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Silabus
Selective Component   SC

Mathematical Methods in Economic Research

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Name of the discipline:	**Mathematical Methods in Economic Research**
Higher education level:	first (Bachelor's degree)
Moodle course page:	https://dl2022.khadi.kharkov.ua/course/view.php?id=3263
Scope of the sample component	4 credits (120 hours)
Final control form	Credit
Consultations:	on schedule
Department name:	Department of higher mathematics
Language of instruction:	English
Course manager:	Yarkho Tetiana Oleksandrivna, Doctor of Pedagogical Sciences, Professor**;** Emelyanova Tetiana Viktorivna, Candidate of Physical and Mathematical Sciences, Associate Professor
Contact phone number:	*(057)707-37-37*
E-mail:	*vmatem @khadi.kharkov.ua*

Summary of the educational component: the purpose of studying the discipline is: special mathematical training of applicants for economic specialties in the direction of forming the ability to identify the optimal method of action in solving organizational management problems in conditions of technical and economic restrictions.

Subject of the discipline: methods of linear programming (geometric, simplex, artificial basis method, dual simplex-method for solving linear programming problems; distribution method and method of potentials for solving transport problems); methods of queuing theory (solving problems in single-channel and multi-channel systems with failures and unlimited queue, systems with fixed service **time). .**

The main objectives of the discipline are:
- study of economic and mathematical models of problems and statements of linear programming problems;
- study of the theoretical foundations of linear programming methods;
- formation of abilities of theoretical application of linear programming methods: geometric, simplex, artificial basis method, dual simplex method, potential method and their practical implementation in the process of solving professional and economic problems ;
- study of the possibilities of applying standard application software packages to solving linear programming problems;
- formation of concepts about queuing systems, their main parameters and tasks of queuing theory;
- formation of the ability to determine the performance indicators of single-channel and multi-channel CFR with failures, single-channel and multi-channel CFR with a limited queue; CFR with a limited waiting time;
- formation of abilities of certain limit probabilities of states and parameters of real systems of bench tests, car maintenance, unloading of building materials.

Prerequisites for studying the educational component: mandatory mathematical discipline of The Bachelor's degree "Higher Mathematics", selective disciplines of The Bachelor's degree "Mathematical Statistics", "Introduction to Probability and Statistical Analysis".

Competencies that the applicant acquires:
General competencies:
ability to think abstractly, analyze and synthesize,
ability to apply the acquired knowledge in practical situations.

Special (professional) competencies:
critical understanding of the theoretical foundations of entrepreneurial, trading and exchange activities,

ability to apply economic and mathematical methods and models to solve economic problems.

Learning outcomes according to the educational program:

use basic knowledge and skills of critical thinking, analysis and synthesis for professional purposes,

apply the acquired theoretical knowledge to solve practical problems and interpret the results in a meaningful way.

Thematic plan

№	Topic name (LC, PR, SR)	Number of hours	
		Ochne	Zaochne
1	LC Methods of linear programming. Setting linear programming problems (LP). General and main tasks of the LP.	2	2
	PR Construction of mathematical models problems on the use of resources on the formation of production and problems on the preparation of a diet (about a mixture)	2	2
	SR Drawing up economic and mathematical models of the problem of capacity utilization (equipment loading); problems of cutting materials.	4	4
2	LC Theoretical foundations of LP methods. Geometric content of a set of solutions for linear inequalities and a compatible system of linear inequalities.	2	2
	PR -	-	-
	CP convex sets in n-dimensional space. Properties of the LP problem.	4	4
3	LC Is a geometric method for solving LP problems. Algorithm for solving the LP problem using the geometric method.	2	2
	PR Solving the resource usage problem using the geometric method. Solving problems (cases of the existence of an infinite number of optimal mating roses; max F=∞).	2	2
	SR Gradient of the function at the gradient point, the level line of the objective function F. Finding the optimum point of the objective function F.	2	2
4	LC Is a simplex method for solving linear programming problems. A system of m linear equations with n variables at m<n. Simplex method algorithm (minimization problem F).	2	2
	PR -	-	-
	SR Solving the main LP problem with selected base variables. Solving the General LP problem with the maximization condition F).	4	4
5	LC Finding the reference plan using the Simplex Method. Algorithm for finding a valid solution. Artificial basis method (two-stage simplex method).	2	2
	PR Solving problems using the simplex method that violates the conditions of compatibility of the constraint system and the uniqueness of the finite solution.	2	2
	SR Special cases of the Simplex Method.	6	6
6	LC Theory of duality. Symmetric mutually dual LP problems. The first duality theorem. The second duality theorem.	2	2
	PR -	-	-
	SP Economic Interpretation of direct and dual problems. Economic content of duality theorems.	6	6
7	LC Is a dual simplex method. Justification and algorithm.	2	2
	PR Solving LP problems using the dual simplex method.	2	2
	CP Objectively determined assessments and their economic content. The third duality theorem.	4	4
8	LC Transport problem of linear programming. Problem statement. Mathematical model. Methods for finding the initial basic distribution of	2	2

	supplies (the first reference plan).		
	PR -	-	-
	SP Distribution plan for solving a transport problem.	4	4
9	LC Method of potentials for finding the optimal basic supply distribution. Algorithm of the potential method.	2	2
	PR Solving transport problems using the potential method (closed models).	2	2
	SR Special cases in solving a transport problem.	6	6
10	LC Unbalanced transport task. Unbalanced transport task with additional conditions (privileges). M is the solution method.	2	2
	PR -	-	-
	SR Application of standard application software packages to solving linear programming problems.	8	8
11	LC Methods of queuing theory. The concept of queuing systems. Basic CFR parameters and TMO tasks. Random process. Event streams. The simplest flow of events. Event graph. The Kolmogorov Equation.	2	2
	PR Plotting state graphs of systems consisting of several nodes.	2	2
	SR Drawing up systems of Kolmogorov equations for state graphs.	4	4
12	LC Limit probabilities of CFR States. A cyclical process. Structure of the queuing process.	2	2
	PR -	-	-
	SR Finding the limit probabilities for systems based on the presented state graphs.	4	4
13	LC Single-channel CFR with failures. Multi-channel CFR with failures. Erlang's Task.	2	2
	PR Determination of service channel performance indicators in steady-state mode.	2	2
	SR Determination of performance indicators for a multi-channel gas station.	4	4
14	LC Single-channel and multi-channel CFR with unlimited queue. CFR with a fixed service time.	2	2
	PR -	-	-
	SR Finding the parameters of a two-channel service station with an unlimited queue. Finding parameters of the road material unloading system with a fixed maintenance time.	4	4
15	LC Single-channel and multi-channel CFR with a limited queue.	2	2
	PR -	-	-
	SR Calculation of parameters of the paid parking registration system (with a limited queue).	4	4
16	LC Closed CFR. CFR with limited waiting time.	2	2
	PR Determination of parameters of the system of bench tests of several cars.	2	2
	SR Determination of the maximum probabilities of vehicle maintenance system States, parameters: average queue length, average number of requests, absolute and relative throughput.	4	4
Together	LC	32	32
	PR	16	16
	SR	72	72

Training methods:
* lectures, practical exercises, explanations, etc.;
* standard calculation works;
* standardized tests;
* tasks for in-depth creative training;
* test papers;

* presentations of completed tasks and research;
* student presentations and presentations at scientific events;
* final comprehensive tests.

Evaluation system and requirements
1 Current academic performance:
1.1 the current success of applicants for performing educational types of work in training sessions and for performing tasks of independent work is evaluated using a four-point Assessment Scale, followed by recalculation to a 100-point scale. When evaluating current academic performance, all types of work provided for in the curriculum are taken into account.
1.2 lectures are evaluated by determining the quality of performance of specified tasks.
1.3 practical exercises are evaluated by the quality of performing a control or individual task, performing and completing practical work.
1.4 assessment of the current academic performance of higher education applicants is carried out at each practical lesson (laboratory or seminar) on a four-point scale ("5", "4", "C", "2") and are entered in the academic performance log.
 - "excellent": the applicant has perfectly mastered the theoretical material, demonstrates deep knowledge of the relevant topic or academic discipline, the main provisions;
- "good": the applicant has mastered the theoretical material well, has the main aspects from the original sources and the recommended literature of the RI, presents it in an argumentative manner; has practical skills, expresses his thoughts on certain problems, but admits certain inaccuracies and errors in the logic of presenting the theoretical content or when analyzing the practical one;
- "satisfactory": the applicant has mainly mastered the theoretical knowledge of the educational topic or discipline, is guided in the primary sources and recommended literature of the RI, but does not answer convincingly, confuses concepts, does not answer additional questions uncertainly, does not have stable knowledge; answering questions of a practical nature, shows inaccuracy in knowledge, does not know how to evaluate facts and phenomena, connect them with the future profession;
- "unsatisfactory": the applicant has not mastered the educational material of the topic (discipline), does not know scientific facts, definitions, almost does not navigate in primary sources and recommended literature, there is no scientific thinking, practical skills are not formed.
2 Final assessment:
An applicant for Higher Education receives a credit in the last lesson in the discipline based on the results of the current assessment. The average score for current activities is converted to points on a 100-point scale.
Higher education applicants who have an average current grade in the discipline below "3" (60 points) can improve their current score in the last lesson by passing tests in the discipline.
Assessment of applicants ' Knowledge by testing is carried out on a scale of:
- "Excellent": the theoretical content of the course is fully mastered, without gaps, the necessary practical skills of working with the mastered material are formed, all the training tasks provided for in the training program are completed, the quality of their implementation is estimated by the number of points close to the maximum. (at least 90% of correct answers);
- "Very good": the theoretical content of the course is fully mastered, without gaps, the necessary practical skills of working with the mastered material are mostly formed, all the training tasks provided for in the training program are completed, the quality of most of them is estimated by the number of points close to the maximum. (82% to 89% of correct answers);
- "Good": the theoretical content of the course is fully mastered, without gaps, some practical skills of working with the mastered material are not sufficiently formed, all the training tasks provided for in the training program are completed, the quality of None of them is evaluated with a minimum number of points, some types of tasks are completed with errors (from 74% to 81% of correct answers);
- "Satisfactory": the theoretical content of the course is partially mastered, but the gaps are not significant, the necessary practical skills of working with the mastered material are mostly formed, most of the training tasks provided for in the training program are completed, some of the completed tasks may contain errors (from 67% to 73% of correct answers);
- "Satisfactory enough": the theoretical content of the course is partially mastered, but the gaps are not significant, the necessary practical skills of working with the mastered material are mostly formed, most of the training tasks provided for in the training program are completed, some of the completed tasks may contain errors (from 60% to 66% of correct answers);
- "Unsatisfactory": the theoretical content of the course is partially mastered, the necessary practical skills of

work are not formed, most of the provided training programs for training tasks are not completed, or the quality of their performance is estimated by a number of points close to the minimum; with additional independent work on the course material, it is possible to improve the quality of performing educational tasks(with the possibility of re-passing)(less than 60% of correct answers);
- "Unacceptable" - the theoretical content of the course is not mastered, necessary
 practical work skills are not formed, all completed training tasks contain gross errors, and additional independent work on the course material will not lead to any significant improvement in the quality of training tasks.(with a mandatory repeat course).
On a 100-point scale on the national scale

Table 1 - Scale of transfer of points to the National Assessment System

on a 100-point scale	on the national scale
from 60 points to 100 points	are credited
less than 60 points	are not credited

Table 2-correspondence of final rating ratings in points to national scale and ECTS scale ratings

Rating	Rating on the national scale (exam, credit)	Rating on the ECTS scale	
		Grade	Criteria
90-100	Excellent	**A**	"Excellent" - the theoretical content of the course is fully mastered, without gaps, the necessary practical skills of working with the mastered material are formed, all the training tasks provided for in the training program are completed, the quality of their implementation is estimated by the number of points close to the maximum.
82 – 89	Good	**B**	"Good" - the theoretical content of the course is fully mastered, without gaps, the necessary practical skills of working with the mastered material are mostly formed, all the training tasks provided for in the training program are completed, the quality of most of them is estimated by the number of points close to the maximum.
75 – 81		**C**	"Good" - the theoretical content of the course is fully mastered, without gaps, some practical skills of working with the mastered material are not sufficiently formed, all the training tasks provided for in the training program are completed, the quality of performance of any of them is not evaluated with a minimum number of points, some types of tasks are performed with errors
67 – 74	Satisfactory	**D**	"Satisfactory" - the theoretical content of the course is partially mastered, but the gaps are not significant, the necessary practical skills of working with the mastered material are mostly formed, most of the training tasks provided for in the training program are completed, some of the completed tasks may contain errors.
60 – 66		**E**	"Enough" - the theoretical content of the course is partially mastered, some practical work skills are not formed, many of the training tasks provided for in the training program are not completed, or the quality of performance of some of them is estimated by a number of points close to the minimum.
35 – 59	Unsatisfactory	**FX**	"Unsatisfactory" - the theoretical content of the course is partially mastered, the necessary practical skills of work are not formed, most of the provided training programs for educational tasks are not completed, or the quality of their performance is estimated by a number of points close to the minimum; with additional independent work on the course material, it is possible to improve the quality of performing educational tasks(with the possibility of re-passing)
1 – 34		**F**	"Unacceptable" -the theoretical content of the course is not mastered, the necessary practical skills are not formed, all completed training tasks contain gross errors, additional independent work on the course material will not lead to any significant improvement in the quality of training tasks.(with a mandatory repeat course)

Course policy:
- the course involves working in a team, the environment in the classroom is friendly, creative, open to constructive criticism;
- mastering the discipline involves mandatory attendance at lectures and practical classes, as well as independent work;
- independent work involves the study of individual topics of the academic discipline, which are submitted in accordance with the program for independent study, or were considered briefly;
- all tasks provided for in the program must be completed on time;
- when studying the course, applicants for higher education must adhere to the rules of academic integrity set out in the following documents: "Rules of academic integrity of participants in the educational process of KHNADU (https://www.khadi.kharkov.ua/fileadmin/P_Standart/pologeniya/stvnz_67_01_dobroch_1.pdf), "Moral and ethical code of participants in the educational process of KHNADU (https://www.khadi.kharkov.ua/fileadmin/P_Standart/pologeniya/stvnz_67_01_MEK_1.pdf).
- cheating during test papers and tests is prohibited (including using mobile devices). Mobile devices can only be used during online testing.

Recommended literature:

1. Навчальний посібник "Лінійне програмування" для бакалаврів спеціальностей 051 «Економіка», 071 «Облік і оподаткування», 073 «Менеджмент», 076 «Підприємництво, торгівля та біржова діяльність» денної та заочної форм навчання / Укладачі: Волков В. Е., Максимова О. Б., Макоєд Н. О. - Одеса: ОНАХТ, 2018. — 115 с.

2. Катренко А. В. Дослідження операцій. Підручник, 3-тє вид., випр. і доп. – Львів: "Магнолія-2006", 2018. – 549 с.

3. Терентьєв О. О. Дослідження операцій: навчальний посібник / О. О. Терентьєв, О. В. Доля, О. І. Баліна. – К.: 2020. –116 с.

4. Фартушний І. Д. Курс дослідження операцій: навчальний посібник / І. Д. Фартушний, М. Г. Охріменко, І. Ю. Дзюбан. – К.: НТУУ«КПІ», 2016. – 212 с.

5. Теорія систем масового обслуговування : навч. посібник / А. Л. Литвинов ; Харків. нац. ун-т міськ. госп-ва ім. О. М. Бекетова. – Харків : ХНУМГ ім. О. М. Бекетова, 2018. – 141 с.

6. Імітаційне моделювання систем масового обслуговування: навч. посіб. [для студентів техн. спец. вищ. навч. закл.] / В. Б. Толубко, А.Д. Кожухівський, В.В. Вишнівський, Г.І. Гайдур, О.А. Кожухівська. – Київ: ДУТК, 2018. - 175 с.

7. Дмитрієв І. А. Математичні методи в економічних дослідженнях / І. А. Дмитрієв, О. І. Дмитрієва, Т. В. Ємельянова, І. Ю. Шевченко, Т. О. Ярхо. – Харків: ФОП Бровін О. В., 2021. – 180 с.

Additional sources:
1. distance learning course: https://dl2022.khadi.kharkov.ua/course/view.php?id=3263

Developer (s)

Sylabus of the academic discipline		Tetiana YARKHO
		Tetiana EMELIANOVA
Head of the Department of Higher Mathematics		Tetiana YARKHO