NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCES OF UKRAINE
Department of Economic Cybernetics
Department of Statistics and Economic Analysis

"**CONFIRMED**"
Dean of Agrarian Management Faculty

_____**Anatolii OSTAPCHUK**
"28" April 2023

"**APPROVED**"
at the meeting of the Department of Economic Cybernetics
Protocol № ___ dated _____ 2023
Chairman of Department
_____**Dmytro ZHERLITSYN**

at the meeting of the Department of Statistics and Economic Analysis
Protocol № ___ dated _____ 2023
Chairman of Department
_____**Inna LAZARYSHYNA**

"**REVIEWED**"
Program Coordinator of the educational program
"Management"

_____**Vitalii LUTSIAK**

PROGRAM OF THE COURSE

APPLIED MODELING

Specialty 073 "Management "
Educational program "Management "
Faculties: information technologies; economics
Developers:
Lyudmyla Galaieva , Associate Professor of the Department of Economic Cybernetic, PhD in Economics, Associate Professor;
Lesia Voliak, Associate Professor of the Department of Statistics and Economic Analysis, PhD in Economics, Associate Professor

Kyiv – 2023

1.Academic discipline description

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	150
Number of credits ECTS	5
Number of content modules	4
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	30 h.	-
Laboratory classes	60 h.	-
Self-study	60 h.	-
Number of weekly classroom hours for full-time study	6 h.	-

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

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 "Applied Modeling" contain theoretical statements and examples of solving linear optimization problems and econometrics tasks using spreadsheets and Excel Solver and Data Analysis 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 Applied Modeling 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 the course;
- to develop logical thought and skills to solve practical tasks;
- to define special probability distributions, to analyze and to make decision;
- mastering the methods of building and evaluating econometric models;
- acquisition of practical skills of quantitative measurement of relationships between economic indicators;
- definition of criteria for testing the hypothesis regarding the qualities of economic indicators and forms of their connection;
- deepening of theoretical knowledge in the field of mathematical modeling of economic processes and phenomena;
- using the results of econometric analysis for forecasting and making sound economic decisions.

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 essence of econometric modeling and its stages;

- methods of testing economic information;
- methods of estimating the parameters of the econometric model taking into account the specifics of specific economic information
- methods of assessing the reliability of models and their parameters;
- methods of evaluating the predictive properties of the model;
- methods of econometric forecasting taking into account the features of econometric models.

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

The form of control: exam.

Acquisition of competencies:

Integrated competency (IC): The ability to solve complex specialized tasks and practical problems characterized by complexity and uncertainty in the 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 4. Ability to apply knowledge in practical situations.
GC 8. Skills in using information and communication technologies.
GC 11. Ability to adapt and act in a new situation.
GC 12. The ability to generate new ideas (creativity).

Professional (special) competencies (PC):
PC 1. The ability to define and describe the characteristics of the organization.
PC 2. The ability to analyze the results of the organization's activities, to compare them with the factors of influence of the external and internal environment.
PC 10. The ability to evaluate the performed work, ensure their quality and motivate the personnel of the organization.
PC 12. Ability to analyze and structure organizational problems, form reasonable solutions.

Program Learning Outcomes (PLO):
PLO 4. Demonstrate skills in identifying problems and justifying management decisions.
PLO 6. Demonstrate the skills of searching, collecting and analyzing information, calculating indicators to substantiate management decisions.

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. Optimization models and methods.	7	2		4		1						
Topic 2. Linear programming. Methods for solving Linear Programming Problems.	8	2		4		2						
Topic 3. Duality in linear programming.	7	2		4		1						
Topic 4. Transportation Problem.	7	2		4		1						
Topic 5. Nonlinear Programming Problems.	5	1		2		2						
Total for Content Module 1	**34**	**9**		**18**		**7**						
Module 2. "Mathematical Modelling"												
Content Module 2. Theoretical Basis of Mathematical Modelling and Practical Support												
Topic 6. The Theoretical Basis of Economic Mathematical Modelling.	8	2		4		2						
Topic 7. The Models in Agriculture.	9	2		4		3						
Topic 8. Some Sections of Modelling.	9	2		4		3						
Total for Content Module 2	**26**	**6**		**12**		**8**						
Total hours 1-2 modules	**60**	**15**		**30**		**15**						
Module 3. "Methods of Building a General Linear Model"												
Content Module 3. Linear Econometrical Models and Methods for its Estimation												
Topic 1. The subject, methods and tasks of the Econometrics.	2	-		-		2						
Topic 2. Methods of building a general linear econometric model.	12	2		4		6						
Topic 3. Multicollinearity and its influence	10	2		4		4						

on model parameter estimates.														
Topic 4. Generalized econometric models.	12	2		4		6								
Topic 5. Econometric models of dynamics.	8	2		2		4								
Total for Content Module 3	**44**	**8**		**14**		**22**								
Module 4. "Econometric Modeling"														
Content Module 4. Empirical methods of quantitative analysis based on statistical equations														
Topic 6. Econometric methods of quantitative analysis based on statistical equations.	10	2		4		4								
Topic 7. Construction of an econometric model with autocorrelated residuals and a distributed lag model.	10	2		4		4								
Topic 8. Methods of instrumental variables.	6	-		2		4								
Topic 9. Distributed lag models.	6	-		2		4								
Topic 10. Econometric models based on the system of structural equations.	6	2		2		2								
Topic 11. Econometric modeling based on nonlinear regression.	8	1		2		5								
Total for Content Module 4	**46**	**7**		**16**		**23**								
Total hours 3-4 modules	**90**	**15**		**30**		**45**								
Total hours	**150**	**30**		**60**		**60**								

4. The Topic of Laboratory Classes

№	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
9.	The subject, methods and tasks of the Econometrics.	-
10.	Methods of building a general linear econometric model.	4
11.	Multicollinearity and its influence on model parameter estimates.	4
12.	Generalized econometric models.	4
13.	Econometric models of dynamics.	2
14.	Econometric methods of quantitative analysis based on statistical equations.	4
15.	Construction of an econometric model with autocorrelated residuals and a distributed lag model.	4
16.	Methods of instrumental variables.	2
17.	Distributed lag models.	2
18.	Econometric models based on the system of structural equations.	2
19.	Econometric modeling based on nonlinear regression.	2
Total		60

5. Self -study

№	Topic	Hours
1.	Bases of Mathematical Programming. Graph Method.	1
2.	Simplex Method for solving Linear Programming Problems.	2
3.	Dual Problem.	1
4.	Transportation Problem.	1
5.	Nonlinear Programming Problems.	2
6.	The Theoretical Basis of Economic Mathematical Modelling.	2
7.	The System of Models in Agriculture.	3
8.	Some Sections of Modelling.	3
9.	The subject, methods and tasks of the Econometrics.	2
10.	Methods of building a general linear econometric model.	6
11.	Multicollinearity and its influence on model parameter estimates.	4
12.	Generalized econometric models.	6
13.	Econometric models of dynamics.	4
14.	Econometric methods of quantitative analysis based on statistical equations.	4
15.	Construction of an econometric model with autocorrelated residuals and a distributed lag model.	4
16.	Methods of instrumental variables.	4
17.	Distributed lag models.	4
18.	Econometric models based on the system of structural equations.	2
19.	Econometric modeling based on nonlinear regression.	5
Total		60

6.The example of exam tasks

NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCES OF UKRAINE			
Educational level "Bachelor" Faculty of Agrarian Management Specialty, educational program 073 Management	Department of Economy Cybernetics & Department of Statistics and Economic Analysis 2023-2024 educational year	**Exam variant №** From the discipline **"Applied modeling "**	**Approved** Head of the Department of Economy Cybernetics _____(D.M. Zherlitsyn) (signature) Head of the Department of Statistics and Economic Analysis _____(I.D.Lazaryshyna) (signature) _____2023

Questions (Tasks)
(max 20 b)

1. The general task of linear programming and its initial forms.. **(10b)**

2. (5 b)

$z = x_1 + 2x_2 \to \max$

$x_1 - 2x_2 \geq 1$

$x_1 + x_2 \leq 5$

$x_1 \geq 0, \ x_2 \geq 0$

3. (5 b) .

Unemployment. A sample of the employment status of the residents in a certain town is given in

$\bar{a} = (18,7,7) \quad \bar{b} = (10,11,11) \quad C = \begin{pmatrix} 5 & 2 & 4 \\ 3 & 6 & 2 \\ 2 & 4 & 6 \end{pmatrix}$

Test
(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

.

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

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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_____

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

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3	potentials, diagonal, double marks;
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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

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. A general task of integer programming.
3. A general task of linear programming and its initial forms.
4. A graphic method of solving the problems of linear programming.
5. A mathematical model where the mathematical functions appearing in both the objective function and the constraints are all linear functions.
6. A method for solving linear programming problems with two decision variables on a two-dimensional graph.
7. A simplex method of the decision of tasks of linear programming.
8. A special type of nonlinear programming problem that fits many engineering design problems, among others.
9. A standard procedure for obtaining the simultaneous solution of a system of linear equations.
10. A streamlined version of the simplex method for solving transportation problems.
11. Accidental constituent of econometrical model.
12. Algorithm of finding of the basic plan by a simplex method.
13. An algorithm that deals with a linear programming problem as if the simplex method were being applied simultaneously to its dual problem.
14. An attribute of an optimality of the plan.
15. Basis of algorithm of the presence of the optimum plan.
1. Check of autocorrelation
16. Choice of variables and structure of connections.
17. Classes of tasks in an agriculture.
18. Classification of tasks of mathematical programming.
19. Coefficient of correlation, verification of hypothesis about meaningfulness of correlation coefficient.
20. Concept of algorithm of solving a task and their kinds.
21. Concept of algorithm of solving a task and their kinds.
2. Concept of autocorrelation
22. Concept of multicollinearity.
23. Cycling in tasks of linear programming and methods of its elimination.
3. Definition of matrix S
4. Definitions of tool variable
24. Distributive models with a parameter.
25. Dual problem.
26. Dual simplex method.
5. Dynamic simulation of processes in agricultural enterprise.
27. Dynamic simulation of processes.
6. Eitken's method
7. Errors of measurement variables
8. Evaluation of model parameters with autocorrelation residues
28. Evaluation of model's parameters by a least-squares method.
29. Exactness of economic information.
30. Examples of tasks from the area of an agriculture and management. Interrelation of discipline with other spheres of economic activity.
31. Farrar-Glober algorithm for multicollinearity determination.
32. Features of multicollinearity.

33. Features of structure of a transport task.
9. Forecasting
10. Forecasting methods in dynamic models
34. Forming of observation aggregate.
35. Geometrical interpretation of objective function and system of restrictions of a task of linear programming.
36. Geometrical interpretations of a task of linear programming in different forms.
37. Index of correlation.
11. Instrumental Variables
12. Iterative method
13. Method of smallest squares (Eitken method)
14. Method of tool variable
38. 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.
15. Methods of determination heteroscedanticity
39. Methods of the analysis of solving the tasks.
40. Methods of the analysis the solution .
16. Methods with time lag.Methods of evaluation
41. Mixed integer programming   and its interpretation.
17. Modeling agrotechnological processes by distributors.
18. Modeling and optimization of allocation of crops to different areas of fertility.
19. Modeling ecological and economic interaction.
20. Modeling of soil fertility in agricultural enterprise.
21. Modeling of soil nutrition of agricultural plants.
22. Modeling the optimal structure of sown areas in the agricultural enterprise.
42. Modified simplex method and its interpretation.
23. Multiobjective optimization problems of economic systems at the level of agricultural enterprises.
43. Nonbasic variables   and its interpretation.
44. Notion of observations homogeneity.
45. Object, method and task of the course of "Econometrics".
24. Optimization of agrarian enterprises in conditions of risk.
25. Optimization of field crop and ways of improving its performance.
26. Optimization of fodder production in the agricultural enterprise.
27. Optimization of forage harvested in the agricultural enterprise.
28. Optimization of industrial structure and specialization of agricultural enterprises.
29. Optimization of industrial structure and specialization of agricultural enterprises as multi task.
30. Optimization of the farming industry and ways to improve its performance.
31. Optimization of the production program of the Agricultural Enterprise stochastic programming methods.
46. Optimizations models with parameter in the objective function.
32. Optimizing the allocation and use of fertilizers in the agricultural enterprise.
33. Planning of development of agricultural production on the basis of models.
34. Programming agricultural production methods linear-optimization modeling.
35. Properties of model estimates within stochastic variable
47. Quadratic programming problems and its interpretation.
48. Role and place of econometric models in the economic systems management.
36. Sence of the phenomenon heteroscedasticity
49. Simulation and optimization of agro resources.
37. Simulation and optimization of agro resources.
38. Simulation and optimization of potential soil fertility.

39. Simulation and optimization of process control in livestock.
40. Simulation and optimization of structure and turnover herd animals.
41. Simulation and optimization of technological processes in plant.
42. Simulation and optimization of the structure of agricultural enterprises by fractional linear programming.
50. Subject, method and tasks of a rate. Objective necessity of application of quantitative methods for agrarian management.
51. The algorithm for solving problems with a parameter in the objective function.
52. The basic analytical properties of tasks of linear programming.
53. The basic concepts of formalization of economic processes.
54. The basic concepts of formalization of economic processes.
55. The basic concepts of formalization of economic processes.
56. The basic kinds of linear parities (ratio).
43. The consequences of autocorrelation remains
57. The method of artificial base.
58. The supply center for a transportation problem.
44. Two-stage procedure
59. Using game method for optimization of technological processes in agricultural enterprise.
45. Using Game method for optimization of technological processes in agricultural enterprise.
60. Verification of model on adequacy by Fisher's a criterion.

8. Methods

Teaching methods are ways of joint activities and communication between teachers and graduates, providing positive motivation to learn, mastering the system of professional knowledge, skills and abilities, forming a scientific worldview, development of cognitive forces, culture of mental work of future professionals.

The following teaching methods are used during the educational process:

Depending on the source of knowledge: verbal (explanation, conversation, discussion, dialogue); visual (demonstration, illustration); practical (problem solving, business games).

By the nature of cognitive activity: explanatory-visual problem statement; partial search and research methods.

By place in educational activities:

- methods of organization and implementation of educational activities that combine verbal, visual and practical methods; reproductive and problem-searching; methods of educational work under the guidance of a teacher and methods of independent work of higher education students;

- methods of control and self-control over educational activities: methods of oral, written control; individual and frontal, thematic and systematic control.

In the process of teaching the discipline to intensify the educational and cognitive activities of higher education seekers provides for the use of the following educational technologies:

- work in small groups allows to structure practical seminars on the form and content, creates opportunities for participation of each student in higher education in the work on the topic of the lesson, provides the formation of personal qualities and experience of social communication;

- seminars-discussions involve the exchange of views and views of participants on this topic, as well as develop thinking, help to form views and beliefs, the ability to formulate opinions and express them, learn to evaluate other people's suggestions, critically approach their own views;

- brainstorming - a method of solving urgent problems, the essence of which is to express as many ideas in a limited period of time, discuss and select them;

- case method - a method of analysis of specific situations, which allows to bring the learning process closer to the real practical activities of specialists and involves consideration of industrial, managerial and other situations, complex conflicts, problematic situations, incidents in the study of educational material;

- presentations - speeches to the audience, used to present certain achievements, results of the group, a report on the implementation of individual tasks, briefings, demonstrations.

9. Forms of assessment

Evaluation of student knowledge is carried out on a 100-point scale and is converted to national grades according to Table 1 "Regulations and Examinations and Credits at NULES of Ukraine" (order of implementation dated 26.04.2023, protocol №10) the types of control of higher education are current control, intermediate and final certification.

Ongoing control is carried out during practical, laboratory and seminar classes and aims to check the level of readiness of higher education students to perform specific work.

Intermediate control is conducted after studying the program material and should determine the level of knowledge of higher education students in the program material obtained during all types of classes and independent work.

Forms and methods of intermediate control, mastering the program material are developed by the lecturer of the discipline and approved by the relevant department in the form of testing, written tests, colloquium, etc., which can be assessed numerically.

Mastering the program material by a higher education student is considered successful if his / her rating is not less than 60 points on a 100-point scale.

Semester control is conducted in the form of a semester exam or semester test in a particular discipline.

The semester exam is a form of final attestation of mastering the theoretical and practical material on the academic discipline for the semester.

Semester test is a form of final control, which consists in assessing the mastering of higher education theoretical and practical material (performed by student certain types of work in practical, seminar or laboratory classes and during independent work) in the discipline for the semester.

Differentiated test is a form of control that allows to assess the implementation and mastery of higher education program of practical training, preparation and defense of course work (project).

Applicants for higher education are required to take exams and tests in accordance with the requirements of the working curriculum within the timeframe provided by the schedule of the educational process. The content of exams and tests is determined by the working curricula of disciplines.

The content of exams and tests is determined by the working curricula of disciplines.

9. Forms of control
- Individual tasks.
- Module tests.
- Exam

10. Distribution of grades received by students.

Evaluation of student knowledge is carried out on a 100-point scale and is converted to national grades according to Table 1 "Regulations and Examinations and Credits at NULES of Ukraine" (order of implementation dated 26.04.2023, protocol №10)

Student rating, points	National grade based on exam results	
	Exams	Credits
90-100	Excellent	
74-89	Good	Passed
60-73	Satisfactory	
0-59	Unsatisfactory	Not passed

In order to determine the rating of a student (listener) in the discipline R_{dis} (up to 100 points), the rating from the exam R_{ex} (up to 30 points) is added to the rating of a student's academic work R_{aw} (up to 70 points): $R_{dis} = R_{aw} + R_{ex}$.

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

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