Institute of Mathematics and Mechanics of ANAS
Semiannual Report of the "Optimal Control" Department for 2019
scientific and scientific organization

The department employs 10 researchers (4 full-time employees, 6 people 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. Doctor of Philosophy in Mathematics Eldar Mamedov – Leading Researcher
10. Dissertant Samin Malik – jun.res.ass-part time
11. Elnare Mammadova – software engineer.
12. Aliyev Kamran – software engineer.
13. Mansimli Kamal – software engineer.
14. Aygun Isaeva – senior laboratory assistant.
15. Konul Rahimli – assistant.

Grant and programs

In 2019, the department won the Science Development Fund grant and the project financed by the Presidium of ANAS:

1. Was a winner of the grant project **"Elaboration of analysis methods and information analytic system based on fuzzy logic"** of Science Development foundation under the President of the Republic of Azerbaijan **("Optimal Control" department of IMM, Baku State University, Azerbaijan State Technical University, Lenkoran State University)** with execution period 12 months, financial volume 55.000 manat.

2. Was a winner of the scientific research program **"Mathematical simulation and optimization of continuous and discrete systems by means of modern computer programs"** financed by decree No. 7/3 dated from March 14, 2018 of the Presidium of the ANAS. (execution period 24 months, financial volume 100000 manat). **("Optimal Control" department of IMM, Baku State University, Institute of Control systems of ANAS, Public Administration Academy, Baku Higher Oil School)**.

In the department of "Optimal control", scientific researches were carried out on the topic **"Optimal control problems described by various systems"** in the first half of 2019 according to the approved plan:

1) Work: "New independent necessary and sufficient conditions for a strong extremum in some variation problems (one-dimensional and multidimensional)".

Authors: Corresponding member of ANAS, prof. Misir Mardanov, doct. of phys. Math. Sci. prof. Telman Malikov

There were suggested two ways to study some of variation problems. Using these methods, different necessary conditions for strong and weak extremum in two variation problems (if integrand $L(\cdot) = L(t, x, \dot{x})$ and $L(\cdot) = L(t, x, \dot{x}, ..., x^{(m)})$) were obtained.

1. Mardanov M.J., Melikov T.K., Malik S.T. "Necessary conditions for extremum in calculus of variation for problems with higher derivatives", An International Workshop dedicated to the 80th anniversary of an academician Mirabbas Geogja oglu Gasymov Spectral Theory and its applications, Baku, June 7-8, 2019, pp.118-121.
2. Misir J. Mardanov, Irane A. Abdullayeva, Akbar J. Mammadov "A movable optimal control problem with additional constraint for one heat process" Trans. Natl. Acad. Sci. Azerb. Ser. Phys.-Tech. Math. Sci. Mathematics, 39 (1), 132-140 (2019).

2) Work: "Development of an information and analytical system and methods for analyzing the university indicators based on the application of expert knowledge and the fuzzy inference".

Authors: Corresponding member of ANAS, professor. M. J. Mardanov, doctor of technical science, professor R. R. Rzayev

Conducted for the reporting period studies are associated with further development of methods and algorithms for solving the problems in the field of decision making under uncertainty and the set of related tasks. In particular, the proposed new method of constructive evaluation of alternatives (or the effectiveness of their behavior) with the involvement of a large variety of criteria of the nature of the subject area of research. In the framework of the proposed methodology, an approach based on the combined use of neural network modeling techniques and expert evaluation is formulated: the knowledge gained from expert opinions, like external representations about weighted total evaluations of alternatives, is compiled into effective internal representations about them in logical basis of a multilayered neural network.

1. Mardanov M.J., Rzayev R.R. One Approach to Multi-criteria Evaluation of Alternatives in the Logical Basis of Neural Networks. Springers's Series "Advences in Intelligent Systems and Computing Systems and Computing", Vol. 896, pp. 279-287, 2019.
2. Марданов М.Дж., Рзаев Р.Р., Ибрагимов Н.С., Джамалов З.Р. Формирование рейтингов университетов на основе компиляции экспертных оценок в логическом базисе нейронной сети. Математични машини и системи, Институт Проблем Математических Машин и Систем, Киев, 2019, №1, стр. 107-123.

3) Work: "Studying linear ordinary differential equations with non local boundary condition nonlinear loading and numerical solution".

Author: Corresponding member of ANAS Kamil Aida-zade

I. Solution of the class of parametric inverse problems for the processes described by loaded differential equations has been investigated. The formulas obtained which allow using efficient first order numerical optimization methods.

1. Aida-zade K.R., Abdullayev V.M. Numerical Method for solving the parametric Identification Problem for Loaded Differential Equations, Bulletin of the Iranian Mathematical Society, 2019. - https//doi.org/10.1007/s41980-019-00225-3

2. Aida-zade K.R. Nonlinearly Loaded Boundary Value Problems for linear Ordinary Differential Equations, Differensial Equations, Pleiades Publishing, Ltd, 2019, Vol. 55, N 6, pp. 1-6.

II. An approach and schemes for numerical solution to the optimal control problems for loaded systems with nonlocal conditions was suggested. Numerical experiments carried out.

1. Aida-zade K.R., Abdullayev V.M. Approach to the Numerical Solution of Optimal Control Problems for Loaded Differential Equations with Nonlocal Conditions, Computatıonal Mathematics and Mathematical Physics, 2019, Vol. 59, N 5, pp. 696-707.

4) Work: "Solution of inverse problems describing various systems with the help of methods of optimal control theory".

Authors: Doct. of phys. Math. Sci. professor. Yusif Gasimov

During the reporting period, studies were conducted on the topic. During this period, one article was published in a journal indexed in the Thomson Reuters base, and other results are in the article publishing process.

1. Farjamnia, G., Gasimov, Y.S., Kazimov, J. Review of the techniques against the wormhole attacks on wireless sensor networks, *Wireless Personal Communications,* Vol.105, No.4, 2019, pp.1561-1584. **Thomson Reuters, ESCI.**

5) Work: "Study of some inverse and ill-posed problems for second order hyperbolic equations by methods of optimal control".

Author: Doct. of phys. Math. Sci. prof. Hamlet Guliyev

During the reporting period, the following prolems for second order hyperbolic equations were studied:

1) The problem on definition of input functions with respect to measurable values boundary function for a second order hyperbolic equation was considered. The problem was reduced to optimal control problem and necessary and sufficient condition for optimality was proved.

2) A problem on the existence and uniqueness of the solution of initial boundary value problem for weak non linear second order hyperbolic equation with non-local boundary condition. The existence and uniqueness of a solution from the class $W_2^1(Q)$ was proved.

Published scientific papers:

1. Guliyev H.F., Safarova Z.R. On a determination of the initial functions from the observed values of the boundary functions for the second-order hyperbolic equation. Advanced mathematical models and applications, 2018. Vol. 3, № 3, pp. 215-222.

2. Кулиев Г.Ф., Сафарова З.Р. Об определении начальных функцей по измеренным значениям граничных функцей для гиперболического уравнения. Материалы V международной научной конференции «Нелокальные краевые задачи и родственные проблемы математической биологии, информатики и физики» к 80-летию А.М.Нахумева. 4-7 декабря 2018 г. Нальчик, Кабардино-Балкарская Республика. с. 115.

3. H.F. Guliyev, H.T. Tagiev. On the existence and uniquenese of the solution of a problem with a nonlocal condition for a hyperbolic type equations. An İnternational Workshop dedicated to the 80th anniversary of an academician Mirabbas Geogja oglu Gasymov "Spectral theory and its applications" . Baku / June 7-8, 2019, pp. 78-79.

6) Work: "Problems with non-local boundary conditions and the study of optimal control problems described by them".

Author: Doct. of phys. Math. Sci. prof. Y. A. Sharifov

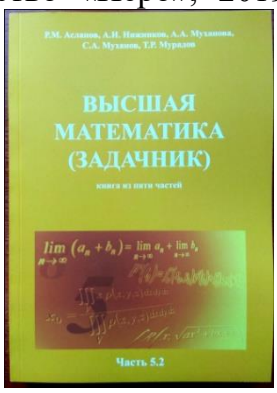
In this paper, we first consider the three-point boundary value problem for ordinary differential equations of the first order. A theorem on the existence and uniqueness of the solution of a differential equation by the method of principle of compressed mappings is proved. A theorem on the existence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

1) Mısır J. Mardanov, Yagub A. Sharifov and Kamala E. Ismayilova. Existence and uniqueness of solutions for nonlinear impulsive differential equations with three-point boundary conditions. E-Journal of Analysis and Applied Mathematics 2018(1) (2018), 21 – 36 DOI 10.2478/ejaam-2018-0003

7) Work: "The study of the history of mathematics in the late 19th and early 20th centuries in Azerbaijan".

Authors: Prof. R. M. Aslanov

Textbooks and manuals

Высшая математика (задачник). Книга из пяти частей часть 5.2. Учебное пособие. – М.:. Издательство «Перо», 2019.- 320 с. (соавторы Нижников А.И., Муханова А.А., Муханов 

С.А., Мурадов Т.Р.)

Published articles:

1. История науки: Роль женщин –математиков Франции/ Современный учитель естественного цикла: сборник материалов Международной научно-практической конференции (15-16 февраля 2019г.; Ишим)- Ишим: издательство ИПИ им. П.П. Ершова (филиала) ТюмГУ, 2019 стр. 25-30
2. З. И. Халилов один из основоположников функционального анализа/ Алгебра, теория чисел и дискретная геометрия: современные проблемы, приложения и проблемы истории Материалы XVI Международной конференции, посвященной 80-летию со дня рождения профессора Мишеля Деза Тула, 13–18 мая 2019 года, Тула, Тульский государственный университет им. Л.Н. Толстого , 2019, стр. 359-363. (соавторы Марданов М.Дж., Гасанова Т.Х.)
3. Методика и учебники по математике в школах Азербайджана (до 1920 года)/ V Международный форум по педагогическому образованию «Развитие профессиональных компетенций учителя: основные проблемы и ценности» 29-31 мая 2019 года, Казанский федеральный университет г. Казань. стр. (соавтор Марданов М.Дж.)
4. Козельский Яков Павлович: энциклопедист, философ-просветитель России XVIII века (290-лет со дня рождения)/Современное образование: научные подходы, опыт, проблемы, перспектива: материалыXV Междунар. Науч.-практ. Конф. «Артёмовские чтения» (г. Пенза, 17-18 апреля 2019 г.) – Пенза: Изд-во ПГУ, 2019.- 366с. стр. 10-18 (соавтор Зейналов Г.Г.(Мордовский государственный педагогический университет))
5. Математик-механик и художник - Пелагея Яковлевна Кочина (к 120-летию со дня рождения) / труды IX Международной научной конференции «Математика. Образование. Культура», 24-26 апреля 2019 г., Россия, г. Тольятти - Тольятти: Изд-во ТГУ, 2019. С.6-11(пленарный доклад).

Following scientific seminars of department were held

1. 10.01.2019 – The head of the laboratory "Mathematical problems of control" of the Institute of Control Systems of ANAS, prof. of ANAS, doctor of mathematics Ilgar Gurbat oglu Mamedov "Some usual and fractional model differential and integral equations of mathematical biology and their applications".

2. 24.01.2019 – Baku Engineering University, head of the department of Mathematics, Ragib Efendiev "Spectral analysis for non-self adjoint Hill operators".

3. 07.02.2019 – The Institute of Control Systems of ANAS, Dr., Assoc. Prof. Anar Rahimov "An approach to numerical solution to inverse source problems with nonlocal conditions".

4. 28.02.2019 – The sen. Res. Ass. of "Optimal Control" department, prof. Yagub Sharifov "Some non-local boundary problems and the investigation of optimal control problems described by them".

5. 14.03.2019 – The sen. Res. Ass. of "Optimal Control" department, prof. Yagub Sharifov "Some non-local boundary problems and the investigation of optimal control problems described by them".

6. 04.04.2019 – Professor of Baku State University, doct. of phys. Math. Sci. Misreddin Allahverdi oglu Sadigov will give a talk on "Extreme problem for integral inclusion".

7. 18.04.2019 – Professor of Baku State University, doct. of phys. Math. Sci. Misreddin Allahverdi oglu Sadigov will give a talk on "Extreme problem for integral inclusion".

8. 02.05.2019 – The Institute of Control Systems of ANAS, Dr., Assoc. Prof. Anar Rahimov "Optimal control of concentrated system on the class of piecewise constant functions with uncertain information on parameters and initial conditions".

9. 16.05.2019 – The acting Candidate of Mathematical Sciences, Associate professor Shakir Yusubov "Some generalizations of the Pontryagin maximum principle in the theory of optimal control".

10. 30.05.2019 – The head of the laboratory "Mathematical problems of control" of the Institute of Control Systems of ANAS, prof. of ANAS, doctor of mathematics Ilgar Gurbat oglu Mamedov "Differentiation and integration of fractional order and illustrative examples and problems about them".

During the reporting period, 9 articles and 8 conference materials of department staff were published (1 articles included in the journals listed at Thomson Reuters).

SCIENTIFIC AND SOCIAL ACTIVITIES

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.

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.

Professor Telman Melikov is a member of the AAC Expert Council in 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."

Department's Senior Researcher Yusif Gasimov 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, TWMS Journal of Pure and Applied Mathematics - member of the editorial board of the International Journal, member of the Organizing Committee of the VI Congress of the Turkish World Mathematical Society.

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).

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