

MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
 NATIONAL AVIATION UNIVERSITY
 Faculty of Transport, Management and Logistics
 Higher Mathematics Department

AGREED

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«__» _____ 2024

APPROVED

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«__» _____ 2024 p.



Quality Management System

COURSE TRAINING PROGRAM

on

“Mathematics for Economists”

Educational Professional Programs: “International business”


Field of study: 29 “International relations”

Specialty: 292 “International Economic Relations”

Training Form	Semester	Total (hours/credits ECTS)	Lectures	Practices	Self-Study	HW/CGP	Semester Grade
Full-time:	1	135/4,5	34	34	67	2 ДЗ -1 с.	Exam – 1 с.

Index CB -17-292-2/23-2.1.1

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Course Training Program on “Mathematics for Economists” is developed on the basis of the Educational Program on “International Economic Relations”, “International business”, Bachelor Curriculum and Extended Curriculum CB-17-292-2/23, ECB-17-292-2/23 for Speciality 292 “International Economic Relations” and corresponding normative documents.

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«__» _____ 2024


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INTRODUCTION

The Course Training Program on “Mathematics for Economists” is developed based on the "Methodical guidance for the subject course training program", approved by the order № 249/поз. of 29.04.2021 p., and correspondent normative documents.

1. EXPLANATORY NOTES

1.1 Place, objectives, tasks of the subject

Place: This subject is considered as a theoretical and practical basis of knowledge and skills that form the expert’s profile in the field of transport technologies.

The subject **target** is to teach students to master the mathematical apparatus that is sufficient to develop mathematical models related to the further practical activities of specialists.

Objectives of the subject are:

- mastering the logical and algorithmic thinking of students;
- mastering the necessary theoretical knowledge and the main directions of their application in the system of disciplines by specialty;
- to instill primary skills of mathematical research of applied problems;
- mastering the ability to use independently the necessary methods and special literature in solving problems.

1.2 Learning outcomes the subject makes it possible to achieve

As a result of this subject mastering a student should acquire such **learning outcomes**:

- ППХ 3. use modern information and communication technologies, general and special purpose software packages;
- ППХ 7. apply the acquired theoretical knowledge to solve practical tasks and meaningfully interpret the obtained results;
- ППХ 7. justify the choice and apply information and analytical tools, economic and statistical calculation methods, complex analysis techniques and methods of monitoring the state of world markets.


1.3 Competences the subject makes it possible to acquire

As a result of this subject mastering a student should acquire such **competencies**:

- ІК. 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, characterized by the complexity and uncertainty of conditions ;
- ЗК 7. skills in using information and communication technologies;
- ЗК 8. the ability to abstract thinking, analysis and synthesis;
- ФК 11 the ability to conduct research on economic phenomena and processes in the international sphere, taking into account cause-and-effect and spatio-temporal relationships.

1.4 Interdisciplinary connections

The subject “Mathematics for Economists” is basic for the study such subjects as: ‘Theory of Probability and Mathematical Statistics’, “Econometrics”, “Microeconomics”, “Economic analysis”, “Macroeconomics”, and others.

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2. COURSE TRAINING PROGRAM ON THE SUBJECT

2.1 The subject content

Training material is structured according to a module principle and consists of two educational modules:

- **module №1** 1 "Linear algebra. Elements of vector algebra. Introduction to mathematical analysis".
- **module № 2** "Differential and integral calculus of functions of one variable. Elements of financial mathematics",

each of which is a logically complete, relatively independent, integral part of the educational discipline, the mastery of which involves conducting a modular control work and analyzing the results of its implementation.

2.2 Module structuring and integrated requirements to each module

Module №1 „Linear Algebra. Elements of Vector Algebra. Introduction to Mathematical Analysis.”

Integrated requirements to module №1. As a result of mastering the educational material of the educational module №1 the student must:

Know:

- definition and notation of determinants, matrices, systems of linear algebraic equations;
- Cramer's formulas;
- Gaussian method and matrix method for solving systems of linear algebraic equations;
- Kronecker-Capelli theorem;
- definitions and properties of dot, cross, triple products of vectors;
- assignment methods and classification of functions;
- determination of the limit of a numerical sequence and the limit of a function at a point;
- formulas of honorable limits and basic theorems about limits;
- determination of the continuity of the function and classifying the discontinuity points.

Be able to:

- perform operations with matrices, apply the theory of matrices to economic problems;
- investigate and solve systems of linear algebraic equations;
- perform linear operations with vectors;
- find products of vectors and apply them to solve geometry and economics problems;
- find the limit of the function and examine the function for continuity.

Topic 1. Determinants and their properties. Matrices, operations on matrices.

Content. *Determinants of the 2nd, 3rd and -th orders, their properties. Minors and algebraic complements. Methods of calculating determinants of the nth order.*

Concept of matrix, operations on matrices.

Topic 2. Inverse matrix. Matrix rank. Application of matrices in economics.


Content. *Inverse matrix. Matrix equations. Matrix rank. Finding the rank of a matrix using elementary transformations. The use of matrices in economic problems.*

Topic 3. Systems of linear algebraic equations. The Kronecker-Capelli theorem.

Content. *System of linear algebraic equations. The Kronecker-Capelli theorem. Investigation of systems of linear algebraic equations for consistence.*

Topic 4. Methods of solving systems of linear equations. Application of SLAR in the economy.

Content. *Solving systems by Cramer's formulas, matrix method, Gauss method. Application of SLAE in the economics.*

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Topic 5. Vectors, linear actions and operations on them. Vectors in the coordinate system. Scalar, vector and mixed products of vectors. Examples of the use of vectors in economics.

Content. *Vectors, linear operations on them. Distribution of the vector by basis. Projection of the vector onto the axis. Linear dependence and independence of vectors. Vectors in a rectangular Cartesian coordinate system (coordinates, length, direction cosines).*

Scalar product of two vectors, its properties. Expression of the scalar product in terms of coordinates. The angle between the vectors. Vector product of two vectors, its properties. Vector product of two vectors given by coordinates. Mixed product of three vectors, its properties. Mixed product of three vectors given by coordinates. The condition of coplanarity of three vectors.

Examples of the use of vectors in economics.

Topic 6. Functions. Classification of functions and their characteristics. Application of functions in the economics.

Content. *Function. Task methods. Classification of functions. Features of the function. Application of functions in the economics.*

Topic 7. The limit of a function. Basic theorems about limits.

Content. *Definition of the limit of a function at a point. Basic theorems about limits. One-sided limits. The limit of the function at infinity. The first and second honorable limits. Elimination of some indeterminacies. Comparison of infinitesimals. Equivalent infinitesimals.*

Topic 8. Continuity of a function.

Content. *Continuity of a function at a point. Discontinuity points of a function and their classification. Properties of functions continuous at a point and on a segment.*

Module №2 “Differential and Integral Calculus of the Function of One Variables. Elements of Financial Mathematics”

Integrated requirements to module №2 As a result of mastering the educational material of the educational module №2 the student must:

Know:

- definition of the derivative, table of derivatives and rules of differentiation;
- definition and properties of the differential;
- principal theorems of differential calculus;
- application of differential calculus to the investigation of functions and problems of economics;
- definition of the indefinite integral and its properties;
- integrals of fundamental elementary functions and methods of integration of various functions;
- definition, conditions of existence and properties of the definite integral; Newton-Leibniz formula;
- definition of improper integral;
- application of a definite integral.

Be able to:

- find derivatives and differentials of different orders of basic elementary functions;
- find derivatives of complicated functions, implicitly and parametrically given functions, perform logarithmic differentiation;
- to conduct a full investigation of the function and construct its graph;
- find elasticity of needs and offers;
- apply methods of integration;
- integrate rational, fractional-rational functions;
- calculate or investigate the convergence of improper integrals;
- calculate the areas of plane figures, using a definite integral in economical problems.

Topic 1. The derivative of a function. Differentiation rules. Geometrical, economical interpretation. Table of derivatives.

Content. *Derivative, its geometrical and economical interpretation. The equation of a tangent and normal. Differentiability and continuity.*

Differentiation rules. Derivatives of elementary functions. Table of derivatives. Derivative of the composite and inverse functions. Derivative of implicit and parametric functions. Logarithmic differentiation.

Topic 2. Differential of function. Derivatives and differentials of higher orders.

Content. *Differential of function. Properties of the differential. Application of differentials in approximate calculations. Derivatives and higher order differentials.*

Topic 3. Basic theorems of the differential calculus. Investigation of the function by means of derivatives and construction of graphs.

Content. *Basic theorems of the differential calculus. L'Hospital's rule. Monotonic functions. Extremum. The greatest and the least values of the function. Intervals of concavity, inflection points. Asymptotes. General scheme of investigation of the function and construction of the graph.*

Topic 4. Application of the differential calculus to economic problems.

Content. *Application of the differential calculus to economic problems.*

Topic 5. Antiderivative. Indefinite integral. Principal methods of integration.

Content. *Antiderivative and indefinite integral. Properties. Table of basic integrals.*

Principal methods of integration: direct integration, method of substitution; integration by parts. Classes of functions that integrate by parts.

Topic 6. Integration of some type of functions.

Content. *Integration of rational fractions with quadratic polynomial in denominator. Integration of elementary fractions. Integration of rational fractions*

Topic 7. Definite integral and its properties. Newton-Leibniz formula. Methods of calculating of definite integrals.

Content. *Definition, conditions of existence, geometric interpretation, properties of the definite integral. Calculation of definite integrals. Newton-Leibnitz formula. Methods of integration of definite integrals: method of substitution, integration by parts.*

Topic 8. The concept of improper integral. Application of the definite integral in geometry and economics.

Content. *Improper integral of the 1st and 2nd type, their calculation.*

Calculation of areas of plane figures. Application of the definite integral in economic problems.

Topic 9. Elements of financial mathematics.


Content. *Calculation of simple and compound interest. Discounting.*

2.3. Training schedule of the subject

№ п/п	Topic	Academic Hours			
		Full-time			
		Total	Lectures	Practical classes	Self study
1	2	3	4	5	6
Module №1 „Linear Algebra. Elements of Vector Algebra. Introduction to Mathematical Analysis”					
1.1	Determinants and their properties. Matrices, operations on matrices	1 семестр			
		6	2	2	2
1.2	Inverse matrix. Rank of the matrix.	7	2	2	3



	Application of matrices in economics				
1.3	Systems of linear algebraic equations. Kronecker-Capelli theorem.	7	2	2	3
1.4	Methods for solving systems of linear equations. Application of SLAE in economics	7	2	2	3
1.5	Vectors, linear operations with them. Vectors in coordinate system. Dot, cross and triple vector products. Examples of application of vectors in economics	7	2	2	3
1.6	Functions. Classification of functions and their characteristics. Application of functions in economics	6	2	2	2
1.7	Limit of the function. Fundamental theorems of limits	7	2	2	3
1.8	Continuity of the function	5	2	-	3
1.9	Homework 1	8	-	-	8
1.10	Module test №1	5	-	2	3
Total for module №1		65	16	16	33
Module №2 "Differential and Integral Calculus of the Function of One Variables. Elements of Financial Mathematics"					
2.1	Derivative of the function. Geometrical and economical interpretation. Table of derivatives	7	2	2	3
2.2	Differential of a function. Derivatives and differentials of higher order	6	2	2	2
2.3	Basic theorems of the differential calculus. Investigation of the function by means of derivatives and construction of graphs	6	2	2	2
2.4	Application of the differential calculus to economic problems	7	2	2	3
2.5	Antiderivative. Indefinite integral. Principal methods of integration.	6	2	2	2
2.6	Integration of some type of functions	6	2	2	2
2.7	Definite integral and its properties. Newton-Leibniz formula. Methods of calculating of definite integrals.	7	2	2	3
2.8	The concept of improper integral. Application of the definite integral in geometry and economics.	7	2	2	3
2.9	Elements of financial mathematics	4	2	-	2
2.10	Homework 2	8	-	-	8
2.11	Module test №2	6	-	2	4
Total for module №2		70	18	18	34
Total for the first semester		135	34	34	67
Total for the second semester					
Total for the discipline		135	34	34	67

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2.4. Homework

Homework (HW) 1, 2 are performed in the first semester. The purpose of homework is to improve theoretical knowledge and practical skills while studying the material of training modules.

Performing, design and defense of homework is carried out by the student individually according to the guidelines.

The time required to complete each homework is up to 8 hours of independent work.

2.5. Questions list for the exam

The list of questions and the content of the tasks for the exam are developed by the leading teachers and approved by the minutes of the department meeting and delivered to the students.

3. BASIC CONCEPTS OF GUIDANCE ON THE SUBJECT

3.1. Teaching methods

The following teaching methods are used in the teaching process: explanatory, illustrative, reproductive, problematic teaching, and research. In addition, students are provided with individual counseling (both when meeting a teacher with a student and online).

These methods are implemented during lectures, practical classes, self-study, performing and defending home work, test work, self-solving tasks, working with educational literature, etc.

3.2. List of references

The basic literature

3.2.1. Математика для економістів : навч. посіб. У 3 ч. Ч. 1 / І.О. Ластівка, В.С. Коновалюк, І.В. Шевченко [та ін.]. – К.: НАУ, 2012. – 432 с.

3.2.2. Математика для економістів : навч. посіб. У 3 ч. Ч. 2 / І.О. Ластівка, Н.І. Затула, Є.Ю. Корнілович [та ін.]. – К.: НАУ, 2012. – 312 с.

3.2.3. Дубовик В.П. Вища математика: Навч. посібник. / В. Дубовик, І. Юрик – К.: А.С.К., 2001. – 681 с.

3.2.4. Вища математика: Збірник задач: Навч. посібник / [В.Дубовик, І. Юрик, І. Вовкодав та ін.]; за ред. В. Дубовика, І. Юрика. – К.: 2001 – 480 с.

3.2.5. Вища математика. Модуль 1. Лінійна алгебра: Навч. посібник для студ. економ. спец. / [В.Ф. Антоненко, Т.І. Олешко, Ю.А. Паламарчук]. – К.: Книжкове вид-во НАУ, 2005. – 140 с.

3.2.6. Вища математика. Модуль 2. Векторна алгебра та аналітична геометрія: Навч. посібник для студ. економ. спец. / [В.В. Кравченко, Т.В. Лубенська, Т.І. Олешко]. – К.: Книжкове вид-во НАУ, 2005. – 144 с.

3.2.7. Вища математика. Модуль 3. Вступ до математичного аналізу: Навч. посібник для студ. економ. спец. / [В.С. Коновалюк, Т.І. Олешко, В.П. Петрусенко]. – К.: Книжкове вид-во НАУ, 2005. – 128 с.

3.2.8. Вища математика. Модуль 4. Диференціальне числення функцій однієї змінної: Навч. посібник для студ. економ. спец. / [І.О. Ластівка, Т.А. Левковська, Т.І. Олешко]. – К.: Книжкове вид-во НАУ, 2005. – 120 с.

3.2.9. Вища математика. Модуль 6. Інтегральне числення функцій однієї змінної: Навч. посібник для студ. економ. спец. / [І.Ю. Ковтонюк, Є.Ю. Корнілович, Т.І. Олешко]. – К.: Книжкове видавництво НАУ, 2005. – 112 с.

3.2.10. Математика для економістів : методичні рекомендації до самостійної роботи / І.О. Ластівка, І.В. Шевченко. – К.: НАУ, 2018. – 92 с.

3.2.11. Математика для економістів (заочна форма навчання): навч. посіб. У 3 ч. Ч. 1 / [І.О. Ластівка, Я.В. Крисак, І.В. Шевченко, Р.В. Горідько, І.П. Кудзіновська]. – К.: НАУ 2012. – 328 с.

3.2.12. Математика для економістів (заочна форма навчання): навч. посіб. У 3 ч. Ч. 2 / [І.О. Ластівка, Н.І. Затула, І.В. Шевченко, Т.А. Левковська, Л.О. Чуб.]. – К.: НАУ, 2014. – 260 с.

3.2.13. Mathematics for Economics and Business / Jan Jacques. – Pearson Education Limited, 2009, - 584 p.

Additional literature

3.2.13. Васильченко І.П. Вища математика для економістів. – К.: Знання – Прес, 2002. – 454 с.

3.1.14. Барковський В.В., Барковська Н.В. Вища математика для економістів. – К.: ЦУЛ, 2002. – 400 с. – Серія: Математичні науки.

3.1.15. А.О. Antonova, V.I. Trofymenko. Algebra of vectors and Analytic geometry: Manual. – К.: НАУ, 2002, – 108 p.

3.3. Internet resources

3.3.1. https://erudyt.net/dubovyk-yuryk-vyscha-matematyka-navch_posibnyk.

3.3.2. <https://pns.hneu.edu.ua/course/view.php?id=929>


3.3.3. <https://books.google.com.ua/books?isbn=9663825383>

4. RATING SYSTEM OF KNOWLEDGE AND SKILLS ASSESSMENT

4.1. Evaluation of certain types of student academic work done for the study of each module is carried out in accordance with table 4.1.

Table 4.1

Kind of Academic Work	Maximum Grade Values
	The first semester
Solving problems, answering theoretical questions during classroom work	Modules №1
	18 (the total)
Performing and protection of homework 1	7
<i>For carrying out a module test №1 (№2), a student must receive not less</i>	<i>15 point</i>
Module Test №1 (№2)	15
Total for the Module №1	40
	Modules №2
Solving problems, answering theoretical questions during classroom work	18(the total)
Performing and protection of homework 2.1 (2.2)	7
<i>For carrying out a module test №1 (№2), a student must receive not less</i>	<i>15 point</i>
Module Test №2	15
Total for the Module №2	40
Semester Examination	20
Total for the first semester	100

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4.2. The completed certain types of educational work on the knowledge of theoretical material and practical tasks are credited to the student if he received a positive rating for them. (Appendix 1)

4.3. The sum of the grades received by the student for certain types of completed educational work is the current module grade, which is entered into the Module Register.

4.4. The sum of the semester module grade and the examination grade in points makes a total semester grade which is also converted into the grades by the national scale and by the ECTS scale. (Appendix 2)

4.5. The Total Semester Grade is entered into the Examination Register, into a student’s record book and into a student’s educational card in values, National Scale grades, and ECTS Scale grades, for example: **92/Ex/A**, **87/Good/B**, **79/Good/C**, **68/Sat/D**, **65/Sat./E**, etc.

4.6. The Total Semester Grade of the subject that is taught for several semesters, is determined as the arithmetic average grade of the final semester of ratings in points, followed transfer it to assess the national scale and ECTS scale.

The Total Grade of the subject is entered in the Diploma Supplement.

(Ф 03.02 – 01)

АРКУШ ПОШИРЕННЯ ДОКУМЕНТА

№ прим.	Куди передано (підрозділ)	Дата видачі	П.І.Б. отримувача	Підпис отримувача	Примітки

(Ф 03.02 – 02)

АРКУШ ОЗНАЙОМЛЕННЯ З ДОКУМЕНТОМ

№ пор.	Прізвище ім'я по-батькові	Підпис ознайомленої особи	Дата ознайомлення	Примітки

(Ф 03.02 – 04)

АРКУШ РЕЄСТРАЦІЇ РЕВІЗІЇ

№ пор.	Прізвище ім'я по-батькові	Дата ревізії	Підпис	Висновок щодо адекватності

(Ф 03.02 – 03)

АРКУШ ОБЛІКУ ЗМІН

№ зміни	№ листа (сторінки)				Підпис особи, яка внесла зміну	Дата внесення зміни	Дата введення зміни
	Зміненого	Заміненого	Нового	Анульованого			

(Ф 03.02 – 32)

УЗГОДЖЕННЯ ЗМІН

	Підпис	Ініціали, прізвище	Посада	Дата
Розробник				
Узгоджено				
Узгоджено				