NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCES OF UKRAINE
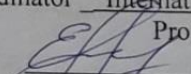
Department of Statistics and Economic Analysis

"CONFIRMED"
Dean of the Economic faculty,

Anatoliy Dibrova
"____"_____ 2023

"APPROVED"
at the meeting of the Department
of Statistics and Economic Analysis
Protocol № 12 from "28" April 2023
Head of the Department

_____ Inna Lazaryshyna

"REVIEWED"
Program Coordinator "International Economics"
Program Coordinator
Olena Kireitseva

PROGRAM OF THE COURSE

"ECONOMIC AND MATHEMATICAL METHODS AND MODEL"

Specialization _____ 051 "Economics" _____
Educational program ____ "International Economics" _____
Economic Faculty _____
Developers:_ Oksana Makarchuk, Associate Professor of the Department of Statistics and Economic Analysis, PhD in Economics

Kyiv – 2023

1. Description of the discipline
ECONOMIC AND MATHEMATICAL METHODS AND MODEL

Field of knowledge, specialization, educational program, educational degree	
Educational degree	*bachelor* *(Bachelor's, Master's)*
Specialization	*051"Economics"_____* *Code and Name of specialization*
Educational program	*International Economics_* *Name of program*

Characteristics of the course	
Type	Compulsory
Total number of hours	120
Number of ECTS credits	4
Number of content modules	2
Course project (work) (if applicable)	-
Form of assessment	*Exam*

Indicators of the course for full-time and part-time forms of study		
	Full-time form of study	Part-time form of study
Course (year of study)	3	
Semester	6	
Lecture classes	*15 hr.*	*hr.*
Practical, seminar classes	*45 hr.*	*hr.*
Laboratory classes	*hr.*	*hr.*
Self-study	*60 hr.*	*hr.*
Individual assignments	*hr.*	*hr.*
Number of weekly classroom hours for the full-time form of study	*4 hr.*	

2. Purpose, objectives, and competencies of the course

Methodological aspects of economic and mathematical modeling, conceptual provisions, models and methods of optimization problems, basics of systems analysis are considered.

The purpose of the discipline "Economic and mathematical methods and models" is to form a system of special knowledge and practical skills in the field of knowledge formation on methodology and tools of construction, as well as adequate use of different types of economic and mathematical models and methods.

The subject of the discipline "Economic-mathematical methods and models" is the methodology and tools of economic-mathematical modeling and analysis of economic objects, processes, phenomena, trends and cause-and-effect relationships in economics; theoretical and practical issues of economic and financial risk analysis.

The main objectives of the discipline "Economic and mathematical methods and models" are students to learn the basic principles and tools for setting problems, basic methods of solving and analyzing them for widespread use in economics and business.

As a result of studying the discipline the student must:

know: the theory of construction of economic and mathematical modeling and mastering the methods of solving optimization problems, as well as some subclasses of nonlinear problems programming;

be able to: use programming as a method of cognition and analysis; professionally and creatively approach the preparation and adoption of management decisions on the enterprise, analyze and summarize the results of production and economic and commercial and financial activities, justify the main directions of economic policy, to predict the consequences of decisions and measures taken at any given time.

The discipline provides the formation of a number of general and special (professional, subject) competencies:

Acquision of competencies:
Integrated competencies (IC): The ability to solve complex specialized problems and practical problems in the economic sphere, which are characterized the complexity and uncertainty of the conditions it implies application of theories and methods of economic science.

General competencies (GC):
GC 3. Ability to abstract thinking, analysis and synthesis
GC 4. Ability to apply knowledge in practical situations
GC 6. Ability to communicate in a foreign language.
GC 7. Information and communication skills technologies.
GC8. Ability to search, process and analyze information from various sources.
GC 11. Ability to make informed decisions.

Professional (special) competencies (PC):
PC 1. Ability to demonstrate knowledge and understanding of issues the subject area, the foundations of the functioning of the modern economy at the micro-, MSSO-, macro-international levels.
PC 4. Ability to explain economic and social processes and phenomena based on theoretical models, analyze and meaningfully interpret the obtained results.
PC 6. Ability to apply economic and mathematical methods and models for solving economic problems.
PC 7. Ability to use computer technologies and data processing software to solve economic tasks, information analysis and preparation analytical reports.
PC 8. Ability to analyze and solve tasks in the field economic and social-labour relations.
PC 9. Ability to predict based on standard theoretical and econometric models of socio-economic trends.
PC 12. The ability to identify problems independently is economical character when

analyzing specific situations, to propose methods of solving them.

Program learning outcomes (PLO):

PLO 3. Know and use economic terminology, explain the basic concepts of micro- and macroeconomics.

PLO 4. Understand the principles of economic science, features functioning of economic systems.

PLO 5. Apply analytical and methodical tools for the justification of proposals and acceptance of managerial ones decisions by various economic agents (individuals, households, enterprises and bodies state authorities).

PLO 7. Explain the models of socio-economic phenomena from the point of view fundamental principles and knowledge based on understanding the main directions of the development of economic science.

PLO 8. Apply appropriate economic and mathematical methods and models for solving economic problems.

PLO 12. Apply acquired theoretical knowledge for solving practical tasks and meaningfully interpret the received the results

PLO 13. Identify sources and understand methodology definitions and methods of obtaining socio-economic data, collect and analyse the necessary information, calculate economic and social indicators.

PLO 16. Be able to use data, provide arguments, critically evaluate logic and form scientific conclusions and analytical texts on economics.

PLO 21. Be able to think abstractly, apply analysis and synthesis to identify key characteristics of economic systems of different levels, as well as the characteristics of the behaviour of their subjects.

3. Program and structure of the course for:

- complete full-time form of education.

The programme of the discipline
Economic and mathematical methods and model

CONTENT MODULE 1. Conceptual aspects of economic and mathematical modeling

Topic 1. Theoretical foundations of mathematical modeling and classification of models

Economic and mathematical modeling is one of the effective methods of describing the functioning of complex socio-economic objects and processes in the form of mathematical models, thus combining economics and mathematics.

Topic 2. Principles and stages of construction of economic and mathematical models

To build a set of interconnected economic and mathematical models, as well as

any individual model, you need a set of principles (rules of the game) that allow you to correctly carry out the process of formalizing modeling systems and objects. The general principles of economic and mathematical modeling follow from the general foundations of systems analysis, ie they should be answers to the questions: 1) what should be done? 2) when should it be done? 3) with whose help should it be done? 4) on the basis of what information are the relevant actions taken? 5) what result should be obtained on the basis of these actions?

Topic 3. The main methods of formalizing economic conditions

Modeling techniques. Target setting of the problem, indicator of optimization criterion, target function. The concept of limiting economic and mathematical problems, their classification. Basic methods of formalization of constraints (conditions) of problems: at the set coefficients at unknown and volumes of restrictions; with varying amounts of restrictions; reception of the "reflected" variable; conditions of proportional communication; under the condition of changing technical and economic coefficients for unknown problems, the method of summation coefficients.

Topic 4. The general problem of linear programming and its canonical figures

Peculiarities of linear programming problems and their application in the national economy are shown.

The concept of the general problem of linear programming is given. An expanded, vector-matrix record of the general problem of linear programming is given. The concepts of basic and natural constraints, matrices of basic conditions are introduced. Basic analytical properties of linear problems programming

Definition of the reference plan of the linear programming problem and its consequences (the concept of degeneracy and nondegeneracy of the reference plan). Hard and non-hard limits. Figures (forms) of linear programming problems. Transition rules and examples. Two ways to eliminate variables that are unlimited by sign.

CONTENT MODULE 2. Fundamentals of the theory of methods optimization

Topic 5. Geometric interpretation tasks linear programming

The concept of n - measurable space (the main variables of the linear problem programming). Geometric interpretation of constraints-equations and constraints-inequalities. The concept of normal vector (gradient vector, guide vector). Interpretation of the linear form (objective function) of the problem as a level line or level hyperplane. Finding extreme points. Finding solutions to linear programming problems.

Topic 6. Solution of ZLP simplex method and its modifications

The idea of the simplex method is to search for the vertices of a polygon (polyhedron) of plans for a linear programming problem in a purposeful direction. Theorem on finiteness of vertices of a polyhedron of problem plans. Simplex - means simple (from Latin). The main requirement of the simplex method for linear programming problems is that the problems must be written in a standard (first canonical figure).

Determination of basic, reference, optimal plan of linear programming problem. Rules for building basic, reference, optimal plans. Signs of support and optimality.

Topic 7. Distribution problems of linear programming

Methods of construction of initial plans: north-western corner, minimum element, double marks.

Application of the potential method to find the optimal plans of the vehicle. Features of solving open transport problems and problems with degenerate plan. Transport problem as a variety of distribution tasks. Distribution tasks are considered and examples of their application in the national economy are given. The statement of the transport problem is given. The concept of balance condition. The issues of closed transport tasks (tasks with the right balance) are considered.

Algorithm of potential method, its phasing: construction of potential system on the basis of the first potential condition, check of plans for fulfillment of the second condition of potentiality, construction of cycle, choice of value change of plan, change of plan, change of system of potentials.

Topic 9. Economic and mathematical analysis of solutions of optimization problems

The given theorems of duality allow to use the solution of double tasks (double estimates, objectively due to estimates) for analysis optimal plan of the direct problem. Thus, if the value of the double score is non-zero - it means that the production resource is limited, limits the further increase of production, and - the greater the value of the double score, the more limited the resource.

Topic 10. The system of models in the study of production processes of the agricultural sector of the economy

The application of modeling methods will be shown on the examples of development of optimization models for livestock, crop production, as well as intersectoral balance, namely feeding rations of farm animals and making optimal plans for the use of fodder harvested for the stall period.

Topic 11. Applied optimization models. Production models

Models of consumer behavior (Behavioral models in the study of operations). Models of behavior of producers (Resource theory and production functions in the study of operations).

Topic 12. Applied financial models

Consider financial management as an object of mathematical modeling. Scope of competence of the financial manager and the possibility of formalizing financial tasks. Features of the formation of financial markets in Ukraine. Risk in the field of financial management. Risk measurement. Economic and mathematical models of optimization of the monetary system: the model of the monetary multiplier, the model of the monetary base, the model of estimating the impact of inflation on the dynamics of% rates. Investment optimization model priorities.

STRUCTURE OF THE DISCIPLINE ECONOMIC AND MATHEMATICAL METHODS AND MODEL

Names of content modules and topics	Number of hours											
	Full-time form						Part-time form					
	weeks	total	including					total	including				
			l	p	lab	ind	self		l	p	lab	ind	self
1		2	3	4	5	6	7	8	9	10	11	12	13
Content module 1. **Conceptual aspects of economic and mathematical modeling**													
Topic 1. Theoretical foundations of mathematical modeling and classification of models	1	8	1	2		5							
Topic 2. Principles and stages of construction Economic mathematical models	1	11	1	4		6							
Topic 3. Basic methods of formalizing economic conditions	2	12	2	4		6							
Topic 4. The general problem of linear programming and its canonical figures	2	12	2	4		6							
Topic 5. Geometric interpretation of linear programming problems	1	11	1	4		6							
Topic 6. The solution of simplex method and its modifications	1	9	1	4		4							
Topic 7. Theory of duality and duality of linear optimization estimates tasks	2	10	2	4		4							
Total for content module 1		73	10	26		37							
Content module 2. Fundamentals of theory and methods optimization													
Topic 8. Transport problems of linear programming	1	9	1	4		4							
Topic 9. Analysis of optimization solutions tasks	1	10	1	4		5							

Topic10. Mathematical modeling of the agricultural industry	1	9	1	4		4							
Topic 11. Applied financial models. Production models	1	9	1	3		5							
Topic 12. Applied financial models	1	10	1	4		5							
Total for content module 2		47	5	19		23							
Total hours		**120**	**15**	**45**		**60**							

4.Seminar topics

№ s / n	Name topics	Number of hours
1		

5. Practical class topics

№	Name topics	Number of hours
1	Mathematical formalization of problem conditions.	2
2	Study of applied programs for solving economic and mathematical problems on an Excel spreadsheet	4
3	Modeling techniques.	4
4	Modeling of the optimal ration of agricultural feeding animals	4
5	Modeling of optimal sowing structure	4
6	Examples of problems	4
7	Examples of athematic programming problems. Canonical figures of ZLP. Transformation of one figure to another.	4
8	Geometric interpretation and graphical solution of ZLP.	4
9	Methods of constructing initial plans of the transport problem	4
10	Construction of the optimal plan of the transport problem	4
11	Construction of dual problems. PDZ geometry.	3
12	The main features of ZNLP. Integer programming problems. Practical implementation on a PC	4

6. Laboratory class topics

Curriculum is not provided this type of work.

7. Independent work topics

№	Topic title	Number of hours
1.	Topic 1. Theoretical foundations of mathematical modeling and classification of models	5
2.	Topic 2. Principles and stages of construction Economic mathematical models	6
3.	Topic 3. Basic methods of formalizing economic conditions	6
4.	Topic 4. The general problem of linear programming and its canonical figures	6
5.	Topic 5. Geometric interpretation of linear programming problems	6
6.	Topic 6. The solution of simplex method and its modifications	4
7.	Topic 7. Theory of duality and duality of linear optimization estimates tasks	4
8.	Topic 8. Transport problems of linear programming	4
9.	Topic 9. Analysis of optimization solutions tasks	5
10.	Topic10. Mathematical modeling of the agricultural industry	4
11.	Topic 11. Applied financial models. Production models	5
12.	Topic 12. Applied financial models	5
Total hours		60

8. Samples of control questions, tests for assessing the level of knowledge acquisition by students.

Control questions

1)   Write a general mathematical model of linear programming problems.

2)   How to reduce the problem of linear programming to the canonical form?

3)   What are the forms of recording linear problems programming?

4)   Explain the geometric interpretation of the problem of linear programming.

5)   What solution to the problem of linear programming is called empty?

6)   Explain what is called the range plans.

7)   What is the plan called supporting?

8)   What reference plan is called degenerate?

9)   What tasks of linear programming can be solved graphically method?

10)   Under which conditions the problem of linear   programming   with   an unlimited area of valid plans has the solution?

11)   The essence of the algorithm of the graphic method for solving linear programming problems.

12)   Simplex is used to solve some mathematical problems method?

13)   The essence of the algorithm of the simplex method.

14)   Formulate the conditions for the optimality of solving the problem by the simplex method.

15)   How to choose a solver element?

16)   Give an economic interpretation of direct and dual linear programming problems.

17)   How to determine that a resource is in short supply (deficient)?

18)   How to determine that production is profitable (not profitable)?

19)   Describe the economic and mathematical formulation of classical transport tasks.

20)   How does the transport problem differ from the general linear problem programming?

21)   Formulate the necessary and sufficient conditions for the existence of the transport interchange tasks.

22)   What properties do you know about the reference plans of the transport problem?

23)   Than is different open transport problem from closed?

24)   How to turn an open transport task on closed?

25)   What methods do you know to build a reference plan?

26)   What means "degeneracy" reference plan? How him get rid of?

27) Name the stages of the method algorithm potentials.
28) As calculated potentials?
29) Name the conditions for optimal transport tasks.
30) Difficulties in solving nonlinear problems programming.
31) What is the problem of mathematical programming called integer?
32) Give examples of economic problems related to integers.

Example of exam test

NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENT SCIENCES OF UKRAINE			
Educational degree "Bachelor" Specialization 076 "Entrepreneurship, trade and exchange activity"	Statistics and Economic Analysis department	**EXAMINATION TICKET № 1** discipline <u>Economic and Mathematical Methods and Models</u>	Approved Head of the Department of Statistics and Economic Analysis _____ (signature) prof. I.D.Lazaryshyna _____2023

Exam questions (maximum score of 10 points per answer to the question)

Task 1. Find the solution of an integer problem: (7 points)

$$z = x_1 + 2x_2 = \max$$
$$x_1 + 2x_2 = 1$$
$$x_1 + x_2 = 5$$
$$x_1 = 0, x_2 = 0$$

Task 2. Method of potentials for solving transport problems.

Tests

1. *Define acceptance of hypothesis Ho for F crterion about the adequacy the model*

   a. if F calculated>F table

   b. if F calculated=F table

   c. if F calculated<F table

2. The main tasks of the correlation analysis:

   a. quntitative assessment of the tightness of connection

   b. mathematical modeling of the dependence of the effective attribute on the factors

   c. qualitative assessment of the tightness of connection

3. An assessment of the significance of the model parameters can be

   a. F-criterion

   b. determination factor

   c. Student's criterion

   d. correlation coefficient

4. Multikollinearity means:

   a. Existence of linear dependence or correlation between two or more independent variables

   b. Presence of tailings of econometric model

   c. Not possibility of prognosis of effective index

   d. Not possibility of establishment of degree of freedom is for dispersion of tailings

   e. Being of fictitious factors is in a model

5. In an economic and mathematical methods investigation forecast of effective index is:

   a. the first stage

   b. the final stage

c. the second stage

d. not used

6. The sum of tailings in correctly built model is evened:

a. It is not possible to define

b. 0

c. 100%

d. To any value from 0 to

e. To any value from -1 to 1

7. It is necessary for application of least-squares method, that dispersion of tailings:

a. Equaled a zero

b. It was permanent

c. It was a positive size

d. It was in scopes from 0 to 1

8. The main signs of 14multicollinearity of factors are:

a. Presence of high values of pairs coefficients of correlation

b. A presence of small values of estimation of model parameters at the high level of coefficient of determination and F-criterion

c. A substantial change of estimations of model parameters at additional introduction to it of explanatory variable

d. The considerable approaching of coefficient of correlation to unit

9. Importance of parameters of equalization of regression is estimated with a help

a. χ2-criterion

b. Dispersion

c. t-criterion

d. Standard deviation

e. The least-squares method

10. The estimation of model importance can be:

a. Coefficient of determination

b. Standard deviation

c. Dispersion

d. Coefficient of correlation

e. F-criterion

9. Teaching methods

Teaching methods are ways of joint activities and communication between teachers and graduates, providing positive motivation to learn, mastering the system of professional knowledge, skills and abilities, forming a scientific worldview, development of cognitive forces, culture of mental work of future professionals.

The following teaching methods are used during the educational process:

Depending on the source of knowledge: verbal (explanation, conversation, discussion, dialogue); visual (demonstration, illustration); practical (problem solving, business games).

By the nature of cognitive activity: explanatory-visual problem statement; partial search and research methods.

By place in educational activities:

- methods of organization and implementation of educational activities that combine verbal, visual and practical methods; reproductive and problem-searching; methods of educational work under the guidance of a teacher and methods of independent work of higher education students;

- methods of control and self-control over educational activities: methods of oral, written control; individual and frontal, thematic and systematic control.

In the process of teaching the discipline to intensify the educational and cognitive activities of higher education seekers provides for the use of the following educational technologies:

- work in small groups allows to structure practical seminars on the form and content, creates opportunities for participation of each student in higher education in the work on the topic of the lesson, provides the formation of personal qualities and experience of social communication;

- seminars-discussions involve the exchange of views and views of participants on this topic, as well as develop thinking, help to form views and beliefs, the ability to formulate opinions and express them, learn to evaluate other people's suggestions, critically approach their own views;

- brainstorming - a method of solving urgent problems, the essence of which is to express as many ideas in a limited period of time, discuss and select them;

- case method - a method of analysis of specific situations, which allows to bring the learning process closer to the real practical activities of specialists and involves consideration of industrial, managerial and other situations, complex conflicts, problematic situations, incidents in the study of educational material;

- presentations - speeches to the audience, used to present certain achievements, results of the group, a report on the implementation of individual tasks, briefings, demonstrations.

10. Forms of assessment

Evaluation of student knowledge is carried out on a 100-point scale and is converted to national grades according to Table 1 "Regulations and Examinations and Credits at NULES of Ukraine" (order of implementation dated 26.04.2023, protocol №10), the types of control of higher education are current control, intermediate and final certification.

Ongoing control is carried out during practical, laboratory and seminar classes and aims to check the level of readiness of higher education students to perform specific work.

Intermediate control is conducted after studying the program material and should determine the level of knowledge of higher education students in the program material obtained during all types of classes and independent work.

Forms and methods of intermediate control, mastering the program material are developed by the lecturer of the discipline and approved by the relevant department in the form of testing, written tests, colloquium, etc., which can be assessed numerically.

Mastering the program material by a higher education student is considered successful if his / her rating is not less than 60 points on a 100-point scale.

Semester control is conducted in the form of a semester exam or semester test in a particular discipline.

The semester exam is a form of final attestation of mastering the theoretical and practical material on the academic discipline for the semester.

Semester test is a form of final control, which consists in assessing the mastering of higher education theoretical and practical material (performed by student certain types of work in practical, seminar or laboratory classes and during independent work) in the discipline for the semester.

Differentiated test is a form of control that allows to assess the implementation and mastery of higher education program of practical training, preparation and defense of course work (project).

Applicants for higher education are required to take exams and tests in accordance with the requirements of the working curriculum within the timeframe provided by the schedule of the educational process. The content of exams and tests is determined by the working curricula of disciplines.

The content of exams and tests is determined by the working curricula of disciplines.

11. Distribution of grades received by students.

Evaluation of student knowledge is carried out on a 100-point scale and is converted to national grades according to Table 1 "Regulations and Examinations and Credits at NULES of Ukraine" (order of implementation dated 26.04.2023, protocol №10).

Student rating, points	National grade based on exam results	
	Exams	Credits
90-100	Excellent	Passed
74-89	Good	
60-73	Satisfactory	
0-59	Unsatisfactory	Not passed

In order to determine the rating of a student (listener) in the discipline R_{dis} (up to 100 points), the rating from the exam R_{ex} (up to 30 points) is added to the rating of a student's academic work R_{aw} (up to 70 points): $R_{dis} = R_{aw} + R_{ex}$.

12. Educational and methodological support
1. Regulations.
2. Complex teaching of the discipline.
3. Methodological guidelines for independent study courses.
4. Methodological guidelines for writing a term paper.
5. Elearn: https://elearn.nubip.edu.ua/course/view.php?id=5109

13. Recommended sources of information
Main
Tutorials

1. Econometric Analysis 8th edition by William H. Greene, Prentice Hall, 2017. 1176 pp.

2. Introduction to Econometrics. 4th edition by James H. Stock and Mark W. Watson, Addison-Wesley, 2018. 800 pp.

3. Introductory Econometrics: A Modern Approach. 7th edition by Jeffrey M. Wooldridge, South-Western College Publishers, 2018. 816 pp.

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5. Волошин О. Р., Галайко Н. В. Економетрія. Ч. 1: навч. посібник. Львів: ЛДУВС, 2019. 192 с.

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