REPUBLIC OF UZBEKISTAN

MINISTRY OF HIGHER AND SECONDARY SPECIALIZED EDUCATION

ANDIJAN MACHINE - BUILDING INSTITUTE

Registered

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" I CONFIRMED "

Rector of the Institute

M.M. Turdialiev

2022 " " _____

FUNDAMENTALS OF MODELING AND OPTIMIZATION OF TECHNOLOGICAL PROCESSES SCIENCE

SCIENCE PROGRAM

Field of study:	320000 –	Engineering work
Type of specialty:	5311000-	Automation and control of technological processes and production

Andijan – 2022

In the year 2022 of Andijon Mashine-Building Institute at Andijan"___" _____ in_ _ dated in the council of "Fundamentals modeling and optimization of technological processes" science program is approved.

Andijan has been developed at the institute of engineering science program.

The developers:

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Educational and methodical council of science program recommended in the review of andijan institute of engineering (2022 year"___" _____ in " _ _ _ " the record number).

I. Relevance of educational science and its role in higher professional education

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

II . The purpose and tasks of educational science

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

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.

The following requirements are set for the knowledge, skills and qualifications of students in science.

Student:

The following requirements are placed on the knowledge, skills and qualifications of students in the subject "Fundamentals of identification and modeling of technological processes" .

Student:

– the main problems of science and its essence in acquiring a profession; the place and role of modeling and identification;
– modeling of technological processes main problems ;
– development of modeling of technological processes trend technological processes to ***have an idea about*** the latest achievements of science , technique and technology , modeling , management through computer technology ;
– mathematical modeling of technological processes and methods of managing processes through the model ;
– mathematical models (MM) . to compose common principles ;

– 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 ;

– Technological facilities at computer and ignore them systems identification and modeling issues solve

– creation of 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;

– ***to have an imagination*** to determine the optimal conditions for technological processes and to be able to apply them in practice .

– ***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 for evaluating the state of linear and non-linear dynamic systems .

III . The main theoretical part (lecture sessions)

Module 1. Fundamentals of mathematical modeling

Topic 1. Introduction to Identification and Modeling

History and development trends of the bases of modeling and identification of technological processes. General information about computer models used in industrial enterprises. Results of reforms in our republic in the field of modeling of technological processes, territorial problems and achievements of science, technology and technology. Tasks of science.

Topic 2. Subject and methods of science

Mathematical modeling the issue common put Modeling-knowing method as. Assumptions system concept. Modeling philosophical issues . Physical and mathematical modeling . Mathematical model, mathematician modeling technique and software supply concepts . Typical issues of mathematical modeling .

Topic 3. Classification of systems modeling types

Imaginary modeling. Obviously modeling . Analog modeling . T year modeling. Mathematics modeling. Imitative modeling . Combined modeling.

Module 2. Mathematical model of object

Topic 4. The structure of the mathematical model and organize doers.

Knowledge models. 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, monadity of the model, application in the optimization of computer models.

Topic 5. Mathematical models main types .

Models with embodied parameters. Models with distributed parameters. Static models . Dynamic models .

Topic 6. Mathematical description of the object make up

Mathematical description in making blocky principles . Analytical methods using a mathematical description make up Mathematical description of making experimental method . Mathematical description composition .

Topic 7 . Calculate H cars (personal possibilities and effectiveness of modeling systems in computers).

Formulation and algorithmization of the system operation process. Implementation of systems models in EHM and development of their sequence. Building a conceptual model of the system and its formation. Algorithmization of the model and its machine implementation.

3 - Module . Methods of creating analytical models of objects _

Topic 8. Mathematical models beat for initial data

Object and his material , energetic and information flows analysis of the structure . of the station recovery q flours based on a mathematical model equations cause Complex object models .

Topic 9. Building blocks of mathematical models principle .

Structural overall model building principles . Mathematical description equations system analysis _

Module 4. Currents in the apparatus mathematical structure description.

Topic 10 . Industry in their devices flow particles time according to distribution of unevenness the most important sources . Currents of the structure research methods (Impulse method).

Topic 11. Research methods of the flow structure (step turbulence method) .

Topic 12. Research methods of flow structure (Equilibrium state method) .

Topic 13. Research methods of flow structure (Sinusoidal disturbance method) .

Topic 14. The main characteristics of the distribution of current elements (moments of the distribution functions) according to the time of stay in the apparatus.

Topic 15. Repeating the experimental S-curves while measuring the moments **.**

Topic 16. Treatment of experimental F– curves.

Module 5. Typical mathematical models.

Topic 17. Ideal Mixing and Ideal Displacement Models.

Topic 18. Diffusive model.

Module 6. Construction of empirical static models of technological processes

Topic 19. Building empirical models based on passive experimental data

Statement of issue. Building empirical models based on empirical data . Determining the type of estimated regression equation.

Topic 20. Regression coefficients - determining the parameters of empirical models (performing the first stage of regression analysis). Changing the one-variable function to a linear representation.

Topic 21. Regression and correlation analysis . Stages of regression and correlation analysis.

Topic 22. Determining numerical descriptions of random variables measuring the output variable. Determination of variance estimates of regression coefficients. Determination of variance estimates.

Topic 23. Determining estimates of variance in experiments in which the independent variables vary in each number of parallel experiments. Determination of estimates of variances with the same number of parallel experiments at each *k point where the independent variables change.*

Topic 24. Determination of variance estimates in parallel tests conducted at an arbitrary cut-off point. Determining the significance of regression coefficients.

Topic 25. The procedure of discarding insignificant regression coefficients. Estimation of the monad of the regression equation.

Module 7. Construction of empirical models on the data of active experience.

Topic 26. Active experimentation sequence. Advantages of active experimentation.

Topic 27. Full factorial experiment and processing of its results. Determination of coded coefficients of regression

Topic 28. Determining the significance of coded coefficients of regression. Checking the monad of the regression equation

Topic 29. Orthogonal central composite experiment (OMKT) and processing of its results

Topic 30. Determining the "star shoulder" sizes a and S from the condition of orthogonality of the planning matrix $\bar{\bar{z}}$

Topic 31. Determining coded coefficients of regression. Determining diagonal elements of information and correlation matrices

Topic 32. Determining the significance of coded coefficients of regression

Topic 33. Checking the monad of regression equations

Module 8. Creation of computer models of typical equipment of chemical technology

Topic 34. Creating computer models of heat exchange devices.

Topic 35. Calculation of stochastic constituents involved in the description of the heat transfer process

Topic 36. Modeling the operation of recuperative heat exchangers. General attitude. Cases where heat capacity and heat transfer coefficients are constant.

Topic 37. Modeling the operation of recuperative heat exchangers. A condition in which the temperature of one of the heat carriers does not change when calculating boilers or condensers. Cases where heat capacity and heat transfer coefficients are variable.

Topic 38. Calculation and agorithmization of heat exchange devices.

Topic 39. Calculation of heat exchangers in which the aggregate state of one of the heat carriers changes.

Topic 40. Calculation of tube heaters of initial mixtures of rectification columns.

Topic 41. Calculation of heat exchangers in which the aggregate state of heat carriers does not change.

Topic 42. Calculation of the cubic residue cooler of the rectification columns.

Topic 43 . Compilation of mathematical description of "mixing-mixing" type heat exchangers and its solution algorithm.

Topic 44. Compilation of mathematical description of spiral heat exchangers and its solution algorithm.

Topic 45. Compilation of the mathematical description of straight (unidirectional) flow "pipe-in-pipe" heat exchangers and its solution algorithm.

Topic 46. Compilation of the mathematical description of reverse (counter-counter) flow "pipe-in-pipe" heat exchangers and its solution algorithm.

Module 9. Fundamentals of model optimization

Topic 47. Optimization issues. Setting the optimization problem. Description of variables to be optimized . Classification of optimization methods. Approximate methods of optimization .

Topic 48. Optimality criteria of automatic control systems.

Topic 49. Objective function and its properties. Geometric interpretation of the objective function .

Topic 50 . Global and local optima. Minimum prerequisites. Sufficient conditions of the minimum. Unimodal functions.

Topic 51 . A sequence of minimization by the classical method.

Topic 52 . Minimization sequence by dichotomy method.

Topic 53 . A minimization sequence with the "golden" intersection.

Topic 54 . A sequence of minimization by the Fibonacci method.

10-Module. Basic information about identification.

Topic 55. Basic concepts of identification theory. Raising the issue of identification .

Identification problems. Identification steps and easy identification solutions. Basic concepts and issues of object identification.

Topic 56 . Representations of mathematical models of the dynamics of objects in the classification of identification methods.

Mathematical models used in identification and their characteristics, classification of models.

Topic 57 . Basic properties of dynamic objects and transient processes in them. Classification of dynamic objects.

Parametric and discrete models of linear dynamic objects. Nonlinear dynamic models.

Topic 58 . Methods of constructing mathematical models of dynamic objects. An analytical method of building a dynamic model.

Analytical model building basics.

11 - Module. Methods of building dynamic models

Topic 59. Experimental method of mathematical model construction. Preparation for active experimentation.

Topic 60 . Identification of time characteristics. Methods of constructing time characteristics based on experience.

Topic 61. Identification using frequency characteristics . A frequency method for determining a transient process with an impulse .

IV. Content of practical training, organization instructions and recommendations

In practical training, students learn various methods of modeling and optimization of technological processes.

Approximate recommended topics of practical training:

- Making a mathematical classification. Ideal mixing reactor: stationary mode of operation .

- Making a mathematical classification. Ideal mixing reactor: dynamic operation mode.
- Making a mathematical classification. Ideal displacement reactor: stationary and dynamic modes of operation.
- Making a mathematical classification. Ideal compression reactor: dynamic operation mode.
- Solving the classification of devices by the method of graphs and the method of simple iterations in numerical methods.
- Algorithmization of device classifications using numerical methods. A method of dividing by two. Khordadar method. Newton's method.
- Algorithmization of mathematical classification of the rectification process.
- Correlation analysis sequence.
- Determination of coefficients of linear, parabolic and multiple regression equation.
- Determining the significance of regression coefficients.
- The method of excluding insignificant coefficients.
- Determining the monad of the regression equation.
- Solving problems using one-dimensional optimization methods. Method of mathematical analysis. The method of dichotomies
- Solving problems using one-dimensional optimization methods. "Golden" cutting method. Fibonacci method
- Multidimensional optimization. Graphical representation of the objective function. Defining the gradient of a function
- Multidimensional optimization methods. The classic way. Methods of descent
- Views of dynamic object mathematical models and their transition from one view to another
- Determination of transfer functions of single-capacitance objects
- Determination of transfer functions of multi-capacitance objects
- Finding the transfer function based on the approximation of the transient function
- Finding W (p) based on IO'F
- Forms of the equation of state and their transition from one form to another
- Determination of condition planters based on experimental results
- Finding the parameters of a one-dimensional object with a determinant based on a transient process
- Smoothing and normalization of experimental results
- Transfer of a mathematical model of a one-dimensional object from one view to another based on the MatLAB program
- Calculation of parameters of a one-dimensional object using the method of least squares
- Parameter estimation of one-dimensional dynamic object
- identification of nonlinear objects
- Estimation of parameters of nonlinear objects

Instructions and recommendations on the organization of practical training are developed by the professors of the department. In it, students enrich the knowledge and skills they have acquired on the main lecture topics by solving practical problems. It is also recommended to strengthen students' knowledge based on textbooks and manuals, use handouts, increase their knowledge by publishing scientific articles and theses, solve problems, prepare visual aids on topics, etc.

V. Contents of laboratory works, instructions for their organization

laboratory work, students gain practical skills and experience in the correct use of computer in modeling technological processes, computer modeling of systems.

Recommended topics of laboratory work:

1. Construction of static mathematical models of simple hydraulic systems
2. Choosing a modeling algorithm for calculating stationary regimes of hydraulic systems.
3. Creating a program for calculating simple hydraulic systems based on block diagrams .
4. Construction of dynamic mathematical models of simple hydraulic systems.
5. Modeling of heat exchangers in stationary mode of operation
6. Creating static mathematical models of objects whose parameters are embodied and obtaining a static description in computer.
7. Creating dynamic mathematical models of objects whose parameters are embodied and obtaining dynamic description in computer.
8. Statistical modeling of control systems.
9. Creating a static model of control systems by correlation analysis method.
10. Creating a control system model by the method of experiment planning.

VI. Instructions for the organization of the course project

to adopt technical solutions suitable for real conditions in direct production, and to create the skills of using modern techniques and technologies.

The topics of the course project are determined directly related to the optimization of technological parameters of processes and devices in production enterprises.

Each student is given a personal assignment.

Suggested course project topics :

- Modeling of control systems of heat exchange processes .
- Modeling of absorption process control systems.

– Modeling of control systems of rectification processes.
– Modeling of control systems of reactive processes.
– Multi-step modeling of this confusing impact .

VII. Independent education organize of reaching shape and content

It is recommended that the student use the following forms in the process of mastering independent education, taking into account the specifics of a particular subject:

- study of chapters and topics of subjects according to textbooks and manuals;
- mastering the part of lectures on handouts;
- work with automated training and control systems;
- work on departments or topics of special literature;
- learning new techniques, equipment, processes and technologies ;
- in-depth study of departments and topics of subjects related to the performance of students' educational-scientific-research work;
- educational activities using active and problem-based teaching methods;
- distance (distance) education.

Recommended topics for independent study:

- Classification of systems modeling types.
- Mathematical modeling, principles of control systems analysis, steps of production hierarchy, types of models.
- Mathematical description and the types of equations that make it up, the monad of the model, its use in optimization of computer models.
- Building empirical models based on passive experimental data. Determining the type of estimated regression equation
- Regression coefficients - determining the parameters of empirical models (performing the first stage of regression analysis). Regression and correlation analysis
- Obtaining and analyzing modeling results. Analysis of methods of creating mathematical models of complex technical - technological objects
- Creating linear models of statics and dynamics based on nonlinear equations; to study the influence of fluctuation of parameters of random processes and equations on output coordinates
- Methods of building analytical models of objects
- Formulation and algorithmization of the system operation process. Implementation of systems models in EHM and development of their sequence. Algorithmization of the model and its machine implementation.
- Choosing a solution method and implementing it in the form of a solution algorithm and a modeling program. Determination of variance estimates of regression coefficients.

- Determining estimates of variance in an experiment in which the independent variable varies, each with a different number of parallel experiments. Determination of variance estimates in parallel tests conducted at an arbitrary cut-off point.
- Determining the significance of coded coefficients of regression.
- Methods of determining the similarity of models to a real object.

VIII. Basic and additional educational literature and information sources

Basic literature

1. Yusupbekov N.R., Mukhitdinov D.P. FUNDAMENTALS OF MODELING AND OPTIMIZATION OF TECHNOLOGICAL PROCESSES. Textbook for higher educational institutions. -T.: Science and technology, 2015.

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 . p osobie 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. Tutorial. - ToshDU .: 1989.

Additional literature

9. Yusupbekov N.R., Mukhitdinov D.P., Bazarov M.B., Khalilov J.A. Fundamentals of computer modeling of control systems. Study guide for higher educational institutions. -N.: Navoi-Gold-Serves, 2009.

10. Yusupbekov N.R., Mukhitdinov D.P., Gulyamov Sh.M. Osnovy protsesov razdeleniya mnogokomponentnyx smesey. - T: "Universitet", 2017.

11. Yusupbekov N.R., Gulyamov Sh.M., Mukhitdinov D.P., Avazov Yu.Sh. Mathematical modeling of process rectification of mnogokomponentnyx smesey. - T.: TashGTU , 2014.

12. Yusupbekov N.R., Gulyamov Sh.M., Mannanov U.V. Modelirovanie sovme shchennyx reaktsinno-razdelitelnyx protsesov. - T.: TashGTU, 1999.

13. Electronic version of lectures .

Internet sites

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16. www.knowledge.allbest.r u
17. www. twirpx.com
18. www.e-lib.kemtipp.ru
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21. www. book fund.ru
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23. www.elibrary-book.ru
24. www.studfiles.ru