NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCES OF UKRAINE

THE FACULTY OF ECONOMICS

TEACHING - METHODOLOGICAL COMPLEX

Academic Discipline
Applied modeling:

“Economic Mathematical Modeling”

for the students of the Faculty of Economics
Level One ("Bachelor") of Higher Education

Speciality: 073 “Management”
Educational program “Management”

Field of Knowledge 07 “Management and Administration”
The Faculty of Agrarian Management

Compiled by: Liudmyla Galaieva
Associate Professor, Ph.D.

NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCES OF UKRAINE

Department of Economic Cybernetics

“APPROVED”:
Dean of the department
_____ Ostapchuk A.D.
"____"_____2022

“ENDORSED”
on the department of economic cybernetics meeting
Record № 10 dated on 06.05. 2022
Head of the department
_____Zherlitsyn D.M.

“REWIEVED”
Guarantor of the educational program

_____Lutsiak V.V.

Work program of the academic discipline Applied modeling: Economic Mathematical Modeling

Specialty: 073 “Management”
Educational program “Management”
The Faculty of agrarian management
Developer: Galaieva L.V. Associate Professor, Ph.D.

Kyiv – 2022

1. Academic discipline description

Applied modeling: “Economic Mathematical Modeling”

Field of knowledge, specialty, educational program, educational degree		
Educational degree	Bachelor	
Specialty	073 Management	
Educational program	Management	
Characteristics of the academic discipline		
Kind	Obligatory	
General number of hours	90	
Number of credits ECTS	3	
Number of content modules	2	
Form of control	Exam	
Indicators of academic discipline for full-time form of studies		
	Full-time studies	Distance education
Year of preparation	2	-
Semester	4	-
Lections	15 h.	-
Laboratory classes	30 h.	-
Independent study (Self-study)	45 h.	-
Number of weekly classroom hours for full-time study	3 h.	-

2. The Purpose and the Tasks of Learning the Academic Discipline

Applied modeling: "Economic Mathematical Modeling"

An effective management of all economic processes is based both on knowledge of their specific features and the study of difficult connections that exist among the economic phenomena, the ability to foresee the consequences of the latter or other economic measures.

A quantitative analysis and mathematical methods of research play an important role since economic systems, that are studied by the modern science, are practically impossible to be effectively investigated by the methods of theoretical methods or direct experiment. It is appropriate to use economic-mathematical modelling to find the optimal operation modes for production systems in agriculture. The main sections of the academic discipline "Economic Mathematical Modelling" contain theoretical statements and examples of solving linear optimisation problems using spreadsheets and Excel Solver to find multiple solutions.

The objective of the course is to study terminology, elementary approaches - methods and models - that are required for being able to study situations in practice and for the construction of economic-mathematical models for tasks of agricultural manufactures, which have a wide sphere of application in economic activity of enterprises of different patterns of ownership under market conditions.

The purpose and role of the course in the system of preparation of experts (specialists).

The purpose of the course is to get students acquainted with basic knowledge of the Optimization Methods and Models and knowledge transfer from modern mathematics which would enable learners to work with special models in practice.

The tasks of learning the course

The primary goals of the course are:

- to learn the main concepts of " Economic Mathematical Methods and Models"
- to develop logical thought and skills to solve practical tasks;
- to define special probability distributions, to analyse and to make decision.

The Requirements for the knowledge and skills obtained as the result of learning the course

The systemic approach, active methods of training, automated educational systems, the unit-rating control system training of students are used in the course.

The student should be competent in:

- the modern theory;
- theorems, methods, and models;

- essence and history of the academic discipline;
- studying the main methods for solving the problems of the course;
- realization of formal research received by the solver;
- performance of the analysis of the solver.

The student should be able to:
- apply the models in economy.

The form of control: exam.

COMPETENCES

Integral competence

Ability to solve complex specialized problems and practical problems, which are characterized by complexity and uncertainty of conditions, in the field of management or in the learning process, which involves the application of theories and methods of social and behavioral sciences

General competencies (GC):

GC 3. Ability to abstract thinking, analysis and synthesis.
GC 8. Skills in using the information and communication technologies.
GC 10. Ability to conduct research at the appropriate level.

Professional competencies of the specialty - Special competencies (SC):

SC 3. Ability to determine the prospects for the development of the organization.

SC 12. Ability to analyze and structure the problems of the organization, to form sound decisions.

Program learning outcomes (PLO):

PLO 6. Identify skills of search, collection and analysis of information, calculation of indicators to justify management decisions.

PLO 19. Demonstrate the ability to make independent decisions, develop a sufficient number of alternatives, choose the best solutions and be responsible for their implementation.

PLO 21. Demonstrate the ability to make independent decisions, develop a sufficient number of alternatives, choose the best solutions and be responsible for their implementation.

3. THE PROGRAMME AND STRUCTURE OF THE ACADEMIC DISCIPLINE
for Full-time study

Name (the module, the topic)	The number of hours											
	Full-time						Extramural					
	Hours	amongst					Hours	amongst				
		l	s	lab	ind	ss		l	s	lab	ind	ss
1	2	3	4	5	6	7	8	9	10	11	12	13
Module 1. "Mathematical Programming"												
Content Module 1. Linear Models and Methods for Finding Solutions of Linear and Nonlinear Optimization Problems												
Topic 1. Bases of Mathematical Programming. Graph Method.	10	2		4		4						
Topic 2. Simplex Method for solving Linear Programming Problems.	10	2		4		4						
Topic 3. Dual Problem.	10	2		4		4						
Topic 4. Transportation Problem.	10	2		4		4						
Topic 5. Nonlinear Programming Problems.	5	1		2		2						
Total for Content Module 1	**45**	**9**		**18**		**18**						
Module 2. "Mathematical Modelling"												
Content Module 2. Theoretical Basis of Mathematical Modelling and Practical Support												
Topic 6. The Theoretical Basis of Economic Mathematical Modelling.	15	2		4		9						
Topic 7. The System of Models in Agriculture.	15	2		4		9						
Topic 8. Some Sections of Modelling.	15	2		4		9						
Total for Content Module 2	**45**	**6**		**12**		**27**						
Total hours	**90**	**15**		**30**		**45**						

4. The Topic of Laboratory Classes

№ n/n	Topic	Hours
1	Bases of Mathematical Programming. Graph Method.	4
2	Simplex Method for solving Linear Programming Problems.	4
3	Dual Problem.	4
4	Transportation Problem.	4
5	Nonlinear Programming Problems.	2
6	The Theoretical Basis of Economic Mathematical Modelling.	4
7	The System of Models in Agriculture.	4
8	Some Sections of Modelling.	4
Total		30

5. Self -study

№ n/n	Topic	Hours
1	Bases of Mathematical Programming. Graph Method.	4
2	Simplex Method for solving Linear Programming Problems.	4
3	Dual Problem.	4
4	Transportation Problem.	4
5	Nonlinear Programming Problems.	2
6	The Theoretical Basis of Economic Mathematical Modelling.	9
7	The System of Models in Agriculture.	9
8	Some Sections of Modelling.	9
Total		45

6.The example of exam tasks

<table>
<tr><td colspan="4">NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCES OF UKRAINE</td></tr>
<tr><td>EL Bachelor
FAM
Specialty
073
“Management”</td><td>Department of Economic Cybernetics

2022-2023 s/y</td><td>Variant
Discipline
Economic Mathematical Modelling</td><td>Heard of Department

_____ D.Zherlitsyn.
___ 2022</td></tr>
<tr><td colspan="4">Questions (Tasks)
(max 20 b)</td></tr>
<tr><td colspan="4">1. The general task of linear programming and its initial forms.. (10b)</td></tr>
<tr><td colspan="4">2. (5 b)
$z = x_1 + 2x_2 \to \max$
$x_1 - 2x_2 \geq 1$
$x_1 + x_2 \leq 5$
$x_1 \geq 0,\ x_2 \geq 0$</td></tr>
<tr><td colspan="4">3. (5 b) .
Unemployment. A sample of the employment status of the residents in a certain town is given in
$\bar{a} = (18,7,7)$ $\bar{b} = (10,11,11)$ $C = \begin{pmatrix} 5 & 2 & 4 \\ 3 & 6 & 2 \\ 2 & 4 & 6 \end{pmatrix}$</td></tr>
<tr><td colspan="4">Test
(max 10 b)</td></tr>
</table>

1. A convex set in a plane is a set in which for any two points A and B of the set, all the points on the line segment AB:

1	also belong to the set;
2	on occasion belong to it;
3	do not belong to it;
4	on occasion do not belong to it.

2. Unit models in accordance to their classification:

a) Volume of Object b) Time – Factor c) Certainty Factor	1. Static 2. Micro 3. Macro 4. Certainty models 5. Risk models 6. Dynamic 7. Uncertainty

3. Optimum solution is:

1	any vector which satisfies the constrains of the problem;
2	nonpositive vector which satisfies the constrains of the problem;
3	a feasible solution which gives to the objective function an extreme value;
4	any plan.

4. Unit forms with their interpretation:

a) Standard Form b) Canonical Form1 (max) c) Canonical Form 2 (min)	1 $\sum a_{ij} x_j = b_i$ 2 $\sum a_{ij} x_j \geq b_i$ 3 $\sum a_{ij} x_j \leq b_i$

5. Is it true:

Method of potentials is used to solve the optimal plan	Yes or No

6. What means the solution of the problem of the Linear Programming graphically?

1	to find the co-ordinates of all tops of polyhedron of the problem;
2	to build the polyhedron of the problem and lines of the levels;
3	among tops of polyhedron following direction of vector-gradient, to find the co-ordinates of those tops which gives the objective function of extreme value;
4	to build the area of legitimate values of problem, sending a vector and line of the level.

7. Methods of construction of primary plans of transport problem:

1	north-western corner, minimum cost, etc.;
2	diagonal, potentials, minimum cost;
3	potentials, diagonal, double marks;
4	north-western corner, minimum cost, minimum chain, balance;
5	diagonal, minimum cost, balance.

8. Put into accordance the criteria of classification and models to them:

A. Time factor	1. Certainly, uncertainly and risk models
B. Form of dependence	2. Micromodels and macromodels
C. Certainly factor	3. Discrete and continuous models
D. Volume of object	4. Static and dynamic models
E. Form of variable	5. Linear and nonlinear models

9. What is an objective function in transportation tasks?

1	Maximal growth of the GDP
2	Minimum costs of transportation
3	Maximal profit
4	Minimum distance of transportation
5	Answers 1 and 4

10. Put the skipped correct word to this definition:

____ is a field of study, which using computers, special programs and skills of executive goals to solve different business tasks	*(in the form of answers enter a one-word faithful answer)*

_____ ***(***Galaieva L.V.***)***

THE EXPLANATORY NOTE

The batch tests of the academic discipline are designed to ensure quality education and to improve the rating module-level control of students.

The batch tests are a set of tasks according to each subject of the syllabus with the answers to the challenges provided. Students are required to select the correct version offered by the author. Solving the problem requires from the student to have the ability to apply knowledge of reproductive theoretical and practical courses and professional creative thinking.

The duration of the tests is 450 minutes. The questions in the test package are not differentiated by their level of difficulty.

TEST EXAMPLE

1. A convex set in a plane is a set in which for any two points A and B of the set, all the points on the line segment AB:

1	also belong to the set;
2	on occasion belong to it;
3	do not belong to it;
4	on occasion do not belong to it.

2. Unit models in accordance to their classification:

a) Volume of Object b) Time – Factor c) Certainty Factor	1. Static 2. Micro 3. Macro 4. Certainty models 5. Risk models 6. Dynamic 7. Uncertainty

3. Optimum solution is:

1	any vector which satisfies the constrains of the problem;
2	nonpositive vector which satisfies the constrains of the problem;
3	a feasible solution which gives to the objective function an extreme value;
4	any plan.

4. Unit forms with their interpretation:

a) Standard Form b) Canonical Form1 (max) c) Canonical Form 2 (min)	1 $\sum a_{ij} x_j = b_i$ 2 $\sum a_{ij} x_j \geq b_i$ 3 $\sum a_{ij} x_j \leq b_i$

5. Is it true:

Method of potentials is used to solve the optimal plan	Yes or No

6. What means the solution of the problem of the Linear Programming graphically?

1	to find the co-ordinates of all tops of polyhedron of the problem;
2	to build the polyhedron of the problem and lines of the levels;

3	among tops of polyhedron following direction of vector-gradient, to find the co-ordinates of those tops which gives the objective function of extreme value;
4	to build the area of legitimate values of problem, sending a vector and line of the level.

7. Methods of construction of primary plans of transport problem:

1	north-western corner, minimum cost, etc.;
2	diagonal, potentials, minimum cost;
3	potentials, diagonal, double marks;
4	north-western corner, minimum cost, minimum chain, balance;
5	diagonal, minimum cost, balance.

8. Put into accordance the criteria of classification and models to them:

A. Time factor	1. Certainly, uncertainly and risk models
B. Form of dependence	2. Micromodels and macromodels
C. Certainly factor	3. Discrete and continuous models
D. Volume of object	4. Static and dynamic models
E. Form of variable	5. Linear and nonlinear models

.

9. What is an objective function in transportation tasks?

1	Maximal growth of the GDP
2	Minimum costs of transportation
3	Maximal profit
4	Minimum distance of transportation
5	Answers 1 and 4

.

10. Put the skipped correct word to this definition:

____ is a field of study, which using computers, special programs and skills of executive goals to solve different business tasks	*(in the form of answers enter a one-word faithful answer)*

.

11. Line of level. Choose the determination:

1	line which goes out from the beginning of co-ordinates;
2	line which specifies direction of growth of objective function;
3	separate line which accord to the expression ***z=const***;
4	line in any point of which the value of objective function will remain unchanging.

12. By the form of dependence, models classified as:

1	Micromodels and macromodels
2	Static and dynamic models
3	Linear and nonlinear models
4	Certainly, uncertainly and risk models
5	Discrete and continuous models
6	All answers are correct

13.Put the skipped correct word into the definition:

_____ is a concentrated expression of the most substantial intercommunications and conformities to law of process of functioning of the economic system in a mathematical form.	*(in the form of answers enter a one-word faithful answer)*

14.The models are divided into 2 groups.

(in the form of answers enter a one-word faithful answer)

15.Is it true?

The method of minimum cost is used to find an optimal solution.	Yes or No

16.. ____ It is an aggregate of numbers or objects of other nature, located as a rectangular table.

(in the form of answers enter a one-word faithful answer)

17.Line of level. Choose the determination:

	line which goes out from the beginning of co-ordinates;
	line which specifies direction of growth of objective function;
	separate line which accord to the expression ***z=const***;
	line in any point of which the value of objective function will remain unchanging.

18.The general problem of the Linear Programming includes the objective function and:

	constraints of inequality of both types at only nonnegative of variables;
	constraints of inequality of both types at only nonpositive of variables;
	constraints of equality and mixed system of constraints as a token of variables;
	constraints of equality at nonnegative variables.

19.Simplex Method:

1	- An algebraic, iterative method to solve linear programming problems. Gauss;
2	- a universal plan which lends for the objective functions the extreme value, named optimum;
3	- name a deciding element extreme or main.;
4	-a universal method for the solution of all problems of the mathematical programming;
5	- a method that is provided by the tops of polygonal of plans of the problem.

20. Is it true:

Method of potentials is used to find feasible solution.	Yes or No

21.Is it true:

The Feasible Solution is a solution that has the most favorable value of the objective function.	Yes or No

22. ____ It is an aggregate of numbers or objects of other nature, located as a rectangular table.

(in the form of answers enter a one-word faithful answer)

23. Is it true? (Yes or No)

Vector-gradient **is** a vector with co-ordinates that is coefficients at the variables of objective function, which goes out from the beginning of co-ordinates and show the direction of growth of values of objective function.

24.Is it true? (Yes or No)

Line of level is a separate line which accord to the expression ***z=const***;

25. A convex set in a plane is a set in which for any two points A and B of the set, all the points on the line segment AB:

1	also belong to the set;
2	on occasion belong to it;
3	do not belong to it;
4	on occasion do not belong to it.

26.Is it true?

The method of potentials is used to find an optimal plan	Yes or No

27. By the form of dependence, models are classified as:

1	Micromodels and macromodels
2	Static and dynamic models
3	Linear and nonlinear models
4	Certainly, uncertainly and risk models

29.The general problem of the Linear Programming includes the objective function and ____

(in the form of answers enter a one-word faithful answer)

30.Choose an accordance

a. simplex method	1. transportation problem
b. Method of potentials	2. linear problem

7.**Questions for control**

Module #1

1. A basic step in a branch-and-bound algorithm that bounds how good the best solution in a subset of feasible solutions can be.
2. An algorithm that deals with a linear programming problem as if the simplex method were being applied simultaneously to its dual problem.
3. A standard procedure for obtaining the simultaneous solution of a system of linear equations.
4. A special type of nonlinear programming problem that fits many engineering design problems, among others.
5. A method for solving linear programming problems with two decision variables on a two-dimensional graph.
6. A mathematical model where the mathematical functions appearing in both the objective function and the constraints are all linear functions.
7. Mixed integer programming and its interpretation.
8. Modified simplex method and its interpretation.
9. Nonbasic variables and its interpretation.
10. Quadratic programming problems and its interpretation.
11. Simulation and optimization of agro resources.
12. Dynamic simulation of processes.
13. Using game method for optimization of technological processes in agricultural enterprise.
14. The supply center for a transportation problem.
15. A streamlined version of the simplex method for solving transportation problems.
16. Subject, method and tasks of a rate. Objective necessity of application of quantitative methods for agrarian management.
17. Classification of tasks of mathematical programming.
18. Examples of tasks from the area of an agriculture and management. Interrelation of discipline with other spheres of economic activity.
19. A general task of linear programming and its initial forms.
20. The basic kinds of linear parities (ratio).
21. Concept of algorithm of solving a task and their kinds.
22. The basic concepts of formalization of economic processes.
23. A graphic method of solving the problems of linear programming.
24. Geometrical interpretations of a task of linear programming in different forms.
25. Geometrical interpretation of objective function and system of restrictions of a task of linear programming.
26. The basic analytical properties of tasks of linear programming.
27. A simplex method of the decision of tasks of linear programming.
28. Algorithm of finding of the basic plan by a simplex method.

29. Basis of algorithm of the presence of the optimum plan.
30. Dual problem.
31. The method of artificial base.
32. Methods of the analysis of solving the tasks.
33. Cycling in tasks of linear programming and methods of its elimination.
34. The basic concepts of formalization of economic processes.
35. Dual simplex method.
36. Features of structure of a transport task.
37. Methods of construction of the basic plans of a transport task. A method of potentials of a presence (finding) the solve of a transport task.
38. An attribute of an optimality of the plan.
39. M*e*thods of the analysis the solve .
40. Optimizations models with parameter in the objective function.
41. The algorithm for solving problems with a parameter in the objective function.
42. Distributive models with a parameter.
43. A general task of integer programming.
44. Classes of tasks in an agriculture.
45. Concept of algorithm of solving a task and their kinds.
46. The basic concepts of formalization of economic processes.

Module #2

1. Planning of development of agricultural production on the basis of models.
2. Simulation and optimization of process control in livestock.
3. Simulation and optimization of agro resources.
4. Optimization of the production program of the Agricultural Enterprise stochastic programming methods.
5. Dynamic simulation of processes in agricultural enterprise.
6. Modeling of soil nutrition of agricultural plants.
7. Modeling of soil fertility in agricultural enterprise.
8. Modeling ecological and economic interaction.
9. Using Game method for optimization of technological processes in agricultural enterprise.
10. Optimization of agrarian enterprises in conditions of risk.
11. Simulation and optimization of potential soil fertility.
12. Optimization of industrial structure and specialization of agricultural enterprises.
13. Modeling and optimization of allocation of crops to different areas of fertility.
14. Modeling agrotechnological processes by distributors.
15. Multiobjective optimization problems of economic systems at the level of agricultural enterprises.
16. Programming agricultural production methods linear-optimization modeling.
17. Simulation and optimization of structure and turnover herd animals.

18. Modeling the optimal structure of sown areas in the agricultural enterprise.
19. Simulation and optimization of the structure of agricultural enterprises by fractional linear programming.
20. Optimization of industrial structure and specialization of agricultural enterprises as multi task.
21. Optimization of the farming industry and ways to improve its performance.
22. Optimization of field crop and ways of improving its performance.
23. Optimization of fodder production in the agricultural enterprise.
24. Optimization of forage harvested in the agricultural enterprise.
25. Optimizing the allocation and use of fertilizers in the agricultural enterprise.
26. Simulation and optimization of technological processes in plant.

8. Methods

- Lectures and Laboratory classes (the use of modern information technology).
- Individual-study and module work (the use of modern information technology).

9. Forms of control

- Individual tasks.
- Module tests.
- Exam

10. The Correlation between the National Grading and Rating of the Higher Education Learners

Distribution of the score that the students receive. The student's assessment is carried out in accordance with the Regulation "On Examinations and Credits at NULES of Ukraine" dated 27.02.2019, Protocol No. 7 from the Table.

National Grade	Rating of the Higher Education Learners, Score
“Excellent”	90 - 100
“Good”	74 - 89
“Satisfactory”	60 - 73
“Failed”	0 - 59

To determine the rating of the student (listener) for mastering the discipline R_{DIS} (up to 100 points) the obtained rating for certification R_{AT} (up to 30 points) is added to the rating of the student (listener) for academic work R_{AW} (up to 70 points): $R_{DIS} = R_{AW} + R_{AT}$

STUDENT ASSESSMENT CRITERIA

The “Excellent” grade is to be awarded to a student who has completely acquired the educational material and is able to present it logically and thoroughly. The theory would be related to practice. The student provides a background to correct answers, possesses different methodological skills and is able to solve additional tasks.

The “Good” grade is given to a student who has acquired the educational material, provides mostly correct answers, being able to use theoretical approaches at solving practical cases.

The grade “Satisfactory” is to be conferred to a student who has learned only educational material, but not in details; there are some mistakes made, not thorough implementation in doing tasks, being non-consecutive in responses.

To be evaluated with the grade “Failure”, a student should fail to have learnt a most of educational material, makes fatal errors, being slow in solving practical tasks.

Rating grades according to modules

Study term, weeks	**Module number**	**Teaching load, hrs**	**Credits ECTS**	**Rating grade for the module**		
				minimum	**estimated**	**real**
1 – 10	1	60	2,0	60	100	
11– 15	2	60	2,0	60	100	
Total	***2***	***120***	***4***	***60***	***100***	

11.LITERATURE

Basic literature

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2. Галаєва Л.В., Коваль Т.В., Шульга Н.Г. Економіко-математичний словник / [для студентів економічних спеціальностей вищих навчальних закладів]. К.: ЦП «Компринт», 2017. 265 с.

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INDIVIDUAL ASSIGNMENTS FOR SELF-STUDY WORK
(under supervision)

Examples of individual tasks

Task #1

Problem 1

Construct a numerical economic-mathematical model for the assembly of an existing set of feed and feed additives of optimum feeding ration for certain types of animals, satisfying biological needs of animals in nutrient, sustained scientific and reasonable balance between individual groups and types of feed and feed additives. Criteria - least cost ration. Solve the problem on your computer. Perform economic and mathematical analysis of the optimal solution. (the required information is attached).

Problem 2

Construct a numerical economic-mathematical model for the optimal plan for use of feeds of the stalled period. Criteria - a maximum of livestock production in monetary terms. Build a matrix problem. Perform calculations on the PC and analyze the obtained solution. (the required information is attached).

Problem 3

Construct a numerical model of economic and mathematical optimization of the allocation and use of fertilizers in terms of field rotation. Use the carrying-optimization for a basic structural model. Solve the problem on your computer and perform analysis of the optimal plan. (the required information is attached).

Problem 4

Construct a numerical model of economic-mathematical structure optimization feed. Criteria - minimum tillage costs. Solve the problem on your computer. Perform analysis of the optimal plan. (the required information is attached).

Problem 5

Using information for Problem 4 and additional information in accordance with our suggestion, create economic and numerical mathematical model and matrix optimization problems of industrial structure and specialization of agricultural enterprises. Criteria - maximum profit. (the required information is attached).

Task #2

To create matrix and to solve the task of optimal resources using for maximization of total profit with help of EXCEL Solver.

The resource of raw materials, norms of its using per 1 product and price are given in the table. You should find:

1. The plan of product production in terms of profit maximization from its realization.
2. The value of each resource and its priority in task solution of the increasing of resources' total amount.
3. The maximum interval of fund changing of each resource in which the structure of the optimal plan won't change.
4. The summary value of the resources for the grade which are used for the producing of each product. Producing of which product is not rentable?
5. How will value of products decline if production is non-rentable?
6. How will reserve of each resource decline without profit declining?

For the production of 4 product types, we use 3 resource types.

Type of resource	Norms of resources using per 1 product					Quantity of resources
	Baked meat	Baked tomato	Salad	Sup	Baked pudding	
Cheese	1	2	1	6	2	18
Tomato	2	3	2	1	2	30
Olives	1	3	3	5	2	40
Price of product	12	7	18	10	10	–

Task # 3

Assume that one of the confectioneries of plant Roshen produces four different types of chocolates: "Baton" "X1", "Dragee" "X2", "Korovka" "X3", "Pivdenna nich" "X4". And it has some part of resources such as: labour, row material and equipment.

Table 1

Type of resource	Resource in the standard cost per unit				Resource
	Baton	Dragee	Korovka	Pivdenna nich	
Labour	8	5	3	3	**120**
Raw material	3	1	2	1	**310**
Equipment	2	4	2	1	**680**
Price of product	22	17	25	19	-

INDIVIDUAL ASSIGNMENTS FOR SELF-STUDY WORK
Graf method, simplex method, dual problem

Variant 1

The view of recourses	The view of production		Quantity of recourses
	P_1	P_2	
R_1	4	4	16
R_2	6	8	48
R_3	8	3	24
Profits, monetary unit	14	70	

Transportation problem

Variant 1
a_i = (8; 10; 5);
b_j = (5; 5; 10);

$$c_{ij} = \begin{pmatrix} 4 & 2 & 1 \\ 2 & 1 & 3 \\ 2 & 4 & 5 \end{pmatrix}$$