

**Ministry of Science and Education Republic of Azerbaijan Institute of
Mathematics and Mechanics of annual report of the “Optimal Control”
Department for 2023
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-parttime.

In the department of "Optimal control", scientific researches were carried out on the topic "**Optimal control problems described by various systems**" 2023 according to the approved plan:

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

Stage: In the calculus of variations and optimal control, high formulation of necessary conditions and their corresponding sufficient conditions.

Executers: Corresponding member of ANAS, prof. Misir Mardanov, doct. of phys. Math. Sci. prof. Telman Malikov, 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 a minimum in classical calculus of variations in the presence of various types of degenerations, Journal of Computational and Applied Mathematics, Volume 418, 15 January 2023, <https://doi.org/10.1016/j.cam.2022.114668>

2. Mardanov M.J., Mahmudov E.N. Optimization of the nicoletti boundary value problem for second-order differential inclusions.// Proceedings of the Institute of Mathematics and Mechanics. National Academy of Sciences of Azerbaijan. Vol. 49. N 1, 2023, p.3-15. (WOS, Scopus)

3. M.J.Mardanov, E.N.Mahmudov. “Optimization of hyperbolic-type polyhedral differential inclusions”, Materials of the International Conference modern problems of mathematics and mechanics, Baku 2023, 26-28 April, page 236-238.

4. Mardanov M.J., Mahmudov E.N. Optimal control of elliptic differential inclusions with mixed boundary conditions, Heydar Aliyev and the Turkish World: Social, economic and cultural relations//International scientific conference, Sumqayıt, 2023, № 2, pp. 5-7.

5. Марданов М.Дж., Мансимов К.Б. К оптимальности квазиисобных управлений в задаче управления интегро-дифференциальными уравнениями, Гейдар Алиев и турецкий мир: общественные, экономические и культурные связи// Международная научная конференция. Сумгайыт, 2023, № 2, pp. 143-144.

6. Марданов М.Дж., Мамедов И.Г., Абдуллаева И.А., О корректности разрешимости одной неклассической краевой задачи для обобщенного уравнения Аллера, Гейдар Алиев и турецкий мир: общественные, экономические и культурные связи// Международная научная конференция. Сумгайыт, 2023, № 2, сс.145-148.

7. M.J.Mardanov, A.M.Isayeva. Euler type system of equations in variational problems with delayed argument. // Modern Problems of Mathematics and Mechanics. Proceedings of the International Conference dedicated to the 100-th anniversary of the National Leader Heydar Aliyev. Baku, 26-28 April 2023. p. 266-267.

About personalities

8. M.C.Mardanov. “Great scientist, selfless organizer of science and education”, Republican newspaper, 15 february, 2023 year.

9. M.C.Mardanov. 629th student, 525th newspaper, 04 february, 2023 year (with professor Adalat Tahirzadeh)

10. Misir Mardanov, “Bu cavan oğlan böyük adam olacaq”, 525th newspaper, April 14, 2023.

11. Misir Mardanov, “General”, 525th newspaper, 18 April, 2023.

12. Misir Mardanov, “Ən böyük dissident”, 525th newspaper, 20 April, 2023.

13. Misir Mərdanov, “Alimliklə insanlığın vəhdəti”, Azərbaycan müəllimi qəzeti, 21 aprel, 2023-cü il.

14. Misir Mardanov, “1969-cu ilin isti yayı”, 525th newspaper, 26 April, 2023.

15. Misir Mardanov, “Heç kəsin tanımadığı, ancaq hamını tanıyan insan”, 525th newspaper, 28 April, 2023.

16. Misir Mardanov, “Kaş bizim Rusiyada da belə adamlar olaydı”, 525th newspaper, 2 May, 2023.

17. Misir Mardanov, “Heydər Əliyev və Bakı Dövlət Universiteti”, Respublika qəzeti, 03 may 2023-cü il.

18. Misir Mardanov, "Naxçıvandan Qurtuluşa gedən yol", 525th newspaper, 5 May, 2023.

19. Misir Mardanov, "Biography of Heydar Aliyev", Proceedings of the International Conference modern problems of mathematics and mechanics, Baku 2023, April 26-28, pages 3-16.

20. Misir Mərdanov, "Qurtuluşdan intibaha", 525th newspaper, 9 May, 2023.

21. Misir Mardanov, "Təhsilimizin himayədarı", "Teacher of Azerbaijan", may 10, 2023.

22. Misir Mardanov "Heydər Əliyev: Mən elə bir qərar verməmişəm", "Khalq" newspaper, may 10, 2023, interview with newspaper correspondent Ilgar Rustamov.

23. Misir Mardanov, "Tarixin qiymət verdiyi insan", 525th newspaper, 12 May, 2023.

24. Misir Mardanov, "Ulu öndərin arzularını reallaşdıran lider", 525th newspaper, 12 May, 2023.

25. Misir Mardanov "Bu adam SSRİ-ni dəyişməyə gəlib", "Khalq" newspaper, may 23, 2023, interview with newspaper correspondent Ilgar Rustamov.

26. Misir Mardanov, Adalat Tahirzadeh, "Böyük kişinin böyük oğlu", 525th newspaper, June 22, 2023.

27. Misir Mərdanov, Calal Allahverdiyev, "Qərbi Azərbaycanın böyük oğlu – Bala Əfəndiyev", 525th newspaper, September 01, 2023.

28. Misir Mərdanov, "Atom Kralı Basarkeçərdən Nevadaya qədər", 525th newspaper, September 08, 2023.

29. Марданов М., Бабаев А., "Насиреддин Туси как учитель" // Математика і фізика, Белорус, 2023 май, номер 3, стр. 62-67.

30. Misir Mardanov, "Nürnbergdən sovet televiziyasının rəhbərliyinə", 525th newspaper, September 14, 2023.

31. Misir Mardanov, "SSRİ-nin Novxanlı Qaz sənayesi naziri", 525th newspaper, September 22, 2023.

Books

1. Misir Mardanov, "Heydər Əliyev Xalqa Həsər olunmuş ömür", Educational publishing house, 2023, 400 pages.

2. Misir Mardanov, Adalat Tahirzade, "1920-ci ilə qədər ali məktəblərdə oxumuş azərbaycanlılar", Baku 2023, Volume VIII, educational publishing house, 736 pages.

2) **Work: "Solving the boundary value problem considering a parabolic differential equation with moving loading points".**

Executer: Corresponding member of ANAS Kamil Aida-zade

An initial-boundary problem is posed for loaded parabolic control. In the considered problem, the positions of the loading points change with time and satisfy the

system of ordinary differential equations. To solve the problem, it is proposed to use the numerical schemes of the finite difference method.

The following results were obtained on the topic:

1. **K.R.Aida-Zade, V.M.Abdullayev.** Rod temperature regulation using current and time-delayed feedback. J. “Quaestiones Mathematicae”, 2023, Vol.46. No.10. pp.1991-2011, DOI: 10.2989/16073606.2022.2125454. (Web of Science IF: 0.7)

2. **Айда-заде К.Р., Ашрафова Е.Р.** Оптимизация параметров источников системы с нелокальными условиями. Материалы VIII международная конференция «Математика, ее приложения и математическое образование» (МПМО'23), 26 июнь-1 июль 2023

3) Work: “Optimization for some equations with practical applications, development of analytical and numerical solution methods for direct and inverse problems”.

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

Numerical and analytical solutions of equations describing various physical and mechanical processes were investigated.

The following results were obtained on the topic:

1. **Adeyemo O.D., Khalique C.M., Gasimov Y.S. & Villecco F.** (2023). Variational and non-variational approaches with Lie algebra of a generalized (3+1)-dimensional nonlinear potential Yu-Toda-Sasa-Fukuyama equation in Engineering and Physics. Alexandria Engineering Journal. (Web of Science Impakt Faktor – 6.626 – Q1).

2. **Jafari H., Ganji R.M., Ganji D.D., Hammouch Z., Gasimov Y.S.** (2023). A novel numerical method for solving fuzzy variable-order differential equations with Mittag-Leffler kernel. Fractals, <https://doi.org/10.1142/S0218348X23400637>. (Web of Science Impakt Faktor – 4.555 – Q1).

3. **Golmankhaneh A.Kh., Welch K., Tunc C., Gasimov Y.S.** (2023). Classical mechanics on fractal curves. Eur. Phys. J. Spec. Top., <https://doi.org/10.1140/epjs/s11734-023-00775-y>. (Web of Science Impakt Faktor – 2.891 – Q2).

4. **Latifa Agamalieva, Yusif S. Gasimov, Juan E. Napoles-Valdes.** (2023). On a generalization of the Wirtinger inequality and some its applications. *Stud. Univ. Babeş-Bolyai Math.*, 68(2), 237-247. <https://doi.org/10.24193/subbmath.2023.2.01>. (Web of Science Impakt Faktor – 0.400 – Q4).

5. **Annaghiili Sh.M., Efendiev, R.F., Gasimov Y.S., Agamalieva, L.F.** (2023). On multiple eigenfunction expansion of an operator pencil with complex almost periodic potentials. *Stochastic Modelling and Computational Sciences*, 3(1), 75-85. (Scopus).

Plenary report at the conference

1. Gasimov Y.S., Guliyev H.F. The speed-in-action problem for the nonlinear hyperbolic equation with a nonlocal condition. *The 7th International Conference on Computational Mathematics and Engineering Sciences, 20 May 2023, Elazığ-Türkiye. (Plenary report)*

4) Work: “The optimal fastest effect problem for a two-order hyperbolic equation with a non-local boundary condition”.

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

Here, the problem of finding the right-hand side of a two-order hyperbolic equation is brought to the problem of optimal control through a functional constructed with the help of an additional condition. In the obtained problem, the existence of an optimal controller is proved, and a necessary condition for optimality is derived in the form of an integral inequality.

The following results were obtained on the topic:

1. М.Дж.Марданов, Г.Ф.Гулиев, Х.Т.Тагиев. Задача оптимального управления для неустойчивого гиперболического уравнения второго порядка с нелокальным граничным условием. // Динамические системы и компьютерные науки: теория и приложения (DYSC 2023). Материалы 5-й Международной конференции, Иркутск, 18-23 сентября 2023. с.112-115.

2. Кулиев Г.Ф., Сейфуллаева Х.И. Задача граничной управляемости для уравнения колебаний тонкой пластины. // Теоретические и прикладные проблемы математики. III Международная научная конференция. 25-26 апреля 2023. Sumqayıt. с. 131-132.

3. Кулиев Г.Ф., Исмаилова Г.Г. Исследование одной обратной граничной задачи для уравнения колебаний струны методом оптимального управления. // Теоретические и прикладные проблемы математики. III Международная научная конференция. 25-26 апреля 2023. Sumqayıt. с. 133-135.

4. H.F.Guliyev, Kh.I.Seyfullayeva. Determination the right hand side of the linear equation of oscillations of plate-like constructions. // Динамические системы и компьютерные науки: теория и приложения (DYSC 2023). Материалы 5-й Международной конференции, Иркутск, 18-23 сентября 2023. с.141-143.

5. H.F.Guliyev, Kh.I.Seyfullayeva. Optimal control problem with coefficients for the equation of vibrations of an elastic plate with discontinuous solutions. // International Journal of Applied Mathematics.(IJAM), Bulgaria. **(accepted for publication).**

6. H.F.Guliyev, H.T. Tagiyev, Y.S.Gasimov. The speed-inaction problem for the nonlinear hyperbolic equation with a nonlocal condition. // Optimal control Applications and Methods. Amerika. **(accepted for publication).**

5) Work: “A study of non-local boundary value problems and optimal control problems described with them”.

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

In this work, the problem of optimal control with a "clean" integral boundary condition is considered. Green's function is constructed. Sufficient conditions for the uniqueness of the solution of the boundary problem have been found with the help of Banach's principle of compressed analysis. Pontryagin's maximum principle was proved with the help of the method of functional increments. The first and second variations of the functional are calculated. With the help of variations of the control functions, different second formulation necessary conditions for optimality are obtained.

The following results were obtained on the topic:

1. M.J. Mardanov, Y.A. Sharifov. An optimal control problem for the systems with integral boundary conditions, Bulletin of the Karaganda university, Mathematics series, 2023, (109) 1 (**WEB of Science**).DOI10.31489/2023 M1/11-123 UDC 517.97

2. M.J. Mardanov, Y.A. Sharifov. Fixed-point iteration method for solution first order differential equations with integral boundary conditions. // Modern Problems of Mathematics and Mechanics. Proceedings of the International Conference dedicated to the 100-th anniversary of the National Leader Heydar Aliyev. Baku, 26-28 April 2023. p. 268-270.

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

The need to evaluate the activities of university teachers arises from the fact that the teacher has a significant idea of the quality in which he works and his reputation. The quality assessment of teachers' activities in most universities of Azerbaijan is not carried out systematically. For example, the procedure for occupying vacant positions, which is carried out in one way or another at the department, is sometimes not based on a clearly formulated concept for assessing the performance of teachers. And this complicates the practical work and negatively affects the reputation of the University. At present, various methods for assessing pedagogical staff are being developed and approved, but there is still no generally accepted methodology in this matter. Analyzing the reasons for the complexity of the development of models and methods for assessing the performance of teachers in higher schools of Azerbaijan, we identified the following as the main factors: 1) the complexity of assessing the contribution of a teacher to education separately, performing many functional tasks in the preparation of a specialist who is the result of collective labor; 2) lack of reliable information about

the qualitative results of the activities of the University in general, and in a special case, teachers; 3) lack of desire of some senior staff and teachers to conduct an objective assessment of the results of scientific and pedagogical activity on the basis of fully verified data. Based on these considerations, the article proposes a method of expert assessment of the performance of teachers according to the final result, systematized at the initial stage in quality committees and by the university administration.

The following results were obtained on the topic:

1. Mardanov M.C., Rzayev R.R., Aliyev E.R., Abdullayev X.X. Calculating the integral index based on the expert analysis of indicators reflecting the academic performance of university teachers // Azerbaijan school. | Azerbaijan Journal of Educational Studies. 2023, №2, page 10-20 <http://as-journal.edu.az>

2. Mardanov M.C., Rzayev R.R., Aliyev E.R., Abdullayev X.X. Formation of the academic index of a university teacher based on weighted evaluation criteria // International Conference on Intelligent and Fuzzy Systems (INFUS 2023), August 22-24, 2023, İstanbul Technical University and Galatasaray University, İstanbul, Turkish

3. Mardanov M.C., Rzayev R.R., Aliyev E.R., Abdullayev X.X. Formation of the academic index of a university teacher based on weighted evaluation criteria // The Springer Series “Lecture Notes in Networks and Systems”, 758, Vol. 2, pp. 600-608, 2023 https://doi.org/10.1007/978-3-031-39777-6_70

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

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

From the structure of the numerical domain of a two-parameter spectral problem with a compact self-adjoint operator under certain deterministic conditions, from the fact that each element of the energetic Hilbert space, which is the tensor product of the given Hilbert spaces in the formulation of the problem, has a one-value correspondence between the numerical domain of the problem and only a finite number of eigenvalues in any finite part of the numerical domain using the presence of numbers, it has been proved that the set of specific elements of the problem in the energy Hilbert space mentioned above form a complete basis.

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 the Council of scientific publications of Anas, head of the general Institute seminar.

Phd in Physics and Mathematics, correspondign member of ANAS, professor Kamil Aydazadə, 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. The Scientific Council of the RMI and 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.

Final Information

Department staff during the year

1. Published 2 book;
2. 48 scientific and popular science works were published, 2 articles were accepted for publication;

3. 11 scientific papers, 13 conference materials (5 published abroad, 8 published in Azerbaijan);

4. 7 scientific works were published in journals included in the base of WOS, 2 in the base of Scopus;

5. Popular Science articles 24 (2 of them are interviews);

6. The number of references to the scientific works of the department employees is 375.

Head of department: **Corr. member of ANAS prof. Misir Mardanov**