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

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

ПОГОДЖЕНО
Проректор з навчально-методичної роботи
_____ Каріна НЕМАШКАЛО

ВИЩА МАТЕМАТИКА В МІДНАРОДНОМУ БІЗНЕСІ
робоча програма навчальної дисципліни (РПНД)

Галузь знань	**29 «Міжнародні відносини»**
Спеціальність	**292 «Міжнародні економічні відносини»**
Освітній рівень	**перший (бакалаврський)**
Освітня програма	**«Міжнародний бізнес»**

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

Розробник:
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старший викладач Степан ЛЕБЕДЄВ

Завідувач кафедри
вищої математики та
економіко-математичних методів Людмила МАЛЯРЕЦЬ

Гарант програми Наталія ПАРХОМЕНКО

Харків
2023

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

APPROVED
At the meeting of the Department of Higher Mathematics Economic and Mathematical Methods
Protocol № 1 dated 21.08.2023

AGREED
Vice-rector for educational and methodical work

_____ Karina NEMASHKALO

HIGHER MATHEMATICS IN INTERNATIONAL BUSINESS

Program of the course

Field of knowledge	**29 International Relations**
Specialty	**292 International Economic Relations**
Study cycle	**first (bachelor)**
Study programme	**International Business**
Course status	**mandatory**
Language	**English**

Developers:
PhD, Associate Professor _____ Iryna YALOVEHA
Senior Lecturer _____ Stepan LEBEDIEV

Head of the Department of Higher Mathematics Economic and Mathematical Methods _____ Lyudmyla MALYRETS

Head of Study Programme _____ Natalia PARKHOMENKO

Kharkiv
2023

INTRODUCTION

Mathematics is the generally accepted universal language of science, a basic element of the general and professional culture of a modern specialist in international economic relations. The study of mathematical disciplines should form in the student a holistic idea of the place and role of mathematics in the modern world, its internal structure, the interrelationships of its sections, models and methods, and its possibilities in solving specific problems. The current state of economic sciences constantly requires the widespread involvement of the mathematical apparatus, therefore studying the discipline "Higher Mathematics in International Business" is a necessary stage of becoming a highly qualified specialist. Mastery of mathematical methods not only plays a decisive role in learning the regularities of various processes and phenomena, but also forms the so-called mathematical style of thinking - abstract, logical, ideally strict, and, most importantly, aimed at the search for regularities.

The main purpose of teaching is to form a complete system of theoretical knowledge of the mathematical apparatus for solving applied problems in the areas of planning, analysis, organization and control of international business, the ability to abstract thinking, analysis and synthesis.

The main tasks

of studying the discipline are:

– mastering the mathematical methods on which the disciplines of senior courses are based;

– scientific substantiation of the application of the basic concepts of higher mathematics in complex specialized tasks and practical problems in the field of international relations;

– reflection of interdisciplinary connections of the mathematical discipline with humanitarian disciplines;

– promoting the process of professional self-determination through the study and understanding of higher mathematics.

The object of study of the discipline is the application of higher mathematics in solving problems in international business.

The subject of study of the academic discipline is the tools of linear algebra, analytical geometry, mathematical analysis, probability theory and mathematical statistics.

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

Table 1

Learning outcomes and competencies formed by the course

Learning outcomes	Competencies
LO3	SC11
LO4	SC5
LO12	GC8
LO13	GC8
LO18	SC11
LO24	IC, GC2, GC8, SC11
LO27	SC11

where: IC (Integral Competence). The ability to solve complex specialized tasks and practical problems in the field of international relations in general and international economic relations in particular, as well as in the learning process, which involves the application of the latest theories and methods in the implementation of complex studies of global economic relations, is characterized by the complexity and uncertainty of conditions.

GC2. The ability to preserve and multiply moral, cultural, scientific values and achievements of society based on an understanding of the history and patterns of development of the subject area, its place in the general system of knowledge about nature and society and in the development of society, technology and technologies, to use various types and forms of motor activity for active recreation and leading a healthy lifestyle.

GC8. Ability to abstract thinking, analysis and synthesis.

SC5. The ability to carry out a comprehensive analysis and monitoring of global market conditions, to assess changes in the international environment and to be able to adapt to them.

SC11. The ability to research economic phenomena and processes in the international sphere, taking into account cause-and-effect and spatio-temporal relationships.

LO3. Use modern information and communication technologies, general and special purpose software packages.

LO4. Systematize and organize information about processes and phenomena in the world economy; evaluate and explain the influence of endogenous and exogenous factors on them; formulate conclusions and develop recommendations taking into account the peculiarities of the national and international environment.

LO12. Carry out a comprehensive analysis of complex economic systems, compare and compare their components, evaluate and justify assessments of the effectiveness of their functioning.

LO13. Select and skillfully apply the analytical toolkit for researching the state and

development prospects of individual segments of the international markets of goods and services using modern knowledge about the methods, forms and tools of regulation of international trade.
LO18. Investigate economic phenomena and processes in the international sphere based on an understanding of categories and laws; highlighting and summarizing trends, regularities of the functioning and development of the world economy, taking into account cause-and-effect and spatio-temporal relationships.
LO24. Justify the choice and apply information and analytical tools, economic and statistical methods of calculation, complex analysis techniques and methods of monitoring the state of world markets.
LO27. Apply the acquired knowledge to solve problems in the areas of planning, analysis, organization and control of international business.

COURSE CONTENT

Content module 1. Elements of linear algebra, analytical geometry and mathematical analysis

Topic 1. Elements of the theory of matrices and determinants. Matrix analysis of the international trade market

1.1. Definition of a matrix, types of matrices

Size matrix $m \quad n$, rectangular matrix, row vector, column vector, square matrix, diagonal matrix, unit matrix, triangular matrix, zero matrix. Technological matrices in economic and social models.

1.2. Actions on matrices: addition, multiplication of a matrix by a number, and a matrix by a matrix

Multiplying a matrix by a number, adding matrices, subtracting matrices, multiplying matrices. Transposition of matrices. Matrix analysis of the international trade market.

1.3. Definition of determinant

Rules for calculating determinants. Determinants of matrices of the first, second and third orders. The rule of triangles and the rule of Sarrus. Higher order determinants.

1.4. Inverse matrix

Definition of inverse matrix. Non-degenerate and degenerate matrices. Joined (union) matrix. Calculation of the inverse matrix by definition. Application of the Leontiev model (two-sector model) in forecasting development of the world economy.

Topic 2. General theory of systems of linear algebraic equations. Linear model of international trade

2.1. Systems of linear algebraic equations

A system of *m* linear algebraic equations with *n* unknowns. Matrix form. Solving a system of linear algebraic equations. Compatible, incompatible, defined, undefined

systems.

2.2. Methods of solving systems of linear algebraic equations

Solving systems of linear algebraic equations using Kramer's formulas. Solving systems of linear algebraic equations using the inverse matrix. Solving systems of linear algebraic equations by the method of successive extraction of unknowns (Gauss method). Formulation of the simplest problems of linear programming and their application in economics.

Topic 3. Elements of vector algebra and analytic geometry

3.1. Elements of vector algebra

Rectangular Cartesian coordinate system on the plane and in space. Definition of a geometric vector. The length of the vector. Types of vectors. Linear actions with vectors in geometric form. Linear operations with vectors in coordinate form. The angle between the vectors. Scalar product of vectors, its properties.

3.2. Elements of analytical geometry. Curves of mutual supply of countries

Equation of a line on a plane. The main types of equations of a straight line on a plane. Angle between two straight lines. Conditions of parallelism and perpendicularity of lines. Construction of the region of admissible solutions of the linear model of international trade when solved by the graphical method.

Topic 4. Functions and their graphs. Graphs in economic modeling. Simple and compound interest in economic studies

4.1. Elements of set theory. Functions and their graphs

Numerical sets. The concept of a function of one variable. Product of sets, mapping graph. Composition of reflections, composite function. Ways of assigning functions. Basic elementary functions. Graphs in economic modeling: the consumption function and the budget constraint line, supply and demand curves, the dependence of the amount of demand on income, graphs of the dependence of costs and income on the volume of production.

4.2. Simple and compound interest in economic studies

Definition of interest (percentage). Three main percentage problems. Simple interest. Compound interest. The task of increasing the bank contribution.

Topic 5. Limit of a function Continuity of a function. Differential calculus of functions of one variable. Analysis of economic indicator interrelationships

5.1. The concept of numerical sequence

The limit of a numerical sequence. Definition of numerical sequence. Methods of specifying sequences. Determination of the limit of a numerical sequence. Convergent and divergent sequences. Geometric interpretation of the limit of a numerical sequence. Infinitely small and infinitely large sequences. Numeric *e*.

5.2. Limit of a function Continuity of a function

Defining the boundary of a function at a point. Infinitesimal and infinitely large functions. The first and second wonderful limits. Asymptotic behavior of functions.

Limit analysis in economics. Definition of a function continuous at a point. Definition of a function continuous on a set. Classification of function breakpoints.

5.3. The derivative of a function at a point

Definition of the derivative function $y = f(x)$ at the point x_0. Geometric and economic meaning of the derivative. The concept of elasticity of function. Types of elasticity. Analysis of relationships of economic indicators. Basic rules of differentiation.

Topic 6. Differential calculus of functions of many variables. Application of the gradient vector in the linear model of international trade. Integral calculus of functions of one variable

6.1. A function of many variables. Partial derivatives of functions of many variables

Definition of the partial derivative function of many variables, calculation of partial derivatives. Vector gradient and its application in optimization of economic problems.

6.2. Primitive function or indefinite integral.

Definition of the primitive function and indefinite integral. The simplest rules of integration. Table of integrals of basic elementary functions. Basic methods of integration.

Content module 2. Elements of probability theory and mathematical statistics

Topic 7. Empirical and logical foundations of probability theory. Elements of combinatorics. Basic theorems of probability theory, their economic interpretation. Probability theory in international trade strategies

7.1. The concept of a random event. Quantification of the possibility of occurrence of a random event

Definition of a random event. Types of random events. Statistical (or stochastic) definition of probability. The classical definition of the probability of an event. Algebra of events. Euler-Venn diagrams and geometric definition of probability.

7.2. Elements of combinatorics

Probability multiplication theorem. The principle of adding combinations. The principle of the product of combinations. Ordered and unordered sets. Combinatorics formulas without repetition: permutations, placement, connections (combinations).

7.3. Basic theorems of probability theory

Discrete probability space. The theorem of addition of probabilities. Conditional probability. Formula for calculating conditional probability. Full set of random events. Formula of total probability. Bayes formula. Scheme of independent tests. Bernoulli's formula. Local and integral theorems of the de Moivre-Laplace.

Topic 8. Random variables and their economic interpretation. Basic laws of distribution

8.1. Definition of a random variable. Discrete random variables

The law of probability distribution of a discrete random variable. Distribution series and probability distribution polygon. Basic numerical characteristics of a random variable. Method of moments. Probability distribution function.

8.2. Continuous random variables

The probability distribution function is the density function of the probability distribution. Basic numerical characteristics of a continuous random variable.

8.3. Distribution laws of discrete and continuous random variables

Basic laws of distribution (binomial and geometric), numerical characteristics of a discrete random variable. Basic laws of distribution: uniform, exponential and normal. Concepts of Pearson distribution, Student distribution, Fisher distribution.

Topic 9. Problems of mathematical statistics. Primary processing of statistical data. Statistical estimates of distribution parameters. Statistical evaluation methods in international trade

9.1. Problems of mathematical statistics

Stochastic nature of economic data. The first and second problems of mathematical statistics. General and selective populations. Representativeness of the sample population.

9.2. Primary processing of statistical data. Processing of economic data

Variants, frequencies and relative frequencies. Discrete variational distribution series. Polygon of frequencies (relative frequencies). Interval variation series. Histogram of frequencies (relative frequencies). Sample probability density estimation. Empirical distribution function.

9.3. Basic and additional numerical characteristics of the variational series. Risk in international business models

Properties to which statistical estimates of the parameters of the general population must correspond. Point estimates of the main numerical characteristics of the distribution. Interval evaluations. Construction of a confidence interval. Risk assessment in international business models.

Topic 10. Relationship of random variables in economics. Correlation dependence. Elements of regression analysis. Forecasting the characteristics of the foreign trade market

10.1. Correlation dependence as a partial case of statistical ice between random variables. Analysis of correlation density in international business

Concept of statistical relationship between random variables. Univariate and multivariate correlation analysis. Covariance. Correlation coefficient. Coefficient of determination.

10.2. Elements of regression analysis. The problem of building a regression model for estimating the relationship between economic variables

The main task of regression analysis. Pairwise and multiple regression. The method of least squares. Confidence intervals of the parameters of the regression equation and the regression line. Application of regression analysis in foreign trade turnover studies.

Topi 11. Basic concepts of game theory. Application of game theory in international trade

11.1. Basic concepts of game theory

Decision-making under conditions of risk. A two-person zero-sum doubles game. A game in pure strategies. The top and bottom price of the game. The matrix game "Buyer-Seller". Determination of the optimal plan when playing in mixed strategies.

11.2. Decision-making in international business under conditions of uncertainty: a game approach

Individual preferences and individual choices. Utility function. Pareto optimality. Group selection. Arrow's impossibility theorem.

The list of practical (seminar) / laboratory studies in the course is given in table 2.

Table 2

The list of practical (seminar)) / laboratory studies

Name of the theme and task	Content
Topic 1. Laboratory class 1	Actions on matrices: addition, multiplication of a matrix by a number and a matrix by a matrix. Calculation of determinants. Construction of the inverse matrix
Topic 2. Practical class 1	Research and solution of systems of linear algebraic equations
Topic 3. Laboratory class 2	Solving economic problems using elements of vector algebra and analytical geometry
Topic 4. Practical class 2	Solving simple and complex percentage problems
Topic 5. Laboratory class 3	Calculating the limit. Monitoring continuity of the function
Topic 6. Practical class 3	Differential calculus of functions of one variable. Study of a function in order to construct its graph
Topic 7. Laboratory class 4	Calculation of the probability of a random event according to the classical definition. Construction of Venn-Euler diagrams
Topic 8. Practical class 4	Determination of the distribution law of a discrete random variable and calculation of the main numerical characteristics

Topic 9. Laboratory class 5	Evaluation of the main numerical characteristics of the distribution of a random variable according to statistical data
Topic 10. Practical class 5	Estimation of the correlation density of two random variables
Topic 10. Laboratory class 6	Construction of a pairwise linear regression equation
Topic 11. Practical class 6	Solving the matrix game "Buyer-Seller"

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

Table 3

List of self-studies

Name of the topic and/or task	Content
Topic 1 - 11	Studying lecture material
Topic 1 - 11	Preparation for practical and laboratory classes
Topic 1 - 11	Completion of homework and preparation of laboratory reports
Topic 6, 10 or 11	Writing an independent creative work
Topic 1 - 11	Preparation for colloquiums, tests and exams

The number of hours of lecture, practical and laboratory classes and hours of independent work is given in the technological card of the course.

TEACHING METHODS

In the process of teaching the course, in order to acquire certain learning outcomes, to activate the educational process, it is envisaged to use such teaching methods as:
Verbal (problem lectures (Topic 2, Topic 4, Topic 5, Topics 7-8, Topic 11), lecture-discussion (Topics 1–11), brainstorming (Topic 1, Topic 5, Topic 7).
Visual (demonstration (Topics 1–11)).
Practical (individual research work (Topics 1–11)).

FORMS AND METHODS OF ASSESSMENT

The university uses a 100-point accumulative system for evaluating the learning outcomes of students of higher education.
Current control is carried out during lectures, practical, laboratory and seminar classes and is aimed at checking the level of readiness of the student to perform a specific job and is evaluated by the number of points scored:

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

The final control includes current control and an exam.

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

The final grade in the course is determined:

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

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

Current control: colloquiums (estimated at 7 points (two colloquiums during the semester – the total maximum number of points – 14)); written tests (maximum score – 8 points (two written tests during the semester, total maximum number of points – 16)); homework (maximum score – 2 points (six homework during the semester, total maximum number of points – 12 points)); laboratory work (maximum score – 2 points (six laboratory work during the semester, total maximum number of points – 12 points)); an independent creative task (maximum score – 6 points).

Semester control: Grading including Exam (40 points).

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

An example of an exam card and assessment criteria.

An example of examination paper

Form № H-5.05

SEMEN KUZNETS KHARKIV NATIONAL UNIVERSITY OF ECONOMICS

Educational level: first (bachelor)

Term 1

Educational discipline: Higher Mathematics in International Business

Examination paper (EXAMPLE)

Task 1 (6 points)

The depositor paid UAH 20,000 to the bank. The annual interest charged by the bank is 5%. Calculate the total profit the depositor will have if you save money in the bank for 5 years in the following cases: a) the depositor annually withdraws funds that are accrued by interest; b) the depositor does not withdraw money within 5 years, i.e. interest capitalization occurs.

Task 2 (8 points)

Find the solution of the system of linear algebraic equations by the Gauss method:

$$\begin{aligned} -4x_2 - x_3 &= -9, \\ 2x_1 - x_2 + 3x_3 &= -1, \\ -3x_1 - x_2 + 4x_3 &= 5. \end{aligned}$$

Task 3 (8 points)
Investigate the function at the extremum.

$$y = \frac{x^2 - 3}{x^2 + 1}$$

Determine the largest and smallest value of this function on the interval $x \quad [-1; 2]$

Task 4 (8 points)
Three employees of the department fill out the reports and put them in a common folder. The probability of making a mistake for the first employee is 0.2, for the second – 0.1, for the third – 0.05. During the day, the first employee filled out 15 reports, the second – 20, the third – 15. At the end of the day, a document was taken from the folder at random. It turned out to contain an error. Determine the probability that this document was prepared by a second employee.

Task 5 (10 points)
20 students took part in training on writing business plans. During the check, it was found that the number of errors is, respectively: 4, 2, 1, 3, 5, 4, 1, 4, 1, 2, 4, 3, 4, 5, 1, 4, 1, 2, 4, 4. Construct a discrete variational series of the distribution of this random variable and its polygon. Calculate numerical characteristics of the sample: the sample mean; the standard deviation of the sample and sample coefficient of skewness. Draw a conclusion about the law of distribution of such errors in the general population.

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

Protocol № _ from ___, 20__

The head of the department L. Malyarets
The lecturer S. Lebediev

An assessment criterion

Each examination paper contains 5 practical tasks, including one first-level (diagnostic) task, three second-level (situational) tasks and one third-level (heuristic) task.
***Task 1 of the first level* (*diagnostic*) *is evaluated*:**
6 points, if the ability to correctly define and use the appropriate formulas is demonstrated. The task was performed flawlessly, at all stages of the solution there is an explanation and theoretical justification of all key points, the results of the calculations are correct;

5 points, if the logically correct sequence of steps to solve the problem is given. The key points of the solution are substantiated. A qualitative and quantitative analysis of the justification of the used formulas was performed. 1 minor error or typo in calculations is possible, which does not affect the correctness of the subsequent solution;
4 points, if the key points of the decision and the logical sequence of steps are not fully justified, but a partial analysis was carried out and the correct formulas were used, which led to the correct quantitative answer;
3 points, if the task is basically completed, but without theoretical justification and with calculation errors;
2 points, if some correct formulas for calculations are written down, but no theoretical justification is given, there is no calculation result, or a logical error was made that led to an incorrect solution;
1 point, if the task execution is not started, but the condition is recorded.

***Tasks 2 - 4 of the second level* (*stereotype*) *are evaluated**:*
8 points each task, if the solution to the given task is characterized by logical correctness, clarity, reasonableness of the solution algorithm and conclusions. An impeccably completed task at work is accompanied by a demonstration of in-depth knowledge of the discipline, which demonstrates formed competencies;
7 points, if the logically correct sequence of steps to solve the problem is given. The key points of the solution are substantiated. However, there is 1 minor error or typo in the calculations, which did not affect the correctness of the further solution;
6 points, if mathematical terminology and basic techniques and methods of research, necessary formulas and dependencies are used correctly; individual key moments of the solution are substantiated, but not all the necessary explanations are given, or 1-2 mistakes were made that affected the calculation result;
5 points, if the task is only partially solved, the basic mathematical toolkit was used, but there are 2 gross errors that affected the process of solving the task;
4 points, if the task is only partially solved with the initial correct reasoning, but there are errors that significantly affected the result;
3 points, if the task is started, theoretical material at the level of basic definitions is used, correct formulas for calculations are chosen and written down, but the result of their application is not given or a logical error is made that led to an incorrect solution;
2 points, if the task as a whole is not completed, but there are some prerequisites for its completion (the correct formula is given, elementary calculation of a fragment of the task is carried out), but the final result is not obtained;
1 point, if the task execution is not started, but the condition is recorded.

***Task 5 of the third level* (*heuristic*) *is evaluated**:*
10 points, if the task solution is characterized by creative use of theoretical material, logic, clarity and reasonableness of conclusions, rationality. A perfectly executed task

is accompanied by a demonstration of in-depth knowledge of the discipline, which corresponds to the acquired competences in modeling the multivariate regression equation;
9 points, if the logically correct sequence of solution steps is given, its individual key points are substantiated. The justification of the used formulas is provided. One minor error or typo in the calculations is possible, which does not affect the correctness of the subsequent solution and interpretation of the results;
8 points, if a logically correct sequence of solution steps is given, its key points are substantiated. However, there are 1-2 minor errors or typos in calculations that do not affect the correctness of the subsequent solution;
7 points, if the mathematical terminology is correctly used and the main steps of the solution algorithm are constructed, the necessary formulas are given. Only certain key points of the solution are substantiated, but not all the necessary explanations are given;
6 points, if the task is basically completed, but without justification and with errors in calculations. There is no interpretation of the results;
5 points, if the task is only partially solved, the mathematical toolkit was used with errors that affected the final result;
4 points, if the task is only partially solved with the initial correct reasoning about the research algorithm, but there are errors that significantly affected the process of correct solution and led to a wrong interpretation of the results;
3 points, if the task was started, theoretical material was used at the level of basic definitions, some correct formulas for calculations were chosen and written down, but the result of their application was not given or logical errors were made that led to a fundamentally incorrect solution;
2 points, if the task as a whole is not completed, but there is an approach to its solution: several correct formulas are given, or some elementary calculations of fragments of the task are carried out;
1 point, if only the initial condition is recorded.

RECOMMENDED LITERATURE

Main

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4. Лабораторний практикум з навчальної дисципліни "Теорія ймовірностей та математична статистика" : навчальний посібник / Е. Ю. Железнякова, І. Л. Лебедєва, Л. О. Норік, К. В. Стєпанова. – Харків : ХНЕУ ім. С. Кузнеця, 2016. – 184 с.
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Additional

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