

**NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCES OF  
UKRAINE**

**Department of Economic Cybernetics**

Dean of the Agrarian Management Faculty



**“CONFIRMED”**

**A. Ostapchuk**

6 2023

**“APPROVED”**

at the meeting of the Department of Economic Cybernetics

Protocol № 10 dated 18.05. 2023

Head of Department

**D. Zherlitsyn**

**“REVIEWED”**

Program Coordinator of the educational program

“Marketing”

Program Coordinator

**V. Geraimovych**

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

Specialty: 075 “Marketing ”

Educational program “Marketing”

The Faculty of agrarian management

Developer: Galaieva L.V. Associate Professor, Ph.D.

**Kyiv – 2023**

## 1. Academic discipline description

### Applied modeling: “Economic Mathematical Modeling”

Field of knowledge, specialty, educational program, educational degree		
Educational degree	Bachelor	
Specialty	075 Marketing	
Educational program Marketing	Marketing	
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	-
Lectures	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 (IC):**

The ability to solve complex specialized tasks and practical problems in the field of marketing activities or in the learning process, which involves the application of relevant theories and methods and is characterized by complexity and uncertainty of conditions.

### **General Competencies (GC):**

GC 3. Ability to abstract thinking, analysis and synthesis.

GC4. Ability to learn and master modern knowledge.

GC5. Determination and perseverance in the assigned tasks and responsibilities.

GC11. Ability to work in a team.

GC14. Ability to act socially responsibly and consciously.

### **Program Learning Outcomes (PLO):**

PLO3. Apply acquired theoretical knowledge to solve problems practical tasks in the field of marketing.

PLO5. Identify and analyze the key characteristics of marketing systems of different levels, as well as the characteristics of the behavior of their subjects.

PLO9. Assess the risks of marketing activities, establish the level of uncertainty of the marketing environment when making management decisions.

PLO11. Demonstrate the ability to apply an interdisciplinary approach and perform marketing functions of a market entity.

PLO14. Perform functional responsibilities in the group, offer sound marketing solutions.

### 3. THE PROGRAMME AND STRUCTURE OF THE ACADEMIC DISCIPLINE

– complete full-time form of study

Names of content modules and topics	Number of hours											
	total	Full-time form					Hours	Extramural				
		including						including				
		1	s	lab	ind	ss		1	s	lab	ind	ss
1	2	3	4	5	6	7	8	9	10	11	12	13
<b>Module # 1. Theoretical Basis of Mathematical Modelling and Practical Support</b>												
Topic # 1. Bases of Economic Mathematical Modelling.	10	2			4		4					
Topic # 2. Methods for Solving Linear Programming Problems.	15	3			6		6					
Topic # 3. Special Methods.	10	2			4		4					
Topic # 4. Nonlinear Programming Problems.	10	2			4		4					
Topic # 5. The System of Models in Agriculture	10	2			4		4					
Topic # 6. Some Sections of Modelling (Risk, Financial etc.).	10	2			4		4					
Topic # 7. Inventory management models	10	2			4		4					
<b>Total hours</b>	<b>75</b>	<b>15</b>			<b>30</b>		<b>30</b>					

#### 4. Laboratory class topics

№	Topic title	Number of hours
1	Topic # 1. Bases of Economic Mathematical Modelling.	4
2	Topic # 2. Methods for Solving Linear Programming Problems.	6
3	Topic # 3. Special Methods.	4
4	Topic # 4. Nonlinear Programming Problems.	4
5	Topic # 5. The System of Models in Agriculture	4
6	Topic # 6. Some Sections of Modelling (Risk, Financial etc.).	4
7	Topic # 7. Inventory management models.	4
Total		30

#### 5. Independent work topics

№	Topic title	Number of hours
1	Topic # 1. Bases of Economic Mathematical Modelling.	4
2	Topic # 2. Methods for Solving Linear Programming Problems.	6
3	Topic # 3. Special Methods.	4
4	Topic # 4. Nonlinear Programming Problems.	4
5	Topic # 5. The System of Models in Agriculture	4
6	Topic # 6. Some Sections of Modelling (Risk, Financial etc.).	4
7	Topic # 7. Inventory management models.	4
Total		30

## 6. The example of exam tasks

<b>NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCES OF UKRAINE</b>			
Educational level “Bachelor” Faculty of Agrarian Management Specialty, educational programmes <u>073</u> <u>Management:</u> <u>075 Marketing</u>	<b>Department of                  Statistics and                  Economic                  Analysis                  &amp;                  Department of                  Economy                  Cybernetics</b>  2022-2023 educational year	<b>Exam variant № <u>1</u></b>  From the discipline <u>“Applied Modeling”</u>	<p style="text-align: center;"><b>Approved</b></p> Head of the Department of Statistics and Economic Analysis _____(I.D.Lazaryshyna) (signature)  Head of the Department of Economy Cybernetics _____(D.M. Zherlitsyn) (signature) _____2023
<b>Questions (Tasks)</b> (max 20 b)			
1. The general task of linear programming and its initial forms.. <b>(10b)</b>			
<b>2. (5 b)</b> $z = x_1 + 2x_2 \rightarrow \max$ $x_1 - 2x_2 \geq 1$ $x_1 + x_2 \leq 5$ $x_1 \geq 0, x_2 \geq 0$			
<b>3. (5 b) .</b> <b>Unemployment.</b> A sample of the employment status of the residents in a certain town is given in $\bar{a} = (18, 7, 7) \quad \bar{b} = (10, 11, 11) \quad C = \begin{pmatrix} 5 & 2 & 4 \\ 3 & 6 & 2 \\ 2 & 4 & 6 \end{pmatrix}$			
<b>Test</b> (max 10 b)			

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

**5. Is it true:**

Method of potentials is used to solve the optimal plan	Yes or No
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**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)
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## 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	1. Static
b) Time – Factor	2. Micro
c) Certainty Factor	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	$1 \sum a_{ij} x_j = b_i$
b) Canonical Form 1 (max)	$2 \sum a_{ij} x_j \geq b_i$
c) Canonical Form 2 (min)	$3 \sum a_{ij} x_j \leq b_i$

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	<i>(in the form of answers enter a one-word faithful answer)</i>
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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.	<i>(in the form of answers enter a one-word faithful answer)</i>
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30. Choose an accordance

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

## 7. Questions for control

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. Methods 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.
47. Planning of development of agricultural production on the basis of models.
48. Simulation and optimization of process control in livestock.
49. Simulation and optimization of agro resources.
50. Optimization of the production program of the Agricultural Enterprise stochastic programming methods.
51. Dynamic simulation of processes in agricultural enterprise.
52. Modeling of soil nutrition of agricultural plants.
53. Modeling of soil fertility in agricultural enterprise.
54. Modeling ecological and economic interaction.
55. Using Game method for optimization of technological processes in agricultural enterprise.
56. Optimization of agrarian enterprises in conditions of risk.
57. Simulation and optimization of potential soil fertility.
58. Optimization of industrial structure and specialization of agricultural enterprises.
59. Modeling and optimization of allocation of crops to different areas of fertility.
60. Modeling agrotechnological processes by distributors.
61. Multiobjective optimization problems of economic systems at the level of agricultural enterprises.
62. Programming agricultural production methods linear-optimization modeling.
63. Simulation and optimization of structure and turnover herd animals.
64. Modeling the optimal structure of sown areas in the agricultural enterprise.
65. Simulation and optimization of the structure of agricultural enterprises by fractional linear programming.
66. Optimization of industrial structure and specialization of agricultural enterprises as multi task.
67. Optimization of the farming industry and ways to improve its performance.
68. Optimization of field crop and ways of improving its performance.
69. Optimization of fodder production in the agricultural enterprise.
70. Optimization of forage harvested in the agricultural enterprise.
71. Optimizing the allocation and use of fertilizers in the agricultural enterprise.
72. 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 grades received by students.** The student's assessment is carried out in accordance with the Regulation "On Examinations and Credits at NULES of Ukraine" dated 26.04.2023, Protocol No. 8 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.

## 11.LITERATURE

### Basic literature

1. Carl P. Simon, Lawrence Blume. Mathematics for economists. New York, London: W.W.Norton & Company, 1994. 930p.
2. Cox D., Cox M. The Mathematics of Banking and Finance. The Atrium, Southern Gate, Chichester, John Wiley & Sons Ltd, 2006. 312 p.
3. Dantzig, G.B. Linear Programming and Extensions. Princeton, NJ: Princeton University Press, 1998. 656 p.
4. Galaieva L, Shulga N, Lipska V. Optimization Methods and Models. Kyiv: Printed Centre CP «Komprint», 2016. 259 p.
5. Drury C. Management and cost accounting. C&C Offset, China, 2008. 775p.
6. Peter B.R. Hazell, Roger Norton. Mathematical programming for economic analysis in agriculture. Macmillan Publishing Company, 1986. 400p.
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11. Жадлун З.О., Галаєва Л.В., Шульга Н.Г. Економіко-математичне моделювання з основами математичного програмування. Навчальний посібник/укл.: Жадлун З.О., Галаєва Л.В., Шульга Н.Г. Київ: ТОВ «Agrar Media Group», 2016. 266с.
12. Жадлун З.О., Галаєва Л.В., Шульга Н.Г. Математичне програмування. Київ.: ЦП «Компринт», 2017. 360с.

### **Additional literature**

1. Наконечний С.І., Гвоздецька Л.В. Збірник задач з курсу «Математичне програмування» 1: Навч.посібник. К.: ІЗМН, 2006.
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.

### **Methodological references**

1. Galaeva L.V., Shulga N.G. Optimization problems and their economical applications. Methodical textbook. Kyiv. Printed Centre CP «Komprint», 2016. 159 p. <http://elibrary.nubip.edu.ua>
2. Жадлун З.О., Галаєва Л.В., Шульга Н.Г. Оптимізаційні моделі та методи їх реалізації/ Київ: НУБіПУ, 2015. 150 с.
3. Методи розв'язку оптимізаційних задач. Методичні вказівки до виконання лабораторних та практичних завдань (для студентів економічних спеціальностей) / НУБіПУ; уклад.: Л. В. Галаєва, Н.Г.Шульга. К.: ТОВ «ЦП КОМПРИНТ», 2015. 93 с. <http://elibrary.nubip.edu.ua>
4. Моделювання використання добрив. Методичний посібник для студентів економічних спеціальностей/ уклад.: З. О. Жадлун, Л. В. Галаєва, Н. Г. Шульга. Київ: Редакційно-видавничий відділ НУБіП України, 2014. 40 с.
5. Оптимізація галузевої структури сільськогосподарського підприємства. Методичні вказівки для економічних спеціальностей/ уклад.: Л.В.Галаєва, Н. А. Рогоза, Н. Г. Шульга. Київ: Видавничий центр НУБіП України, 2013. 34 с.

## **12.Recommended sources of information**

### **Electronic Resources**

- 1.MOODLE: <https://elearn.nubip.edu.ua/course/view.php?id=5115>
2. Food and Agriculture Organization Corporate Statistical Database <http://faostat.fao.org>
3. Державна служба статистики України <http://www.ukrstat.gov.ua/>  
Market outlook report: [http://www.agr.gc.ca/pol/mad-dam/index\\_e.php?s1](http://www.agr.gc.ca/pol/mad-dam/index_e.php?s1)

**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, raw 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	<b>120</b>
Raw material	3	1	2	1	<b>310</b>
Equipment	2	4	2	1	<b>680</b>
Price of product	22	17	25	19	-

### 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

$a_i = (8; 10; 5);$

$b_j = (5; 5; 10);$

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