Educational Establishment
"Grodno State Agrarian University"

APPROVED
rector
_____ V.K.Pestis
"___" _____ 2019
Registration № UD ____

MODELING AND OPTIMIZATION OF BUSINESS PROCESSES IN AIC

The curriculum of higher education institutions for undergraduates

1-25 80 01 "Economics" (profiling - "Agricultural Economics")

2019 y.

COMPILED BY:

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RECOMMENDED FOR APPROVAL:

Department of computer science and economics and mathematical modeling in the agricultural sector
(protocol № 15 on 24.05.2019);
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(protocol № on __.__.____)
Responsible for editorial I. G. Ananich
Responsible for release T.V. Snopko

EXPLANATORY NOTE

The goals and objectives of the discipline

The purpose of studying the discipline is to master theoretical and practical knowledge and skills of undergraduates, as well as modern instrumental systems for modeling and optimizing business processes in the agricultural sector.

Objectives of the discipline:

 give an idea of the methodological base and modern approaches to modeling business processes of enterprises;

 develop practical skills in the selection, construction and analysis of mathematical models for optimizing business processes, their analysis and use in the process of developing effective management decisions.

Place of discipline in the system of training a specialist with higher education

The discipline program is developed on the basis of the competency-based approach and the requirements for the formation of competencies in the discipline, which refers to the cycle of special disciplines and is a component of the institution of higher education.

Mastering the discipline is based on competencies acquired earlier in the study of “Computer Information Technologies”, “Higher Mathematics”, “Econometrics and EMM and M”, as well as “Modeling and Optimization in the Agro-Industrial Complex”.

Requirements for the level of development of the content of the academic discipline

As a result of studying the discipline, the undergraduate must consolidate and develop the following academic (AC) and social-personal (SPC) competencies:

AC-1. To be able to apply basic scientific and theoretical knowledge to solve theoretical and practical professional problems.

AC-2. Be able to do comparative analysis.

AC-3. Be able to work independently.

AC-4. Have an interdisciplinary approach to solving problems.

AC-5. Have skills when working with computer equipment.

SPC-1. Have the ability to interpersonal communications.

SPC-2. Be able to work in a team.

As a result of studying the discipline, the undergraduate must possess the following professional competencies (PC):

PC-1. Have a clear idea of the business processes in the organizations of the agro-industrial complex.

PC-2. Have an idea of modern approaches to their classification.

PC-3. Have the skills to work with basic software products, databases, means of supporting mathematical calculations.

PK-4. Be able to collect, analyze and process the data necessary to create a business process model.

PC-5. Be able to build standard models of business processes based on a description of economic processes and phenomena, analyze and meaningfully interpret the results.

PC-6. To be able to use methods of mathematical modeling and optimization when solving applied in various fields of agriculture.

PC-7. Work with scientific literature.

To acquire professional competencies PC-1 - PC-7 as a result of studying the discipline, the undergraduate must know:

-modern trends and problems in the development of the theory and practice of modeling and optimization of business processes;

- methodological foundations for modeling business processes;

- methodology and tools for designing, analyzing and optimizing the business processes of the agricultural enterprise;

- the nature, specificity and conditions of the effective use of information technology in modeling business processes;

differences in the use of software products used in the optimization of business processes;

- various approaches to modeling business processes, their strengths and weaknesses, conditions for effective application;

- The principles of building a network of business processes, bringing it into line with the enterprise development strategy.

To be able and able to:

- select appropriate methods for modeling business processes and apply them effectively;

- solve linear programming problems using the graphical and simplex method;

- solve linear fractional and integer programming problems;

- apply the method of potentials to the solution of the transport problem;

- solve the problems of network planning, network optimization;

- solve typical problems of queuing theory;

- solve typical problems of single-inventory models of inventory management.

Total hours and class hours

102 hours are maximum allocated for mastering the discipline, including 44 hours of classroom hours.

Higher Education Form

When studying the discipline, such forms of training are provided: full-time and part-time.

Classroom time distribution by occupation, course and semester

Discipline is studied for full-time study in the 1st semester, while the class time is divided into 22 hours of lecture and 22 hours of practical classes.

Forms of current certification in academic discipline

Assessment of academic achievements of a graduate student is an exam. To assess the educational achievements of undergraduates, criteria are used, approved by the Ministry of Education of the Republic of Belarus.

Evaluation of intermediate academic achievements of undergraduates is carried out in accordance with the selected grade scale.

To assess the achievements of undergraduates, the following diagnostic tools are used (competencies are checked):

- presentation by a graduate student at a conference on a prepared abstract (AC-1, AC-3, AC-4, AC-5, SPC-1, SPC-2, PC-6);

- conducting ongoing quizzes on selected topics (PC-1 - PC-7);
- passing the test in the discipline (AC-1 - AC-5, PC-1 - PC-7).

CONTENT OF EDUCATIONAL MATERIAL

Theme 1. Multidimensional classification as the basis for modeling and optimization of business processes

Business process: concept, essence. Classification of enterprise business processes. Characteristics of business processes, distinctive features. Typical models for highlighting business processes.

Methodology for identifying stable classification groups. Implementation of multidimensional classification by methods of sum of places, multidimensional average, pattern, relative differences in the environment. Analysis of the degree of convergence of results using Spearman's rank correlation coefficient. The use of cluster analysis in multidimensional classification problems.

Theme 2. Linear tasks of business process optimization

The concept of a mathematical model in linear programming. Economic statement of the problem of linear programming. Methods for solving linear programming problems. Main elements. Forms of recording linear programming problems.

Basic definitions (admissible and optimal solutions).

The basics of the simplex method. Algebra of the simplex method. General characteristics of the simplex method as a method of directed enumeration of support plans for a linear programming problem. The procedure of transition from one basic plan to another basic plan of a linear programming problem.

Geometric interpretation and graphic method for solving linear programming problems. Simplex table. Directional transition to a new basic plan of the linear programming problem. Building a simplex table. Simplex algorithm. Methods of finding the initial reference plan of the linear programming problem.

The concept of duality. Mutually dual tasks. The rules for their construction. Economic interpretation of dual tasks. Objectively determined estimates.

Properties of the transport problem. Transport task of open type and closed type. Construction of the initial basic plan: the method of the "north-west corner", the method of the minimum element, the Vogel method, the method of potentials. The optimality condition for the basic plan.

Theme 3. Balance models

Modeling intersectoral relations. The general scheme of intersectoral balance. The main balance ratios. Mathematical model of interindustry balance. The solution of the system of equations of interindustry balance. Coefficients of direct and total costs of production factors. Signs of productivity of the matrix of direct cost coefficients. The construction of a price system based on the intersectoral balance. Interdisciplinary forecast model. Algorithms for carrying out calculations on models of interindustry balance. Optimization models based on interindustry balance. The simplest dynamic model of intersectoral balance.

Theme 4. Network tasks

The concept of network planning. Network model, network diagram. The basic concepts of a network model. Rules for building network diagrams. Event numbering. The path, the critical path. Critical work. Critical time. Full reserve of time. Free time reserve. Private reserve of time of the first and second type. Independent reserve of time.

Theme 5. Queuing systems

General information and basic concepts and characteristics of queuing problems.

The essence of the elements of the queuing system (QS): the incoming stream of requirements and the outgoing stream of served requests; turn; service channels. Classification of queuing models.

Properties of the simplest stream of random events, its characteristics. Key performance indicators of the service system.

QS with failures or losses: single and multi-channel. QS with a queue or waiting: single and multi-channel.

Theme 6. Inventory management models

Stock concept. The role of inventories. Criteria for optimal production and inventory management. The simplest model of the optimal size of the ordered batch.

Features of information support tasks. Models with the final intensity of the receipt of the consignment. Models of optimal supply batches in short supply. Point of order. Determining the optimal order point in a model with a finite order receipt rate.

EDUCATIONAL-METHODICAL MAP

Section number, topics, classes	Section title, topics, classes; list of issues under study	Total hours	The number of class hours				The number of hours devoted to independent work of students (including hours allocated for the implementation of the course work / project	Financial support classes (visual, manuals, etc.)	Literature	The forms of knowledge control
			lectures	practical (seminar) classes	laboratory classes	Independent work of students controlled (CEB)				
1	2	3	4	5	6	7	8	9	10	11
Theme 1.	**Multidimensional classification as the basis for modeling and optimization of business processes** *Business process: concept, essence. Classification of enterprise business processes. Characteristics of business processes, distinctive features. Typical models for highlighting business processes.* *Methodology for identifying stable classification groups. Implementation of multidimensional classification by methods of sum of places, multidimensional average, pattern, relative differences in the environment. Analysis of the degree of convergence of results using Spearman's rank correlation coefficient. The use of cluster analysis in multidimensional classification problems.*	**10**	**2**			**8**		EEMC and online tutorials featured in the local network of the library, testing through distance learning site	[1-4]	Testing
Theme 2.	**Linear tasks of business process optimization**	**24**	**8**	**6**		**10**		EEMC and online tutorials featured in the local network of the library, testing through distance learning site	[1-4]	Testing
2.1	**Llinear programming basics** *The concept of a mathematical model in linear programming. Economic statement of the problem of linear programming. Methods for solving linear programming problems. Main elements. Forms of recording linear programming problems. Basic definitions (admissible and optimal solutions).*	**4**	**2**			**2**				
2.2	**Simplex method algorithm.**	***14***	***6***	***4***		**4**				

2.2.1	*Algebra of the simplex method. General characteristics of the simplex method as a method of directed enumeration of support plans for a linear programming problem. The procedure of transition from one basic plan to another basic plan of a linear programming problem.*	***4***	***2***	***2***						
2.2.2	*Simplex table. Directional transition to a new basic plan of the linear programming problem. Building a simplex table. Simplex algorithm. Methods of finding the initial reference plan of the linear programming problem.*	6	2	2		**2**				
2.2.3	*The concept of duality. Mutually dual tasks. The rules for their construction. Economic interpretation of dual tasks. Objectively determined estimates.*	4	2			**2**				
2.3	***Transport problem.*** *Properties of the transport problem. Transport task of open type and closed type. Construction of the initial basic plan: the method of the "north-west corner", the method of the minimum element, the Vogel method, the method of potentials. The optimality condition for the basic plan.*	**6**		**2**		**4**				
Theme 3.	**Balance models**	**18**	**4**	**4**		**10**		EEMC and online tutorials featured in the local network of the library, testing through distance learning site	[1-4]	Testing
3.1	*Modeling intersectoral relations. The general scheme of intersectoral balance. The main balance ratios. Mathematical model of interindustry balance. The solution of the system of equations of interindustry balance. Coefficients of direct and total costs of production factors. Signs of productivity of the matrix of direct cost coefficients. The construction of a price system based on the intersectoral balance.*	10	2	2		6				
3.2	*Interdisciplinary forecast model. Algorithms for carrying out calculations on models of interindustry balance. Optimization models based on interindustry balance. The simplest dynamic model of intersectoral balance.*	8	**2**	**2**		**4**				
Theme 4.	**Network tasks**	**18**	**4**	**4**		**10**		EEMC and online tutorials featured in the local network of the library, testing through distance learning site	[1-4]	Testing

4.1	*The concept of network planning. Network model, network diagram. The basic concepts of a network model. Rules for building network diagrams.*	**8**	**2**	**2**		**4**				
4.2	*Event numbering. The path, the critical path. Critical work. Critical time. Full reserve of time. Free time reserve. Private reserve of time of the first and second type. Independent reserve of time.*	**10**	**2**	**2**		**6**				
Theme 5.	**Queuing systems** *General information and basic concepts and characteristics of queuing problems.* *The essence of the elements of the queuing system (QS): the incoming stream of requirements and the outgoing stream of served requests; turn; service channels. Classification of queuing models.* *Properties of the simplest stream of random events, its characteristics. Key performance indicators of the service system.* *QS with failures or losses: single and multi-channel. QS with a queue or waiting: single and multi-channel.*	**16**	**2**	**4**		**10**		EEMC and online tutorials featured in the local network of the library, testing through distance learning site	[1-4]	Testing
Theme 6.	**Inventory management models** *Stock concept. The role of inventories. Criteria for optimal production and inventory management. The simplest model of the optimal size of the ordered batch.Features of information support tasks. Models with the final intensity of the receipt of the consignment. Models of optimal supply batches in short supply. Point of order. Determining the optimal order point in a model with a finite order receipt rate.*	**16**	**2**	**4**		**10**		EEMC and online tutorials featured in the local network of the library, testing through distance learning site	[1-4]	Testing
	Итого	**102**	**22**	**22**		**58**				

INFORMATION AND METHODOLOGICAL PART

Monitoring the academic achievements of undergraduates

For current monitoring of academic achievements of undergraduates, tests, multilevel control tasks, oral questioning during classes and other diagnostic tools are used. The final assessment of academic achievement is carried out on the test. For this, criteria approved by the Ministry of Education of the Republic of Belarus are used.

Examples of test tasks for the final control of knowledge

1. Clustering is..
1) Division of the total population into homogeneous groups
2) Finding the parameters of the linear equation
3) Quality control of the regression model
4) Forecasting for the future
2. Who is the author of linear balance models?
1) Leontiev
2) Landau
3) Lenkov
4) Leonov
3. The linear optimization problem in general is
1) A system of restrictions that obeys the objective function
2) A graph showing the relationship between objects
3) A chart that reflects the relationship between indicators
4) The system of linear equations
4. What is the universal mathematical method?
1) Simplex method
2) The potential method
3) Approximation Method
4) Graphical method
5. What problem can be solved using the potential method?
1)Freight optimization
2)Feed ration optimization
3)Critical Path Optimization
4)The solution of the quadratic equation
6**. The graphical method for solving problems is the method**
1)approximate
2)universal
3)linear
4) there is no correct answer
7. It is known that the value of the objective function of the direct problem is 100. Indicate the value of the objective function of the dual task.
1) 100
twenty
3) -100
4) depends on the dimension of the problem

8. The direct problem includes 5 variables and 8 restrictions. How many variables does the dual task include?
eighteen
2) 5
3) 13
4) 40
9. The dual task includes 5 variables and 8 constraints. How many variables does the direct task include?
eighteen
2) 5
3) 13
4) 40
10. Indicate a synonym for "dual ratings".
1) objectively determined
2) parallel
3) stochastic
4) probabilistic
11. Which graph is called oriented?
1) On each edge of the graph the direction is indicated
2) The critical path is indicated on the graph
3) The graph indicates the execution time of each operation
4) Two or more operations come out of each event.
12. Which graph is called weighted?
1) The graph indicates the execution time of each operation
2) The critical path is indicated on the graph
3) On each edge of the graph the direction is indicated
4) Two or more operations come out of each event.
13. What is the name of the network path, which is characterized by the greatest duration?
1) Critical
2) Maximum
3) Peak
4) Long-term
14. Indicate the method used for clustering.
1) k-means
2) potentials
3) simplex
4) northwest corner
15. Stochastic models are ...
1) Models in which the source information is probabilistic
2) Models whose dimension exceeds 100 variables
3) These models use moving variables
4) The objective function of these models will be unlimited
16. Dynamically models are ...
1) Models in which the process under study is divided into several stages
2) Models where auxiliary variables are found
3) In models of this type, the objective function is always maximum
4) Models that are presented in the form of a network diagram

17. Who is the founder of queuing theory?
1) Erlang
2) Kantorovich
3) Leontiev
4) Braslavets
18. Indicate a mandatory element included in the QS?
1) Queue
2) Event
3) Operation
4) Vector
19. What is the measure of the QS load?
1) In erlangs
2) In the topals
3) In the graphs
4) In joules
20. How are QS classified according to the number of channels?
1) Single-channel and multi-channel
2) Paired and multiple
3) Single and multiple
4) Fixed and indefinite
21. How are QS classified by limiting the flow of applications?
1) Closed and open
2) Open and closed
3) Limited and unlimited
4) Connected and open
22. The author of the model for determining the optimal delivery lot is ..
1) Wilson
2) Liebig
3) Kantorovich
4) Leontiev
23. What determines the optimal batch of delivery?
1) Costs for the organization of delivery
2) Forms of ownership of the enterprise
3) seasons
4) Human resources
24. What is the demand for raw materials in the Wilson model?
1) Demand per time unit is constant
2) Demand changes over time
3) Demand depends on cycle length
4) Demand is probabilistic
25. How is a batch of raw materials supplied in the Wilson model?
1) Instantly
2) For some time
3) It depends on the size of the delivered lot
4) It depends on the length of the cycle
26. For what purpose is the k-means method intended?
1) For clustering
2) To find the parameters of the regression equation

3) To optimize the business process
4) To perform structural grouping

27. How is the time reserve of the network event calculated?

1) The expected term of the event is subtracted from the deadline
2) The deadline for the completion of the event is subtracted from the expected term
3) The deadline and expected timing of the event are summarized
4) Summarizes the duration of operations included in this event

28. What methodology is not used to develop a business plan

1) IGI?
2) UNIDO
3) TACIC
4) EBRD

29. What is the name of the method of strategic planning, which consists in identifying factors of the internal and external environment?

1) SWOT analysis
2) UNIDO
3) TACIC
4) EBRD

30. What is measured in erlangs?

1) QS load indicator
2) Business process stress
3) The erudition of management workers
4) Labor productivity of management workers

Sample list of questions for the final control

1. Tell us about the nature and necessity of clustering.
2. Tell us about the basic elements of the economic-mathematical model.
3. Explain the possibility of using the graphical method in solving optimization problems.
4. Explain the structure of intersectoral balance.
5. Explain the methodology for calculating the matrix of total costs.
6. Explain the essence of the elements of the matrix of direct costs.
7. Explain the essence of the elements of the matrix of total costs.
8. Explain the rules for constructing a dual task.
9. Explain the essence of the direct and dual tasks.
10. Explain the essence of dual estimates.
11. Explain the procedure for calculating the expected completion dates of network events.
12. Explain the procedure for determining the critical path of a network model.
13. Tell us the rules for building a network model.
14. Explain the procedure for calculating the deadlines for the completion of network model events.
15. Explain what is the optimization of a set of operations on time.
16. Explain what is the optimization of a set of operations at a cost.
17. Specify ways to reduce critical time.
18. Give examples of queuing systems in the economic sphere.
19. Indicate the main elements of QS.
20. Explain the nature of performance indicators using QS.
21. Explain the essence of indicators of the quality of service applications in the QS.
22. Give the classification of QS by limiting the flow of applications.
23. Draw a graph of single-channel QS with failures.
24. Give performance indicators of the functioning of a single-channel QS with failures.
25. Draw a graph of multichannel QS with failures.
26. Give and disclose the performance indicators of the functioning of multichannel QS with failures.
27. Explain the reasons for the creation of inventories.
28. Explain what types of costs affect the choice of inventory management solution.
29. Explain the nature of the costs of stockpiling.
30. Explain the nature of the costs of organizing the order.
31. Draw the conclusion of Wilson's formula.
32. Explain the essence of the concept of “cycle length” when planning the optimal batch of stock.
33. Explain the essence of the model with the final intensity of the receipt of the order.
34. Explain the essence of the model, taking into account the unmet requirements.
35. Explain the formula for calculating the optimal supply lot taking into account unmet requirements.

LITERATURE

1.Brennan M.J.Preface to Quantitative Economics and Econometrics.Cincinnati:South-western Pub,1987, 580 p.
2.Griffiths W.E. Mathematical modeling in Economics. New York:McGraw-Hill,1992, 466 c.
3.Maddala G.S. Introduction to business planning. New York: Macmillian, 1992, 465 p.
4.Pindyck R. S. The basics of game theory. New York:McGraw-Hill,1999, 436 c.

PROTOCOL AGREEMENT CURRICULUM SVR

The name of discipline, which requires approval	Name of department	Proposals for changes in the content of the training on the subject matter under study program	Action taken by the Department, develop training programs (With date and protocol number)
Computer Information Technology	Department of Informatics and EMM in AIC	No offers	Considered at the meeting of the department, to Protocol N ° 15 on May 24, 2019
Econometrics and economic-mathematical methods and models	Department of Informatics and EMM in AIC	No offers	Considered at the meeting of the department, to Protocol N ° 15 on May 24, 2019
Modeling and optimization in AIC	Department of Informatics and EMM in AIC	No offers	Considered at the meeting of the department, to Protocol N ° 15 on May 24, 2019

ADDITIONS AND CHANGES TO EDUCATIONAL PROGRAM SVR

on ____ / _____ school year

№	Additions and changes	Base

The curriculum is reviewed and approved at a meeting of the department
Informatics and EMM in the AIC (protocol № __ from _____ __ 20__)
(the department name)

Head of Department

Candidate of Physics and Mathematics Sciences, Associate Professor _____ T.N.Izosimova
(academic degree, academic title) (signature) (Initials and Family names)

APPROVED
Dean of the Faculty
Candidate of Economics. Sciences, Associate Professor _____ A.V. Gribov
(academic degree, academic title) (signature) (Initials and Family names)