

Institute of Mathematics and Mechanics of AR Ministry of Science and Education the “Optimal Control” Department for 2024 scientific and scientific organization

Employees of the department

The department of “Optimal Control” employs 9 researchers (4 full-time employees, 5 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
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.).

In accordance with the approved plan for 2024, scientific research on "**Optimal management issues described by various systems**" was conducted in the department:

1) Work: “New necessary and sufficient conditions in calculus of variations and optimal control

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 for the optimality of the specific controller are obtained.

In this direction, the following scientific works were published during the reporting period:

Conference: (Plenary Presentation)

1. Misir Mardanov. Necessary conditions for a minimum in variational problems with delay in the presence of degeneracies. *6th International Conference Dynamical Systems and Computer Science: Theory and Applications (DYSC 2024). (17 sentyabr)*

1. Misir Mardanov. Nasireddin Tusi, outstanding personality, talented teacher, encyclopedic scientist Tusi's life. Modern problems of Mathematics and Mechanics, materials of XI international conference. 03-06 iyul 2024, Bakı. səh. 3-11.

2. E.N.Mahmudov, M.J.Mardanov. Optimal control of hyperbolic type differential inclusions. Modern problems of Mathematics and Mechanics, materials of XI international conference, 03-06 iyul 2024, Bakı, səh. 146-148.

3. M.J.Mardanov, Y.A.Sharifov. Studying the Goursat-Darboux problems with integral conditions. *XI International Scientific Conference "Modern Problems of Mathematics and Mechanics"*. 03-06 July, 2024. Baku, Azerbaijan. pp. 161-165.

4. 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>

5. 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.seh. 159-161.

6. M.J.Mardanov, T.K.Melikov, G.V.Hajiyeva. Necessary conditions for a minimum in variational problems with delay in the presence of degeneracies. 2024, arxiv.org. <https://doi.org/10.48550/arXiv.2410.22885>

7. T.K.Melikov, G.V.Hajiyeva. Necessary conditions for the extremum in non-smooth problems of variational calculus with delay. *Baku Mathematical Journal*. 2024. pp. 136-144.**ZbMATH**

8. 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>. **ZbMATH**

2) WORK: “Non-local conditional ordinary linearity under highly ordered smooth additive conditionsstudy of parametric inverse problems for differential equations”

Executer: Corresponding member of ANAS Kamil Aida-zade

In this work, inverse parametric problem classes were studied. The observations carried out carry information about the higher-order derivatives involved in the differential equations. The conditions for the existence of the solution have been obtained. Two approaches have been proposed for the 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*, 1(113), 2024, pp. 5-20. (WOS IF: 0.6).<https://doi.org/10.31489/2024m1/5-20>

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. Aida-zade K.R., A.Baghirov A. About a class at nonlinear optimization problems large dimension // *Abstracts of XI International Conferences "Modern Problems of Mathematics and Mechanics"*, 2024, p. 49-51.

4. Айда-заде К.Р., Ашрафова Е.Р. Об одной обратной задаче относительно колебательной системы стержней. // *Материалы Международной Конференции, "Дифференциальные уравнения и их предложения"*, Казань, 2024, с. 20-21.

Айда-заде К.Р., Асадова Д.А. Оптимальное управление режимами переходных процессов в нефтепроводной системе на классе кусочно-непрерывных и кусочно-постоянных функций // *Материалы Пятой Международной Научно-Практической Конференции "Инновационные технологии в нефтегазовой отрасли"* Ставрополь, 2024, с.127-133.

3) WORK: "Construction of mathematical models describing some physical processes and development of their effective solution methods".

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

During the reporting period, research was conducted in the direction of building mathematical models describing some physical processes and developing their effective solution methods.

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**).

3. Gasimov Y.S., Kirci O., Agamaliev L., Bulut H. (2024). Investigation of the wave solutions of two space-time fractional equations in physics. *Partial Differential Equations in Applied Mathematics*. 100775, <https://doi.org/10.1016/j.padiff.2024.100775> (**Scopus - Q1**)

4. Efendiev R., & Gasimov Y. (2024). Spectral analysis of the indefinite non-self-adjoint Sturm–Liouville operator. *Partial Differential Equations in Applied Mathematics*, 100831. <https://doi.org/10.1016/j.padiff.2024.100831> (**Scopus - Q1**)

Conference: (Plenary Presentation)

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-Türkiye. (17 May)

https://www.cmescongress.org/wp-content/uploads/2024/05/Abstract_Book-1.pdf (səh.11)

Conference: (Section Presentation)

1. 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 (səh.54)

4) WORK: “Optimal control problems for some two-order special differential equations and the vibration equation of three-layer plates”

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

The problem of optimal control for a two-order hyperbolic equation with a controller and a discontinuity in the main part of the work was considered, the existence theorem of the optimal controller was proved, and a necessary condition for optimality was obtained in the form of a variational inequality.

In 2024, under the guidance of Hamlet Guliyev, 2 people defended their PhD in mathematics.

The following scientific works were published during the reporting period:

1. Hamlet F.Guliyev, 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. 50, № 2.2024.pp. 167–177 (**WEB of Science**).

<https://doi.org/10.30546/2409-4994.2024.50.2.167>

3. H.F.Guliyev, T.M.Huseynova. Optimal control problems for a system of second order hyperbolic equations. *Modern problems of Mathematics and Mechanics*. 03-06 July, 2024. Baku, Azerbaijan. pp. 119-121.

4. 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. pp. 121-123.

5. H.F.Guliyev, Kh.I.Seyfullayeva. On the Determination of the right side of the transverse equation vibrations of a circular plate // *The International Conference on Modern Problems of Mathematics, Mechanics and their Applications*, 20-22 June 2024, Baku Azerbaijan. p. 202-203.

6. H.F.Guliyev, Kh.I.Seyfullayeva. Optimal control problem of an inhomogeneous equation of vibrations of a three-layer plate // *The conference on Control Optimization with Industrial Applications (COIA 2024)*, August 27-29, 2024, Istanbul, Turkey. p. 114. (**WOS, Scopus**).

7. H. Guliyev, A. Javadova. An optimal control problem in the final observation case for a hyperbolic equation with a governing coefficient. // *Republican*

scientific conference on modern issues of Mathematics, Mechanics and Information Technologies dedicated to the 101st anniversary of the birth of Heydar Aliyev, the national leader of the Azerbaijani people. 02-03 May 2024. Pg. 2

5) WORK: “An iterative study of two-point boundary value problems”.

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

First-order nonlinear differential equations with non-local boundary conditions were studied in the work. Green's function is constructed to bring the considered boundary problem into an integral equation. Thus, by applying Banach's principle of compressed analysis and Krasnoselsky's fixed point theorem to the integral equation, the theorems on the existence of a unique solution to the boundary problem have been 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**).

2. M.J. Mardanov, Y.A. Sharifov. Studying the Goursat-Darboux problems with integral conditions. XI International Scientific Conference "*Modern Problems of Mathematics and Mechanics*". 03-06 July, 2024. Baku, Azerbaijan. pp. 161-165.

6) WORK: Development of an Academic Rating System to evaluate 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 multifaceted activity of university teachers, the 13 evaluation criteria system adopted at the University of Tennessee, USA, was selected as the basis, and based on it, fuzzy methods and relevant algorithms were developed.

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), August 27-29, Istanbul University Cerrahpaşa, Istanbul, Turkish (WOS, Scopus)

2. Mardanov M.C., Rzayev R.R., Aliyev E.R., Rahmanov A.S., Abdullayev X.Kh. Comprehensive assessment of university teachers' performance quality using fuzzy methods of multi-criteria analysis // Azerbaijan school. | Azerbaijan Journal of Educational Studies. 2024, No. 2, pp. 31-46. <http://as-journal.edu.az> (AAK)

7) WORK: “Study of the numerical representation of the multiparameter spectral problem”.

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

In this work, the structure of the numerical representation of the spectral problem with two-parameter, Compact self-adjoint operator in Hilbert space was studied separately within each of the left-definite and full-definite conditions. Based on the characteristic features of this numerical image, the theorem defining the principle of variation given by the linear functional tool for the considered spectral problem has been proved. Through the principle of variation, the method of finding the sequence of specific elements and the sequence of specific numbers corresponding to them, which form a complete orthogonal basis of the spectral problem considered separately within each of the two determination conditions, is given.

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. pp. 258-261.

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)*, 27-29 August, Istanbul, Türkiye. pp. 60-61. (WOS, Scopus).

7) WORK: “Second order extremum conditions in various problems of the calculus of variations with quadratic functions”.

Executers: Doctoral student Gubatova Narmina Yusif gizi

The following problems of calculating variations with quadratic functions are considered: the isoperimetric problem, the problem of calculating variations with higher order derivatives, various special cases of the Lagrange problem. In these matters, theorems about sufficient conditions for the absolute minimum were formulated and proved.

The following scientific works were published during the reporting period:

1. Elfat M. Galeev, Narmina Y. Gubatova. Isoperimetric problem of the calculus of variations with a quadratic Functional. *Transactions Issue Mathematics. National Academy of Sciences of Azerbaijan. Series of Physical-Technical & Mathematical Sciences (Trans. Natl. Acad. Sci. Azerb. Ser. Phys.-Tech. Math. Sci. Mathematics)*, Volume 44 (2024), Issue 4, 34-42. (Q3, SCOPUS).

2. Аскерова Н.Ю., Галеев Э.М. Условия 2-го порядка в задаче вариационного исчисления с одним закрепленным концом. *Материалы конференции Воронежская зимняя математическая школа С.Г.Крейна -2024, посвященная памяти В.П. Маслова*, 41-42. (SCOPUS).

3. Narmina Gubatova. Second order conditions in the problem of the calculus of variations with a quadratic functional and higher-order derivatives. *Book of Abstracts of COIA 2024, 134. (WOS).*

Final Information

Department employees during the year

1. 33 scientific and 15 scientific popular works were published;
2. 15 of the scientific works are articles, 18 are conference materials;
3. 6 scientific papers were published in WOS, 5 in Scopus, 3 in both WOS and Scopus, 2 in ZbMATH databases.

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 deputy 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, corresponding member of ANAS, professor Kamil Aydazade, 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**.

Professor Hamlet Guliyev, doctor of physical and mathematical sciences, is the head of the "Mathematical methods of management theory" department, Faculty of Mechanics and Mathematics of BSU, a member of the editorial board of "Advanced Mathematical Models & Applications" magazine.

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 .

The leading researcher of the department, Yusif Gasimov, is the founder and director of Jomard Publishing, which publishes 8 scientific journals, the editor-in-chief of the international journal Advanced Mathematical Models & Applications, a member of the editorial board of the international journal Journal of Modern Technology and Engineering, a member of the editorial board of the international journal Applied Mathematics & Information Sciences, a member of the editorial board of Proceedings of the Institute of Mathematics and Mechanics, and the editor of the special issue of Fractals (Impact Factor-3.3, Q1) magazine.

Head of department:

**Corr. member of ANAS
prof. Misir Mardanov**