

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

"ЗАТВЕРДЖУЮ"

Проректор з науково-педагогічної роботи

Каріна НЕМАШКАЛО



ДОСЛІДЖЕННЯ ОПЕРАЦІЙ ТА МЕТОДИ ОПТИМІЗАЦІЇ

робоча програма навчальної дисципліни

Галузь знань	05 Соціальні та поведінкові науки
Спеціальність	051 Економіка
Освітній рівень	перший (бакалаврський)
Освітня програма	Міжнародна економіка

Вид дисципліни	обов'язкова
Мова викладання, навчання та оцінювання	англійська

Завідувач кафедри вищої математики та економіко-математичних методів

Людмила Малярець

Харків
2021

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



"APPROVED"
Vice-Rector on Scientific and Pedagogical work

Karina K. SHKALO

OPERATIONS RESEARCH AND OPTIMIZATION METHODS
syllabus of the academic discipline

Training direction **05 Social and behavioral sciences**

Speciality **051 Economics**

Academic degree **first (bachelor)**

Academic program **International economics**

Type of the academic discipline

Compulsory

Language of teaching, training and assessment

English

Chief of the department of higher mathematics,
economical and mathematical methods

 Lyudmyla Malyrets

Kharkiv
2021

APPROVED

at the meeting of the department of higher mathematics and economic mathematical methods

Protocol № 1 dated 27.08.2021

Compiled by:

L. Malyrets, doctor of economics, professor of the department of higher mathematics and economic mathematical methods

Ie. Misiura, PhD, Associate professor of the department of higher mathematics and economic mathematical methods;

Sheet of renewal and re-approval of the academic discipline syllabus

Academic year	Date of the department meeting – the developer of syllabus of the academic discipline	Protocol number	Signature of chief of the department

The annotation of the academic discipline

The task of the economic and mathematical modelling is construction of models of economic objects and processes in order to describe, optimize, analyze, forecast, provide analytical support for these objects and processes when making decision at all levels of management. Thus, modelling is a fundamental basis of the methodology of management of the economy. Economic and mathematical models are constructed with the help of mathematical methods. Operations Research and Optimization Methods are tools for learning and investigation of economic systems of different complexity. They form a fundamental basis for solving real analytical problems in different fields of activity of management subjects.

The fundamental basis in the mathematical preparation of economists and managers is the academic discipline "Operations Research and Optimization Methods" which is a compulsory discipline of the natural scientific series and a component of the structural logical scheme which is provided for the educational professional program of Bachelor's (first) degree students of speciality 051 "Economics".

The basic problems of teaching the academic discipline is giving students knowledge of the basic parts of Operations Research and Optimization Methods; raising the level of the fundamental mathematical training of students with intensification of its applied direction, mastering the fundamentals of Operations Research and Optimization Methods and application of this knowledge to the economic investigations for solving economic problems, forming skills in the application of elements of Operations Research and Optimization Methods to investigations where mathematical methods (the mathematical programming and econometrics) are applied as an instrument of investigation and solving optimization economic problems for forming models of economic processes and developments, acquiring the necessary theoretical and practical knowledge for solving specific problems which are set in the process of forming and a construction of economic and mathematical models, and obtaining the required mathematical knowledge for the study of other disciplines.

The main purpose of teaching is to form future specialists' basic mathematical knowledge for solving theoretical and practical problems in professional activity of a competent specialist in any sphere of his activity, skills in analytical thinking and skills in using mathematical knowledge for formation of real processes and developments, and for solving economic problems.

The characteristics of the academic discipline:

Academic year	2nd
Term	3rd or 4th
Number of credits	5
Form of the final control	exam

Structural and logical scheme of studying the academic discipline:

Previous academic disciplines	Next academic disciplines
Higher mathematics Probability theory and mathematical statistics	Econometrics, Statistics, Economic and mathematical methods and their realization using PC

Competences and result of mastering the academic discipline

Professional competences (PC)	Learning outcomes (LO)
PC4 (CK4). Ability to explain economic and social processes and phenomena on the basis of theoretical models, analyze and interpret the results. PC11 (CK11). An ability to interpret economic decisions on the basis of understanding the laws of economic systems and processes using modern methodological tools	LO2 (PH2). Reproduce moral, cultural, scientific values, increase the achievements of society in the socio-economic sphere, promote a healthy lifestyle

PC4 (CK4). An ability to explain economic and social processes and phenomena on the basis of theoretical models, analyze and interpret the results.	LO3 (PH3). Know and use economic terminology, explain the basic concepts of micro- and macroeconomics
PC6 (CK6). An ability to use economic and mathematical methods and models to solve economic problems.	LO4 (PH4). Understand the principles of economics, features of economic systems
PC5 (SC5). Understanding the features of the modern world and national economy, their institutional structure, a substantiation of the directions of social, economic and foreign economic policy of the state	LO7 (PH7). Explain the models of socio-economic phenomena in terms of fundamental principles and knowledge based on an understanding of the main directions of a development of economics
PC4 (CK4). An ability to explain economic and social processes and phenomena on the basis of theoretical models, analyze and interpret the results. PC6 (CK6). An ability to use economic and mathematical methods and models to solve economic problems.	LO8 (PH8). Use corresponding economic and mathematical methods and models to solve economic problems.

*CK – спеціальні (фахові) компетентності, PH – результати навчання

The syllabus of the academic discipline

The themes of lectures

Content module 1. Basic notions of mathematical modeling of economic systems.

Methods of linear programming. Integer programming

Theme 1. Optimization economic and mathematical methods and models

Theme 2. Problems of linear programming and methods for solving them

Theme 3. Duality theory and analysis of linear models of economic optimization problems in international economics

Theme 4. The transportation problem and its application to international economics

Theme 5. Integer programming

Content module 2. Methods of nonlinear and dynamic programming. Game theory. Queuing systems and inventory management

Theme 6. Nonlinear optimization models of economic systems

Theme 7. Game theory. Analysis and risk management in international economics on the base of the concept of game theory

Theme 8. Dynamic programming

Theme 9. Multicriteria optimization problems and methods for solving them

Theme 10. Network planning and management methods

Theme 11. Models of inventory management

Theme 12. Models of queuing systems

Methods of study and teaching

To intensify the process of teaching the academic discipline "Higher Mathematics" the following educational technologies are applied problem lectures, mini-lectures, work in small groups, brainstorm, computer simulation (games).

The basic difference of active and interactive methods of education from traditional ones is not only defined by the methods and techniques of teaching, but also by a high effectivity of the educational process, which reveals itself in: the high motivation of students; consolidation of theoretical knowledge in practice; improvement of students' consciousness; forming the ability to make

an independent decision; forming the ability to approve collective decisions; forming the ability for social integration; getting the skills in resolving conflicts; development of the ability to reach compromises.

Mini-lectures provide for the delivery the educational material during a short-length segment of time and they are characterized by a significant content, complexity of logical constructions, forms, proofs and generalizations. They are conducted, as a rule, as a part of a study-investigation. Mini-lectures differ from full-size lectures by a shorter duration. Usually, they last no more than 10 – 15 minutes and they are used in order to give briefly new information for all students. Mini lectures are often used as parts of a whole theme, which it is desirable to teach as a full-size lecture in order to avoid the audience's getting tired. Then the information is given by turn as several particular fragments, between them other forms and methods of study are used (*themes: 1, 7, 10*).

Brainstorming is a method of solving urgent tasks, its core lies in expressing as many ideas as possible in a short period of time, discussing and selecting them (*themes: 2, 7, 9*).

A computer simulation (game) is an education method, which is based on the use of a specific computer program in order to get visual modelling of a process. Students can change the parameters and data, decisions and analyze the results of such decisions. The purpose of using this method is the development of systematic thinking of students, their ability to plan, form skills to identify and analyze problems, compare and estimate alternatives, make optimal decisions and work under the condition of a limited time (*theme: 3*).

Banks of a visual support help to intensify the education process of studying the themes of the academic discipline with the help of visualization (*themes: 4, 5, 6, 8,10*).

Work in small groups gives an opportunity to structure practical studies in the form and content, gives a possibility for each student's partaking in the work on the theme under study, stimulates forming personal qualities and experience of social communication (*themes: 5, 10, 11, 12*).

The order of assessment of studying results

The system of assessment of competences which were formulated for a student during the learning of the academic discipline, takes into consideration the forms of studies which according to the syllabus of the academic discipline provide lectures, practical studies, laboratory works, fulfillment of students' independent work. The assessment of the formed competences of students is carried out on the accumulative 100-point system. Control ways include:

current control which is carried out within a term during lectures, practical studies and laboratory works and it is assessed as a sum of accumulative points (the maximum equals 60 points; the minimum which makes it possible for a student to pass an exam, equals 35 points);

module control which is carried out in the form of a colloquium with taking into account the current control according to a corresponding thematic module, provides an integral assessment of student's results after learning the material of a logically completed part of the discipline (or a thematic module);

final/term control, which is carried out as a terminal exam, according to the schedule of the educational process.

Current control on the given academic discipline is carried out in the following forms: homework; defence of laboratory works; a written test; an independent creative work, a colloquium.

The total number of points is 60, which are distributed as lectures (including 2 colloquiums (12 points) and one independent creative work (8 points), practical studies (including 3 written tests (18 points) and homework (10 points)) and laboratory studies (including 6 laboratory works (12 points)).

Final/term control is conducted in the form of a term exam. **Term exams** are a form of assessment of students' final mastery of the theoretical and practical material of a particular module of the academic discipline or the academic discipline on the whole, which is conducted as a test.

Assessment of student's knowledge during practical studies and carrying out laboratory works is conducted on the accumulative system according to the following criteria: understanding, the degree of the mastery of the theory and methodology of problems which are considered; the degree of the

mastery of the factual material of the academic discipline; familiarizing with the recommended literary sources and modern literature on the questions which are considered; the ability to connect theory and practice in the consideration of particular examples, solving problems, carrying out laboratory works, carrying out calculations in the process of doing homework and tasks which are considered in class; the logic, structure, style of presenting the material in written works and in oral answers in class, the ability to ground one's position, carry out generalization of the information and draw conclusions.

The general criteria for the assessment of *independent work* of students are profound and deep of knowledge, the level of thinking, skills in systematization knowledge on particular themes, skills in drawing conclusions, attainments and techniques of carrying out practical tasks, the ability to find necessary information, carry out its classification and processing, self-realization in practical and laboratory studies.

The criteria for assessment of independent creative work and independent tests are: the ability to carry out a critical and an independent estimation of the defined problem questions; skills in the explanation of alternative views and availability of a students' own point of view, position on the defined problem question; using the analytical approach; the quality and accuracy of expressing the thought; the logic, structure and explanation of conclusions about a particular problem; independence of carrying out of the work; grammatical correctness of the presentation of the material; using the methods of comparison, generalization of the concepts and facts; the design of the work; the quality of presentation.

Independent work is a scheduled educational and scientific work which is carried out on a lecture task under the methodical and scientific guidance of a lecturer, it is a specific form of the educational activity, its main objective is forming independence of a person.

The educational time, which is intended for students' independent work of the day-time form of education, is defined according to the educational plan and makes 68 % out of the total educational time for learning the discipline.

During independent work a student becomes an active participant in the educational process, learns to master consciously theoretical and practical knowledge, orientates easily in the information space, has to take responsibility for the quality of his own professional training.

The necessary element of successful mastery of the material of the academic discipline is the students' independent work (SIW) with specific literature of the mathematical and economic direction.

SIW includes: processing of the lecture material of (a lecture as a form of education provides theoretical knowledge, besides being used for carrying out practical calculations); processing and learning the recommended literature, basic terms and concepts on the themes of the academic discipline; preparation for practical and laboratory studies; preparation for the defence of laboratory works; an advanced study of particular themes or questions of lectures; carrying out practical homework, solving computational competence oriented tasks on the given theme; choosing and consideration of literature sources on the given problem of the academic discipline; analytic consideration of scientific publications; self-control of students' knowledge by questions for self-diagnostics; carrying out independent work; carrying out independent creative work; preparation for tests and other forms of current control; preparation for module control (a colloquium); systematization of the studied material with the purpose of preparation for terminal exams on each module of the academic discipline.

The final control (the exam) of knowledge and competences of students on the academic discipline is carried out on the base of the term exam. The examination paper includes the syllabus of the discipline and provides for assessment of the knowledge level and a degree of the mastery of corresponding competences of students.

The purpose of the exam is to test student's understanding of the syllabus material on the whole, the logic and relations between its particular parts, the skills in the creative use of the stored knowledge, the ability to formulate one's attitude to a particular problem of the academic discipline and so on. The competent approach to the assessment of the exam implies measuring the level of the student's mastery of the competences provided by the qualifying requirements.

Each examination paper contains 5 practical tasks, including two first-level (diagnostic) tasks, two second level (situational) tasks and one third level (heuristic) task.

The assessment of the exam is carried out according to the temporary provision "About the Order of Assessment of Students' Academic Performance on the Accumulative Point Rating System" of Simon Kuznets Kharkiv National University of Economics.

A student can't be allowed to take the exam, if the number of points, obtained during the current and module control according to the thematic module during the term, does not make 35 points. After the examination period the dean of the department gives a notice about sitting the failed exams. In a given period the student adds the required points.

In the case of irreproachable fulfillment of all the examination tasks with the demonstration of deep knowledge of the academic discipline, skills in the practical use of the formed competences which are based on the ability to analyze and solve a wide range of tasks, a high level of completing the written work the student obtains 40 points.

The final mark on the academic discipline is calculated according to points, obtained during an exam, and points, obtained during a current control by an accumulative system.

It should be assessed student's progress, if a sum of points, obtained as the total result of an assessment by all forms of a control, equals or exceeds 60. Accordingly the minimal possible quantity of points by a current and a module control during a term equals 35 and the minimal possible quantity of points, obtained on an exam, equals 25.

The result of a terminal exam is assessed in points (the maximum is 40 points, the minimum of a quantity, which is passed, equals 25 points) and it is entered into the corresponding column of an examination «Mark sheet».

The final mark of the academic discipline is calculated according to the points obtained during the exam and points obtained during the current control on the accumulative system.

The total result in points during the term is "60 and more points mean passed", "59 and less points mean failed" and it is entered into the "Mark sheet" on the academic discipline.

The scales of assessment: national and ECTS

Sum of points including all forms of study	Mark on the ECTS scale	Mark on the national scale	
		for an exam, a term paper, practice	for a test
90 – 100	A	excellent	passed
82 – 89	B	good	
74 – 81	C	satisfactory	
64 – 73	D		
60 – 63	E	unsatisfactory	failed
35 – 59	FX		
1 – 34	F		

Rating-plan of the academic discipline

Them	Forms and types of study		Forms of assessment	Maximal point
1	2		3	4
Theme 1	<i>Class work</i>			
	Lecture	Lecture 1. Optimization economic and mathematical methods and models		
	Practical study	Practical study 1. Optimization economic and mathematical methods and models		
	<i>Independent work</i>			
	Questions and	Search, choice and looking through literary		

	tasks to self-study	sources on the theme. Learning the lecture material. Carrying out practical homework		
Theme 2	<i>Class work</i>			
	Lecture	Lecture 2. Problems of linear programming and methods for solving them		
	Laboratory study	Laboratory work 1. Problems of linear programming and methods for solving them	laboratory work	2
	<i>Independent work</i>			
Questions and tasks to self-study	Search, choice and looking through literary sources on the theme. Learning the lecture material. Carrying out a laboratory work.			
Theme 3	<i>Class work</i>			
	Lecture	Lecture 3. Duality theory and analysis of linear models of economic optimization problems in international economics		
	Practical study	Practical study 2. Problems of linear programming and methods for solving them		
	<i>Independent work</i>			
Questions and tasks to self-study	Search, choice and looking through literary sources on the theme. Learning the lecture material. Carrying out practical homework		homework	2
Theme 4	<i>Class work</i>			
	Lecture	Lecture 4. The transportation problem and its application to international economics		
	Laboratory study	Laboratory work 2. Duality theory and analysis of linear models of economic optimization problems	laboratory work	2
	<i>Independent work</i>			
Questions and tasks to self-study	Search, choice and looking through literary sources on the theme. Learning the lecture material. Carrying out a laboratory work.			
Theme 5	<i>Class work</i>			
	Lecture	Lecture 5. Integer programming		
	practical study	Practical study 3. The transportation problem.	written test	6
	<i>Independent work</i>			
Questions and tasks to self-study	Search, choice and looking through literary sources on the theme. Learning the lecture material. Carrying out a laboratory work.		homework	2
Theme 6	<i>Class work</i>			
	Lecture	Lecture 6. Nonlinear optimization models of economic systems	colloquium 1	6
	Laboratory study	Laboratory work 3. The transportation problem. Integer programming	laboratory work	2
	<i>Independent work</i>			
Questions and tasks to self-study	Search, choice and looking through literary sources on the theme. Learning the lecture material. Carrying out a laboratory work.			
Theme 7	<i>Class work</i>			
	Lecture	Lecture 7. Game theory. Analysis and risk management in international economics on the base of the concept of game theory		

	Practical study	Practical study 4. Integer programming		
	<i>Independent work</i>			
	Questions and tasks to self-study	Search, choice and looking through literary sources on the theme. Learning the lecture material. Carrying out practical homework	homework	2
Theme 8	<i>Class work</i>			
	Lecture	Lecture 8. Dynamic programming	colloquium 2	7
	Laboratory study	Laboratory work 4. Game theory. Analysis and risk management in international economics on the base of the concept of game theory	laboratory work	2
	<i>Independent work</i>			
	Questions and tasks to self-study	Search, choice and looking through literary sources on the theme. Learning the lecture material. Carrying out a laboratory work.		
Theme 9	<i>Class work</i>			
	Lecture	Lecture 9. Multicriteria optimization problems and methods for solving them		
	Practical study	Practical study 5. Game theory. Analysis and risk management in international economics on the base of the concept of game theory	written test	6
	<i>Independent work</i>			
	Questions and tasks to self-study	Search, choice and looking through literary sources on the theme. Learning the lecture material. Carrying out practical homework	homework	2
Theme 10	<i>Class work</i>			
	Lecture	Lecture 10. Network planning and management methods		
	Laboratory study	Laboratory work 5. Dynamic programming. Inventory management methods	laboratory work	2
	<i>Independent work</i>			
	Questions and tasks to self-study	Search, choice and looking through literary sources on the theme. Learning the lecture material. Carrying out a laboratory work.		
Theme 11	<i>Class work</i>			
	Lecture	Lecture 11. Models of inventory management		
	Practical study	Practical study 6. Nonlinear optimization methods of economic systems	written test	6
	<i>Independent work</i>			
	Questions and tasks to self-study	Search, choice and looking through literary sources on the theme. Learning the lecture material. Carrying out practical homework	homework	2
Theme 12	<i>Class work</i>			
	Lecture	Lecture 12. Models of queuing systems	colloquium 2 independent creative task	6 + 8
	Laboratory study	Laboratory work 6. Network planning methods	laboratory work	2
	<i>Independent work</i>			

	Questions and tasks to self-study	Search, choice and looking through literary sources on the theme. Learning the lecture material. Carrying out a laboratory work.		
	Exam			40

Recommended reading

Main

1. Дослідження операцій та методи оптимізації. Методичні рекомендації до практичних завдань для студентів усіх спеціальностей першого (бакалаврського) рівня [Електронний ресурс] / укл. Л.М. Малярець, О.В. Мартинова; Харківський національний економічний університет ім. С. Кузнеця. - Електрон. текстові дан. (4,26 МБ). – Х. : ХНЕУ ім. С. Кузнеця, 2019. – 84 с.

2. Малярець, Л. М. Дослідження операцій та методи оптимізації [Електронний ресурс] : практикум : у 2-х ч. Ч. 2 / Л. М. Малярець, І. Л. Лебедева, Л. О. Норік ; Харківський національний економічний університет ім. С. Кузнеця. – Електрон. текстові дан. (2,69 МБ). – Харків : ХНЕУ ім. С. Кузнеця, 2019. – 160 с.

3. Малярець Л. М. Дослідження операцій та методи оптимізації: лабораторний практикум в середовищі MATLAB [Електронний ресурс] / Л. М. Малярець, К. О. Ковальова ; Харківський національний економічний університет ім. С. Кузнеця. – Електрон. текстові дан. (2,24 МБ). – Х. : ХНЕУ ім. С. Кузнеця, 2018. – 122 с.

4. Исследование операций и методы оптимизации. Методические рекомендации к практическим заданиям по разделу "Динамическое программирование" для иностранных студентов всех специальностей первого (бакалаврского) уровня [Электронный ресурс] / сост.: А.К. Шевченко, А.В. Жуков; Харьковский национальный экономический университет им. С. Кузнеця. – Электрон. текстовые дан. (917 КБ). – Х. : ХНЭУ им. С. Кузнеця, 2019. – 44 с.

5. Frederick S. Hillier & Gerald J. Lieberman, Introduction to Operations Research. – New York, NY : McGraw-Hill Education, 2021. – 1214 p.

6. Taha A. H. Operations Research: An Introduction : 10Th Edition. – Pearson, India, 2018. – 843 p.

Additional

7. Бескровний О. І., Павленко В. І., Тимошенко А. Г. Дослідження операцій і методи прийняття технічних рішень. – Київ : Університет «Україна», 2019. – 420 с.

8. Білоусова С.В.. Економіко-математичне моделювання. Компендіум і практикум: навч.посіб. /С.В.Білоусова,Т.В. Ковальчук. – Київ: КНТЕУ, 2018. – 468 с.

9. Латанська Л. О. Методичні вказівки до виконання самостійних робіт з дисципліни "Математичні методи дослідження операцій"/ Л. О. Латанська, Т. А. Фаріонова. – Миколаїв: НУК, 2018. – 29 с.

10. Латанська Л. О., Устенко І. В., Каіров В. О. Математичні методи дослідження операцій. Методичні вказівки до виконання лабораторних робіт (Частина 2). – Миколаїв: ФОП Швець В.М., 2018. – 36 с.

11. Синєглазов В. М. Математичні методи оптимізації: навч. посібн./ В.М. Синєглазов, О. А. Зеленков, Ш. І. Аскеров. – К.: Освіта України, 2018. – Ч. 1. – 329 с.

12. Ємець О. О. Методи оптимізації та дослідження операцій: навчальний посібник / О.О. Ємець. – Полтава: ПУЕТ, 2019. – Ч.1. – 245 с.

Internet Information Resources:

13. Державна служба статистики України [Електронний ресурс] – Режим доступу : <http://www.ukrstat.gov.ua/>

14. Mathematical Programming Glossary. – Режим доступу: <http://glossary.computing.society.informs.org/>

15. Optimization Methods and Software. – Режим доступу:
<https://www.tandfonline.com/toc/goms20/current>

16. Snyman, J. A.; Wilke, D. N. (2018). Practical Mathematical Optimization : Basic Optimization Theory and Gradient-Based Algorithms (2nd ed.). Berlin: Springer. ISBN 978-3-319-77585-2. 9. Mathematical Programming Glossary. – Режим доступу:
<http://glossary.computing.society.informs.org/>

17. Ukrstat.org – публікація документів Державної Служби Статистики України. [Електронний ресурс] – Режим доступу :
https://ukrstat.org/uk/druk/publicat/Arhiv_u/01/Arch_Ukr_.htm

Methodical support

18. Сайт персональних навчальних систем: Operations Research and Optimization Methods (6.051.130), доц. Місюра Є.Ю. <https://pns.hneu.edu.ua/course/view.php?id=5366>