

Institute of Mathematics and Mechanics of ANAS
semi-annual report of the “Optimal Control” Department for 2022
scientific and scientific organization

Employees of the department

The department of “Optimal Control” employs 9 researchers (2 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 Məmmədov – Leading Researcher.
Samin Malik, Ph.D. – Scientific Researcher(part-time.).

In the department of "Optimal control", scientific researches were carried out on the topic "**Optimal control problems described by various systems**" 2022 according to the approved plan:

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

Stage: Strengthening the necessary conditions for optimality.

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

For a simple optimal control problem, new and more powerful necessary conditions for the optimization of a special controller have been obtained.

The following results were obtained on the topic:

1. **M.J.Mardanov, T.K.Melikov, S.T.Malik.** Necessary conditions for the extremum in non-smooth problems of variational calculus//Journal of Computational and Applied Mathematics <https://doi.org/10.1016/j.cam.2022>, 2022, vol. 399 (113723) **Q₁.**

2. **M.J.Mardanov, T.K.Melikov, S.T.Malik.** Minimum conditions in calculus of variations problems In the presence of various types of degenerations, Динамические системы и компьютерные науки: Теория и приложения (DYSC), Материалы 3-й Международной конференции, с. 126-128.

3. M.J.Mardanov, S.T.Malik. Strong Kelley condition in theory of singular optimal controls. Modern Problems of Mathematics and Mechanics proceedings of the International scientific conference devoted to the 110-th anniversary of academician Ibrahim Ibrahimov. 29 June-01 July, 2022, Baku. pp. 140-142.

4. Y.S.Gasimov, H.Jafari, M.J.Mardanov, R.A.Sardarova&Y.A.Sharifov. Existence and uniqueness of the solutions of the nonlinear impulse differential equations with nonlocal boundary conditions // Quaestiones Mathematicae. 2021 DOI:10.2989/16073606.2021.1945702, Q₁.

5. М.Дж.Марданов, Р.М.Асланов. Штрихи к портрету Давида Гильберта, X Международная научная конференция (К 160-летию со дня рождения Давида Гильберта 27-29 апреля 2022 года).

6. M.J.Mardanov, P.M.Aslanov. Бесценное наследие Насиреддина Туси в развитии тригонометрии, Материалы XVII Всероссийской с международным участием научно – практической конференции «Артемовские чтения», г. Пенза, 21 апреля 2021 г., стр. 71-78.

7. M.J.Mardanov, Sh.E.Alieva. Necessary conditions for the extremum in non-smooth problems of variational calculus. Modern Problems of Mathematics and Mechanics proceedings of the International scientific conference devoted to the 110-th anniversary of academician Ibrahim Ibrahimov. 29 June-01 July, 2022, Baku. pp. 138,139.

8. M.J.Mardanov, I.G.Mamedov, I.A.Abdullayeva. Integral representation of functions in Sobolev's anisotropic space with a dominant mixed derivative. Modern Problems of Mathematics and Mechanics proceedings of the International scientific conference devoted to the 110-th anniversary of academician Ibrahim Ibrahimov. 29 June-01 July, 2022, Baku. pp. 143, 144.

1) WORK: “Research and development of a numerical method for solving the problem of synthesis of power control and movement of concentrated heat sources.”

Executer: Corresponding member of ANAS Kamil Aida-zade

The analysis has been carried out, the formulations of problems for the synthesis of optimal control of capacities and the movement of concentrated heat sources have been proposed and investigated.

The following results were obtained on the topic:

1. К.Р.Айда-заде, В.М.Абдуллаев. Управление процессом нагрева стержня с использованием текущей и предыдущей по времени обратной связи Ж. “Автоматика и телемеханика”, М., №1, 2022, с. 130-149. (РИИЦ)

2. K.R.Aida-zade, V.M.Abdullayev. Controlling the Heating of a Rod Using The Current Time Feedback. Automation and Remote Control, Pleiades Publishing, ltd.,2022, V.83, №1, p.106-122. (WOS-0, 520).

3. Aida-zade K.R., Rahimov A.B. Numerical Solution to Inverse Problems of Recovering Special-Type Source of a Parabolic Equation. *Mathematical Analysis in Interdisciplinary Research. Springer Optimization and Its Applications*, 2022, vol 179. pp. 85-100, Springer, Cham. https://doi.org/10.1007/978-3-030-84721-0_6 (**WOS**)

4. Aida-zade K.R., Rahimov A.B. On recovering space or time-dependent source functions for a parabolic equation with non-local conditions. USA: *Applied Mathematics and Computation*, Elsevier Inc., – 2022. v. 419, – 126849 (17 pages). (**Web of Science, SCIE, IF: 4.091**) <https://doi.org/10.1016/j.amc.2021.126849>

3) WORK: “Methods for solving direct and inverse problems for some ordinary and special derivative equations”.

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

On the regularization Cauchy problem for matrix factorizations of the Helmholtz equation in a multidimensional bounded domain was investigated. Also the inverse spectral problem for pt -symmetric Schrodinger operator on the graph with loop was considered.

The following results were obtained on the topic:

1. **D.A.Juraev, Y.S.Gasimov.** On the regularization Cauchy problem for matrix factorizations of the Helmholtz equation in a multidimensional bounded domain. *Azerbaijan Journal of Mathematics*, 12(1), 2022, 142-161. (**Web of Science – Emerging Source Citation Index**).

2. **Efendiev, R., Gasimov, Y.** (2022). Inverse spectral problem for pt -symmetric Schrodinger operator on the graph with loop. *Global and Stochastic Analysis*, 9(2), *Special Issue: Modern Problems of Equations of Mathematical Physics and its Applications*, 67-77. (**Scopus**).

4) WORK: “The problem of finding the coefficients of a two-form hyperbolic equation with a non-local boundary condition”.

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

In the work the problem of finding the coefficients of the second order hyperbolic equation was considered. First, the problem of the existence of an optimal controller was studied, then the necessary optimality condition in the form of a variational inequality was obtained.

1. **Кулиев Г.Ф.** Сейфуллаева Х.И. Задача граничной управляемости для уравнения колебаний тонкой пластины. “Mathematics application issues and

newinformation technologies” IV Republican scientific conference. Sumgait, 09-10 december 2021. s.62-63

2. **H.F.Quliyev, İ.M.Askerov.** On a determination of the boundary function in the initial-boundary value problem for the second order hyperbolic equation. Вісник Київського національного університету імені Тараса Шевченка. Серія: Фізико-математичні науки, 2022, № 1, с. 56-60. ZbMATH.

3. **H.F.Quliyev, İ.M.Askerov.** On a determination of the coefficients of the second order hyperbolic equation with discontinuous solution. Advanced Mathematical Models and Applications. Vol. 7, № 1, 2022, pp. 30-37. (Scopus).

4. **H.F.Guliyev, İ.M.Asgarov.** A two-order hyperbolic equation with a truncated solution the problem of finding the prime factor. The birth of national leader Heydar Aliyev"Actual problems of mathematics and mechanics" dedicated to the 99th anniversary Materials of the Republican scientific conference. May, 2022, s. 3.

5) WORK: “Exploration of some integrated boundary conditional boundary and optimal control issues”.

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

This work considers boundary value problems for nonlinear integro-differential fractional equations with nonlocal boundary conditions, A suitable Green function was constructed for the first time in order to reduce this problem into a corresponding integral equation. So that by using the Banach contraction mapping principle (BCMP) and Krasnoselskii’s fixed point theorem (KFPT) on the integral equation, we can show that the solution of the nonlocal problem exists and it is unique.

The following results were obtained on the topic:

1. **M.J.Mardanov, Y.A.Sharifov, H.N.Aliyev.** Existence and Uniqueness of Solutions for Nonlinear Fractional Integro-Differential Equations with Nonlocal Boundary Condition, EUROPEAN JOURNAL OF PURE AND APPLIED MATHEMATICS Vol. 15, No. 2, 2022, 726-735. **WEB of science.**

6) WORK: Scientific research on "Comprehensive approach to the calculation of university rankings" was conducted:

Stage: “Development of adequate models

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

A comprehensive assessment of the competitiveness of universities, as a weakly structured issue, requires a multifaceted approach. Therefore, methods and models of mathematical statistics, elements of fuzzy logic, fuzzy sets and theories of neural networks, as well as hybrid (neural-fuzzy) systems and modern information technologies were used to solve it. The following results were obtained on the topic:

1. **Mərdanov M.C., Rzayev R.R., Jamalov Z.R.** Assessment of the University Competitiveness in the Paradigm of the Humanistic System Behavior // Lecture Notes in Networks and Systems, Vol. 362, pp. 591-598, 2022 URL: <https://link.springer.com/bookseries/15179> (**Scopus və Web of Science**)

2. **M.J.Mardanov, R.R.Rzayev.** L.A.Zadeh's "Fuzzy Logic" As A Key To The Description Of Humanistic Systems // Problems of Information Society.

3. **Misir Mərdanov, Ramin Rzayev, Xanmurad Abdullayev.** The importance of Lotfi Zadeh's heritage and fuzzy logic in the study of the behavior of humanistic systems // Azerbaijan school.Azerbaijan Journal of Educational Studies. 2021, №3, pp. 11-28.

7) WORK: "Investigation of the two-parameter spectral problem with a compact self-adjoint operator".

Executer: Ph.D. of Physics and Mathematics Eldar Mammadov

The eigenvalues and eigenelements of the two-parameter spectral problem with a compact self-adjoint operator were investigated, and a constructive method for finding their sequence was determined. Since the variation method was applied to solve this problem, it was necessary to investigate the construction of the numerical domain of the problem.

1. E. Sh. Mamadov. Completeness of a system of eigenelements of twoparameter problems. // the 5th International E-Conference on Mathematical Advances and Applications, held on May 11-14, 2022, Istanbul, Turkey

ABOUT SPEECHES OF DEPARTMENT COLLEAGUES AT THE CONFERENCE

Misir Mardanov. Life of a scientist dedicated to mathematics. *Modern Problems of Mathematics and Mechanics proceedings of the International scientific conference devoted to the 110-th anniversary of academician İbrahim İbrahimov.* **29 June-01 July, 2022, Baku.**

K.R.Ayda-zadə (V.A.Nashimov). Об одной задаче управления с обратной связью источниками нагревастержня. *Международная молодежно-практическая конференция элементароведения «Прикладная математика и фундаментальная информатика», посвященная 110-летию Академии наук Республики Казахстан Леонид Витальевич Канторович.* **Россия, Омск, 16 мая - 21 мая 2022 г.**

Hamlet Guliyev (İ.M.Asgarov). The problem of finding the prime factor of a two-order hyperbolic equation with a truncated solution. Materials of the Republican

scientific conference "Actual problems of Mathematics and Mechanics" dedicated to the 99th anniversary of the birth of national leader Heydar Aliyev. **May, 2022**

Gasimov Y.S. Some variable domain eigenvalue problems and applications. *Plenary Talk, The First International Conference on New Trends in Applied Mathematics, BeniMellal, Morocco, 19-21 May, 2022.*

SCIENTIFIC AND SOCIAL ACTIVITIES

Head of department professor Misir Mardanov is a chairman of the Dissertation Council D.01.111 and of the Scientific Council of IMM. He is depute editor-in-chief of "AMEA Xəbərləri" 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 is 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