

Institute of Mathematics and Mechanics of MSE RA
semi-annual report of the “Optimal Control” Department for 2024
scientific and scientific organization

Employees of the department

The department of “Optimal Control” employs 9 researchers (3 full-time employees, 6 part time) 7 of them are doctors of science, 2 of them are corresponding members of ANAS:

1. Professor Misir Mardanov – head of department (corr. member of ANAS)
2. Professor Kamil Aidazade – Senior Researcher-part time (Corr. Member of ANAS)
3. Professor Telman Melikov – Senior Researcher
4. Professor Hamlet Guliyev – Senior Researcher-part time
5. Professor Yagub Sharifov – Senior Researcher-part time
6. Professor Ramin Rzayev – Senior Researcher-part time
7. Professor Yusif Gasimov – Leading Researcher-part time
8. Ph.D. of Physics and Mathematics Eldar Mammadov – Leading Researcher.
9. Samin Malik, Ph.D. – Scientific Researcher (part-time.).

According to the approved plan for 2024, the department carried out scientific research on the topic “**Optimal control problems described by various systems**”:

1) Work: “New sufficient conditions for variation calculation and optimal management.

Executers: Corresponding member of ANAS, prof. Misir Mardanov, doct. of phys. Math. Sci. prof. Telman Malikov, Scientific Researcher Samin Malik

The following results were obtained on the subject:

For a simple optimal control problem, new stronger necessary conditions have been obtained for the optimality of the private controller.

The following results were obtained on the topic:

1. M.J. Mardanov, Y.A. Sharifov. A study of one approach to solution of the first-order non-linear impulsive differential equations with multipoint boundary conditions, *Proceedings of the Institute of Mathematics and Mechanics*, **2024**, Vol. 50, no 1, pp. 39-52, (**WEB of Science**). <https://doi.org/10.30546/2409-4994.2024.50.1.39>

2. M.J.Mardanov, T.K.Melikov, G.V.Hajiyeva. Some necessary conditions for an extremum in variational problems with delay. XI International Scientific Conference “*Modern Problems of Mathematics and Mechanics*”. 03-06 July, 2024. Baku, Azerbaijan. (Çapa qəbul edilib).

3. T.K.Melikov, G.V.Hajiyeva. Necessary conditions for the extremum in non-smooth problems of variational calculus with delay. *Baku Mathematical Journal*. 2024. (Çapa qəbul edilib).

4. Mardanov M.J., Isayeva A.M. Euler type system of equations in variational problems. with delayed argument. *Baku Mathematical Journal*. 2024, 3 (1), 119-124. DOI: <https://doi.org/10.32010/j.bmj.2024.11>

Popular scientific publications

- 1. Misir Mardanov.** Decisive position of our delegation to pace, Republican newspaper, January 27, 2024.
- 2. Misir Mardanov.** Achievements of multifaceted politics, people's newspaper, March 14, 2024.
- 3. Misir Mardanov.** "Public successes and personal tragedies of 42 years of Life", Part One, 525th newspaper, 2024, April 23.
- 4. Misir Mardanov.** "Public successes and personal tragedies of 42 years of life", part two, 525th newspaper, 2024, April 24.
- 5. Misir Mardanov.** "Public successes and personal tragedies of 42 years of life", part three, 525th newspaper, 2024, April 25.
- 6. Misir Mardanov.** "Scientific work that serves to increase our defense power", people's newspaper, 2024, April 28.
- 7. Misir Mardanov.** "Architect of our successes", Khal newspaper, may 10, 2024.
- 8. Misir Mardanov.** "West Azerbaijan realities. To the 100th anniversary of Yunis Rzayev", 525th newspaper, may 17, 2024.

2) Work: "Investigation of parametric inverse problems for ordinary linear differential equations with non-local conditions under high-order smooth addition conditions".

Executer: Corresponding member of ANAS Kamil Aida-zade

In the work, inverse parametric problem classes were studied. The observations carried out carry information about higher order derivatives involved in differential equations. The conditions for the existence of the solution have been obtained. Two approaches were proposed for numerical solution of the problem.

The following scientific works were published during the reporting period:

1. K.R. Aida-zade, V. M. Abdullayev. On the class of pointwise and integrally loaded differential equations. *Bulletin of the Karaganda University. Mathematics Series*, No. 1(113), 2024, pp. XX–XX. (WOS).

2. K.R. Aida-zade, V. M. Abdullayev. Optimization of the right-hand sides of nonlocal condition of a controllable system with multipoint and integral objective functional. *Optimization A journal of Mathematical Programming and Operations Research*, No. 1(73), 2024, pp. 205-228.

3) Work: “Construction of mathematical models describing some physical processes and development of effective methods for their solution”.

Executer: doct. of phys. Math. Sci. prof. Yusif Qasimov.

During the reporting period, studies were carried out to build mathematical models describing some physical processes and to develop methods for their effective solution.

The obtained results were published in the following scientific works:

1. Gasimov, Y., & Cattani, C., (2024). The Schrödinger-Pauli equation in a finite square domain. *Mediterranean Journal of Mathematics*, 21(3), 92-104. (WOS Impact Factor - 1.1 - Q2).

2. Gasimov, Y.S., Koç, D.A., & Bulut, H. (2024). A study on the investigation of the traveling wave solutions of the mathematical models in physics via $(m+(1/G'))$ -expansion method. *Advanced Mathematical Models & Applications*, 9(1), 5-13. (Scopus - Q2).

Conference: (Plenary Report)

1. Yusif Gasimov. On some inverse problems in untraditional formulation. *The 8th International Conference on Computational Mathematics and Engineering Sciences / 17-19 May, 2024, Şanlıurfa-Turkey. (17 May)* https://www.cmescongress.org/wp-content/uploads/2024/05/Abstract_Book-1.pdf (page.11)

Conference: (Section Report)

2. Natavan Allahverdiyeva, Yusif Gasimov. Some properties of the eigenfrequencies of the plate on the domain. *The 8th International Conference on Computational Mathematics and Engineering Sciences / 17-19 May, 2024, Şanlıurfa-Türkiye. (18 May)* https://www.cmescongress.org/wp-content/uploads/2024/05/Abstract_Book-1.pdf (p.54)

4) Work: “Optimal control problems for some bidirectional special derivative equations and the equation of oscillations of three-layer plates”.

Executer: doct. of phys. Math. Sci. prof. Hamlet Guliyev.

In the work, the problem of optimal control for a two-way hyperbolic equation with a control and a discontinuity of the solution in the head part was considered, the existence theorem of the optimal control was proved, the necessary condition for optimality in the form of variational inequality was obtained.

The following scientific works were published during the reporting period:

1. Hamlet F. Quliyev, Idrak M. Askerov. The problem of optimal control by the leading coefficient of the second order hyperbolic equation with discontinuous solution. *Baku State University Journal of Mathematics & Computer Sciences* 2024, v. 1 (1), p 99-109.

2. M.J.Mardanov, H.F.Guliyev, H.T.Tagiev. Optimal control problem for the second order unstable hyperbolic problem with a nonlocal boundary condition. *Proceedings of the Institute of Mathematics and Mechanics, National Academy of Sciences of Azerbaijan*, Vol, № pp. (çapa qəbul edilib)

3. H.F.Guliyev, H.T.Tagiev. An optimal control problem for a wave equation with the third nonlocal boundary condition. *Modern problems of Mathematics and Mechanics. 03-06 July, 2024. Baku, Azerbaijan.*

5) Work: "Iteration study of two-point boundary value problems".

Executers: Corresponding member of ANAS, prof. Misir Mardanov and doct. of phys. Math. Sci. prof. Yaqub Sherifov

In the work, nonlinear differential equations of the first order with non-local boundary conditions were studied. To bring the boundary value problem under consideration to the integral equation, the Green function is constructed. Thus, by applying Banach's principle of compressed mappings and Krasnoselsky's theorem on immovable point to the integral equation, theorems on the uniqueness of the existence of the solution of the boundary value problem were proved.

The following scientific works were published during the reporting period:

1. M.J. Mardanov, Y.A. Sharifov. A study of one approach to solution of the first-order non-linear impulsive differential equations with multipoint boundary conditions, *Proceedings of the Institute of Mathematics and Mechanics*, 2024, Vol. 50, no 1, pp. 39-52, (WEB of Science).

6) WORK: Scientific research on " Development of an academic rating system for assessing the performance of university teachers" was conducted:

Executers: Corresponding member of ANAS, prof. Misir Mardanov, doctor of technical science, professor Ramin Rzayev

In order to evaluate the multidisciplinary activities of university teachers, 13 assessment criteria systems adopted at the University of Tennessee in the United States were selected as the basis and fuzzy methods and appropriate algorithms were developed on its basis.

The following scientific works were published during the reporting period:

1. Mardanov M.C., Rzayev R.R., Aliyev E.R., Rahmanov A.S. Comprehensive Assessment of the Activities of University Teachers Using Fuzzy Decision-Making Methods // *The 9th International Conference on Control and Optimization with Industrial Applications (COIA – 2024)*, 27-29 August, Istanbul University Cerrahpaşa, Istanbul, Turkish

2. Mardanov M.C., Rzayev R.R., Aliyev E.R., Rahmanov Ə.S., Abdullayev X.X. Comprehensive assessment of the quality of activity of university teachers using fuzzy methods of Multi-Criteria Analysis / / *Azerbaijan school./ Azerbaijan Journal of Educational Studies*. 2024, №2, səh. XX-XX <http://as-journal.edu.az>

7) Work: "Investigation of numerical image of multiparametric spectral problem".

Executive: a.e.i. candidate of physical and mathematical sciences Eldar Mammadov

In the work, the structure of the numerical image of a Bipharametric, compact self-adjoint operator spectral problem in Hilbert space within each of the left-defined and full-defined conditions was studied separately. Based on the characteristic features of this numerical image, the theorem defining the variational principle given by linear functional means for the spectral problem under consideration has been proved. The methodology for finding the sequence of eigenvalues and the sequence of eigenvalues corresponding to them, forming a complete orthogonal basis of the spectral problem considered separately within each of the two conditions of determination is given by the principle of variation.

The following scientific works were published during the reporting period:

1. Eldar Mammadov. Variational principle for a two-parameter spectral problem using a linear functional. *Modern problems of Mathematics and Mechanics*. 03-06 July, 2024. Baku, Azerbaijan.

2. Eldar Mammadov. On The Structure of The Numerical Range of a Two-Parameter Problem Under The Left Definiteness Condition. *The 9-th International Conference on Control and Optimization with Industrial Applications*. COIA 2024 Istanbul.

Final Information

Department employees

1. 20 scientific and popular science works were published, 2 articles and 2 theses were accepted for publication;
2. 16 scientific papers are articles, 4 are Conference materials ;
3. 3 scientific works were published in journals included in the base of WOS, 1-in the base of Scopus;
4. Popular Science articles number 8.

SCIENTIFIC AND SOCIAL ACTIVITIES

Head of department professor Misir Mardanov is a chairman of the Dissertation Council ED 1.04 and of the Scientific Council of IMM. He is depute editor-in-chief of “ANAS News” journal, a member of the editorial board of “Azerbaijan Journal of Mathematics” and “Chebyshevskii sbornik”, editor-in-chief of “Proc. of IMM ANAS”, a member of the international editorial board of “TWMS Journal of Applied Mathematics” and chairman of Scientific Publishing of ANAS.

Phd in Physics and Mathematics, correspondign member of ANAS, professor Kamil Aydzadə, chairman of the laboratory “Numerical methods of decision on the deterministic systems” of ANAS, editor in board in the journal published in Turkey “Ege University journal of the Faculty of Science”, editor in board in “NASA Proceedings of the Institute of Mathematics and mechanics” international journal, the journal published in Russia, “Прикладная математика и фундаментальная информатика”, TWNS “Pure and Applied Mathematics” international journal, Proceedings of Institute of Applied Mathematics, ANAS news (physics-and technology, mathematics), ANAS news (“Problems of Informatics and Control”), editor in board in Azerbaijan State Exam Center journal of “Abituriyent”.

Professor Telman Melikov is a member of the AAC Expert Council in Mathematics and Mechanics. Editor in board in **Proceedings of the Institute of Mathematics and Mechanics**.

Doctor of Physical and Mathematical Sciences of Department of Mechanics and Mathematics, BSU, Department of Mathematical Control, professor Hamlet Guliyev is a member of the editorial board of the journal "Modern Mathematical Models and Applications".

Professor Yagub Sharifov is a member of the editorial board of the journal "Proceedings of the Institute of Applied Mathematics", a member of the Scientific Committee of the ICRAPAM-2019 conference.

Professor Ramin Rzayev is a senior researcher at the Institute of Control Systems of ANAS, a member of the editorial board of the Scientific Journal of Automation and Metabolism, a member of the program committee of the International Scientific Conference "Information Systems and Technologies: Achievements and Prospects." Member of "ICSCCW - International Conference on Theory and Application of Soft Computing, Computing with Words and Perceptions" and "ICAFS - International Conference on Theory and Applications of Fuzzy Systems and Soft Computing" program committee of the international conference .

Department's Senior Researcher Yusif Gasimov **a founder and director of Jomard Publishing that issues 8 scientific journals**, is editor in-chief of international journal "Advanced Mathematical Models and Applications", journal of "Modern Technology and Engineering" - International journalist member of the editorial board of Applied Mathematics and Information Science - international editorial board, Proceedings of the Institute of Mathematics and Mechanics.

Head of department:

Corr. member of ANAS prof. Misir Mardanov