INTERNATIONAL EUROPEAN UNIVERSITY
Education and Research Institute "European Business School"
Department of Information Technology

Approved by
The Scientific and Methodical Council of the University

Chair of SMC _____

WORKING PROGRAM OF THE ACADEMIC DISCIPLINE:

HIGHER AND APPLIED MATHEMATICS

Knowledge area: 12 Information Technology

Specialty: 121 Software Engineering

Educational program: 121 Software Engineering

Discipline status: Compulsory

Kyiv – 2023

The working program of the Higher and applied mathematics academic discipline is based on the 121 Software Engineering educational and professional program for the first (Bachelor) level of the 121 Software Engineering specialty approved by the University Academic Council on May 30, 2023, protocol No. 4.

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The working program of the academic discipline is reviewed and approved by the Department of Information Technology, protocol dd. August 31, 2023, No. 1.

Head of the Department
Doctor of Science (Techn.),
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The program is reviewed and approved by the Academic Council of the European Business School, protocol dd. September 11, 2023, No. 1.

Chair of the Academic Council
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of the European Business School
Y.S. Remyha,

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INTRODUCTION

The **program of the Higher and applied mathematics academic discipline** is designed according to the Higher Education Standard of Ukraine (hereinafter referred to as the Standard) of the knowledge area: 12 Information Technology, specialty: 121 Software Engineering.

Discipline description (annotation). This academic discipline is one of the obligatory components of the Software Engineering educational program for training future software developers.

Table 1

<table>
<tr><td rowspan="2">Criteria</td><td rowspan="2">Knowledge area, training program, educational level</td><td colspan="2">Discipline characteristics</td></tr>
<tr><td>full-time mode of study</td><td>part-time mode of study</td></tr>
<tr><td>Number of credits – 8</td><td>Knowledge area:
12 INFORMATION TECHNOLOGY</td><td colspan="2"><u>Compulsory</u></td></tr>
<tr><td>Sections – X</td><td rowspan="7">Specialty:
121 SOFTWARE ENGINEERING</td><td colspan="2">Year of training</td></tr>
<tr><td>Content sections – 2</td><td>2023-2024</td><td>2023-2024</td></tr>
<tr><td rowspan="3">Individual research task:</td><td colspan="2">Semester</td></tr>
<tr><td>1st, 2nd</td><td></td></tr>
<tr><td colspan="2">Lectures</td></tr>
<tr><td>48 hours</td><td></td></tr>
<tr><td></td><td colspan="2">Practical classes</td></tr>
<tr><td rowspan="5">Weekly load:
class hours – 4
independent work of students – 6</td><td rowspan="5">Educational level:
Bachelor</td><td>48 hours</td><td></td></tr>
<tr><td colspan="2">Independent work</td></tr>
<tr><td>144 hours</td><td></td></tr>
<tr><td colspan="2">Type of control:</td></tr>
<tr><td>Pass/Fail test, exam</td><td>Pass/Fail test, exam</td></tr>
</table>

Subject matter of the academic discipline: mathematical methods and models.

Interdisciplinary links: the program is arranged according to the annotation of the Bachelor's educational and professional program, is based on the school course of mathematics, precedes the study of such compulsory disciplines as Fundamentals of programming and Fundamentals of software engineering.

The knowledge obtained by students during the study of the Higher and applied mathematics discipline is the foundation for mastering professional disciplines as well as can be applied in on-the-job practical training, preparation of term and qualifying papers on the specialty.

1. GOAL AND OBJECTIVES OF THE ACADEMIC DISCIPLINE

1.1. The **goal** of the **Higher and applied mathematics** discipline: to develop the ability to use mathematical tools to study economic processes, to solve applied economic and optimization problems; to apply economic and mathematical methods and models to solve economic problems; to work in a team and autonomously; to develop abstract thinking, the ability to analyze, synthesize and apply knowledge in practical situations; to develop the ability to make reasoned decisions; to apply computer technologies and data processing software to solve economic problems, analyze information and prepare analytical reports.

1.2. Key objectives of the **Higher and applied mathematics** discipline: to provide students with logical thinking; knowledge and erudition in the application of mathematics in the formulation, analysis and solution of economic and management problems; the ability to independently use and study the literature on mathematics, as well as to develop their intelligence and creative independence.

1.3. **Competencies and learning outcomes** encouraged by the discipline (interrelation with the statutory content of student training stipulated in learning outcome terms of the Standard).

According to the Standard requirements, the discipline provides students with the following ***competencies*** (Table 2):

Table 2

Integral competence	Ability to solve complicated specialized tasks and practical problems in software development characterized by complexity and uncertainty of conditions.
General competencies	Ability to abstract thinking, analysis and synthesis. Ability to apply knowledge in practical situations. Ability to understand the subject matter and professional activities. Ability to learn and acquire contemporary knowledge. Ability to find, process and analyze information from different sources. Ability to keep and multiply moral, cultural, scientific values and achievements of society based on the understanding of history and regularities of subject area development, its place in the general system of knowledge about nature and society and in the evolution of society, engineering and technologies, as well as to use different types and forms of physical activity for outdoor activities and a healthy lifestyle.
Specialized (professional, subject) competencies	Ability to analyze the object of design or operation and its subject area. Ability to use information systems and technology standards in developing functional profiles, designinh and integrating systems, products, services and infrastructure elements of an organization. Ability to design, develop and use the means of implementation of information systems, technologies and information communications (methodical, informational, algorithmic, technical, software, etc.). Ability to select, design, deploy, integrate, manage, administer and mainten information systems, technologies and information communications, services and infrastructure of the organization. Ability to conduct computational experiments, compare the results of experimental data and obtained solutions.

Specification of competencies according to the National Qualifications Framework descriptors in the Competency matrix form:

Table 3

No.	Competence	Knowledge	Skills / Abilities	Communication	Autonomy and responsibility
Integral competence					
1.	Ability to solve complicated specialized tasks and practical problems in software development characterized by complexity and uncertainty of conditions.	Experience in using mathematical methods and models in different industries	Use mathematical apparatus, mathematical methods and models to solve practical problems	Human-machine interaction	Independent construction of mathematical models and approbation on the production site
General competencies					
2.	Ability to abstract thinking, analysis and synthesis. Ability to apply knowledge in practical situations. Ability to understand the subject matter and professional activities. Ability to learn and acquire contemporary knowledge. Ability to find, process and analyze information from different sources.	basic mathematical apparatus, principles of designing mathematical models	mathematically investigate applied problems (of software engineering);	Relation between theoretical and practical knowledge	Monitoring of software engineering processes
Specialized (professional, subject) competencies					
3.	Ability to analyze the object of design or operation and its subject area. Ability to use information systems and technology standards in developing functional profiles, designinh and integrating	using mathematical methods and models of linear and vector algebra, analytical geometry, linear programming, differential and integral calculus, probability theory and	to solve the set mathematical problems; independently study and learn the mathematical apparatus found in the special literature necessary for mastering the profession, choose the optimal methods	to apply mathematical methods and models in professional activities	description of software engineering processes

	systems, products, services and infrastructure elements of an organization. Ability to design, develop and use the means of implementation of information systems, technologies and information communications (methodical, informational, algorithmic, technical, software, etc.). Ability to select, design, deploy, integrate, manage, administer and mainten information systems, technologies and information communications, services and infrastructure of the organization. Ability to conduct computational experiments, compare the results of experimental data and obtained solutions.	mathematical statistics	of solving problems, carry out interpretation and evaluation of the results; choose and use the necessary computational tools.		

Integrated final program learning outcomes encouraged by the academic discipline:

Program learning outcomes Bachelor's qualifying paper

Learning outcomes:

After learning the discipline, students should

know:

- basic mathematical concepts and methods of solving typical problems of linear algebra, analytical geometry, differential and integral calculus of functions of one and many variables, numerical and functional series, differential equations;
- the role and place of mathematics in modern information and communication

space and professional activities of a specialist;
- methods of mathematical research of applied problems of basic economic theory, microeconomics, management and other professional disciplines.

be able to:

- solve the set mathematical problems;
- independently study and recognize mathematical apparatus encountered in special literature necessary for mastering the profession;
- mathematically investigate applied problems (of aviation management);
- choose optimal methods of problem solving, interpret and evaluate the results; choose and use the necessary computational tools.

1. INFORMATION CAPACITY OF THE ACADEMIC DISCIPLINE

SECTION 1

CONTENT SECTION 1
METHODS AND MODELS OF LINEAR ALGEBRA

Topic 1.1. Matrices and determinants.
Topic 1.2. Systems of linear equations.
Topic 1.3. Leontiev model of multi-sectoral economy.

CONTENT SECTION 2
METHODS AND MODELS OF VECTOR ALGEBRA AND ANALYTIC GEOMETRY

Topic 2.1. Actions on vectors.
Topic 2.2. Eigenvectors and matrix values. International trade model.
Topic 2.3. Economic problems solved using elements of analytic geometry.

CONTENT SECTION 3
LINEAR PROGRAMMING MODELS

Topic 3.1. Problems of linear programming. Graphical method of resolution.
Topic 3.2. Simplex method of solving linear programming problems.
Topic 3.3. Duality in linear programming
Topic 3.4. Transportation problem

SECTION 2

CONTENT SECTION 4
METHODS AND MODELS OF DIFFERENTIAL AND INTEGRAL CALCULUS

Topic 4.1. Boundary function.
Topic 4.1. Problems of monetary mathematics.
Topic 4.3. Derivative of a function, its economic content.
Topic 4.4. Extremum of a function.

Topic 4.5. Function of many variables.
Topic 4.6. Extremum of a function of many variables.
Topic 4.7. Undefined integral.
Topic 4.8. Using definite integrals.
Topic 4.9. Differential equations.

CONTENT SECTION 5
DIFFERENTIAL EQUATIONS

Topic 5.1. Basic concepts and theorems of probability theory
Topic 5.2. Random variables. Basic laws of distribution of random variables.
Topic 5.3. The law of large numbers and boundary theorems.
Topic 5.4. Elements of mathematical statistics.

Sections and topics	Amount of hours			
	Total	including		
		Lectures	Practical classes	Independent work
Section 1.				
Content section 1. Methods and models of linear algebra				
Topic 1.1. Matrices and determinants.	11	2	2	7
Topic 1.2. Systems of linear equations.	15	4	4	7
Topic 1.3. Leontiev model of multi-sectoral economy.	11	2	2	7
Content section 2. **Methods and models of vector algebra and analytic geometry**				
Topic 2.1. Actions on vectors.	11	2	2	7
Topic 2.2. Eigenvectors and matrix values. International trade model.	11	2	2	7
Topic 2.3. Economic problems solved using elements of analytic geometry.	11	2	2	7
Content section 3. **Linear programming models**				
Topic 3.1. Problems of linear programming. Graphical method of resolution.	11	2	2	7
Topic 3.2. Simplex method of solving linear programming problems.	12	2	2	8
Topic 3.3. Duality in linear programming	13	2	2	8
Topic 3.4. Transportation problem	15	4	4	7
Total per section 1	120	24	24	72
Section 2.				
Content section 4. **Methods and models of differential and integral calculus**				
Topic 4.1. Boundary function.	10	2	2	6
Topic 4.1. Problems of monetary mathematics.	10	2	2	6

Topic 4.3. Derivative of a function, its economic content.	10	2	2	6
Topic 4.4. Extremum of a function.	10	2	2	6
Topic 4.5. Function of many variables.	10	2	2	6
Topic 4.6. Extremum of a function of many variables.	10	2	2	6
Topic 4.7. Undefined integral.	10	2	2	6
Topic 4.8. Using definite integrals.	10	2	2	6
Content section 5. Differential equations				
Topic 5.1. Basic concepts and theorems of probability theory	10	2	2	6
Topic 5.2. Random variables. Basic laws of distribution of random variables.	10	2	2	6
Topic 5.3. Elements of mathematical statistics.	20	4	4	12
Total per section 2	120	24	24	72

4. TOPICS OF LECTURES

No.	Lecture topic and list of key questions
1	MATRICES AND DETERMINANTS. Matrices, main concepts. The determinant of a matrix, calculation of determinants. Practical application.
2	SYSTEMS OF LINEAR EQUATIONS. Matrices, main concepts. The determinant of a matrix, calculation of determinants. Practical application. Systems of linear equations, basic definitions. Methods of solving systems of linear equations: Gauss method, Cramer's formulas.
3	LEONTIEV MODEL OF MULTI-SECTORAL ECONOMY. Leontiev model of multi-sector economy, concept of cost matrices, full costs, intermediary costs, Leontiev's productivity criterion, equilibrium price and international trade models.
4	ACTIONS ON VECTORS. The concept of vector. Actions on vectors. Scalar, vector, mixed product. Concept of product space, price vector.
5	EIGENVECTORS AND MATRIX VALUES. The concept of eigenvector, characteristic equation, eigenvalue of matrix. Linear model, structural mother of trade. Matrix and Frobenius numbers. Matrix performance criterion.
6	ECONOMIC PROBLEMS SOLVED USING ELEMENTS OF ANALYTIC GEOMETRY. Equation of a line in a plane, a plane and a line in space. Curves (lines) of the second order: circle, ellipse, hyperbola, parabola. Economic model of market equilibrium, equilibrium price and equilibrium point, the essence of the economic model of equilibrium and company losses. Economic content tasks.
7	PROBLEMS OF LINEAR PROGRAMMING. GRAPHICAL METHOD OF RESOLUTION. Examples of linear programming problems. General mathematical model of linear programming, the form of its recording. Geometric interpretation of linear programming problems. Graphical method.

8	SIMPLEX METHOD OF SOLVING LINEAR PROGRAMMING PROBLEMS. Simplex method with standard basis. Basic terms and concepts. Construction of economic and mathematical model. Description of the simplex method.
9	DUALITY IN LINEAR PROGRAMMING. A pair of mutually dual problems. Basic duality theorems. Finding the solution of dual problems.
10	TRANSPORTATION PROBLEM. Formulation of the transportation problem and its characteristics. Methods of search of initial reference plans of the transportation problem by the method of potentials.
11	BOUNDARY FUNCTION. The concept of function. Methods of function assignment. Basic elementary functions. Boundary function.
12	PROBLEMS OF MONETARY MATHEMATICS. Simple and compound interest. Calculation of rent, repayment of debt.
13	DERIVATIVE OF A FUNCTION, ITS ECONOMIC CONTENT. The concept of derivative, its geometric, mechanical, economic content. Differential of a function. Calculation of average costs, labor productivity. Derivatives and differentials of higher orders. Price elasticity of supply and demand.
14	EXTREMUM OF A FUNCTION. Maximum and minimum of a function. Necessary and sufficient conditions for the existence of an extremum of a function. The second sufficient condition for the existence of an extremum. Necessary and sufficient conditions for the existence of inflection points. Extremum of a function in applied problems.
15	FUNCTION OF MANY VARIABLES. The concept of a function of many variables. Level lines of a function of two variables x. Partial increments and partial derivatives. Elasticity of demand function; Cobbo-Douglas production function. Average labor productivity, average stock output and average stock-employment. Fisher's equation of exchange.
16	EXTREMUM OF A FUNCTION OF MANY VARIABLES. Necessary and sufficient conditions for the existence of the extremum of a function of two variables. Finding the conditional extremum by the Lagrange method. The method of least squares.
17	UNDEFINED INTEGRAL. The concept of the original, indefinite integral. Table and methods of calculating integrals. Applied problems.
18	USING DEFINITE INTEGRALS. Definite integral, properties, Newton-Leibniz formula. Substitution of variable and integration by parts in the definite integral. Economic content of the definite integral. Area of plane figures and volumes of bodies of revolution. Finding the change of total cost; configuration of profit and income; mean values of cost, profit and income; total profit by means of definite integral. Lorenz curve, coefficient of inequality of income distribution of the Lorenz curve. The surplus value of the producer.
19	BASIC CONCEPTS AND THEOREMS OF PROBABILITY THEORY. Random event. Classical and statistical definition of probability. Theorems of addition and multiplication of probabilities. Total probability formula and Bayes formulae. Bernoulli's scheme.

20	RANDOM VARIABLES. BASIC LAWS OF DISTRIBUTION OF RANDOM VARIABLES. Discrete and continuous random variables. Numerical characteristics of random variables. Basic laws of distribution of random variables.
21	ELEMENTS OF MATHEMATICAL STATISTICS. Statistical distribution of a sample. Numerical characteristics. Point and intervals for estimating parameters of the general population. Hypothesis testing.

5. TOPICS OF PRACTICAL CLASSES

No.	Topic	Amount of hours
1.	MATRICES AND DETERMINANTS. Matrices, main concepts. The determinant of a matrix, calculation of determinants. Practical application.	2
2.	SYSTEMS OF LINEAR EQUATIONS. Matrices, main concepts. The determinant of a matrix, calculation of determinants. Practical application. Systems of linear equations, basic definitions. Methods of solving systems of linear equations: Gauss method, Cramer's formulas.	4
3.	LEONTIEV MODEL OF MULTI-SECTORAL ECONOMY. Leontiev model of multi-sector economy, concept of cost matrices, full costs, intermediary costs, Leontiev's productivity criterion, equilibrium price and international trade models.	2
4.	ACTIONS ON VECTORS. The concept of vector. Actions on vectors. Scalar, vector, mixed product. Concept of product space, price vector.	2
5.	EIGENVECTORS AND MATRIX VALUES. The concept of eigenvector, characteristic equation, eigenvalue of matrix. Linear model, structural mother of trade. Matrix and Frobenius numbers. Matrix performance criterion.	2
6	ECONOMIC PROBLEMS SOLVED USING ELEMENTS OF ANALYTIC GEOMETRY. Equation of a line in a plane, a plane and a line in space. Curves (lines) of the second order: circle, ellipse, hyperbola, parabola. Economic model of market equilibrium, equilibrium price and equilibrium point, the essence of the economic model of equilibrium and company losses. Economic content tasks.	2
7	PROBLEMS OF LINEAR PROGRAMMING. GRAPHICAL METHOD OF RESOLUTION. Examples of linear programming problems. General mathematical model of linear programming, the form of its recording. Geometric interpretation of linear programming problems. Graphical method.	2
8	SIMPLEX METHOD OF SOLVING LINEAR PROGRAMMING PROBLEMS. Simplex method with standard basis. Basic terms and concepts. Construction of economic and mathematical model. Description of the simplex method.	2
9	DUALITY IN LINEAR PROGRAMMING. A pair of mutually dual problems. Basic duality theorems. Finding the solution of dual problems.	2

10	TRANSPORTATION PROBLEM. Formulation of the transportation problem and its characteristics. Methods of search of initial reference plans of the transportation problem by the method of potentials.	4
11	BOUNDARY FUNCTION. The concept of function. Methods of function assignment. Basic elementary functions. Boundary function.	2
12	PROBLEMS OF MONETARY MATHEMATICS. Simple and compound interest. Calculation of rent, repayment of debt.	2
13	DERIVATIVE OF A FUNCTION, ITS ECONOMIC CONTENT. The concept of derivative, its geometric, mechanical, economic content. Differential of a function. Calculation of average costs, labor productivity. Derivatives and differentials of higher orders. Price elasticity of supply and demand.	2
14	EXTREMUM OF A FUNCTION. Maximum and minimum of a function. Necessary and sufficient conditions for the existence of an extremum of a function. The second sufficient condition for the existence of an extremum. Necessary and sufficient conditions for the existence of inflection points. Extremum of a function in applied problems.	2
15	FUNCTION OF MANY VARIABLES. The concept of a function of many variables. Level lines of a function of two variables x. Partial increments and partial derivatives. Elasticity of demand function; Cobbo-Douglas production function. Average labor productivity, average stock output and average stock-employment. Fisher's equation of exchange.	2
16	EXTREMUM OF A FUNCTION OF MANY VARIABLES. Necessary and sufficient conditions for the existence of the extremum of a function of two variables. Finding the conditional extremum by the Lagrange method. The method of least squares.	2
17	UNDEFINED INTEGRAL. The concept of the original, indefinite integral. Table and methods of calculating integrals. Applied problems.	2
18	USING DEFINITE INTEGRALS. Definite integral, properties, Newton-Leibniz formula. Substitution of variable and integration by parts in the definite integral. Economic content of the definite integral. Area of plane figures and volumes of bodies of revolution. Finding the change of total cost; configuration of profit and income; mean values of cost, profit and income; total profit by means of definite integral. Lorenz curve, coefficient of inequality of income distribution of the Lorenz curve. The surplus value of the producer.	2
19	BASIC CONCEPTS AND THEOREMS OF PROBABILITY THEORY. Random event. Classical and statistical definition of probability. Theorems of addition and multiplication of probabilities. Total probability formula and Bayes formulae. Bernoulli's scheme.	2
20	RANDOM VARIABLES. BASIC LAWS OF DISTRIBUTION OF RANDOM VARIABLES. Discrete and continuous random variables.	2

	Numerical characteristics of random variables. Basic laws of distribution of random variables.	
21	ELEMENTS OF MATHEMATICAL STATISTICS. Statistical distribution of a sample. Numerical characteristics. Point and intervals for estimating parameters of the general population. Hypothesis testing.	4
Total:		48

6. INDEPENDENT WORK

No.	Topic	Amount of hours
1.	MATRICES AND DETERMINANTS. Matrices, main concepts. The determinant of a matrix, calculation of determinants. Practical application.	7
2.	SYSTEMS OF LINEAR EQUATIONS. Matrices, main concepts. The determinant of a matrix, calculation of determinants. Practical application. Systems of linear equations, basic definitions. Methods of solving systems of linear equations: Gauss method, Cramer's formulas.	7
3.	LEONTIEV MODEL OF MULTI-SECTORAL ECONOMY. Leontiev model of multi-sector economy, concept of cost matrices, full costs, intermediary costs, Leontiev's productivity criterion, equilibrium price and international trade models.	7
4.	ACTIONS ON VECTORS. The concept of vector. Actions on vectors. Scalar, vector, mixed product. Concept of product space, price vector.	7
5.	EIGENVECTORS AND MATRIX VALUES. The concept of eigenvector, characteristic equation, eigenvalue of matrix. Linear model, structural mother of trade. Matrix and Frobenius numbers. Matrix performance criterion.	7
6.	ECONOMIC PROBLEMS SOLVED USING ELEMENTS OF ANALYTIC GEOMETRY. Equation of a line in a plane, a plane and a line in space. Curves (lines) of the second order: circle, ellipse, hyperbola, parabola. Economic model of market equilibrium, equilibrium price and equilibrium point, the essence of the economic model of equilibrium and company losses. Economic content tasks.	7
7.	PROBLEMS OF LINEAR PROGRAMMING. GRAPHICAL METHOD OF RESOLUTION. Examples of linear programming problems. General mathematical model of linear programming, the form of its recording. Geometric interpretation of linear programming problems. Graphical method.	7
8.	SIMPLEX METHOD OF SOLVING LINEAR PROGRAMMING PROBLEMS. Simplex method with standard basis. Basic terms and concepts. Construction of economic and mathematical model. Description of the simplex method.	8

9.	DUALITY IN LINEAR PROGRAMMING. A pair of mutually dual problems. Basic duality theorems. Finding the solution of dual problems.	8
10.	TRANSPORTATION PROBLEM. Formulation of the transportation problem and its characteristics. Methods of search of initial reference plans of the transportation problem by the method of potentials.	7
11.	BOUNDARY FUNCTION. The concept of function. Methods of function assignment. Basic elementary functions. Boundary function.	6
12.	PROBLEMS OF MONETARY MATHEMATICS. Simple and compound interest. Calculation of rent, repayment of debt.	6
13.	DERIVATIVE OF A FUNCTION, ITS ECONOMIC CONTENT. The concept of derivative, its geometric, mechanical, economic content. Differential of a function. Calculation of average costs, labor productivity. Derivatives and differentials of higher orders. Price elasticity of supply and demand.	6
14.	EXTREMUM OF A FUNCTION. Maximum and minimum of a function. Necessary and sufficient conditions for the existence of an extremum of a function. The second sufficient condition for the existence of an extremum. Necessary and sufficient conditions for the existence of inflection points. Extremum of a function in applied problems.	6
15.	FUNCTION OF MANY VARIABLES. The concept of a function of many variables. Level lines of a function of two variables x. Partial increments and partial derivatives. Elasticity of demand function; Cobbo-Douglas production function. Average labor productivity, average stock output and average stock-employment. Fisher's equation of exchange.	6
16.	EXTREMUM OF A FUNCTION OF MANY VARIABLES. Necessary and sufficient conditions for the existence of the extremum of a function of two variables. Finding the conditional extremum by the Lagrange method. The method of least squares.	6
17.	UNDEFINED INTEGRAL. The concept of the original, indefinite integral. Table and methods of calculating integrals. Applied problems.	6
18.	USING DEFINITE INTEGRALS. Definite integral, properties, Newton-Leibniz formula. Substitution of variable and integration by parts in the definite integral. Economic content of the definite integral. Area of plane figures and volumes of bodies of revolution. Finding the change of total cost; configuration of profit and income; mean values of cost, profit and income; total profit by means of definite integral. Lorenz curve, coefficient of inequality of income distribution of the Lorenz curve. The surplus value of the producer.	6
19.	BASIC CONCEPTS AND THEOREMS OF PROBABILITY THEORY. Random event. Classical and statistical definition of probability. Theorems of addition and multiplication of probabilities. Total probability formula and Bayes formulae. Bernoulli's scheme.	6

20.	RANDOM VARIABLES. BASIC LAWS OF DISTRIBUTION OF RANDOM VARIABLES. Discrete and continuous random variables. Numerical characteristics of random variables. Basic laws of distribution of random variables.	6
21.	ELEMENTS OF MATHEMATICAL STATISTICS. Statistical distribution of a sample. Numerical characteristics. Point and intervals for estimating parameters of the general population. Hypothesis testing.	12
Total:		144

7. TRAINING METHODS

Teaching the Higher and applied mathematics discipline, one uses information and practical training methods: classical lectures, discussion lectures and practical classes, as well as consultations on the accomplishment of independent work of students, written assignments during test works.

Methods of learning and cognitive activity: explanatory and illustrative method, reproductive method, problem presentation method, partially exploratory or heuristic method, research method.

Methods of stimulation and motivation of learning and cognitive activity: inductive and deductive teaching methods; methods of stimulation and motivation of learning.

8. CONTROL METHODS

The plan of the Higher and applied mathematics discipline implies carrying out of current and final control.

Current control is the assessment of the level of knowledge, skills and abilities of students carried out during the educational process by conducting a written survey at the end of sections (module colloquium). Modular control in special situations can be carried out in the form of a networked computerized test with fixed response time.

9. FORM OF STUDENT PERFORMANCE FINAL CONTROL

The form of final control is the **exam** taken on-campus (or in the form of computer test in case of a specific situation) in the period stipulated by the Dean's office or according to the individual schedule stipulated by the curriculum.

10. SCORING SYSTEM

Scoring during the semester

No.	Type of activity	Number of points per didactic unit	Number	Total points
1	Testing on lecture materials	3	8	24
3	Accomplishment of independent works	5	12	36
Exam		40		40
Maximum grade				100

General assessment of student knowledge due to current control

The results of current control of student knowledge are assessed in general ranging from **0** to **60** points.

Students are allowed to final control if they fulfil the requirements of the training program and obtain at least **36** points for the current learning activity.

Final assessment of student knowledge

Final assessment of student knowledge is conducted in the form of **exam**.

Knowledge assessment criteria during the exam

Maximum amount of points that can be obtained in the exam is **40** points.

Allocation of assessment points during final control in the academic discipline

Grade in points for current assessment	Grade in points for final assessment	Grade according to the national scale
54-60	36-40	Excellent
45-53	30-35	Good
36-44	24-29	Satisfactory
less than 36	less than 24	Fail

Assessing the answer to the particular question, one takes into account the following gaps and mistakes:

– untidy preparation of work (nonconventional abbreviations, unclear handwriting, use of pencils instead of clear inks) (minus **2** points);

– incorrectness in certain economic categories and definitions (minus **4** points).

Assessment criteria for answers to theoretical questions of the exam card:

1. The full answer to the question rated as ***excellent (40 points)*** should correspond to the following requirements:

– detailed, comprehensive representation of the content of the given problem;

– full list of economic categories and laws required to reveal the question;

– ability to carry out a comparative analysis of various theories, concepts, approaches and make logical conclusions and generalizations;

– ability to apply methods for the scientific analysis of economic phenomena, processes and characterize their features and forms of appearance;

– demonstration of the ability to express and reason your own attitude to alternative views on this question;

– use of relevant actual and statistical data, knowledge of dates and historical periods that prove key points of the answer.

2. The answer to the question is rated as ***good (30 points)*** if:

– the answer for the highest grade does not reveal at least one of the above-mentioned points (if it is definitely required to reveal the question comprehensively), or if:

– revealing the question correctly in general according to the above-mentioned requirements, one makes some mistakes while using digital materials.

3. The answer to the question is rated as ***satisfactory (20 points)*** if:

– the answer for the highest grade does not reveal four and more points specified in its requirements (if they are required to reveal the question comprehensively);

– there are four or more gaps characterizing individually assessment criteria;

– conclusions made during the answer do not correspond to correct or generally defined ones with the absence of evidence for opposite facts given in the answer;

– the character of the answer gives reason to state that persons fail to understand the question properly or do not know the correct answer, and that is why fail to answer in actual fact, making serious mistakes.

Taking into account the above-said, the exam results are assessed between **0** and **40** points. Besides, if the answer is rated as less than 30%, students receive the fail grade due to the exam results and the fail overall final grade.

The overall final grade in the discipline consists of the sum of points for the results of knowledge current control and for accomplishment of tasks defined for the exam.

The overall final grade cannot exceed **100 points**.

The overall final grade in points according to the national and ECTS scales is put into the examination and test register, academic card and credit book of students.

National and ECTS grading scale

<table>
<tr><td rowspan="2">Sum of points for all types of educational activities</td><td rowspan="2">ECTS grade</td><td colspan="2">Grade according to the national scale</td></tr>
<tr><td>for exam, term paper, practical training</td><td>for Pass/Fail test</td></tr>
<tr><td>90-100</td><td>A</td><td>excellent</td><td rowspan="5">pass</td></tr>
<tr><td>82-89</td><td>B</td><td rowspan="2">good</td></tr>
<tr><td>74-81</td><td>C</td></tr>
<tr><td>66-73</td><td>D</td><td rowspan="2">satisfactory</td></tr>
<tr><td>60-65</td><td>E</td></tr>
<tr><td>30-59</td><td>FX</td><td>fail with possible repeated pass</td><td>fail with possible repeated pass</td></tr>
<tr><td>1-29</td><td>F</td><td>fail with obligatory repeated learning of the discipline</td><td>fail with obligatory repeated learning of the discipline</td></tr>
</table>

11. METHODICAL SUPPORT:

- working program of the discipline;
- electronic course with lectures, guidelines to practical classes, tests and materials for independent work of students;
- list of questions for the exam.

12. RECOMMENDED READING

1. Bilousova S.V. Economic and mathematical modeling. Compendium and workshop: study guide / S.V. Bilousova, T.V. Kovalchuk. - Kyiv: KNUTE, 2018. - 468 p.

2. Kovalchuk T.V. Higher mathematics for economists: textbook / T.V. Kovalchuk, V.S. Martynenko, V.I. Denysenko. - Kyiv: KNUTE. - Part 2, 2007. - 341 p.

3. Mathematics for economists. Collection of tasks: study guide / Bilousova S.V., Boryseiko V.O., Hladka Y.A. et al. - K.: KNUTE, 2015. - 504 p.

4. Shchetinina O.K. Higher and applied mathematics in economic examples and problems. Workshop, part 1: study guide / O.K. Shchetinina, T.V. Kovalchuk et al. - K.: KNUTE, 2017 - 229 p.

5. Shchetinina O.K. Higher and applied mathematics in economic examples and problems. Workshop, part 2: study guide / O.K. Shchetinina, S.V. Bilousova, Y.A. Hladka, T.V. Kovalchuk. - K.: KNUTE, 2019 - 310 p.

6. Dubovyk V.P., Yuryk I.I. Higher Mathematics. - K.: Higher School, 1993. - 648 p.

7. Ventzel E.S. Probability Theory. – M.: Nauka, 1979. - 576 p.

Additional literature

8. Barkovskyi V.V. Higher Mathematics for Economists: study guide / V.V. Barkovskyi, N.V. Barkovska. - K.: Center for Educational Literature, 2010. – 448 p.

9. Borovyk O.V., Borovyk L.V. Research of operations in the economy. – K.: Center for Educational Literature, 2007.

10. Hryshchenko M.V. Mathematics for economists: textbook / M.V. Hryshchenko. – K.: Kyiv University Publishing Center, 2008. - 599 p.

11. Pasichnyk Y.A. Mathematics for economists: textbook / Y.A. Pasichnyk. - Ostroh: National University of Ostroh Academy, 2010. – 432 p.