A YEAR REPORT OF 2021 ON SCIENTIFIC AND SCIENTIFIC-ORGANIZATIONAL ACTIVITY OF THE DEPARTMENT OF "EQUATIONS OF MATHEMATICAL PHYSICS" OF INSTITUTE OF MATHEMATICS AND MECHANICS OF ANAS

In the department of "Equations of Mathematical Physics" 12 workers, 9 of whom are research workers. Of them 3 **doctors of sciences, professors:**

1. Akhundov Adalat Ya. – chief researcher associate, (full time).
2. Mammadov Farman I. – chief researcher associate, (full time).
3. Kerimov Nazim B. – chief researcher associate, (a part time).

5 doctors of philosophy in mathematics:

4. Guliyev Abdurrahim F. – head of department, leading researcher associate, (full time).
5. Bagirov Shirmail H. – leading researcher associate, ass. prof., (a part time).
6. Mammadov Elchin M. – leading researcher associate, ass. prof., (full time).
7. Shukurova Shahla Yu. – senior researcher associate, (full time).
8. Hasanova Aynur H. – senior researcher associate, ass. prof., (full time).
9. Mammadli Sayali M. – researcher associate, (full time).

3 laboratory assistants:

10. Mustafayeva Lala M. – laboratory assistant, (full time).
11. Abdullayeva Aydan J. – laboratory assistant, doctoral student, (full time).
12. Jabrailova (Shafiyeva) Aynur F. – laboratory assistant, (a part time).

I. SCIENTIFIC PART.

In 2021, according to the approved plan, the department conducts 7 research works on the topic "Solvability of initial-boundary value problems for various types of differential equations, qualitative properties of solutions and their applications".

Work 1: "Different types of growth theorems for solutions of second-order parabolic equations and their applications".

Executor: head of department A.F. Guliyev

During the reporting period, weak and strong growth-type theorems, theorems in terms of parabolic capacity and parabolic potential, reflecting the qualitative properties of solutions, were proved for positive solutions of second-order parabolic equations. The obtained results were used to obtain the Wiener type criterion for the regularity of the boundary point with respect to the Dirichlet problem for the heat transfer equation in symmetric regions.

Published papers:

Abdurrahim Guliyev, *The Simple Proof of Regularity of the Boundary Point with Respect to the Dirichlet Problem for Heat Equation in the Symmetric Domains*. 4th International E-Conference on Mathematical Advances and Applications (ICOMAA 2021), Yıldız Technical University, May 26-29, 2021, Istanbul / Turkey, p. 32. https://2021.icomaas.com/wp-content/uploads/2021/05/ICOMAA-2021-ABSTRACT-BOOK.pdf

Work 2: "Some inverse problems for parabolic equations in variable boundary domains".

Executor: prof. A.Ya. Akhundov.

In the indicated class of correctness, a theorem on the uniqueness and stability of the solution is proved. In addition, the inverse problem of finding an unknown coefficient to the right of the parabolic equation in a variable boundary region is considered. An additional condition for finding the unknown coefficient depending on the time variable is given in integral form. The theorem on the uniqueness of the solution and the "conditional" stability is proved.

Published papers:

1. Adalat Ya. Akhundov and Arasta Sh. Habibova, *On an inverse problem for a parabolic equation in domain with moving boundaries.* Proceedings of the Institute of Mathematics and Mechanics,National Academy of Sciences of Azerbaijan, volume 47, number 2, 2021, pp. 262-269.

   http://proc.imm.az/volumes/47-2/47-02-06.pdf

Work 3: "Qualitative properties of uniformly and nonuniformly degenerate elliptic and parabolic equations".

Executors: prof. F.I. Mammadov, Sh.Yu. Shukurova, S.M. Mammadli.

During the reporting period, a number of results were obtained that can give impetus and direction to new research in the field of uniform and non-uniform elliptic and parabolic equations. Sufficient conditions are found for a number of Poincaré-Sobolev-type inequalities, which are widely used in non-uniform elliptic equations, and inequalities that follow from the general results obtained are proved. These results will soon find their application to equations.

In addition, the existence of a strong solution to the Dirichlet problem for second-order semilinear elliptic equations of a nondivergence structure was investigated in the case when the coefficients in the main part are continuous and satisfy the Cordes condition and the growth condition for the Carathéodory function. For this problem, the existence of a solution in Sobolev spaces was proved when the norm of the right-hand side of this equation is sufficiently small. In the proof of this theorem, Schauder's theorem was used, which continuously maps into itself a closed and compact set in a Banach space.

Published papers:

1. Farman Mamedov and Cesaret Qasimov, *On estimates of the fundamental solution* Farman Mamedov, *A Poincare's inequality with non-uniformly degenerating gradient*. Monatshefte für Mathematik **(**Impact factor 0.933), 2021, volume 194, issue 1, pp. 151-165.

   https://link.springer.com/article/10.1007/s00605-020-01506-4

2. Farman I. Mamedov and Shahla Yu. Salmanova, *On strong solvability of the dirichlet problem for a class of semilinear elliptic equations with discontinuous coefficients*. Proceedings of the Institute of Mathematics and Mechanics, National Academy of Sciences of Azerbaijan, volume 47, number 1, 2021, pp. 15-23.
   http://proc.imm.az/volumes/47-1/47-01-02.pdf

3. Sh.Yu. Salmanova, *The Dirichlet problem for of semilinear elliptic equations of the second order*. Journal of Baku Engineering University Mathematics and Computer Science, volume 4, number 1, 2020, pp. 28-34. (Published in 2021)
   https://journal.beu.edu.az/

4. Farman Mamedov, *On existence of positive solution for a class of nonuniformly elliptic equation.* 4th International E-Conference on Mathematical Advances and Applications (ICOMAA 2021), Yıldız Technical University, May 26-29, 2021, Istanbul / Turkey, p. 23.

https://2021.icomaas.com/wp-content/uploads/2021/05/ICOMAA-2021-ABSTRACT-BOOK.pdf

5. Farman Mamedov and Cesaret Qasimov, *An existence result for a semilinear nonuniformly elliptic equation.* 4th International E-Conference on Mathematical Advances and Applications (ICOMAA 2021), Yıldız Technical University, May 26-29, 2021, Istanbul / Turkey, p. 70. https://2021.icomaas.com/wp-content/uploads/2021/05/ICOMAA-2021-ABSTRACT-BOOK.pdf

Work 4: "Investigation of some spectral properties of higher order differential operators with regular boundary conditions".

Executor: prof. N.B. Kerimov.

The paper investigates the spectral properties of an ordinary differential operator of the 4th order with a spectral parameter in two boundary conditions. For specifically considered operators, the following questions are investigated:

a) the properties of the oscillation of the system of eigenfunctions;

b) basis property of the system of eigenfunctions in the spaces L_p , $1< p < \infty$, (defective basis property);

c) necessary and sufficient conditions for uniform convergence on an interval of biorthogonal expansions in terms of a system of eigenfunctions.

Published papers:

З.С. Алиев, Н.Б. Керимов, В.А. Мехрабов. *Свойства собственных частот и гармоник изгибных колебаний балки Эйлера-Бернулли, на одном из концов которой сосредоточен упруго закрепленный инерционный груз.* Математический сборник, 2021, 38 pp. (in printing)

Work 5: "Investigation of the problem of the existence of a positive global solution in a cylindrical domain, the basis of which is the outer part of a compact set, of a system of semilinear parabolic equations with a singular potential and an operator of the Baouendi-Grushin type in the main part".

Executor: ass. prof. Sh.H. Bagirov.

During the reporting period, the existence of a positive global solution in the outer region of the ball, containing the origin, of a fourth-order semilinear elliptic equation with a singular potential and an operator of the Baouendi-Grushin type in the

main part was investigated, and an exact sufficient condition was found that ensures the absence of a solution. At the same time, the problem of the existence of a positive global solution to a semilinear elliptic equation with a principal part in divergent form was investigated.

Published papers:

Bağırov Ş.H., Musayeva N.Z., *Sonsuz oblastda yarımxətti elliptik bərabərsizliyin müsbət qlobal həllinin varlığı,* Republican virtual scientific conference "Mathematics, mechanics and their applications" dedicated to the 98th anniversary of national leader Heydar Aliyev, May 24-25, 2021, Baku.

Work 6: "Investigation of the qualitative properties of solutions to initial-boundary value problems for hyperbolic equations with various modifications".

Executor: ass. prof. E.M. Mammadov.

During the reporting period, a number of problems related to the study of the qualitative properties of solutions of hyperbolic equations with linear and nonlinear boundary conditions were considered. In addition, for the nonlinear problem posed for the fourth-order equation, a conclusion is drawn about the stabilization of the solution under certain smoothing conditions imposed on the nonlinear functions given in the equation and boundary condition. And for the third-order equation, which is nonlinear in the main part, the theorem on the solution of a mixed problem in finite time is proved.

Published papers:

Elchin Mamedov, *On the stabilization of the solutions for nonlinear fourth order equation.* 4th International E-Conference on Mathematical Advances and Applications (ICOMAA 2021), Yıldız Technical University, May 26-29, 2021, Istanbul / Turkey, p. 77.
https://2021.icomaas.com/wp-content/uploads/2021/05/ICOMAA-2021- ABSTRACT-BOOK.pdf

Work 7: "Investigation of the existence of an integral solution to an inverse problem for a second-order semilinear parabolic equation".

Executor: ass. prof. A.H. Hasanova.

During the reporting period, an approximate solution of an inverse problem for a second-order semi-linear parabolic equation with a nonlinear Neumann boundary condition was investigated. The problem under consideration is reduced to an

equivalent problem – to a system of integral equations. At this stage, the existence of an integral solution to this problem is investigated.

Published papers:

1. Misir Mərdanov, Aynur Həsənova, *"Qeyri-səlis məntiq nəzəriyyəsinin banisi – Lütfi-Zadə"*. 525-ci qəzet, 2021-ci il, 4 fevral, № 21 (5587), s. 10-11. https://525.az/news/161540-qeyri-selis-mentiq-nezeriyyesinin-banisi-lutfi-zade
2. Misir Mərdanov, Aynur Həsənova, *"Elmlərin sultanı – riyaziyyat"*. 525-ci qəzet, 2021-ci il, 13 mart, № 47 (5613), s. 18-19. https://525.az/news/164168-elmlerin-sultani-riyaziyyat-meqale
3. Aynur Hasanova, *Existence of a solution of the inverse problem for a second-order parabolic equation.* 4th International E-Conference on Mathematical Advances and Applications (ICOMAA 2021), Yıldız Technical University, May 26-29, 2021, Istanbul / Turkey, p. 56. https://2021.icomaas.com/wp-content/uploads/2021/05/ICOMAA-2021-ABSTRACT-BOOK.pdf

II. ORGANIZATIONAL ACTIVITY.

Head of the department, Ph.D. Abdurrahim Guliyev is the scientific secretary of the Dissertation Council, lectures to the master's students of the Institute of Mathematics and Mechanics on the subject "Modern problems of mathematics". Head of the department Abdurrahim Guliyev works as a teacher at ASOIU and in lyceum No.1 with a physics-mathematics-informatics bias, is an expert in the SEC on the subject of "mathematics".

Cheif researcher associate of the department prof. Adalat Akhundov is a member of the Scientific Council, the deputy chairman of the Dissertation Council, a member of the editorial board of the journals Proceedings of Mathematics and Mechanics Institute, "Scientific works" of Baku University for girls. Professor Adalat Akhundov lectures to the master's students of the Institute of Mathematics and Mechanics in the specialties "Differential Equations" and "Equations of Mathematical Physics", works as a professor at Lankaran State University.

Cheif researcher associate of the department prof. Farman Mammadov is a member of the Dissertation Council, a member of the Expert Council of the HAC (Higher Attestation Commission), a member of the editorial board of the journals Azerbaijan Journal of Mathematics, Proceedings of Mathematics and Mechanics Institute, Journal of Contemporary Applied Mathematics, Universal Journal of Applied

Mathematics, a reviewer of the journal of Mathematical Reviews of American Mathematical Society.

Chief researcher associate of the department prof. Nazim Kerimov is a professor at the Khazar University, a member of the editorial board of the journals Proceedings of Mathematics and Mechanics Institute, Transactions issue mathematics of Mathematics and Mechanics Institute, Azerbaijan Journal of Mathematics.

Leading researcher of the department associate professor Shirmail Bagirov lectures to the master's students of the Institute of Mathematics and Mechanics on the subject "Nonlinear differential equations", works as an associate professor at Baku State University and at the National Aviation Academy.

Leading researcher of the department associate professor Elchin Mammadov is a member of the commission for control of the IMM trade union organization, works as an associate professor at Baku State University.

Senior researcher of the department associate professor Aynur Hasanova is a member of the working group created to use the platform Web of Science of the Clarivate Analytics and collect information.

The laboratory assistant of the department Aydan Abdullayeva works as a teacher at Baku State University.

Classes of master's students of the department were held online in accordance with programs and schedules. Master's students Asadli Afag, Gasimov Cesaret and Aliyev Azer on June 17, 2021 defended their master's theses online under the guidance of scientific advisers. Doctoral students and dissertators under the guidance of scientific leaders (Abdurrahim Guliyev, Adalat Akhundov, Farman Mammadov, Shirmail Bagirov) continue their research on the approved topics.

This year, an employee of the department, Shirmail Bagirov, was an opponent on the defense of one thesis.

Chief Researcher of the Department, Professor Farman Mammadov made a report on "The existence of a positive solution for elliptic equations with one class irregular curvature" at the general institute seminar held online at the Institute of Mathematics and Mechanics on June 2, 2021

Head of the department, Abdurrahim Guliyev and professor Farman Mammadov continuing their cooperation with Turkish scientists, expanded their scientific ties. Also, professor Farman Mammadov continues to cooperate with Italian scientists. In addition, employees of our department cooperate with scientists from Russia, Ukraine, Turkey, America, Sweden and other countries.

Every week, on Wednesdays, under the leadership of the head of the department Abdurrahim Guliyev, and on Mondays, under the leadership of professor Farman Mammadov, the department's seminar on the topic “Modern problems of mathematical physics” is traditionally held.

KONFERENCES

Head of the department, Abdurrahim Guliyev and cheif researcher associate of the department professor Farman Mammadov (as a plenary speaker on the topic “On existence of positive solution for a class of nonuniformly elliptic equation”), Elchin Mammadov, Aynur Hasanova, master’s student Cesaret Gasimov took part online in the 4rd International Scientific Conference entitled “Mathematical Advances and Applications”, which was held on May 26-29, 2021 at Yildiz Technical University, Istanbul, Turkey.

Thus, in 2021, employees of the department published 12 papers, of which 4 scientific papers (2 (1 abroad) included in journals from the Web of Science and Scopus list), 2 popular science articles, 6 abstracts (5 abroad).

Head of department: **Ph.D. Abdurrahim Guliyev**