Report on scientific and scientific-organization activity of

"Optimal Control" department for 2016.

"Optimal Control" department consists 6 research associates, 5 of them doctor of sciences, professor, including one corr.-member of ANAS.

1. Misir Mardanov, head of department (a part time)
2. Telman Melikov, senior research associate (full time)
3. Kamil Ayda-zadeh, (a part time) senior research associate (corr.-member of ANAS)
4. Ramin Rzayev, (a part time) leading research associate
5. Yusif Gasimov, (a part time) leading research associate

One philosophy doctor in mathematics.

Eldar Mammadov, (full time) leading research associate.

I. Scientific part

In 2106 the department conducts research works on "Optimal control problems describes by different systems".

1) WORK: "Necessary conditions for the optimality of problems in continuous and discrete systems".

Executor : prof. Misir Mardanov & prof. Telman Malikov

The optimal control problem with delay in control was considered, and first time the sequence of new high order necessary conditions were obtained in the reccurent form of Kelly, Kopo-Moyer, matrix impulse and the equality type for the optimality of an admissible control.

To study the wide class of extremal problems, new notions that have a practical significance were introduced, and by using these notions, the stronger necessary conditions were obtained for the optimality of problems in discrete systems.

The obtained results are in the following papers:

Published manuscript:

1. Misir J. Mardanov, Telman K.Melikov. On first and second order optimality conditions in discrete control systems. International Workshop on

“Non-harmonic Analysis and Differential Operators” May 25-27, 2016, Baku, Azerbaijan, pp. 76.

2. Misir J. Mardanov, Telman K. Melikov. Analogue of the Kelley condition for optimal systems with retarded control. International Journal of Control, 01 August, 2016, pages 1-9 (IF=1.880) 3.Misir J. Mardanov, Telman K. Melikov. Conditions for Optimality of Singular Controls in Dynamic Systems with Retarded Control. Nonlinear Systems - Design, Analysis, Estimation and Control, USA, 2016, pp. 195-226.

3. Misir J. Mardanov and Yagub A. Sharifov Impulsive two-point boundary value problems for nonlinear *qk*-difference equations 07-10 September 2016 Almata, Qazaxstan AIP Conference Proceedings 1759, 020011 (2016); doi: 10.1063/1.4959625 pp. 5.

4. Akademik Məcid Rəsulov “Nəzəri və tətbiqi riyaziyyatın actual məsələləri” Respublika Elmi Konfransının materialları, 28-29 oktyabr 2016, Şəki, səh.6-13. (AMEA-nın müxbir üzvü Y.Ə. Məmmədovla)

5. К 100-летию со дня рождения Меджида Лятифовича Расулова, Дифференциальные уравнения, 2016, том 52, № 9, с. 1147–1149.

6. The bibliography, scientific activity and some topical issues in the study of legacy of Nasraddin Tusi, «News Journal of ANAS», 2016, volume 3, issue 3, pp 12-29 (with Eminaga Mammadov).

Accepted manuscripts for publication

1. Misir J. Mardanov, Telman K. Melikov. On strengthening of optimality conditions in discrete control systems. (Об усилении условий оптимальности в дискретных системах управления). Məqalə yüksək impact faktorlu SİAM J. of Control and Optimization jurnalına təqdim olunub və ilkin müsbət rəy alınıb. Çap olunması gözlənilir.

2. М. Дж. Марданов, Т.К. Меликов “Различные условия оптимальности особых управлений в динамических системах с запаздыванием в управлении” adlı məqalə Журнал вычислительной математики и математической физики- *(İmpact Factor- 0.789)* jurnalında çapa qəbul edilmişdir.

3. M.J. Mardanov, R A. Teymurov, Optimal control problem for a parabolic equation with nonlocal integral conditions, Dokl. NAN

4. М.Д. Марданов, Р.А. Теймуров Необходимые условия оптимальности в одной задаче оптимального управления для параболического уравнения с нелокальными интегральными условиями, Докл. РАН.

Published books:

1. М.Дж. Марданов, Р.М. Асланов, «Предшественники Современной Математики Азербайджана», Москва, издательство «Прометей» 2016, 516с.

2. Misir Mardanov, Sabir Mirzoev & Shabala Sadiqov. Mathematics vocabulary with explanation. Oko Ofset, 294

Submitted manuscript

М.Д. Марданов, Р.А.Теймуров. Об одной задаче оптимального управления для параболического уравнения с нелокальными интегральными условиями. Журнал вычислительной математики и математической физики.

2) Work. "Optimal control problem of moving sources for a parabolic type equation with nonlocal integral boundary condition".
Executor: phil. doctor in math Rafig Teymurov

Optimal control problems of motions of heat sources in control systems described by a state parabolic equation and a systems of ordinary differential equations are studied. Existence and uniqueness of the solution of such optimal control problems were proved, differentiability of aim functional in Frechet sense was shown, expressions for the gradient with respect to control parameters were obtained, necessary conditions of optimality in pointwise and maximum principle form were obtained, solution algorithms of numerical solution of the problems were constructed. The obtained theoretical results were successfully applied to some production processes, including optimal control of interlayer combustion processes in oil production processes.

The obtained results are in the following papers:

1. Teymurov R.A., Akhmedov T.A. the problem of optimization with control of mobile sources for the linear parabolic equation // *Azerbaijan Journal of Mathematics. January 2016, Volume 6, №1 , pp. 3-14.*

2. Теймуров Р.А. Об одном классе задач оптимального управления с распределенными и сосредоточенными параметрами // *РАН. Журнал вычислительной математики и математической физики. 2016, том 56, №3. С.409-420. (İmpact Factor- 0.789)* DOI: 10.7868/S0044466916030182

3. Теймуров Р.А. О задаче оптимального управления подвижными источниками для параболического уравнения // *Изв.РАН. Теория и системы управления. 2016, том 55, №2. С.19-28. (İmpact Factor- 0.483)*
DOI: 10.7868/S0002338816020062

4. Teymurov R.A. Optimal control of mobile sources for heat conductivity processes // *International Journal of Control. 2016. V. 89. №8. P.1-16. (İmpact Factor- 1.654)* DOI: 10.1080/00207179.2016.1187306

5. Teymurov R.A., Akhmedov T.M. Optimal control of the mobile sources for parabolic equation with nonlocal integral conditions / *International Workshop on «Non-Harmonic Analysis and Differential Operators», 25-27 May, 2016, Baku, Azerbaijan. P.105-106.*

6. Теймуров Р.А. О разрешимости одной краевой задачи с нелокальными интегральными условиями для параболического уравнения / *Десятая Всероссийская научная конференция с международным участием «Математическое моделирование и краевые задачи» - ММиКЗ-2016, Самара, РФ, Сам ГТУ , 24-28 мая, 2016.*

7. Теймуров Р.А. Задача оптимального управления для параболического уравнения с нелокальными условиями / *Международная конференция по дифференциальным уравнениям и динамическим системам*. Суздаль, РФ, Владимир. Гос.Унив. , 8-13 июля, 2016.

3) WORK: Solution of the domain minimization problems associated with eigenvalues of different operators.

Executant: doctor of Sciences Yusif Gasimov

The problems related with the variable domain eigenvalue problems, minimization problems with respect to domain and their application have been investigated. Transverse vibrations of the plates described by the biharmonuc operators have been studied, various problems related with its eigenfrequency are investigated. Necessary conditions for optimality in the considered problems are derived and the caseы are found when these conditions are also sufficient. Some new results are obtained for the fractional order diffusion equation. Multidimensional diffusion equation in fractional order spaces is considered, and its solution is found by the variables separation method. The graphs of exact solutions are given and the efficiency of the proposed method is demonstrated on the example of a class of local fractional differential equations.

The obtained results are in the following papers:

1. Y.S. Gasimov, N. A. Allahverdiyeva, A.R. Aliyeva. On an optimal shape problem for the eigenfrequency of the clamped plate // *TWMS Journal of Pure and Applied Mathematics, Vol.7, No.1, 2016, pp.28-33*(Thomson Reuters Emerging Sources Citation Index).

2. Y.S. Gasimov, N.A. Allahverdiyeva. Shape optimization for the eigen vibrations of the plate, *Georgian Mathematical Journal . İmpact Factor- 0.452.* çapa qəbul edilib.

4) WORK: Analysis of the organizational structures of unevercity as a semi-structured systems

Executor: prof. Misir Mardanov, prof. Ramin Rzayev

Carried out during the reporting period the scientific study were related to the conduct of the comprehensive review and the development of methods and algorithms for solving decision-making problems in semi-structured systems under uncertainty and complex problems related to them. In particular, it carried out the analysis of the mathematical apparatus of fuzzy logic and tools of multicriteria choice of alternatives to significantly improve the quality of the decision-making process and, thereby, increase the effectiveness of management in a variety of management structures. For example, for the evaluation of unevercity in general, and their organizational and structural units, studied in the form of semi-structured systems for their efficiency, it is developed special methods and algorithms.

The obtained results are in the following papers:

1. М.Дж. Марданов., Р.Р.Рзаев Альтернативное агрегирование рейтинговых оценок в рамках QS-технологии ранжирования высших учебных заведений // Математичні машини і системи, Институт Проблем Математических Машин и Систем, Киев, 2016, № 6, стр. 34-44
2. М.Дж. Марданов., Р.Р.Рзаев Два подхода к комплексной оценке высшего учебного заведения // Проблемы управления и информатики. 13 стр. (çapa qəbul olunub)

5) WORK: Development of numerical methods of solution to the inverse and optimization problems for systems with distributed parameters

Executor: corr.-member of ANAS. Kamil Aida-zade.

The numerical approach is suggested for the the solution to the problems with nonlinear inverse coefficients. Feedback control and the ideas for constructions of zonal controls introduced by author are used in this approach. An identification of the hydraulic resistance coefficient of pipeline segment at unsteady fluid flow regime is considered as model problem and is solved numerically.

The obtained results are in the following papers:

1. Ayda-Zade K.R., Kuliev S.Z. Hydraulic Resistance Coefficient Identification in Pipelines // **Automation and Remote Control.** V.77, №7, 2016. C. 1225-*1239*.0.770).

2. K.R.Aida-zade, Y. R. Ashrafova. Calculation of the State of a System of Discrete Linear Processes Connected by Nonseparated Boundary Conditions // **Journal of applied and industrial mathematic**s Vol. 10 No. 4 2016 13 p.

3. К. Р. Айда-заде, Е. Р. Ашрафова. Расчет состояния системы дискретных Линейных процессов, связанных Неразделенными краевыми условиями // **Сибирский журнал индустриальной математики** Октябрь–декабрь, 2016. Том XIX, № 4(68) 14 стр.

4. К. Р. Айда-Заде, С. З. Кулиев. Задача идентификации коэффициента гидравлического сопротивления трубопровода // **Автоматика и телемеханика,** 2016, вып. 7, 123–141.

5. К. Р. Айда-заде. Автоматизированные информационно-управляющие системы, системы управления производством // **Автоматика и телемеханика, № 7, 20.**

II. Organizational activity

Head of the department prof. M.J.Mardanov is the chairman of the dessertation Council D.01.111 and of Scientific Council of the Institute. He is a member of editorial staff of “Translactions of ANAS”, “Azərbaycan Riyaziyyat Jurnalı”, “Чебышевский сборник” və “TWMS Journal of Applied Mathematics” (Turkic World Mathematical Society) is the editor in chief of “Procceding of IMM, ANAS” journal.

Professor Mardanov Misir delivered a lecture to the masters of the Institute of Mathematics and Mechanic under the name of “The history of Mathematics and methodology”.

On 19.10.2016 and 26.10.2016 senior research associate of IMM, prof. Telman Melikov has given a talk on “Development stages of extremum problems. Variational calculas and the role of different variations in optimal control”.

Every thusday the seminar “Urgent problems of theory of optimal control” is conducted.

On the report period, 17 papers(12 of them were published in Thomson Reuter index journals), 9 abstracts, 2 books were published, 6 papers were accepted for publicaton, 1 paper was submilted to the journal.

Head of department: **prof.Misir Mardanov**