structural logical scheme which is provided for the educational professional program of bachelors of specialities 291 «International relations, public communications and regional studies», 292 «International economic relations».

The basic problems of teaching the academic discipline is giving students knowledge of the basic parts of mathematical analysis, linear algebra, probability theory and mathematical statistics; rising the level of the fundamental mathematical training of students with intensification of its applied direction; mastering the fundamentals of mathematical analysis, linear algebra, probability theory and mathematical statistics and application of this knowledge to the economic investigations for solving economic problems; forming skills in the application of the elements of mathematical analysis, linear algebra, probability theory and mathematical statistics in investigations where higher mathematics is applied as an instrument of investigation and solving optimization economic problems for modelling 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 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, probability theory and mathematical statistics; learning 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 the 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: the limit of a sequence and the 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, the Cauchy problem; the particular and general solutions; types of 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; general notions of probability theory; random persistent and impossible events; a notion of a probability and methods of its definition; dependent and independent events and basic formulas of an addition and a multiplication of probabilities for these events, formulas of a total probability and Bayes; a trial by Bernoulli's scheme; discrete and continuous random variables; basic laws of a distribution of discrete and continuous random variables and their basic numerical characteristics; conditional laws of a distribution of probabilities of components of discrete two-dimensional random variable; a definition of basic numerical characteristics of two-dimensional random variable; characteristics of a function of one random argument; limiting theorems of probability theory; the general notions of mathematical statistics; the sampling method; statistical distribution and its basic numerical characteristics; statistical estimations of parameters of a population; requirements for statistical estimations; the notions of point and interval estimations and definition of their accuracy; the methods of parametric and nonparametric estimations of parameters; statistical hypotheses and statistical criteria for checking them; investigation of the form of correlation; construction of a model of pair regression using the least-squares method; the methods of a checking of parameter significance of a model of pair regression; estimation of the adequacy of a model in whole;

***be able to*:** learn mathematical literature by oneself; calculate the mean values; carry out the operations with vectors, matrices, calculation of determinants; solve the systems of linear equations; investigate the forms and properties of 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	**42**
	laboratory studies	**-**
Independent work		**76**
Form of final control	**test**	

Structural and logical scheme of studying the academic discipline:

Previous academic disciplines	**Next academic disciplines**
Algebra, Geometry (Mathematics)	Economic and mathematical methods

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)
Using methods of probability theory for a prognosis of a probabilistic random events and making graphic interpretation of solutions of economic problems with the help of instruments of probability theory	Use basic definitions and theorems for calculation of the probability of a random event. Define laws of distribution of discrete and continuous (one-dimensional) random variables, calculate their basic numerical characteristics, plot distribution functions find numerical characteristics of a function of a discrete and continuous random argument. Use the concept of the theory of random processes and the theory of queueing, the theory for modelling economic processes
An identification of quantitative characteristics of economic processes with the help of a sampling method	Understand the relationship between the instruments of the probability theory and mathematical statistics. Form a prepresentative sampling totality, plot a variational series and estimate basic numerical characteristics of a random variable using the results of investigation of a sample. Check the statistical hypothesis of correspondence of properties of numerical characteristics and the distribution law of a random variable in a population and their estimations using the results of investigation of a sample; understand the possibilities and

Competences	Results of mastering the academic discipline
	restriction of using the instruments of mathematical statistics when solving real economic problems
Using of variance analysis for an investigation of economic processes, using correlation and regression analysis during learning different economic phenomenons, understanding a meaning of economic values, which form a model of a pair regression	Understand the possibilities of using the single-factor analysis of variance when checking the existence of a difference between the investigated samples; distinguish the types of dependences between economic factors and define the essence of correlation; investigate the form of correlation and construct a model of pair regression using the least-squares method; know the methods of checking the parameter significance of a model of pair regression and estimation of the adequacy of a model in whole

3. The syllabus of the academic discipline

Thematic module 1. The elements of mathematical analysis and linear algebra

Theme 1. Limits of functions 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 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 elementaty functions.

1.2. Numerical sequences and their limits.

The notion of a numerical sequence. Ways to define sequences. Arithmetic operations with sequences. The limit of a sequence, its geometrical meaning. Infinitesimals and infinitely large sequences, their properties. Basic theorems for limits of sequences.

1.3. Limits of functions.

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.

1.4. 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**.**

Theme 2. The differential calculus of the function of one variable

2.1. 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.

2.2. 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.

2.3. Application of a derivative to economics.

Marginal analysis. Elasticity of economic indicators.

Theme 3. Analysis of the function of several variables

3.1. Basic notions.

The definition of a function of several variables. The domain of the definition of a function of two variables and its graph. Lines and surfaces of a level. The continuity and the limit of a function of two variables.

3.2. Partial derivatives. A gradient and a directional derivative.

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

3.3. 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.

3.4. 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.

Theme 4. The indefinite and definite integral

4.1. An antiderivative and an indefinite integral.

The notions of an antiderivative of a function and an indefinite integral. Properties of an indefinite integral. The table of basic integrals. The concept of integrals, which are not taken.

4.2. Basic methods of integration.

The method of direct integration. The method of a change of a variable (a substitution) in an indefinite integral. The formula of integration by parts, basic cases of using it.

4.3. The notion and properties of a definite integral.

The definition of a definite integral, its geometric meaning. The conditions of an integrability of a function. The properties of a definite integral and their application to calculation. The theorem of the mean value.

4.4. Calculation of a definite integral.

The Newton – Leibnitz formula. Change of a variable (substitution) in a definite integral. The formula of integration by parts for a definite integral.

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

The notion of improper integrals with infinite limits of integration and improper integrals of unbounded functions. Conditions of convergence of improper integrals.

Theme 5. Differential equations

5.1. 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***.

5.2. 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.

Theme 6. Series

6.1. 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.

6.2. 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.

6.3. Functional series.

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

Theme 7. The elements of the theory of matrices and systems of linear algebraic equations

7.1. 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.

7.2. 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).

7.3. 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.

7.4. 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 consistent or inconsistent system of linear algebraic equations. Determined or undetermined systems of linear algebraic equations.

7.5. 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.

7.6. Homogeneous systems of linear algebraic equations.

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

Theme 8. The elements of vector algebra

8.1. The basic notions of vector algebra.

Types of vectors, comparison of vectors. Linear operations with vectors in the geometric and coordinate forms, properties of these operations. A scalar product of vectors, its properties. An angle between vectors. Collinear vectors, the condition of collinearity. Vector (cross) and mixed products of vectors and their geometric meaning. Properties of vector and mixed products of vectors. The condition of complanarity of vectors.

8.2. The elements of the theory of linear spaces.

The definition of the *n-th*-dimensional vector and the *n-th*-dimensional vector (linear) space. Linear independence of vectors. The definitions and main theorems of linear dependence and linear independence of linear space elements. The basis of linear space. Coordinates of a vector in a given basis. Transformation to other basis. Economic examples.

8.3. Eigenvectors.

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

8.4. Quadratic forms.

The notion of a quadratic form. 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.

Thematic module 2. The elements of probability theory and mathematical statistics

Theme 9. Empirical and logical bases of probability theory

9.1. The subject and problems of the discipline.

The role of the discipline as a theoretical base of mathematical modelling of economic processes and phenomena, which include possible risks.

9.2. A probabilistic model of an experiment.

Sure (certain), random and impossible events. Rules of operations with random events. The space of elementary events. A classical definition and calculation of probability. Basic formulas of combinatorics. A statistical definition of probability. A geometrical definition of probability.

9.3. Basic theorems of probability theory, their economic meaning.

Probabilistic space. Addition theorems of probabilities. Dependent and independent events. Conditional probability. Joint (compatible) and disjoint (incompatible) events. Multiplication theorems of probabilities. A complete group of events. Complementary events. The probability of at least one event. The probability that an event will occur at least one. Formula of total probability. Bayes' formula (the theorem of hypothesis).

Theme 10. The scheme of independent trials

10.1. Bernoulli's formulas.

The scheme of repeated independent trials.

10.2. The local theorem of Moivre – Laplace.

Gauss function, its properties, application to approximate calculations of the probability of occurrence of a random event of a definite number times in the series of independent trials.

10.3. The integral theorem of Moivre – Laplace. Poisson's theorem.

Laplace's function, its properties and application to approximate calculations of a probability that values of a random variable lies in a definite interval. Poisson's theorem.

Theme 11. Random variables and their economic meaning

11.1. The definition of a random variable.

Discrete and continuous random variables. Distribution laws of probabilities for a random variable and ways of finding them.

11.2. Basic numerical characteristics of a random variable.

Mathematical expectation, varience and root-mean-square deviation. Properties of basic numerical characteristics. The function of distribution of probabilities, its properties. Distribution density and its probable explanation. A density function of the distribution of a random variable and its properties.

11.3. Additional numerical characteristics of a distribution.

A mode, a median, an excess, initial and central theoretical moments of an arbitrary order.

11.4. Distribution laws of a discrete random variable.

Binomial distribution, a geometrical distribution, a hypergeometrical distribution. Specificities and properties of these distributions, their basic numerical characteristics and the economic meaning.

Theme 12. Basic distribution laws of a continuous random variable

12.1. Distribution laws of a continuous random variable.

A uniform distribution, a normal distribution and an exponential distribution. Properties of these distributions and their basic numerical characteristics. The influence of parameters of distribution on the density function of probabilities in the normal distribution law.

12.2. Student's distribution, Pearson's distribution and Fisher's distribution.

Specificities and properties of these distributions. The relationship of these distributions and the normal distribution law of a continuous random variable.

Theme 13. Preprocessing of statistical data

13.1. Basic problems of mathematical statistics.

The sampling method. Definitions of a population and its sample.

13.2. The empirical distribution law.

Ways of presentation of sampling totalities and representation of the results of observations. Discrete and interval variational series. A polygon and a histogram. Basic sampling characteristics and their asymptotic behavior.

Theme 14. Statistical estimation of the distribution parameters

14.1. Statistical estimations of distribution parameters of a population and their properties.

Unbiasedness, possibility and efficiency. Point estimations.

14.2. Interval estimations.

The confidence interval for mathematical expectation and the root mean square deviation of a normal population.

Theme 15. Checking the statistical hypothesis

15.1. Basic notions of checking the statistical hyphotesis.

Main and alternative statistical hypothesis. A statistical criterion (test). Construction of critical domains for a statistical criterion (test). Errors of the first and second kinds. The

concept of power of a criterion (test).

15.2. Checking the statistical hypothesis about defining the distribution law for a population using the results of investigation of a sample.

The Pearson fitting test. The fitting test relative to frequencies.

15.3. Checking the statistical hypothesis about the equality of two population means on the assumption of a normal distribution law.

Student's fitting test.

15.3. Comparison of variences.

The Fisher − Snedeker fitting test.

Theme 16. The elements of the theory of correlation and regression

16.1. Problems of correlation analysis.

The sampling coefficient of a correlation, its properties and the confidence interval. A coefficient of determination. The correlation ratio, its properties.

16.2. Problems of regression analysis.

The correlation dependence. The correlation table. Empirical lines of a regression. Estimation of parameters of a pair regression equation using the least-squares method. The accuracy of the estimation. Checking the significance of parameters of a pair regression equation. The confidence interval for a line of a pair regression.

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 100 points; the minimum which makes it possible for a student to pass a test, equals 60 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: the final mark on the academic discipline is calculated according to the points obtained during the current control on the accumulative system.

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.

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 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

Themes of the thematic module			Lectures	Practical study	Homework	Competence oriented task	Independent test	Written test	Independent creative work	Colloquium	Total
Thematic module 1. The elements of mathematical analysis and linear algebra	Theme 1	Week 2	1	1	0.5	–	–	–	–	–	**2.5**
	Theme 2	Week 3	1	2	1	–	–	–	–	–	**4**
	Theme 3	Week 4	1	1	0.5	–	–	–	–	–	**2.5**
	Theme 4	Week 5	1	3	1.5	–	–	–	–	–	**5.5**
	Theme 5	Week 6	1	1	0.5	–	5	–	–	–	**7.5**
	Theme 6	Week 7	1	1	0.5	–	–	6	–	–	**8.5**
	Theme 7	Week 8	1	2	1	–	-	-	–	7	**11**
	Theme 8	Week 9	1	1	0.5	5	–	–	–	-	**7.5**
Thematic module 2 The elements of probability theory and mathematical statistics	Theme 9	Week 10	1	1	0.5	–	–	–	–	–	**2.5**
	Theme 10	Week 11	1	1	0.5	–	–	–	–	–	**2.5**
	Theme 11	Week 12	1	1	0.5	–	–	–	–	–	**2.5**
	Theme 12	Week 13	1	1	0.5	–	–	–	–	–	**2.5**
	Theme 13	Week 14	1	2	1	–	5	–	–	–	**9**
	Theme 14	Week 15	1	1	0.5	-	–	6	–	–	**8.5**
	Theme 15	Week 16	1	1	0.5	–	-	-	–	7	**9.5**
	Theme 16	Week 17	1	1	0.5	5	–	–	7	–	**14.5**
Total			**16**	**21**	**10**	**10**	**10**	**12**	**7**	**14**	**100**

The scales of assessment: national and ECTS

<table>
<tr><th rowspan="2">Sum of points including all forms of study</th><th rowspan="2">Mark on the ECTS scale</th><th colspan="2">Mark on the national scale</th></tr>
<tr><th>for an exam, a term paper, practice</th><th>for a test</th></tr>
<tr><td>90 – 100</td><td>A</td><td>excellent</td><td rowspan="5">passed</td></tr>
<tr><td>82 – 89</td><td>B</td><td>very good</td></tr>
<tr><td>74 – 81</td><td>C</td><td>good</td></tr>
<tr><td>64 – 73</td><td>D</td><td rowspan="2">satisfactory</td></tr>
<tr><td>60 – 63</td><td>E</td></tr>
<tr><td>35 – 59</td><td>FX</td><td rowspan="2">unsatisfactory</td><td rowspan="2">failed</td></tr>
<tr><td>1 – 34</td><td>F</td></tr>
</table>

5. Recommended reading

5.1. Main

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

2. Збірник вправ з розділу "Теорія ймовірностей та математична статистика" навчальної дисципліни "Математика для економістів» для студентів галузі знань "Економіка і підприємництво" усіх форм навчання / уклад. Е. Ю. Железнякова, А. В. Ігначкова, З. Г. Попова та ін. – Харків : Вид. ХНЕУ, 2009. – 116 с.

3. Лабораторний практикум із розділу "Теорія ймовірностей та математична статистика" навчальної дисципліни "Математика для економістів" : навч.-практ. посіб. / І. Л. Лебедєва, О. О. Єгоршин, Е. Ю. Железнякова та ін. – Харків : Вид. ХНЕУ, 2009. – 116 с.

4. Малярець Л. М. Вища математика для економістів у прикладах, вправах і задачах : навч. посіб. / Л. М. Малярець, А. В. Ігначкова. – Харків : ВД "ІНЖЕК", 2006. – 544 с.

5. Малярець Л. М. Математика для економістів : практ. посіб. до розв'язання задач / Л. М. Малярець, Л. Д. Широкорад. – Харків : Вид. ХНЕУ, 2008. – 476 с.

6. Малярець Л. М. Математика для економістів : навч. посіб. / Л. М. Малярець під ред. Л. М. Малярець. – Харків : Вид. ХНЕУ, 2011. – 568 с.

7. 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.

8. 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.

9. Малярець Л. М. Математика для економістів. Теорія ймовірностей та математична статистика : навч. посіб. У 3-х ч. Ч. 3 / Л. М. Малярець, І. Л. Лебедєва, Л. Д. Широкорад – Харків : Вид. ХНЕУ, 2011. – 568 с.

10. Малярець Л. М. Практикум з теорії ймовірностей та матема-тичної статистики в Excel : навч.-практ. посіб. / Л. М. Малярець, І. Л. Лебедєва, Е. Ю Железнякова. – Харків : Вид. ХНЕУ, 2007. – 160 с.

11. Малярець Л. М. Математика для економістів : практ. посіб. до розв'язання задач економічних досліджень в MatLab / Л. М. Малярець, Є. В. Резнік, О. Г. Тижненко. – Харків : Вид. ХНЕУ, 2008. – 212 с.

12. Малярець Л. М. Теория вероятностей и математическая статистика в примерах и задачах. Учебное пособие для студентов-иностранцев отрасли знаний 0305 «Экономика и предпринимательство» / Л.М. Малярец, Е.Ю. Железнякова, А.В. Игначкова – Харків : ХНЕУ. – 2012. – 124 с.

13. Теорія ймовірностей та математична статистика : навч. посіб. / Л. М. Малярець, І. Л. Лебедєва, Е. Ю. Железнякова та ін. – Харків : Вид. ХНЕУ, 2010. – 404 с.

5.2. Additional

14. Барковський В. В. Математика для економістів : навч. посіб. / В. В. Барковський, Н. В. Барковська. – Київ : НАУ, 1999. – 448 с.

15. Барковський В. В. Теорія ймовірностей та математична статистика / В. В. Барковський, Н. В. Барковська, О. К. Лопатін. – 5-е вид. – Київ : Центр учбової літератури, 2010. – 424 с.

16. Вища математика для економістів : підручник / під ред. О. І. Ляшенка, О. І. Черняка. – Київ : Видавничо-поліграфічний центр "Київський університет", 2008. – 497 с.

17. Высшая математика для экономистов / под ред. Н. Ш. Кремера. – Москва : ЮНИТИ, 2002. – 440 с.

18. Гмурман В. Е. Руководство по решению задач по теории вероятностей и математической статистике / В. Е. Гмурман. – Москва : Высшая школа, 2001. – 576 с.

19. Гмурман В. Е. Теория вероятностей и математическая статис-тика : учеб. пособ. для вузов / В. Е. Гмурман. – 6-е изд. – Москва : Высшая школа, 1998. – 480 с.

20. Данко П. Е. Высшая математика в упражнениях и задачах. У 2-х ч. Ч. 1 / П. Е. Данко, А. Г. Попов, Т. Я. Кожевникова. – Москва : Высшая школа, 2003. – 304 с.

21. Данко П. Е. Высшая математика в упражнениях и задачах. У 2-х ч. Ч. 2 / П. Е. Данко, А. Г. Попов, Т. Я. Кожевникова. – Москва : Высшая школа, 2003. – 416 с.

22. Ермаков В. И. Общий курс высшей математики для экономистов / В. И. Ермаков, Б. М. Рудык, Р. К. Гринцевичюс. – Москва : ИНФРА-М, 2007. – 657 с.

23. Елисеева И. И. Теория статистики с основами теории вероятнос-тей : учеб. пособ. / И. И. Елисеева, В. С. Князевский. – Москва : ЮНИТИ-ДАНА, 2001. – 446 с.

24. Жлуктенко В. І. Теорія ймовірностей і математична статистика : навч.-метод. посіб. У 2 ч. Ч. І. Теорія ймовірностей / В. І. Жлуктенко, С. І. Наконечний. – Київ : КНЕУ, 2000. – 304 с.

25. Жлуктенко В. І. Теорія ймовірностей і математична статистика : навч.-метод. посіб. У 2 ч. Ч. ІІ. Математична статистика / В. І. Жлуктенко, С. І. Наконечний, С. С. Савіна. – Київ : КНЕУ, 2001. – 336 с.

26. Красс М. С. Основы математики и ее приложения в экономическом образовании : учебник / М. С. Красс, Б. П. Чупрынов. – 2-е изд., испр. – Москва : Дело, 2001. – 688 с.

27. Кремер Н. Ш. Теория вероятностей и математическая статистика / Н. Ш. Кремер. – Москва : ЮНИТИ-ДАНА, 2000. – 544 с.

28. Минорский В. П. Сборник задач по высшей математике / В. П. Минорский. – Москва : Наука, 2002. – 352 с.

29. Тевяшев А. Д. Высшая математика. Сборник задач и упражнений / А. Д. Тевяшев, А. Г. Литвин. – Харьков : ХТУРЭ, 1999. – 192 с.

30. Травкін Ю. І. Математика для економістів: підручник / Ю. І. Травкін, Л. М. Маляpець. – Харків : ВД "ІНЖЕК", 2005. – 816 с.

5.3. Methodical support

31. Сайт персональних навчальних систем:
https://pns.hneu.edu.ua/course/view.php?id=3817