Institute of Mathematics and Mechanics of ANAS
Report of the "Optimal Control" Department for 2020
scientific and scientific organization

Employees of the department

The department of "Optimal Control" employs 11 researchers (3 full-time employees, 6 part time). 8 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. Professor Ramiz Aslanov – Senior Researcher.
9. Ph.D. of Physics and Mathematics Eldar Məmmədov – Leading Researcher.
10. Samin Malik, Ph.D. – Scientific Researcher(part-time.).
11. Aliyev Nijat.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"** 2020 according to the approved plan:

1) Work: "Obtaining new necessary as well as sufficient conditions for weak and strong extremum in problems one-dimensional and multidimensional variation"

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 topic:

The problem of simple variation has been studied. For this purpose, new first-order necessary conditions design for strong and weak minimums, including the concept of Weierstrass-type variation, were obtained.

1. Misir J.Mardanov, Yagub A.Sharifov, Yusif S.Gasimov and Carlo Cattani. "Non Linear First Order Differential Boundary Problems with Multipoint and Integral Conditions", *Fractal Fract.* 2021, *5*, 15. pp. 1-14.
https://doi.org/10.3390/fractalfract5010015 www.mdpi.com/journal/fractalfract, T.R.
2. M.J.Mardanov, S.T.Malik. "Discrete maximum principle in systems with a delay in control", Dynamic Systems and Computer Science: Theory and Applications (DYSC)

2020, Journal of Physics: Conference Series **1847** (2021) 012021 IOP Publishing, doi:10.1088/1742-6596/1847/1/012021

3. Misir Mərdanov, Aynur Həsənova. "Qeyri-səlis məntiq nəzəriyyəsinin banisi – Lütfi Zadə", 525-ci qəzet, 04 fevral 2021, № 21(5587), səh. 10-11.

4. Misir Mərdanov, Aynur Həsənova. "Elmlərin sultanı-riyaziyyat!", 525-ci qəzet, 13 mart 2021, 47 (5613).

5. Misir Mərdanov. "AMEA-nın müxbir üzvü, fizika-riyaziyyat elmləri doktoru, professor Kamil Ayda-Zadənin 70 illiyinə" Kamil Rəcəb oğlu Ayda-Zadə, Biblioqrafiq göstərici kitabının 102-105 səhifəsində.

6. Sh.E.Guseynov, S.I.Matyukhin, M.J.Mardanov, J.V.Aleksejeva, O.V.Sidorenko (2021). On the issue of planning sowing agricultural crops with the minimum risk under the presence of various agroclimatic conditions. – *Proceedings of the 13th International Scientific and Practical Conference "Environment. Technology. Resources"*, June 17-18, 2021, Rezekne, Latvia, ISSN: 2256-070X, Vol. 1, pp. 72-83. https://doi.org/10.17770/etr2021vol1.6649 **SCOPUS**

7. 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.2021.113723, Q_1.

8. M.J.Mardanov, T.K.Melikov, S.T.Malik. The thesis entitled "Necessary minimum conditions in calculus of variations problems in the presence of various degenerations" was adopted as a report to the conference to be held in Minsk on October 5-10, 2021.

2) Work: "Investigation of the of feedback optimal control problem of the heating process with moving sources"

Executer: Corresponding member of ANAS Kamil Aida-zade

Necessary conditions for the optimality of the right-hand sides values of nonlocal boundary conditions with pointwise and integral values of an unknown phase trajectory with respect to ordinary differential equations system are obtained. An algorithm for the numerical solution to the problem has been developed, computer experiments have been carried out.

Published scientific papers:

1. Abdullayev V.M., Aida-zade K.R. Optimization of Source Parameters in Multipoint Nonseparated Conditions for Linear Dynamical Systems. Comput. Math. Math. Phys., 2021, Vol.61, No.4, pp. 512–526, Springer, Pleiades Publishing, Ltd DOI 10.1134/S0965542521020020 **(Clarivate Analytics SCI Expanded) İF-0, 565.**

2. Aida-zade K.R., Ashrafova Y.R. Optimization of locations and parameters of sources for objects of network structure. Automation and Remote Control, 2021, **WOS.**

3. Айда-заде К.Р., Ашрафова Е.Р. Control of influences in the right-hand sides of a large ODE system of a block structure and op-timization of sources in unseparated boundary conditions. Numerical analysis and applications, V.14, №3, 2021, **WOS.**

4. Айда-заде К.Р., Абдуллаев В.М. Оптимизация параметров источников в многоточечных неразделенных условияъ линейных динамических систем. Ж. вычисл. матем. и матем. физ., 2021, Т.61, №4, С. 539–554.

5. Айда-заде К.Р., Абдуллаев В.М. Оптимизация правых частей нелокальных краевых условий управляемый динамической системи. Ж. "Автоматика и телемеханика", N3, 2021, с. 3-31.

6. Айда-заде К.Р., Ашрафова Е.Р. Control of influences in the right-hand sides of a large ODE system of a block structure and op-timization of sources in unseparated boundary conditions. Numerical analysis and applications, V.14, №3, 2021, **WOS.**

7. Айда-заде К.Р., А.Г.Багиров, В.А.Гашимов. Управление с обратной связью мощностью псущихся источников при нагрева стержня. Кибернетика и системный анализ, Киев, №4, 2021.

8. Айда-заде К.Р., Bagirov A.H., Hashimov V.A. Feedback control of the power of moving sources when heating the bar. J. "Cybernetics and" Systems Analysis, Springer, №4, 2021.

3) Work: "Development of analytical and numerical solutions of problems for a class of equations describing different processes".
Executer: doct. of phys. Math. Sci. prof. Yusif Qasımov.

The following articles have been published in journals indexed on the Web of Science:

1. Valdés, J.E.N., Gasimov, Y.S., & Aliyeva, A.R. (2021). On the oscillatory behavior of some qeneralized differential equation. *Punjab University Journal of Mathematics*, *53*(1), 71-82.

2. Mardanov M.J., Sharifov Y.A., Gasimov Y.S. & Cattani C. (2021). Non-linear first-order differential boundary problems with multipoint and integral conditions. *Fractal and Fractional*, *5*(1), 15. https://doi.org/10.3390/fractalfract5010015

3. Srivastava, H.M., Iqbal, J., Arif, M., Khan, A., Gasimov, Y.S., & Chinram, R. (2021). A new application of Gauss quadrature method for solving systems of nonlinear equations. *Symmetry*, *13*(3), 432. https://doi.org/10.3390/sym13030432.

(Web of Science Impakt Faktor – 2.645 – Q2, Scopus)

4. Li, J., Singh, G., Ilhan, O.A., Manafian, J., & Gasimov, Y.S. (2021). Modulational instability, multiple Exp-function method, SIVP, solitary and cross-kink solutions for the generalized KP equation. *AIMS Mathematics*, *6*(7), 7555-7584. https://doi.org/10.3934/math.2021441 **(Web of Science Impakt Faktor – 0.882 – Q2, Scopus).**

5. T. Usman, N. U. Khan, M. Aman, Y. Gasimov. **A unified family of multivariable Legendre poly-Genocchi polynomials.** ***Tbilisi Mathematical Journal,*** **Vol.14, No2, 2021.** https://doi.org/10.32513/tmj/19322008130 **(Web of Science)**

4)Work: "The most immediate effect problem for a two-order hyperbolic equation".

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

The most immediate effect for a nonlinear two-order hyperbolic equation was considered. The theorem of the existence of an optimal controller has been proved, and the necessary condition for optimality in the form of variational inequalities has been derived.

Under H.F.Guliyev's leadership, Vusala Nazim gizi Nasibzadeh defendes her PhD in mathematics in June.

1. H.F.Quliyev, Z.R.Səfərova, "İki tərtibli hiperbolik tənlik üçün ən tez təsir məsələsi", BakıUniversitetinin xəbərləri jurnalı, №1, 2020, s. 55-68.

2. Кулиев Г.Ф. Сейфуллаева Х.И. «Задача граничной управляемости для уравнения колебаний тонкой пластины», **Актуальные вопросы современной науки и практики. II Международной научно-практической конференции**. 30 октября 2020 г. с.11.

3. Г.Ф.Кулиев, Х.Т.Тагиев. Об определении коэффициента гиперболического уравнения второго порядка с нелокальным условием. Тезисы научн. Конф. Посв. Р. Габбасова, Беларусь, 2021.

4. Г.Ф.Кулиев, Х.Т.Тагиев. Об определении коэффициента гиперболического уравнения второго порядка с нелокальным условием. Вестник БГУ, серия физико-математических наук, 2021.

5) Work: "Investigation of some multi-point boundary conditional boundary and optimal control problems".

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

In this paper, we first consider the multipoint and integral boundary value problem for ordinary differential equations of the first order. A theorem on the existence and uniqueness of the solution of a differential equation by the method of principle of compressed mappings is proved. A theorem on the existence of a solution is proved using the Schaufer fixed-point theorem. Similar results were obtained for the boundary problem given by two-point boundary conditions for integrodifferential equations.

1. Mardanov M.J., Sharifov Y.A., Gasimov Y.S. & Cattani C. (2021). Non-linear first-order differential boundary problems with multipoint and integral conditions. *Fractal and Fractional*, *5*(1),15. **(Web of science)**
https://doi.org/10.3390/fractalfract5010015

2. M.J. Mardanov, R.S. Mammadov, S.Y. Gasimov, Y.A. Sharifov. Existence and uniqueness results for the first-order non-linear impulsive integro-differential equations with two-point boundary conditions. Bulletin Karaganda University, **(Web of science)** Mathematics Series, №2 (102)/2021, DOI 10.31489/2021Ì2/74-83, MSC 34B37, 37C25, 37C75

3. Y.A. Sharifov, S.A. Zamanova, R.A. Sardarova. Existence and uniqueness of solutions for the nonlinear fractional differential equations with two-point and integral boundary conditions. EUROPEAN JOURNAL OF PURE AND APPLIED MATHEMATICS Vol. 14, No. 2, 2021, 608-617. **(Web of science)**

4. М. ДЖ. Марданов, Я. А. Шарифов. Условия оптимальности первого порядка для задач оптимального управления с нелокальными условиями при импульсных воздействиях, Международная научная конференция "Динамические системы: устойчивость, управление, оптимизация" (DSSCO'21) памяти профессора Р.Ф. Габасова (5 – 10 октября 2021 года, Минск) çapa qəbul olunub**.**

6) Scientific research on **"Optimization of higher education management"** was conducted:

Work: "Development of a model for calculating the rankings of universities by compiling the knowledge gained about their activities".

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

The decision-making process, described in this work as a continuous chain of multi-criteria choices developed and implemented under the influence of numerous factors of a different nature, is perceived as a type of human intellectual activity. The article considers each university as a system of humanistic education in the presence of the human factor, uncertainty. The assessment of the university's level of competitiveness and the calculation of the relevant rating is described as a poorly structured problem with quantitative and qualitative properties.

1. М.Дж. Марданов, Р.Р. Рзаев "Нечёткая логика Л.А. Заде, как ключ к описанию гуманистических систем" – "İnformasiya cəmiyyəti jurnalı"na çapa qəbul olunub.

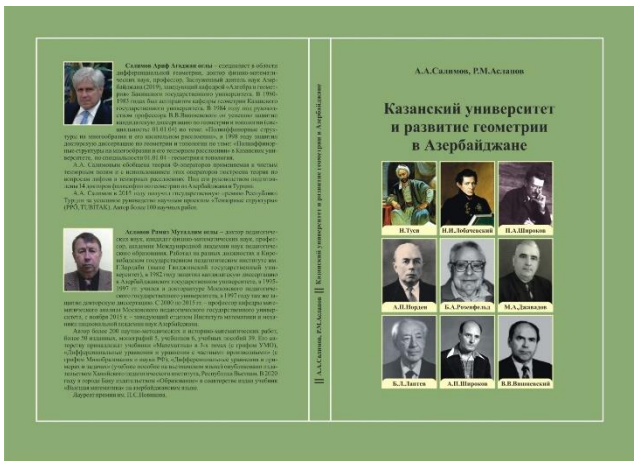
7) The research was conducted entitled **"History of Science-History of Mathematics**:

Work: "Research on the history of mathematics and mathematical education".

Executer: professor Ramiz Aslanov

Published works of R.M.Aslanov during the reporting period:

1. Марданов М.Д., Асланов Р.М., Салимов А.А. Казанский университет и развитие геометрии в Азербайджане. Очерки истории. – Калуга: ИП Стрельцов И.А., Научный редактор проф. (Изд-во «Эйдос»). 2021.192 с.



2. Марданов М.Д., Асланов Р.М., Гасанова Т.Х. Штрихи к портрету З.И. Халилова (к 110-летнему юбилею), Математическое образование в школе и вузе: опыт, проблемы, перспективы (MATHEDU'2021): Материалы X Международной научно-практической конференции, Казан, 22-28 марта 2021 г./отв. ред. Л.Р. Шакирова. – Казань: Издательство Казанского университета, 2021. – 240 с. (стр. 130-143) ISBN 978-5-00130-463-0 **(РИНЦ).**

3. Асланов Р.М., Timur R.Fazliakhmetov, Leila L.Salekhova, Gulnur I.Muhutinova. Using the messenger software opportunities in distance education. **RPGE**– Revista on line de Política e Gestão Educacional, Araraquara, v. 25, n. esp. 1, p.378-386, mar. 2021. e-ISSN:1519-9029

DOI: https://doi.org/10.22633/rpge.v25iesp.1.14974 (**SCOPUS).**

4. Марданов М.Д., Асланов Р.М. Бесценное наследие Насиреддина Туси в развитии тригонометрии // Современное образование: научные подходы, опыт, проблемы, перспективы: материалы XVII Всерос. с междунар. участием науч.-практ. конф. «Артемовские чтения» (г. Пенза, 21 апреля 2021 г.) / под общ. ред. д-ра пед. наук, проф. М. А. Родионова. – Пенза: Изд-во ПГУ, 2021. – 356 с. стр.71-78. ISBN 978-5-907456-18-1 **(РИНЦ).**

R.M.Aslanov received an invitation for speech at the conference (Mordkovich's 40-th workshop) to be held on October 7-9, 2021 at Bryansk State Pedagogical University.

8) Work: "Necessary and sufficient conditions for a delayed argument variation problem".

Executer: doctorantAygun Isayeva.

The following thesis was published during the reporting period:

1. Necessary conditions in the variation problem with free right end with delay. Republican virtual scientific conference on "Mathematics, Mechanics and their application" dedicated to the 98th anniversary of National Leader Heydar Aliyev.

SCIENTIFIC AND SOCIAL ACTIVITIES

In 2021, 672 pages the fundamental book "Baku State University" of the head of department Professor Misir Mardanov was published in "Təhsil" publishing house. He 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.

The second volume of the “The Azerbaijanis studied of higher institutes to 1920 year” written by director of the Institute of Mathematics and Mechanics of ANAS, corresponding member of ANAS, professor Misir Mardanov and professor Adalat Tahirzade devoted to 100 years of People Republic of Azerbaijan was published.

Head of the department professor Misir Mardanov is 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 Aydazadə,chairmanof the labaratory “Numerical methods of decision on the deterministic systems” of ANAS, editor in board in the journal pubslihed in Turkey “Ege University journal of the Faculty of Science”, editor in board in “NASA Proceedings of the İnstitute 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 İnstitute 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 Proceedings of the Institute of Applied Mathematics.

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.

Professor Ramiz Aslanov is a member of the editorial board of the following journals:

1. «Вестник Сыктывкарского университета. Серия 1. Математика. Механика. Информатика». (г. Сыктывкар, РФ)

2. Научно-методический журнал «CONTINUUM. Математика. Информатика. Образование». Елецкий государственный университет им. И.А. Бунина (г. Елец, РФ).

3. «Вестник Елецкого государственного университета» им. И.А. Бунина. – Серия «Педагогика».(История и теория математического образования) (г. Елец, РФ).

4. «Учебный эксперимент в образовании». Мордовский государственный педагогический институт им. М.Е. Евсевьева (г. Саранск- Мордовия, РФ).

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