REPUBLIC OF UZBEKISTAN

MINISTRY OF HIGHER AND SECONDARY SPECIALIZED EDUCATION

ANDIJAN MACHINE - BUILDING INSTITUTE

Registered

№ 234

2022-year "17" 03

"I CONFIRMED"
Vice-rector of the institute
_____ S. R.Aliev

2022-year "28" 03

FUNDAMENTALS OF MODELING AND OPTIMIZATION OF TECHNOLOGICAL PROCESSES

SCIENCE

EMPLOYEE TRAINING PROGRAM

Field of study: 320000 – Engineering work

Type of specialty: 5311000- Automation and control of technological processes and production

General study time	290 hours	5th semester	6th semester
Including :			
Lecture	96 hours	48 hours	48 hours
Practical training	32 hours	16 hours	16 hours
Laboratory exercises	32 hours	16 hours	16 hours
Self study education hours	130 hours	64 hours	66 hours

Andijan – 2022

The working curriculum of the subject is approved by the Order No. 3 of August 8 , 2018 (Appendix 2 of the order) of the Ministry of Higher and Secondary Special Education of the Republic of Uzbekistan and is registered under the number BD5311000. It was developed on the basis of the science program "Fundamentals of modeling and optimization of technological processes".

The working curriculum of the subject was approved by the statement of the Educational - Methodical Council of the Andijan Mechanical Engineering Institute No.

Developers:

A.Yusupov – Associate Professor of the Mashine-Building automation department, The Andijan Mashine-Building Institute.

B.Olimov – Assistant of the Mashine-Building automation department, The Andijan Mashine-Building Institute.

S.Kosimov–Trainee-teacher of the Mashine-Building automation department, Andijan Mashine-Building Institute.

Reviewers:

M. Mirzayeva - senior lecturer of the "Computer Engineering" department of Andijan State University, fm.fn

M. Yusupov - head of the "Information technologies" department of the Andijan Machine-Building Institute , associate professor.

Head of the educational department:

2022-year "__1__" _____A.B. Akhmedov

(signature)

Dean of the Faculty of Technological Process Management and Computer Systems :

2022-year "__2__" __IF__ _____M. Sherboyev

(signature)

Head of mechanical engineering production :

2022-year "__2__" __13__ _____09_____23 A . Yusupov

(signature)

I. The relevance of educational science and its place in higher professional education

This program covers the classification of modeling and optimization of technological processes in industrial enterprises, the history and development trends of science, and the impact of socio-economic reforms in our republic on the perspective of modeling and optimization of technological processes.

II. Objectives and tasks of educational science

The purpose of teaching science is to form students the necessary knowledge and skills for computer-aided research of management systems of technical and technological objects, to train students in the field of identification of objects and control systems based on the results of experimental data, construction of mathematical models and their evaluation algorithms. is to ensure the level of necessary knowledge, skills and experience.

The task of the subject is to teach students to model technological processes, identify control objects and calculate models based on the level of demand, choose them correctly, and prepare project documents.

Within the framework of the issues to be implemented in the process of mastering the **subject** " Fundamentals of modeling and optimization of technological processes " bachelor :

- The main problems of science and its essence in acquiring a profession;
- the main problems of technological process modeling;
- development trends of technological process modeling;
- mathematical modeling of technological processes and methods of managing processes through the model;
- general principles of creating mathematical models (MM);
- to determine the values of the main parameters and optimal plans of the process on the basis of structured models of technological processes;
- know and be able to use methods of identification and modeling of technological processes;
- Solving issues of identification and modeling of technological objects and their control systems on a computer ;
- to create static and dynamic models of typical technological processes;
- the main types of models used to describe objects and control systems, the interaction between them, the properties of observation and identification;
- ability to determine optimal conditions for technological processes and use them in practice;
- to have an idea of the elements of the evaluation theory and the properties of

the received evaluations (displacement, validity, productivity, etc.) ;

– know and be able to use parametric and non-parametric identification methods and algorithms of models of objects and control systems;

– calculation of the main optimization criteria used in evaluation problems;

– should have the skills to calculate the methods and algorithms of linear and non-linear dynamic systems .

III. The main theoretical part (lecture sessions)

the main part , the topics of the science are presented in the correct sequence . The essence of each topic is revealed through key concepts and theses. In this, the knowledge and skills necessary to be delivered to students on the basis of DTS should be fully covered .

for the quality of the main part are the relevance of the topics, their compatibility with the demands of employers and the needs of production, the socio-political and democratic changes taking place in our country , the liberalization of the economy, the priority issues of reforms in the economic-legal and other fields, and science and It is recommended to take into account the latest advances in technology .

Lecture classes

Table 1

No	Lecture classes	Hour
1	**Introduction to the science of modeling and optimization of technological processes.**	**2**
1.1.	History and development trends of modeling and optimization of technological processes.	
1.2.	General information on the basics of computer modeling and optimization used in industrial enterprises.	
1.3.	Results of socio-economic reforms in our republic in the field of modeling and optimization of technological processes, regional problems and achievements of science, technology and technology.	
1.4	Tasks of science.	
2	**Subject and methods of science.**	**2**
2.1.	**overview** of the issue of mathematical modeling .	
2.2	Modeling as a way of knowing.	
2.3 _	The concept of a system of hypotheses.	

2.4	Philosophical issues of modeling.	
2.5	Physical and mathematical modeling.	
3	**Mathematical model, technical and software concepts of mathematical modeling.**	**2**
3.1.	Typical issues of mathematical modeling.	
3.2.	Combined modeling.	
4	**Classification of systems modeling types.**	**4**
4.1.	Imaginary modeling.	
4.2.	Visual modeling.	
4.3	Analog modeling.	
4 . 4 .	Language modeling.	
4. 5.	Mathematical modeling.	
4.6	Simulation modeling.	
5	**The structure and constituents of the mathematical model.**	**2**
5.1 .	Knowledge models.	
5.2 .	Mathematical modeling, principles of analysis of control systems, steps of the production hierarchy, types of models, mathematical description and types of equations that make it up, model analogies, use of computer models in optimization issues.	
6	**The main types of mathematical models.**	**2**
6.1 .	Models with embodied parameters.	
6.2 .	Models with distributed parameters.	
6.3 .	Static models .	
6.4 .	Dynamic models.	
7	**Creating a mathematical description of the object.**	**4**
7.1 .	Block principles in constructing a mathematical description.	
7.2 .	**Creating a mathematical description using analytical methods.**	
7.3	An experimental method of constructing a mathematical description.	
7.4 .	**The composition of the mathematical description.**	

8	**Possibilities and effectiveness of modeling systems on computing machines (personal computers).**	**4**
8.1 .	Formation and algorithmization of the system operation process.	
8.2 .	Computer implementation of systems models and development of connection sequences.	
8.3.	Building a conceptual model of the system and forming it.	
8.4	Algorithmization of the model and its machine implementation.	
9	**Basic information for building mathematical models .**	**4**
9.1 .	Analysis of the structure of the object and its material, energy and information flows.	
9.2 .	Derivation of mathematical model equations based on the conservation laws of the station.	
9.3 .	Complex object models.	
10	**The block principle of building a mathematical model.**	**2**
1 1 .1.	General principles of building a structural model.	
1 1 .2.	Analysis of the system of mathematical descriptive equations.	
12	**The most important sources of non-uniformity of the distribution of current particles over time in industrial equipment .**	**2**
12 .1.	Research methods of flow structure (Impulse method).	
13	**Research methods of flow structure**	**8**
13.1	Stepwise perturbation method.	
13.2	Equilibrium state method.	
13.3	Sinusoidal disturbance method.	
14	**The main characteristics of the distribution of flow elements according to the time of stay in the apparatus**	**2**
14.1	Moments of distribution functions.	
15	**Experimental S-curve processing using the method of moments**	**4**

15.1	Experimental F - curve processing.	
16	**Ideal Mixing and Ideal Displacement Models.**	**2**
17	**Diffusion model.**	**2**
	Total in the 5th semester:	**48**
	6th semester	
18	**Building an empirical model based on passive experience data.**	**2**
18.1.	Statement of issue.	
18.2.	Building empirical models based on passive experience data.	
18.3.	Determining the type of estimated regression equation.	
19	**Regression coefficients - determining the parameters of empirical models (performing the first stage of regression analysis)**	**4**
19.1	one **variable** to a linear representation.	
20	**Regression and correlation analysis.**	**4**
20.1	Stages of regression and correlation analysis.	
21	**Determining numerical descriptions of random variables measuring the output variable .**	**2**
21.1	Determination of variance estimates of regression coefficients.	
21.2	Determination of variance estimates.	
22	**Determining estimates of variance in experiments in which the independent variables vary in each number of parallel experiments.**	**2**
22.1	Determination of estimates of variances with the same number of parallel experiments at each *k point where the independent variables change.*	
23	**Determining the estimate of variances in parallel tests conducted at an arbitrary cut-off point .**	**2**
23.1	Determining the significance of regression coefficients.	
24	**discarding insignificant regression coefficients .**	**2**
24.1	Estimation of regression equation monad.	
25	**of active experiments .**	**2**
25.1	Advantages of active experimentation.	

26	**Full factorial experiment and processing of its results.**	**2**
26.1	Determination of coded coefficients of regression.	
27	**the significance of coded coefficients of regression .**	**2**
27.1	Checking the monad of the regression equation	
28	**Orthogonal central composite experiment (OMCT) and its resulting processing.**	**2**
29	**Determining the "star shoulder" quantities *a and S* from the condition of orthogonality of the planning matrix z .**	**2**
30	**Determining coded coefficients of regression.**	**2**
30.1	Determination of diagonal elements of information and correlation matrices	
3 1	**Determining the significance of coded coefficients of regression.**	**2**
31.1	Checking the monad of regression equations	
32	**Creating computer models of heat exchange devices.**	**2**
32.1	Calculation of stochastic constituents involved in the description of the heat transfer process.	
33	**Modeling of operation of recuperative heat exchangers.**	**4**
33.1	General attitude.	
33.2	Cases where heat capacity and heat transfer coefficients are constant.	
33.3	A condition in which the temperature of one of the heat carriers does not change when calculating boilers or condensers.	
33.4	Cases where heat capacity and heat transfer coefficients are variable.	
34	**Calculation and agorithmization of heat exchange devices.**	**2**
34.1	Calculation of heat exchangers in which the aggregate state of one of the heat carriers changes.	
35	**Calculation of tube heaters of initial mixtures of rectification columns .**	**2**
35.1	Calculation of heat exchangers in which the aggregate state of heat carriers does not change.	
36	**Calculation of the cubic residue cooler of the rectification columns.**	**2**
36.1	Mixing - creating a mathematical description of mixing type heat exchangers and an algorithm for its solution.	

37	**Creating a mathematical description of heat exchange devices and its solution algorithm.**	**2**
38	**straight (unidirectional) flow "pipe-in-pipe" heat exchangers and selection of its solution algorithm .**	**2**
38.1	direct (counter - counter) flow "pipe **- in** -pipe" heat exchangers and selection of its solution algorithm.	
	Total in the 6th semester:	**48**
	Grand total:	**96**

Lectures are held in an auditorium equipped with multimedia facilities for the flow of academic groups.

IV . Instructions and recommendations for practical training

Practical training provides students with practical skills and experience in designing **a technological process operation, which** is a component of modeling and optimization of technological processes in their enterprises, to know its structural elements, to make calculations related to them, to solve examples and problems :

Instructions and recommendations for practical training

Table 2

T/r	Topics of practical training	Hour
	5th semester	
1.	Making a mathematical classification. Ideal mixing reactor: steady state operation.	2
2.	Making a mathematical classification. The ideal mixing reactor: dynamic performance mode.	2
3.	Making a mathematical classification. Ideal displacement reactor: stationary and dynamic modes of operation.	2
4.	Making a mathematical classification. Ideal compression reactor: dynamic operation mode.	2
5.	Among digital methods, solving the classification of devices by the method of graphs and the method of simple iterations.	2
6.	Algorithmization of device classifications using numerical methods. The method of dividing by two. The method of chords. Newton's	2

	method.	
7.	Algorithmization of mathematical classifications of the rectification process.	2
8.	Correlation analysis sequence.	2
Total:		16
6th semester		
9.	Determination of coefficients of linear, parabolic and multiple regression equation.	2
10.	Determining the significance of regression coefficients. The method of excluding insignificant coefficients.	2
11.	Determining the monad of the regression equation.	2
12.	Solving problems using one- dimensional optimization methods. Method of mathematical analysis. The method of dichotomies.	2
13.	Solving problems using one- dimensional optimization methods. Method of mathematical analysis. The method of dichotomies.	2
14.	Solving problems using one- dimensional optimization methods. Golden cutting method. Fibonacci method.	2
15.	Multidimensional optimization . Graphical representation of objective functions. Determining the gradient of a function.	2
16 .	Multidimensional optimization . Graphical representation of objective functions. The classic way.	2
Total:		16
Grand total:		32

Practical classes are held separately for each academic group in an auditorium equipped with multimedia facilities. Classes are conducted using active and interactive methods.

V. Laboratory training

Table 3

Topics of laboratory training		**Hours**
5th semester		
1	Construction of static mathematical models of a simple hydraulic system	2
2	Construction of static mathematical models of a simple hydraulic system	2
3	Choosing a modeling algorithm for calculating the stationary	2

	regimes of the hydraulic system.	
4	Choosing a modeling algorithm for calculating the stationary regimes of the hydraulic system.	2
5	Creating a program for calculating a simple hydraulic system based on block diagrams.	2
6	Creating a program for calculating a simple hydraulic system based on block diagrams.	2
7	Construction of dynamic mathematical models of a simple hydraulic system.	2
8	Modeling of heat exchangers in stationary mode of operation	2
	Total:	16
6th semester		
9	Creating static mathematical models of objects whose parameters are embodied and obtaining a static description in computer .	2
10	Creating static mathematical models of the object whose parameters are embodied and obtaining a static description in computer .	2
11	Creation of dynamic mathematical models of the object whose parameters are embodied and obtaining a dynamic description in computer.	2
12	Creation of dynamic mathematical models of the object whose parameters are embodied and obtaining a dynamic description in computer.	2
13	Statistical modeling of control systems.	2
14	Creating a static model of control systems by correlation analysis method .	2
15	Creating a static model of control systems by correlation analysis method.	2
16	Creating a control system model by the method of experiment planning.	2
	Total:	16
	Grand total:	**32**

learn to conduct tests on experimental determination of technological process modeling .

VI. Instructions and recommendations for course work, course project and calculation - graphic work

Course work, course project and calculation - graphic work are not included in the curriculum

VII. Self study education and self study work

Student on the subject " Basics of modeling and optimization of technological processes " . independent education that's it learning science of the process structural Part of it is methodical and information resources with fully secured.

Table 4

T/r	Independent study topics	Hour
	5th semester	
1.	Classification of system modeling types.	12
2.	stages of production hierarchy , types of modeling.	12
3.	Mathematical description and the types of equations that make it up, the similarity of the model, the use of the computer model in optimization problems.	12
4.	Building an empirical model based on passive experience data. Determining the type of estimated regression equation	14
5.	Regression coefficients - determination of empirical model parameters (first stage of regression design). Regression and correlation analysis	14
	Total:	64
	6th semester	
6.	Obtaining and analyzing modeling results. Analysis of methods of constructing mathematical models of complex technical-technological objects	14
7.	Creating linear models of statics and dynamics based on nonlinear equations;	14
8.	Studying the influence of fluctuations of parameters of random processes and equations on output coordinates	12

9.	Methods of building analytical models of the object	12
10.	Formation and algorithmization of the system operation process. Computer implementation of systems models and development of their sequence. Algorithmization of the model and its machine implementation.	14
	Total:	66
	Grand total:	130

It is recommended to prepare abstracts and present them by students on subjects to be mastered independently.

VIII. Criteria for monitoring and evaluating student knowledge in science

Table 5

Evaluation methods	Oral test , interview, control work, homework check , written work, presentations and other similar forms.
B criteria	**5 - "Excellent" grade** - The student makes independent conclusions and decisions; - can think creatively; - conducts independent observation; - can apply the acquired knowledge in practice; **when** it is considered that he has an idea about science (topic) - he is evaluated with 5 (**excellent) grade.** **4 - "Good" grade** - The student observes independently; - can apply the acquired knowledge in **practice** ; **about** science (topic) - he is evaluated with 4 (good) grade. **3 - "Satisfactory" rating**

	can apply the acquired knowledge in practice ; when it is considered that he has an idea **about** science (topic) - he is evaluated with 3 (satisfactory) grade. **2 - "Unsatisfactory" grade** **considered that the student has not mastered** the science program , does not understand the essence of the science (topic) and does not have an idea about the science (topic) - he is evaluated with a grade of 2 (unsatisfactory).		
	Types of assessment	**Max. price**	**Transfer and q-ti**
	Intermediate control Intermediate control (conducting the ON type **and** evaluating the student's knowledge according to this type of control **is carried out** by the professor - **teacher** who conducted training **in the subject).** **-** term control is held during the semester after the completion of the relevant section of the work science program **in** order **to** assess the student **'s** knowledge and practical **skills** . Depending on the nature of the **subject,** the type of midterm examination can **be** conducted up to 2 times, and the form and duration **of** the examination are determined by the department based on the nature of the subject and the hours allocated to the subject. When evaluating a student according **to** the type of interim control, the grades he received during the training sessions are **taken into account .** **was** evaluated with a "2" (unsatisfactory) grade for this control type will not be included in the final control type.	5	9- 16 weeks

	Final control the final control type **and** evaluating the student's knowledge **on this type of** control is carried out by a professor **- teacher who did not conduct** the training **.** The form of conducting the final inspection **is** determined based on the nature of the subject, hours allocated to the subject.	5	18-19 weeks
	Written work, oral , test, etc	5	

IX . Basic and additional educational literature and information sources

Basic literature

1. Yusupbekov NR, Mukhitdinov DP Fundamentals of modeling and optimization of technological processes. Textbook for higher education institutions . - T.: Science and technology, 2015. 185 p .
2. Luigi Bocola Identifying Neutral Technology Shocks. University of Pennsylvania, 2014.
3. Hartman T.N., Klushin D.V. Basic computer modeling of chemical and technological processes: Ucheb. posobie dlya vuzov. - M.:IKTs "Akademkniga", 2006. 416p.
4. Kafarov V.V. Mathematical modeling of basic processes of chemical technology. - M.: Vysshaya shkola. 1999.
5. Kafarov V.V., Glebov M.B. Mathematical modeling of fundamental processes of chemical production. - M.: Vysshaya shkola, 1991. - 400 p.
6. Dvoretsky S.I., Egorov A.F., Dvoretsky D.S. Computer modeling and optimization of technological processes and equipment: Ucheb. posobie. Tambov: Izd-vo Tamb. Mr. tech. flour, 2003. 224 p
7. Komissarov M.A., Glebov M.B., Gordeev L.S. Chemical and technological process. Theory and experiment. - M.: Khimiya, 1999. - 358 p.
8. Yusupbekov N.R. Mathematical modeling of technological processes. Study guide . - ToshDU.: 1989.

Additional literature

1. Yusupbekov NR, Mukhitdinov DP , Bazarov MB, Halilov JA Fundamentals of computer modeling of control systems. Study guide for higher educational institutions . _ - N.: Navoi - Gold - Serves , 2009.

2. Yusupbekov NR, Mukhitdinov DP , Gulyamov Sh.M. Osnovy protsesov razdeleniya mnogokomponentnyx smesey. - T: "Universitet", 2017.

3. Yusupbekov NR, Mukhitdinov DP , Gulyamov Sh.M., Avazov Yu.SH. Mathematical modeling of process rectification of mnogokomponentnyx smesey. - T.: ToshDU, 2014.

4. Yusupbekov NR, Gulyamov Sh.M., Mannonov UV . - T.: ToshSU, 1999.

5. Electronic version of lecture texts .

Internet sites

14. www.ziyonet.u z
15. http://www.allbest.ru
16. www.knowledge.allbest.r u
17. www. twirpx.com
18. www.e-lib.kemtipp.ru
19. www.newlibrary.ru
20. www.priapp.ru
21. www. book fund.ru
22. www.ozon.ru