

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

AGREED

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«__» _____ 2021

APPROVED

Vice-Rector for Academics

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«__» _____ 2021



Quality Management System

COURSE TRAINING PROGRAM

on

«Higher and Applied Mathematics»

Educational Professional programs: «Management of foreign economic activity»

"Logistics"

"Aviation logistics"

«Management of airlines and airports»

Field of study: 07 "Management and administration"

Specialty: 073 "Management"

Training Form	Semester	Total (hours/credits ECTS)	Lectures	Practicals	Lab. clas.	Self-study	HW/CGP	Semester Grade
Full-time	2	210/7	34	68	-	108	1 HW -1s	Examination -1s

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№ CB-7-073-4 / 21-2.1.8

№ CB-7-073-5 / 21-2.1.8

QMS NAU CTP 19.03-01-2021



Course Training Program on «Higher and Applied Mathematics» is developed on the basis of Educational Professional programs: "Management of foreign economic activity", "Logistics", "Aviation logistics", «Management of airlines and airports», Bachelor Curriculum and Extended Curriculum № CB-7-073-1/21, № ECB-7-073-1/21, № CB-7-073-2/21, № ECB-7-073-2/21, № CB-7-073-3/21, № ECB-7-073-3/21, № CB-7-073-4/21, № ECB-7-073-4/21, № CB-7-073-5/21, № ECB-7-073-5/21 for Speciality 073 "Management" and corresponding normative documents.

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«___» _____ 2021

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INTRODUCTION

The Course Training Program of the subject "Higher and applied mathematics" is developed on the basis of the "Methodical guidance for the development of a course training program of the subject", approved by the order № 249/од. dated 29.04.2021 p. correspondent normative documents.

1. EXPLANATORY NOTE

1.1. Place: this training course is the theoretical basis of knowledge and skills required to master the vast majority of disciplines of professional and practical training in the field of economics.

Objectives of teaching the discipline is to teach students to master the appropriate mathematical tools, which should be sufficient to develop mathematical models related to the further practical activities of specialists.

Tasks of the subject are:

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

1.2. Learning outcomes the subject makes it possible to achieve.

As a result of studying this discipline, the student must acquire the following **learning outcomes:**

- basic knowledge and understanding of mathematics to the extent necessary for the development of general professional and professional disciplines and the use of their methods in the chosen profession;
- identify skills of search, collection and analysis of information, calculation of indicators to justify management decisions.

1.3. Competences the subject makes it possible to acquire

- ability to abstract thinking, analysis, synthesis;
- ability to understand and skillfully use mathematical and numerical methods that are often used in economics and management;
- ability to perform experiments independently, as well as to describe, analyze and critically evaluate experimental data;
- ability to learn and master modern knowledge;
- ability to conduct research at the appropriate level;
- ability to apply knowledge in practical situations;
- the ability to analyze the results of the organization, to compare them with the factors of external and internal environment;
- skills of using information and communication technologies.

1.4. Interdisciplinary Connections

The discipline "Higher Mathematics" is the basis for the study of further disciplines, namely: "Probability theory and mathematical statistics", "Business statistics in management", "Operational management", "Management of economic activity of the enterprise", "Fundamentals of logistics and supply chain management" and others.

2. COURSE TRAINING PROGRAM ON THE SUBJECT

2.1. The subject content

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



–module №1 „Linear algebra. Elements of algebra of vectors and analytic geometry. Pre-calculus. Calculus”;

– module №2 „Integral calculus. Differential equations. Introduction to operations research”, each of which is a logically complete, relatively independent, holistic part of the academic discipline, which involves the assimilation of module test and analysis of the results of its implementation.

2.2. Modular structuring and integrated requirements for each module

Module №1 „Linear algebra. Elements of algebra of vectors and analytic geometry. Precalculus. Calculus”

Integrated requirements for 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;
- Gaussian method and matrix method for solving systems of linear algebraic equations;
- Kronecker-Capelli theorem;
- definition and properties of actions with vectors, scalar product of vectors;
- different types of equations of the line on the plane;
- methods of assignment and classification of functions;
- determination of the boundary of the function at a point;
- formulas of important boundaries and basic theorems about boundaries;
- determination of function continuity and classification of breakpoints;
- definition definition, table of derivatives and rules of differentiation;
- definition and properties of the differential;
- application of differential calculus to the study of functions.
- define the functions of many variables, the scope of its definition, boundaries and continuity;
- definition of partial derivatives, full differential function of many variables;
- application of partial derivatives.

Be able to:

- investigate and solve systems of linear algebraic equations;
- perform linear operations with vectors;
- find the scalar product of vectors and apply it to solving geometric problems;
- write different equations of the line on the plane;
- determine the angles between two lines;
- write down the conditions of parallelism and perpendicularity of lines.
- find the boundary of the function and investigate the function for continuity;
- find derivatives and differentials of different orders of basic elementary functions;
- find derivatives of composite functions, implicitly and parametrically given functions, perform logarithmic differentiation;
- to conduct a full study of the function and build its schedule;
- find partial derivative functions and full differential function of many variables;
- write the equation of the tangent plane and the normal to the surface;
- find the local and conditional extrema of the function of two variables.

Topic 1. Determinants. Matrices.

Content. Determinants of the second and third and n-th order and their properties and their evaluation. Cofactors and minors. Matrices and operations with matrices. Inverse of a matrix. The rank of a matrix.

Topic 2. Systems of linear equations.



Content. *The concept of a system of linear algebraic equations and their solution. Inconsistent and consistent systems of equations. Consistency criterion. Solving the systems of linear equations by Gaussian and matrix methods.*

Topic 3. Vectors. Some types of the line equations in a plane.

Content. *Vector concept. Arithmetics of vectors. Vector in cartesian system of coordinates. Dot product of vectors and its properties.*

Types of equations of a line on a plane: general equation of a line, the slope - intercept form of a line, two-point form of a line, canonical equation of a line, the equation of a line in the segments form.

Topic 4. Limit of a function. Remarkable limits.

Content. *Limit of a function at a point. One-sided limits. Unbounded functions. The limit of function at infinity. Basic theorems about a limit of a function. The first and second remarkable limits.*

Topic 5. Evaluation of a function limit. Continuity of function.

Content *Infinitesimals and their properties. Equivalent infinitesimals. Continuity of a function at a point. Examples of uncertainty calculations. Basic theorems for continuous functions. The points of discontinuity of functions and their classification.*

Topic 6. Derivative of a function, its geometric and economic interpretation. Differential of a function.

Content. *Derivative, its geometric and economic interpretation. Differentiation rules. Table of derivatives. Differentiation of some types of functions. Definition, geometric interpretation and evaluation of differentials.*

Topic 7. Investigation of functions. Curve sketching.

Content. *Monotonic function. Local extremum of a function. Necessary and sufficient conditions for a local extremum. Convexity and concavity a function. Points of inflection. Asymptotes of a curve. The general scheme of sketching the graph of a function.*

Topic 8. Functions of several variables.

Content. *Functions of several variables. Domain of function of two variables. Partial derivatives of first and second orders. Total differentials of first and second orders. Local and conditional extremum of a function of two variables.*

Module №2. „Integral calculus. Differential equations. Introduction to operations research”

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

Know:

- definition of the indefinite integral and its properties;
- integrals of basic elementary functions and methods of integration of various functions;
- definition, conditions of existence and properties of the definite integral; Newton-Leibniz formula;
- application of a definite integral;
- definition of the improper integral of the first kind;
- definition of the first-order differential equation, its general solution, Cauchy problem;
- definition of differential equations with separable variables, homogeneous and linear differential equations;
- definition of linear homogeneous and inhomogeneous differential equations of the second order with constant coefficients;
- the concept of the model of linear programming problems, geometric interpretation and graphical method of solving linear programming problems;
- statement of the transport problem and methods of its solution;
- tasks on minimizing aircraft fuel consumption and distribution of investments.

Be able to:



- apply methods of integration by parts and replacement of variables;
- integrate rational, fractional-rational, some irrational and trigonometric functions;
- calculate the areas of flat figures, the length of the arc of the curve, the volume of the body of rotation, using a definite integral;
- find improper integrals of the first kind;
- solve differential equations with separable variables, homogeneous and linear differential equations;
- solve linear homogeneous differential equations of the second order with constant coefficients and inhomogeneous differential equations of the second order with constant coefficients and the right part of the special form;
- to make models of problems of linear programming and to solve them by a graphic method;
- solve the transport problem and the problem of minimizing fuel consumption by aircraft and the distribution of investment.

Topic 1. Antiderivative. Indefinite integral. Basic methods of integration

Content. *The concept of antiderivative and indefinite integral. Properties of indefinite integral. Table of integrals. Integration by substitution and integration by parts.*

Topic 2. Integration of some functions. Definite integral.

Content. *Integration of rational, irrational and trigonometric functions.*

Topic 3. Definite integral.

Content. *Definite integral. Properties of definite integral. Definite integral with variable upper limit. The Newton-Leibniz formula. Basic methods of evaluating a definite integral.*

Topic 4. Application of definite integral. Improper integral of the first kind.

Content. *Geometric applications of definite integral for calculation of the area of plane figures, length of curve and volumes of solid. Definition and evaluation of improper integral of the first kind.*

Topic 5. First order differential equations.

Content. *The concept of ODE of the first order. General solution of ODE. The Cauchy problem. Separable ODE. Homogeneous first order ODE. The first order linear ODE.*

Topic 6. Second order linear ODE with constant coefficients.

Content. *Homogeneous second order linear ODE with constant coefficients. Characteristic equation. Second order linear ODE with constant coefficients and special form of right-hand side.*

Topic 7. Linear programming (LP) problems. Graphical method for solving LP problems.

Content. *Model building of LP problems. Geometric interpretation and graphical method of solving LP problems.*

Topic 8. Transportation problem.

Content. *Transportation problem. Constructing of initial basic feasible solutions for a transportation problem by least-cost method. Application of potentials method for finding the optimal solution of a transportation problem.*

Topic 9. Some dynamic programming problems.

Content. *Dynamic programming problems. The fuel consumption optimization in air transport. Investment distribution problem.*



2. SUBJECT CONTENT

2.1. Training schedule of the subject

№	Theme (thematic section)	Total, Hours			
		Full-time			
		Total	Lectures	Practical classes	Self study
1	2	3	4	5	6
Module №1. «Linear algebra. Elements of algebra of vectors and analytic geometry. Precalculus. Calculus» .					
1 semester					
1.1	Determinants and matrices	12	2	2 2	6
1.2	Systems of linear equations	12	2	2 2	6
1.3	Vectors. Some types of the line equations in a plane	12	2	2 2	6
1.4	Limit of a function. Remarkable limits	12	2	2 2	6
1.5	Evaluation of a function limit. Continuity of function	12	2	2 2	6
1.6	Derivative of a function, its geometric and economic interpretation. Differential of a function	12	2	2 2	6
1.7	Investigation of functions. Curve sketching	8	2	2	4
1.8	Functions of several variables	12	2	2 2	6
1.9	Homework 1.1	4	–	–	4
1.10	Module Test № 1	4	–	2	2
Total for the module № 1		100	16	32	52
Module №2 «Integral calculus. Differential equations. Introduction to operations research»					
2.1	Antiderivative. Indefinite integral. Basic methods of integration	12	2	2 2	6
2.2	Integration of some functions.	12	2	2 2	6
2.3	Definite integral	8	2	2	4
2.4	Application of definite integral. Improper integral of the first kind	12	2	2 2	6
2.5	First order differential equations	12	2	2 2	6
2.6	Second order linear ODE with constant coefficients	11	2	2 2	5
2.7	Linear programming (LP) problems. Graphical method for solving LP problems.	11	2	2 2	5



2.8	Transportation problem.	12	2	2 2	6
2.9	Some dynamic programming problems	12	2	2 2	6
2.10	Homework 1.2	4	–	–	4
2.11	Module Test № 2	4	–	2	2
Total for the module № 2		110	18	36	56
Total for the 1 semester		210	34	68	108
Total for the subject		210	34	68	108

2.4. Homework

Homework 1.1, 1.2 are performed in the first semester. The purpose of homework: to improve theoretical knowledge and practical skills while studying the material of training modules.

Execution, design and defense of homework is carried out by the student individually in accordance with the guidelines.

The time required to complete each homework is up to 4 hours of independent work.

2.5. Questions list for the examination

The list of questions and content of tasks for preparation for the exam are developed by the leading teacher of the department in accordance with the course training program, approved at the meeting of the department and distributed among students.

3. Basic concepts of guidance on the subject

3.1. Teaching methods

The following teaching methods are used in the study of the discipline:

- explanatory and illustrative method;
- method of problem presentation;
- reproductive method;
- research method.

The implementation of these methods is carried out during lectures, demonstrations, independent problem solving, work with educational literature, analysis and solving economic problems.

3.2. List of references

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. Ластівка І.О. Вища математика: Навч. посібник / І.О. Ластівка, О.І. Безверхий, І.П. Кудзіновська. – К.: НАУ, 2018. – 452 с.

3.2.4. Математичне програмування. Методичні рекомендації до практичних занять для студентів напряму «Менеджмент» / Ластівка, О.С. Давидов. – К.: «НАУ-друк», 2010. – 84 с.

3.2.5. Бурій В.В., Шевченко І.В. Математичне програмування. Модуль 1. Лінійне програмування: Навчальний посібник / За заг. ред. Т.І. Олешко. – К.: НАУ, 2007. – 168 с.

3.2.6. Lial M.L. Mathematics with Applications with Applications in the Management, Natural and Social Sciences (11th Edition) / M.L. Lial, T.W. Hungerford, J.P. Holcomb, B. Mullins. – Pearson: 2014. – 1005p.

3.2.7. Higher mathematics. Linear algebra. Algebra of vectors. Elements of analytic geometry:



Method Guide / compilers: A.O.Antonova, I. S. Klyus, I. O. Lastivka, V. I. Trofymenko. – K. : NAU, 2018. – 60 p

3.2.8. Higher mathematics. Introduction to mathematical analysis: Method Guide / compilers: I. S. Klyus, I. O. Lastivka. – K. : NAU, 2019. – 48 p.

3.2.9. Higher mathematics. Differential calculus of one variable: Method Guide / compilers: I. S. Klyus, I. O. Lastivka. – K. : NAU, 2021. – 48 p.

Additional literature

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

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

3.2.12. Ульянченко О.В. Дослідження операцій в економіці: Підручник для студентів вузів /Харк. нац. аграр. ун-т ім. В. В.Докучаєва. – Х. : Гриф, 2002. – 580 с.

3.2.13. Крюков М.М. Дослідження операцій у транспортних системах у прикладах і задачах: навч. посіб. / М.М. Крюков, Т.В. Кравець, Т.В. Крижановська, В.С. Коновалюк, Т.М. Семененко. – К. : ДЕДУТ, 2010. – 199 с.

3.3 Internet resources

3.3.1. <https://erudyt.net/dubovyk-yuryk-vyscha-matematyka-navch-posibnyk.html>

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

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

3.3.4. <https://www.twirpx.com/file/1579788/>

4. RATING SYSTEM OF KNOWLEDGE AND SKILLS ASSESSMENT

4.2.1. Grading of different kinds of academic work performed by a student is done in accordance with Table 4.1.

Table 4.1

Kind of Academic Work	Maximum Grade Values
	1st semester, modules №1, №2
Solving problems, answers the theoretical questions, etc. during practical classes	22 (the total)
Carrying out and defense of homework 1.1 (1.2)	4 (total)
<i>For admission to complete module test №1(№2), a student must receive not less than</i>	<i>16 point</i>
Module Test №1 (№2)	14
Total for the Module №1 and №2	40
Total for the Module №1 + №2	80
Exam	20
Total for the 1st semester	100



4.2. Completed types of educational work are credited to the student, if he received a positive rating for them.

4.3. The sum of rating assessments received by the student for certain types of completed academic work is the current modular rating assessment, which is recorded in the module control.

4.4. The final semester rating is converted into a grade on the national scale and the ECTS scale.

4.5. The final semester rating in points, on the national scale and the ECTS scale is entered in the test report, study card and individual curriculum of the student (record book), for example, as follows: **92 / Excellent / A, 87 / Good / B, 79 / Good / C, 68 / Sat./D, 65 / Sat./E, etc.**

4.6. The Total Grade for the subject is equal to the average grade from Total Semester Grades with its further transformation into national scale and ECTS system.

The Total Grade is recorded to the Diploma Appendix.



(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				