

REPORT

INSTITUTE OF MATHEMATICS AND MECHANICS OF ANAS

**on the annual scientific and scientific - organizational activities for 2020
of the Department “Computing mathematics and information science”**

About scientific activity

During the reporting period, the department " Computational Mathematics and Information Science" conducted a scientific research on the topic "Development of methodological foundations for creating a software package for screen display of controlled trajectories on the space of three-dimensional states" and 3 works were performed.

The department has 12 employees. 2 of them are doctors of philosophy, 7 are software engineers and 3 are laboratory assistants. The department employs one doctoral student and one master.

Before the onset of the pandemic, the department held a workshop every Wednesday of the week (12:00) (three workshops).

In the same period, on every Tuesday and Thursday (at 11:00), seminars were held together with the Non-Harmonic Analysis Department and the Laboratory for Mathematical Problems of Signal Processing.

In the reporting period, the department staff published 3 articles, 3 materials for conferences. One of the articles was published abroad (posted in the Web of Science database, IF 0.603, Q3), two articles were published in the journals of the Republican editions.

About individual works

Work 1: Building a model of isobutane dehydrogenation process dynamics.

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

As a priority area of research carried out in the department, it should be noted the modernization of computerization algorithms for the control of the processes of oil refining complexes and petrochemical industries, an example for which is the technological process of hydrocarbon dehydrogenation. The main methodological basis is the technology of computer research of motion trajectories in phase space. To date, the development of visualization algorithms for the control of the named technological process has been completed.

Since the beginning of the reporting period, the tasks that have found their successful solution on the named topic include the following:

- a model of isobutane dehydrogenation process has been developed, which is a differential equation in four phase variables;

- Parametric identification of the named model was carried out according to the technical conditions for the functioning of the technological process;

- carried out a study of the topological properties of the state space with the allocation of equilibrium positions. Algorithms and techniques of nonlinear dynamics and computational experiment are taken as a methodological basis. The topological properties of the state space in a wide range of nominal modes are studied.

The results obtained are highlighted in the following articles and conference materials:

1. Nagiyev G.A. , Alieva F.A. Optimization of the average quality of products in a given production period, taking into account the distribution function of the disturbance factor / Book storage and information, Scientific and practical journal, 2019. No. 3 (30). p.66-72.

Other articles submitted to editors on the named topic:

1. G.A. Nagiyev. Critical manifestations in the model of controlling the thermal dynamics of industrial reaction-regeneration systems, caused by positive internal feedbacks and a plurality of stationary states. // News of higher educational institutions. Journal "Applied nonlinear dynamics".

2. G.A. Nagiyev, N.A. Guliyev. Indirect estimation of state variables of industrial reaction-regeneration systems characterized by a plurality of equilibrium positions. // Journal "Information and Control Systems".

3. H. Nağıyev, F. A. Aliyeva. Fasiləsiz axında karbohidrogenlərin hidrotəmizləmə proseslərinin qeyri-stasionar təsirli idarə strategiyası // BDU, Nauchnye Izvestia, // 2019, No. 3, səh 65-68.

Conference materials on topics:

1. H.A. Nagiev, F.A. Aliyeva On an algorithm for controlling the depth of feedback in an optimization problem taking into account the distribution function of perturbations / 3rd International E-conference on Mathematical Advances and its Applications (June, 24-27,2020, Istanbul / Turkey), pp 100 ...

2. Gulieva N.A., Nagiyev G.A. On one approach to reducing the dimension of a dynamic system for visualizing control on the example of the process of dehydrogenation of hydrocarbons // II International Scientific Conference Information Systems and Technologies: Achievements and Prospects July 09-10, 2020, Sumgait, p. 40-42.

3. H.A. Nagiev, F.A. Aliyeva On a problem of choosing the optimal strategy for controlling the intensity of production for a given volume of output // The 7th International Conference on Control and Optimization with Industrial Applications. 26-28 August 2020, Baku, Azerbaijan. pp 284-287.

Work 2: Development of differential equations of thermal dynamics of reaction-regeneration systems and study of properties based on the method of computational experiment

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

The problem of operational estimation of the phase coordinates of reaction-regeneration systems operating in the oil refining industry is formulated, which is one of the important problems of controlling their thermal dynamics. Appropriate estimation algorithms have been developed.

The physical measurability of only two state variables of the model system of differential equations in the absence of proper technical means of measuring the remaining two others makes it necessary to formulate the problem of indirect measurement. Indirect measurement based on the dynamic coupling of all state variables of a nonlinear system with a plurality of stationary states is problematic due to the fact that more than one state vector can correspond to the same input vector. This is the reason for the emergence of the problem of the problem of adaptive simulation in dynamics, which aims to solve the problem of indirect measurement of the degree of coking of the catalyst in reaction-regeneration systems. In connection with this problem, a method is proposed based on the introduction of the second derivatives of the functions of the right-hand sides of differential equations. The proposed method is applied to solving the problem of operational control of thermal conditions of reaction-regeneration systems. The ability to take into account the non-uniqueness of the equilibrium positions of nonlinear systems of differential equations can contribute to solving a number of production systems characterized by a variety of equilibrium positions.

Some results related to these studies are highlighted in the journal "Technical Physics", which is included in the "Web of science" database in collaboration with the doctoral student of the department V.V. Sadikhova:

1. Nagiev A.G., Sadykhov V.V. , Gashimova U.M. Identification of Properties of Composite Polymer Materials in the Space of Their Rotational – Viscous

Characteristics. // Technical Physics. 65, 232–237 (2020), Published: 26 April 2020. <https://doi.org/10.1134/S1063784220020176>.

Work 3: Investigation of solutions to boundary value problems of parabolic type of equations with variable coefficients, characterized by the presence of points on the edges of the characteristics.

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

Boundary value problems are investigated and an analysis of the uniqueness of solutions for parabolic equations in the case of continuous coefficients is carried out. The results are published as the following article:

1. N. Cafarov. Unique wear solvability of the first boundary value problem for Hilberq-Serrin parabolic equation in non-cylindrical domains // Transaction of National Academy of Sciences of Azerbaijan, v. XXXIX, No 4, December 2019, pp 96-106.

About scientific - organizational activity

At the beginning of the reporting period, the final stage of the research work "NDVI analysis of a given spectral image" and the delivery of the topic to the customer "Azercosmos JSC" were carried out. The work was carried out jointly by: - the department of "nonharmonic analysis", the laboratory "Mathematical problems of signal processing" and our department under the agreement with "Azercosmos JSC" concluded on 06.09.2019 between the IMM of ANAS.

The employees of our department carried out part of the work directly related to the technology of applying mathematical and statistical methods to solving the problem of automatic classification. The work performed was presented to the customer in detail with practical comments on the software and the demonstration of the necessary actions for operation.

Head of the department G.A. Nagiyev carried out work on pedagogical work within the framework of the magistracy of the AMM of ANAS (1st year, Durra

Shafizade, course "Bioinformatics). Classes were held remotely over the ZOOM service system. In addition, he was also engaged in conducting "online classes" by masters of the 2nd year in the discipline "Application of numerical methods to solving technical problems."

In the period 18.02.2019 - 16.03.2019 G.A. Nagiev every working day of the week was busy with 30 students of ASOIU on conducting scientific and industrial practice.

G.A.Nagiev published a methodological guide for students of technical schools of higher education "Laboratory work in the course of research of operations in management" in collaboration with a number of teachers of higher education of the Republic.

Head of Department:

Doctor of Philosophy in Technology,

Associate Professor

Hasan Nagiev