MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
SUMY NATIONAL AGRICULTURAL UNIVERSITY

Department of Technology of milk and ' meat

"Approve "
Head of the department
milk and meat technologies
"07 "September 20 20 y.
(Samilyk M.M.)

CURRICULUM WORKING PROGRAM

Information technologies and optimization of technical and technological objects of the processing industry

Specialty: 181 "Food Technology"

Educational program: "Food Technology"

Educational degree: *The second level (master's) of higher education*

Faculty: Food Technology

2020 - 2021 academic year

Work program in the discipline of **Information Technology and optimization of technical and technological objects of the processing industry** for students majoring in : ***181, Food Technology, studying at the III level of higher education.***

Developers:
Ph.D., Associate Professor Helikh Anna _____
signature

The work program was approved at the meeting of the Department of Milk and Meat Technology from "07" September 2020 №.

Head of the department
milk and meat technology _____ **(Samilyk M.)**

Agreed:

Guarantor of the educational program _____ (Pertsevoi F.)

Dean of the Faculty _____ (Melnyk O.)
on which the discipline is taught

Dean of the Faculty _____ (Melnyk O.)
to which the department belongs

Methodist of the Department of Education Quality, licensing and accreditation _____ _____

Registered in the electronic database: date: 08.06 2020

1. **Description of the discipline**

<table>
<tr><td rowspan="2">Name of indicators</td><td rowspan="2">Field of knowledge, direction of training, educational and qualification level</td><td>Characteristics of the discipline</td></tr>
<tr><td>full-time education</td></tr>
<tr><td>Number of credits - 5</td><td>Training direction:
181 Food Technology</td><td>Normative</td></tr>
<tr><td>Modules - 2</td><td rowspan="7">Specialty: 181 "Food Technology"</td><td>Year of preparation:</td></tr>
<tr><td>Content modules: 2</td><td>2020-2021</td></tr>
<tr><td rowspan="2">Individual calculation task: yes</td><td>Course</td></tr>
<tr><td>1</td></tr>
<tr><td>Semester</td></tr>
<tr><td>The total number of hours is 150</td><td>2</td></tr>
<tr><td>Lectures</td></tr>
<tr><td rowspan="12">Weekly hours for full-time study:
classroom - 14
Ind. work - 22</td><td rowspan="12">Educational degree:
master</td><td>14 years</td></tr>
<tr><td>Practical, seminar</td></tr>
<tr><td>-</td></tr>
<tr><td>Laboratory</td></tr>
<tr><td>60 years</td></tr>
<tr><td>Individual work</td></tr>
<tr><td>76 years</td></tr>
<tr><td>Individual tasks:
-</td></tr>
<tr><td>Type of control:</td></tr>
<tr><td>exam</td></tr>
</table>

Note . The ratio of the number of hours of classroom classes to independent and individual work is (%): 38 , 9 / 61,1 (190/2 30);

2. THE PURPOSE AND OBJECTIVES OF THE DISCIPLINE

The processes that take place in food technology are carried out in order to convert raw materials into semi-finished and ready-made culinary dishes, products, food products. Optimization of methods and modes of heat treatment, recipe composition, modeling of production costs is a priority of the food industry and restaurants. This goal is achieved by the optimal choice of equipment and modes of operation (time, temperature, pressure, etc.) and ingredients, which requires sufficiently accurate calculation methods and, thus, the use of modern computer technology. To do this, future industry professionals need to be able to make reliable and reliable computer models of technological processes, among which there are two types: physico-chemical (deterministic) models and empirical models based on experimental data processing.

Goals: to study the principles of building mathematical models of food technology as objects of design, management and optimization. Checking the reliability and reliability of computer models of technological processes, among which there are two types: physico-chemical (deterministic) models and empirical models based on the processing of experimental data.

Objectives: to acquire the ability to optimally select equipment and modes of its operation (time, temperature, pressure, etc.); methods and modes of heat treatment, prescription composition, to model the cost of production that requires sufficiently accurate methods of calculation and, thus, the use of modern computer technology.

Learning outcomes of the discipline (LOD)

As a result of studying the discipline the student will be able to demonstrate:

- ability to search, process and analyze information from various sources;
- ability to apply mathematical methods and models in applied research, to optimize technological processes for the development of innovative technological solutions in food production;
- ability to organize production and practically implement scientific developments taking into account energy efficiency and resource saving and improvement of quality indicators of food products;
- ability to develop and implement commercial and scientific and technical projects in the field of food technology, taking into account technical, commercial, legal and labor protection and environmental issues;
-knowledge of the main functions of MS Office Excel, MathCAD and STATISTICA software;
- knowledge of the concept of modeling theory;
- solve a one-parameter problem of nonlinear programming;
- solve a multiparameter problem of nonlinear programming;
- rules of optimization of technological modes with the use of multicriteria objective function.
- ability to choose optimization parameters and set limits on them;
- knowledge of methods of modeling the course of technological processes of the food industry;
- methods of determining the parameters of food technology models according to experimental data;
- development of the plan of the optimum experiment, to carry out the system analysis and optimization of technological systems and processes of food manufactures;
- ability to solve specific applied problems of food technology optimization;
- have an information base for the development and implementation of innovations, taking into account the basics of management;
- to organize the work of food industry enterprises and restaurants in accordance with the requirements of resource conservation;
- apply the most suitable methods of mathematical modeling and optimization in the development of scientific and technical projects in the field of food technology;
- to plan and manage innovative scientific projects of fundamental and applied direction taking into account the current state of science and technology in food technology.

3. CONTENT OF THE DISCIPLINE

Content module 1.

Topic 1: Content, purpose and main objectives of the discipline. General information about modeling. General concepts of optimization of technological processes.

The main objectives of the course, its relationship with the disciplines of special training. Statement of modeling problems. The essence and stages of mathematical modeling. Simulation objects. The generalized algorithm of development of mathematical models of technological processes. Hierarchical structure of a modern food enterprise. General idea of the technological system. General concepts of process optimization.

Topic 2: Software functions of the desktop environment MS Office Excel, MathCAD and STATISTICA used to solve practical problems of modeling food technology.

Application in engineering practice of mathematical models and software functions of the working environment MS Office Excel, Mathcad, STATISTICA - as modern methods of solving optimization problems and their graphical interpretation for presentation and visual understanding. Processing the results of the implementation of plans for complete and fractional multifactorial experiments. Analysis of results and their design.

Content module 2.

Topic 3 General information about the theoretical prediction of the experiment. A complete multifactorial experiment.

Basic concepts and definitions. Checking the reproducibility of experiments. Calculation of experiment error. Planning an extreme experiment.

Topic 4. Experimental and statistical models.

Mathematical description. Study of the method of complete factorial experiment to obtain mathematical descriptions of the studied process in some local area of the factor space of the technological process. Planning matrix of a complete factorial experiment and its properties. The value of the regression equation and verification of its adequacy using the Student's and Fisher's criteria.

Content module 3.

Topic 5. Optimization of technological processes or properties of multicomponent technological systems.

Determination of the optimality criterion. Optimization of technological processes by the method of steep ascent. Simplex optimization on the example of food production models.

Topic 6. Research of optimal conditions.

Scheme of experiments of orthogonal CCP for two factors. Determining the number of experiments in orthogonal central compositional planning. Schemes and essence Contour-graphic analysis according to the scheme of Kleiman and Birch.

4. THE STRUCTURE OF THE DISCIPLINE

Name the topics	Number of hours											
	Full-time						Correspondence form					
	Total	Including					Total	Including				
		Lectures	Practical	Lab		Ind. work		Lectures	Practical	Lab		Ind. work
1	**2**	**3**	**4**	**5**	**6**	**7**						
Module 1												
Content module 1.												
Topic 1. Content, purpose and main objectives of the discipline. General information about modeling. The general concept of optimization of technological processes .		**4**		**10**		**12**						
Topic 2. Software functions of the desktop environment MS Office Excel , Math CAD and STATISTICA used to solve practical problems of modeling food technology.		**1**		**10**		**12**						
Together on the content module 1		**5**		**20**		**24**						
Content module 2 .												
Theme 3. FROM General notes information about the theoretical prediction experiment.		**2**		**10**		**14**						
Topic 4. Experimental and statistical models. A complete multifactorial experiment.		**3**		**10**		**14**						
Together on the content module 2		**5**		**20**		**28**						
Module 2												
Content module 3.												
Topic 5. Optimization of technological processes or properties of multicomponent technological sys tems .		**2**		**10**		**12**						
Topic 6. Research of optimal conditions .		**2**		**10**		**12**						
Together on the content module 3		**4**		**20**		**24**						
Together for the semester	**150**	**14**		**60**		**76**						

5. Topics and plan of lectures

№ s/n	Name topics	Number hours
1	**Lecture 1. Content, purpose and main tasks of the discipline. General information about modeling. General concepts of process optimization.** **Plan:** 1. The main objectives of the course, its relationship with the disciplines of special training. 2. Statement of modeling problems. 3. The essence and stages of mathematical modeling. 4. Modeling objects. The generalized algorithm of development of mathematical models of technological processes. 5. Hierarchical structure of a modern food enterprise. General idea of the technological system. 6. General concepts of process optimization.	4
2	**Lecture 2. Software functions of the working environment MS Office Excel, MathCAD and STATISTICA used to solve practical problems of modeling food technology.** **Plan:** 1. Application in engineering practice of mathematical models and software functions of the working environment MS Office Excel, MathCAD, STATISTICA - as modern methods of solving optimization problems and their graphical interpretation for presentation and visual understanding. 2. Processing the results of the implementation of plans for complete and fractional multifactorial experiments. Analysis of results and their design .	2
3	**Lecture 3. FROM General notes information about the theoretical prediction experiment.** **Plan:** 1. Basic concepts and definitions of experimental factors. 2. Checking the reproducibility of experiments. 3. Calculation of experiment error .	2
4	**Lecture 4. Experimental and statistical models. A complete multifactorial experiment.** **Plan:** 1. Mathematical description 2. Planning an extreme experiment 3. Complete factorial experiment	4
5	**Lecture 5. Application of basic types of mathematical models to describe technological processes.** **Plan:** 1. The method of steep ascent. 2. Simplex method .	2

6	**Lecture 6. Research of the area of optimal conditions** 1. Orthogonal central compositional planning. 2. Rotatable planning 3. Contour- graphic analysis.	2
Total for the semester:		**14**

6. Topics of laboratory classes

№ s/n	Name topics	Number of hours
1	**Laboratory work 1.** Approximation of experimental data by linear equations. **Plan:** 1. Choice of type of empirical equation. 2. Calculation of coefficients of the equation. 3. Statistical evaluation of the equation.	**14**
2	**Laboratory work 2.** Approximation of experimental data by nonlinear equations. **Plan:** 1. The procedure for choosing an empirical formula. 3. Graphs of empirical formulas and methods of their alignment.	**16**
3	**Laboratory work 3.** Regression equation of multifactor experiment and its statistical analysis. **Plan:** 1.Complete factorial experiment. 2.Determining the adequacy of the regression equation. 3.Determining the requirements for factors affecting the object. 4.Determining the interval of variation (factors). 5. Determining the number of experiments in terms of experiment. 6. Checking the significance of regression coefficients. 7. Give a formula for determining the variance of a unit result. 8. Give a formula for determining the variance of the average result.	**14**
4	**Laboratory work 4.** Analysis of the regression equation for finding the gradient of free ascent. **Plan:** **1.**Study of the method of steep ascent. 2.Application of the method to a multifactorial experiment. 3.Plotting the dependence of the function on the influence of factors. 4.Analysis of equations on the curves of equal yield, find the maximum of the function (gradient of growth of the function *y).*	**16**
Total		**60**

7. Independent work

№ s/n	Name topics	Number of hours
1	One-dimensional problem in the context of solving the problem of optimization for food production.	**6**
2	Interpolation of data obtained during the planning of a statistical experiment.	**6**
3	Interpolation by means of splines in planning experiment in the optimization processes of enterprises of food industry.	**6**
4	Two-dimensional optimization and its practical application in modeling processes.	**6**
5	Implementation of optimization tasks in Mathcad. One-dimensional optimization problems and their practical implementation.	**6**
6	Solving two-dimensional problems graphical method in MathCAD .	**6**
7	Selection of optimality criteria. The main ways of forming a consolidated criterion of optimality. The convolution of partial criteria of weight coefficients. Approaching the "ideal". A fair deed. Optimality Pareto. Taking into account random factors in the optimality criteria .	**8**
8	Typical problems of optimal control of technological processes. Static mode optimization. Optimization of the mode in the device of periodic action .	**8**
9	Problems of optimal control of technological processes and methods of their solution. Geometric interpretation of the objective function and constraints. Special points and lines of the objective function. Global and local optimums.	**6**
10	Methods classical analysis functions technologically 's process along. Method search for unconditional extremum and extremes of the function of one variable. extremes of the function of many variables.	**6**
11	Minimization of a function with constraints of the equality type. Method of direct substitution. multiplier method Lagrange.	**6**
12	Optimal static process control process.	**6**
Together		**76**

9. Individual tasks

1. One-parameter and multi-parameter optimization problems. Modeling of prescription composition and selection of the optimal composite mixture in the given intervals of variation during production:

- meat products,
-dairy products and dairy products,
- sauces,
-bakery products,
-confectionery,
-structured and jelly products,
-innovative types of combined meat and vegetable products,
-products with extended shelf life.

2. One-parameter and multi-parameter optimization problems. Modeling of structural and mechanical parameters in the given intervals of variation at production:

- meat products,
-dairy products and dairy products,

- sauces,
-bakery products,
-confectionery,
-structured and jelly products,
-innovative types of combined meat and vegetable products,
-products with extended shelf life.

3. One-parameter and multi-parameter optimization problems. Modeling of rheological parameters in given intervals of variation in production:
- meat products,
-dairy products and dairy products,
- sauces,
-bakery products,
-confectionery,
-structured and jelly products,
-innovative types of combined meat and vegetable products,
-products with extended shelf life.

4. One-parameter and multi-parameter optimization problems. Modeling of organoleptic parameters in the given intervals of variation at production:
- meat products,
-dairy products and dairy products,
- sauces,
-bakery products,
-confectionery,
-structured and jelly products,
-innovative types of combined meat and vegetable products,
-products with extended shelf life.

5. Optimization of the heat treatment process (in time and temperature) during production:
- meat products,
-bakery products,
-structured and jelly products,
-innovative types of combined meat and vegetable products,
-products with extended shelf life.

6. Optimization of the drying process in different ways in the production of candied fruits and snack products in the given intervals of variation with the help of linear programming problems by the simplex method and the method of steep ascent.

7. Optimization of the process of structure formation in the production of jellies, mousses, whipped cheese desserts in given intervals of variation with the help of linear programming problems by the simplex method and the method of steep ascent.

8. Teaching methods

1. Methods of learning by source of knowledge:

1.1. Verbal: story, explanation, conversation, lecture, instruction, etc.).

1.2. Visual: demonstration.

1.3. Practical: laboratory method.

2. Teaching methods by the nature of the logic of cognition.

2.1. Analytical

3. Teaching methods by the nature and level of independent mental activity of students.

3.3. Research

3.5. Explanatory and demonstrative

4. Active teaching methods - the use of technical teaching aids, the use of problem situations, the use of training and control tests, the use of reference notes of lectures.

5. Interactive learning technologies - the use of multimedia technologies, interactive whiteboards and spreadsheets.

9. Methods to evaluate

1. Rating control according to the 100-point scale of ECTS assessment
2. Carrying out intermediate control during the semester
3. Polycriteria assessment of current work of students:
 - the level of knowledge demonstrated in practical, laboratory and seminar classes;
- activity during the discussion of issues raised in class;
 - results of performance and protection of laboratory works;
- - performance of analytical and calculation tasks;
- test results.
4. Direct consideration in the final assessment of the student's performance of a particular individual task:
 - educational and practical research with presentation of results, etc.

10. Distribution of points received by students

In the form of control "exam" full-time form

Module 1 0 - 20 points	**Module 2 0 -20 points**	**Ind. work**	**Together modules and Ind. task**	**Certification**	**Final control knowledge**	**Summary**
Topics 1-6	**Topics 7-9**	**15**	**55**	**15**	**30**	**100**
20	**20**					

Assessment scale: national and ECTS

The sum of points for all types of educational activities	**ECTS assessment**	**Score on a national scale**	
		for exam, course project (work), practice	**for offset**
90 - 100	**AND**	perfectly	credited
82-89	**IN**	fine	
7 5 -81	**WITH**		
6 9 -7 4	**D**	satisfactorily	
60-6 8	**IS**		
35-59	**FX**	unsatisfactory with the possibility of reassembly	not credited with the possibility of re-assembly
0-34	**F**	unsatisfactory with mandatory re-study of the discipline	not enrolled with mandatory re-study of the discipline

11. Methodical support

1. Methodical instructions on the implementation of laboratory classes for students of educational level master's degree in specialty 181 "Food Technology" full-time and part-time education. - Sumy National Agrarian University, 2020.

2. Summary of lectures for students of educational level master's degree in specialty 181 "Food Technology" full-time and part-time education. - Sumy National Agrarian University, 2020.

3. Methodical instructions on the implementation of modular course work for students of educational level master's degree in specialty 181 "Food Technology" full-time and part-time education. - Sumy National Agrarian University, 2020.

12. Recommended literature

Basic

1. Ostapchuk M., Stankevich G. Mathematical modeling on a computer: Textbook. - Одеса: Друк, 20 18. -313 С.
2. Optimization of technological processes of the industry: a method. recommendations for studying the discipline and performing controls. Work for students along with specials. 7.05170107, 8.05170107 " Technologies for storage, canning and processing of fruits and vegetables " full-time and part - time education / way. O.B. Tochkova - K.: NUHT, 201 8 - 35 p.
3. Alekseev, E. Modeling and optimization of technological processes in the food industry / EL Алексеев, В.Ф. Pakhomov. - M.: Agropromizdat, 2016. - 273 p.
4. Bondar, A. Mathematical modeling in chemical technology / A.G. Bondar- K.: Higher school, 2017. - 289 p.
5. Sukharev, A. Course of optimization methods / A.G. Sukharev, A.V. Тихонов, B.B. Fedorov. - M.: Nauka, 2019. - 356 p.
6. Ladieva, LR Optimization of technological processes. / L.R. Ladieva. - Kyiv: Polytechnic Publishing House, 2016. - 192 c.
7. L. Sztangret, L. Rauch, J. Kusiak, P. Jarosz, and S. Małecki, “Modeling of the oxidizing roasting process of zinc sulphide concentrates using the artificial neural networks,” *Computer Methods in Materials Science*, vol. 11, no. 1, pp. 122–127, 2017.
8. A. Stanisławczyk, J. Gawad, and J. Kusiak, “Multi scale modelling and optimization of production chains based on metal forming,” in *Proceedings of the 8th Conference World Congress on Computational Mechanics (WCCM '08)*, Venice, Italy, 2018.
9. M. Pietrzyk, L. Madej, and R. Kuziak, “Optimal design of manufacturing chain based on forging for copper alloys, with product properties being the objective function,” *CIRP Annals—Manufacturing Technology*, vol. 59, no. 1, pp. 319–322, 2019.
10. J. Kusiak, A. Danielewska-Tu lecka, and P. Oprocha, *Optimization. Selected Methods with Examples of Applications*, Polish Scientific Publishers, Warszawa, Poland, 2019, (Polish).
11. K. Deb, *Multi-Objective Optimization Using Evolutionary Algorithms*, John Wiley & Sons, London, UK, 2018.
12. K. Miettinen, *Nonlinear Multiobjective Optimization*, Springer, Berlin, Germany, 2019.
13. F. Flegiel, S. Sharma, and G. P. Rangaiah, “Development and multiobjective optimization of improved cumene production processes,” *Materials and Manufacturing Processes*, vol. 30, no. 4, pp. 444–457, 2015.

Auxiliary

14. Kafarov, VV Mathematical modeling of the main processes of chemical production / VV Кафаров, M.B. Glebov. - M.: Высшая школа, 2018. - 432 p.
15. Optimization of technological processes of the industry: Method, instructions for studying the discipline and performing controls. work for students. special 7.091713 " Technology of sugar substances " by correspondence. forms of teaching. / Compiled by: VO Miroshnyk. - K.: УДУХТ, 2019. - 48 p.

16. H. Fang, M. Rais-Rohani, Z. Liu, and M. F. Horstemeyer, “A comparative study of metamodeling methods for multiobjective crashworthiness optimization,” *Computers & Structures*, vol. 83, no. 25-26, pp. 2121–2136, 2015.
17. S. L. Ho, S. Yang, G. Ni, E. W. C. Lo, and H. C. Wong, “A particle swarm optimization-based method for multiobjective design optimizations,” *IEEE Transactions on Magnetics*, vol. 41, no. 5, pp. 1756–1759, 2015.
18. A. E. Shiel, D. Weis, and K. J. Orians, “Evaluation of zinc, cadmium and lead isotope fractionation during smelting and refining,” *Science of the Total Environment*, vol. 408, no. 11, pp. 2357–2368, 2019.
19. R. H. Myers and D. C. Montgomery, *Response Surface Methodology: Process and Product Optimization Using Designed Experiments*, John Wiley & Sons, New York, NY, USA, 2018.

Information resources

1. https: // cdn. snau. edu. ua / moodle / course / view. php? id = 4351