

## **REPORT**

### **Institute of Mathematics and Mechanics ANAS**

**on the annual scientific and scientific - organizational activities for 2019 of the department "Computing mathematics and information science"**

#### **About scientific activity**

During the reporting period, in the department “Computational Mathematics and Information Science”, a scientific study was conducted on the topic “Development of methodological foundations for creating a software package for screen reflection of controlled trajectories into the space of three-dimensional states” and 4 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 has one doctoral candidate and one master's degree.

The department holds an internal scientific seminar every Wednesday (12:00). The department discusses some topical issues of applied mathematics in connection with the ongoing research on methods of solution in the Matlab system.

On Tuesdays and Thursdays (11:00), regular institute seminars are held in conjunction with the Non-Harmonic Analysis Department and the Mathematical Problems of Signal Processing Laboratory.

In the reporting period, the department staff published 4 articles, 1 material for conferences. 2 of the articles were published abroad (one of them was posted in the Web of Science database. IF 0.5, Q4), and 2 articles were published in local magazines.

#### **About individual works**

**Work 1:** Theoretical development of the stability criterion on three-dimensional moment spaces for a topological analysis of the stationary states of dynamical systems with distributed parameters and an indication of efficiency using practical examples.

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

The statement of this problem is connected with the value arising from the assessment of such fundamental properties as the trajectory, stationary mode and its stability in the design and control of a number of production processes with distributed parameters. The extension of the term trajectory to elements that can be parameterized by three parameters in a bounded class that carries certain properties of the functional space arises from the need for a mathematical description of the time revival of these elements. The effect obtained from transferring this rebirth from the shape of an element of space of infinite size to the space of three-dimensional parameters is primarily associated with visualization of the motion of a dynamic system, from here the trajectory and criteria characteristic of other dynamic systems are reflected. As a result of the study, based on a number of examples, it was shown that if the composite initial moments of the 0th, 1st, and 2nd are used as a parameterization tool, models of a chemical reactor of the pipe type, which are solutions in the class with one extremum, of smooth functions, can meet the principles of such visualization. It is shown that for a family of solutions parameterized in this way, the use of terms such as phase priorities, stationary mode point and the concept of its stability justifies itself from a practical point of view.

The results are published in 1 article:

1. A.G.Nagiev, H.A.Nagiev, N. A. Gulieva. On the Structure of the Space of States for a Thermal Model of Fluidized-Bed Reactor–Regenerator Units and Control Visualization Principles // Theoretical Foundations of Chemical Engineering // Springer 2019, Volume 53, Issue 1, pp 29–42, **IF-0.515. Q4.** (<https://doi.org/10.1134/S0040579519010111> )

In connection with the topic, 1 thesis was published:

1. H.A.Nagiev “Vizualization of control of izobutane dehydrogenation process based on phase trajectories method” // Proceedings of the International conference devoted to the 60<sup>th</sup> anniversary of the Institute of Mathematics and Mechanics of Azerbaijan National Academy of Sciences. // Baku 23-25 okt. 2019. pp403-405. <https://imm60.imm.az/programme/>

**Work 2:** Theoretical development of a two-parameter spectral density function, which serves to increase the information content in the statistical analysis of random time sequences and carries the goal of encoding the image of the signal source.

**(Executer: Cand.tech.sci., senior researcher V.V. Sadikhov)**

The task of recognizing a signal source based on samples of statistical observations presented by realizations in a limited volume is posed. Attention is directed to the fact that a change in the signal in time forms a modulation in amplitude of all harmonics carrying it. Their analysis can be used as additional information to study the individual properties of the signal. Using the reflection on the space of harmonics of the signal selected in a certain order, the task is set to use it as an additional source of statistical information, except for their distribution in amplitude. Using the distribution of the amplitude in the implementation of the power of the signal that falls into one or another harmonic, allowed the implementation of two-dimensional spectral analysis and made it possible to recognize the signal source.

One article by V. V. Sadikhov was accepted for publication in the journal "Journal of Technical Physics", which is a publication of the Ioffe Russian Institute of Physics.

1. Nagiev A. G., Sadikhov V. V., Gashimova W. M. Identification of the properties of composite materials in the space of their rotational - viscous characteristics. Journal of Technical Physics, 2020, No. 2.

This publication is part of the Web of Science database, which is translated in America.

**Work 3:** Mapping of economic zones, physical landscapes based on mathematical statistical methods based on a database (based on geoinformation data).

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

Using statistical methods, an algorithm is given for creating a map of landscape coverings of the Lesser Caucasus (part of Azerbaijan), and on its basis calculations have been made to ensure the accuracy of the map.

The results are published in 2 articles, and 1 article has been prepared and sent to the publisher.

1.N. Jafarov. Promodern methods of resistance to the influence of pathogenic factors on the person and biospheric processes. IASHE. GISAP. London 2019. pp. 20-27 <http://iashe.eu/en/periodicals-journals-academy>

2. Jafarov N.J. Weak Solvability of the first Boundary Value Problem for Class of Parabolic Equations with Discontinuous Coefficients in Paraboloid Type

Discontinuous Coefficients in Paraboloid Type Domains // Caspian Journal of Applied Mathematics, Ecology and Economics. vol. 6, N 2, December 2018, pp 42-53

3. N. Jafarov. Unique wear solvability of the first boundary value problem for Hilberq-Serrin parabolic equation in non-cylindrical domains. Bulletin of ANAS. Mathematical issue (sent to the editors).

**Work 4:** Investigation of some “hidden” properties of orthogonal polynomials and application of these properties both to solving discrete problems and to problems of continuous quantum mechanics.

**(Executer: Ph D. in Physics, senior researcher A.M. Jafarova)**

Given the existence of orthogonally in a certain continuous size for Lager polynomials, a new orthogonal relation is proposed that has a continuous size for Charlier polynomials with discrete variables  $x > m + n$ . Using the well-known properties of the Pochhammer symbol and the Gamma function, the validity of this orthogonal relation is proved. Applied issues related to the proposed new orthogonal relation for Charlier polynomials are considered.

The results are published in 1 article:

1. A.M. Jafarova, G.H. Guliyeva, E.I. Jafarov. Orthogonality relation for the Charlier polynomials with respect to the continuous measure // Mathematics and Computer Science, Journal of Baku Engineering University, 2018, volume 2, number 1, pp. 31-36.

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

In the reporting period, as part of a grant competition held by the Scientific Fund of the State Oil Company, the project “Optimal management of oil refining processes based on non-linear dynamics and computer visualization technologies” (project cost 50,000 manats) was presented. The goal of the project is to study the positive effects formed by the effects of non-stationary control, which is an important property of large-capacity oil refining processes, and to develop appropriate methodologies. The scientific idea of the project is to improve control through the use of periodic modes in dynamic systems of an industrial scale, characterized by non-linearity, a multiplicity of stationary states. As a result of the project, it is expected to increase the production efficiency of carbohydrates of petroleum origin, which are of great economic importance in the oil refining industry of our Republic.

On the basis of the contract dated September 6, 2019 between the IMA of ANAS and the Open Joint-Stock Company Azercosmos, the department implements the project "NDVI analysis of a given spectral image" together with the department of the Institute "Inharmonic Analysis" and the laboratory "Mathematical Problems of Signal Processing". The department staff carried out image processing in Matlab and other problem-oriented software packages based on mathematical, static methods and compiled software modules that conduct land - plant classification.

H. Nagiev is engaged in pedagogical activity in ASOIU and IMM ANAS.

02/18/2019 - 05/25/2019 all days of the week, 27 students of Faculty of Information Technologies and Control ASOIU underwent scientific and industrial practice under the bachelor's program of study and their activities were scientifically - practically led by our staff. Students - trainees were divided into 3 groups and their practical activities were identified on the following topics:

1. Compilation and programming of structural queries of the management software of mass service enterprises (lecturer - H. Nagiev);
2. Modeling and programming in CAD systems (lecturer - V. Sadikhov);
3. A set of documents and the use of macro extensions in the LaTeX system (lecturer - A. Takhirova).

02/01/2019 - 05/31/2019 on the basis of a corresponding letter from ANAS, students of the Sabah group of Azerbaijan State University of Oil and Industry were in scientific and industrial practice in the department "Computational Mathematics and Information Science" of the Institute of Mathematics and Mechanics. Head of Practice A. Jafarova during the production practice gave lectures to students and conducted seminars on "Informatics" and its basic concepts, character encoding standards (ASCII and UNICODE), number systems, the basics of algorithms, computer and its hardware (Hardware), software (Software) , system software (System Software), application software (Application Software), tool software - programming tools (Software tools), operating systems (MS DOS, UNIX, Linux, Mac OS, Windows), etc.

**Head of Department:**

**Doctor of Philosophy in Technology,**

**Associate Professor**

**Hasan Nagiyev**