

## **REPORT**

### **INSTITUTE OF MATHEMATICS AND MECHANICS OF ANAS**

**on the annual scientific and scientific - organizational activities for 2021  
of the Department “Computer Technologies and Mathematical Statistics”**

#### **About scientific activity**

During the reporting period, the Department of Computer Technologies and Mathematical Statistics carried out 3 scientific studies on the topic “Research of some issues of visual control algorithms and the theory of probabilities of dynamic production processes”.

The department has 12 employees. Of these, 1 doctor of sciences, 4 - doctors of philosophy, 5 - software engineers, 2 - laboratory assistants. There are two doctoral students at the department.

During the reporting period, the department staff published 1 article (WOS) and 2 conference materials.

#### **About individual works**

**Work 1:** Compilation of the problem of automatic estimation of physically unmeasurable coordinates and development of a solution method taking into account the number of stationary states in the phase space of the thermal dynamics model of the dehydrogenation process.

**(Executer: Ph.D. in Engineering, Associate Professor H. A. Nagiev, Head of Department)**

In this scientific research, carried out in the department, the problem of operational control of the thermal dynamics of reaction-regeneration systems of the oil refining industry on the basis of a mathematical model was put forward as a priority direction. In this direction, based on the method of phase trajectories, the problem of automatic estimation of physically not measurable coordinates has been

developed and a solution method has been developed that takes into account the number of stationary states of the model of thermal dynamics of the technological process. From the beginning of the year to the present, the following issues have been resolved:

- Mathematically developed the problem of assessing the phase coordinates of nonlinear reaction-regeneration systems facing the problem of operational control on the basis of mathematical modeling, and not direct measurement, the implementation of which is not feasible due to high temperatures and the presence of an aggressive environment. The multiplicity of stationary states, which is a feature of the system, requires a special approach to the problem and has determined the analysis of the structure of families of phase trajectories.

- The impossibility of determining the state of the dynamical system in terms of the velocity vectors and phase coordinates required the construction of the Jacobi matrix in real time in connection with physical measurements, through which the problem of estimating the phase coordinates was solved.

The results are reflected in the following article and conference proceedings:

1. Nagiev H.A., Gulieva N.A. Indirect assessment of the changing state of dynamic systems with multiple equilibrium positions based on computer modeling using the example of industrial reaction-regeneration systems. // Measurement Techniques No. 8, 2021. p.41-50 (wos IF - 0.29)

In connection with the topic, a report was sent to participate in the IV Republican Scientific Conference "Applied Mathematics and New Information Technologies", which will be held at Sumgait State University:

2. Nagiev H.A., Guseinova A.S. Algorithm for solving a system of stiff differential equations based on iteration with a variable step.

**Work 2:** Mathematical formulation and development of a methodology for solving the problem of early forecasting, which is aimed at preventing the gel effect in the process of polymerization

**(Executer: Ph.D. in Engineering, Associate Professor H. A. Nagiev, Head of Department, Ph.D. in Engineering, Sadikhov V.V., doctoral student)**

The main goal of this research work was to obtain a quality forecast based on mathematical modeling in the technology of polymer materials and composites, as well as to develop and solve a mathematical problem of operational control for this purpose.

The mathematical model proposed by us has passed the stage of parametric identification according to the statistical data of the functioning of an industrial technological process in nominal conditions, using mathematical and statistical methods. Computational experiments have shown that the model of polymerization processes has a specific dynamics of change in the non-Newtonian fluidity of the reaction mass. Particularly noteworthy is the presence of a strong correlation between the dynamics of viscosity change during polymerization and the mechanical properties of the finished product:

-In this regard, the resulting display of the fluidity functions of the blanks of polymeric materials obtained using a rotary installation in the space of moments of three orders (using computer visualization technologies) is directly aimed at operational control within the framework of the functioning of "man-machine" systems;

- The problem of quality management was solved by the results of mapping a set of trajectories of the third order of moments into the space of material quality indicators.

The extension of the results obtained to the technology of polymer materials was also studied, which was aimed at using them as a scientific basis for the beginning of the design phase in terms of application.

**Work 3:** Construction of the Green's function for the first boundary value problem in equations of parabolic Hilberg-Serrin type

**(Executer: Cand.ph.math.sci., senior researcher N. J. Jafarov)**

For equations of parabolic Hilberg-Serrin type in domains of paraboloid type, the Green's function is explicitly constructed from the eigenvalues of the corresponding elliptic operator, and an asymptotic estimate is obtained for it depending on the 1st eigenvalue.

### **About scientific - organizational activity**

Master student D.M. Shafizade took part in the republican online conference of doctoral students and young researchers on the topic "Information, science, technology and prospects of universities", held on December 18, 2020 at Lankaran State University, as well as on May 11-12, 2021 at the Republican scientific conference held in Sumgait State University "with theses:

1. Nagiev H.A., Shafizade D.M. Diagnostics of cracks on multilayer electronic boards based on the method of dynamic mechanical analysis // Materials of the republican online conference for doctoral students and young researchers "Information, Science, Technology and University Prospects", Lankaran, December 18, 2020, p. 161-162.

2.D.M. Shafizade. Flaw detection of composite plates with non-metallic reinforcement based on the method of dynamic mechanical analysis. // Ministry of Education of the Republic of Azerbaijan. Sumgait State University. Conference proceedings, Sumgayit, May 17, 2021, part 3, p. 367-369.

All days of the week, 27 students of the " Information Technologies and Control" faculty of ASOIU were in the department of online practical training under the bachelor's program, under the guidance of the department employees.

**Head of Department:**

**Doctor of Philosophy in Technology,**

**Associate Professor**

**Hasan Nagiev**