Project name, IRN	**AP19676629** – The method of periodic characteristics in the study of oscillations in systems with a diagonal differentiation operator
Completion date	01.07.2023-31.12.2025
Project supervisor	Sartabanov Zhaishylyk, d.ph.-m.s. professor
Report	The Project investigates phenomena that are described by multiperiodic systems with a differentiation operator in the direction of the diagonal of the space of independent time variables. Here, differentiation is performed in the direction of a constant vector with unit coordinates. Since the system is multiperiodic, it turns out that a variable changing along the diagonal can be considered along a periodic discontinuous function consisting of segments with the same direction as the diagonal, and the generalized derivatives in the direction of such a periodic function coincide with the derivatives of the function along the diagonal. Thus, there are two alternative ways to study the systems under consideration. One of them is a study based on a non–periodic characteristic representing the diagonal of variables, which has been used so far. The other is a study using periodic characteristics, which is a new direction in the theory of multiperiodic solutions of systems with a diagonal differentiation operator, which we are going to reveal in this Project. *The degree of influence* of the research results in the sense of their applicability in the mathematical theory of oscillations and among specialists should be quite noticeable. Tasks with a century-old history are investigated here. We are dealing with the problems of fluctuations in the Republic in the singular, our scientific school has no competitor in the country, we differ in the methods of conducting research abroad. The Project is theoretical in nature, dedicated to the fundamental issues of the theory of differential equations and oscillations.
Purpose	Development of method based on construction of generically differentiable periodic characteristic of DO in direction of diagonal and the distributions theory, its use to establish necessary and sufficient condition for multiperiodicity of solutions of systems with diagonal DO, proof reducibility of linear multiperiodic systems with DO. Applications of developed method.
Expected results	Multiperiodic system with differentiation operator describes physical and mathematical process or phenomenon that consists of sets of periodic subsystems with incommensurable frequencies. Therefore, all input data to the system have the property of periodicity in time variables. In order to integrate this system according to the general theory of partial differential equations, we reduce it to system of ordinary differential equations, replacing differentiation operator with ordinary derivative of unknown function, and the right part with composition of multiperiodic vector function and characteristics of differentiation operator. Thus, differential mathematical model of multiperiodic process was replaced by another type of differential mathematical model of the same process. Here, during the transition from one mathematical model to another, mathematical error was not made. But it should be noted that in physical sense they are not equivalent, since in second case the models have

	discrepancy with the multi-periodicity of process, in other words, mathematical model is not periodic. This discrepancy has not been taken into account in previous studies. Now we see that it can be removed by replacing non-periodic characteristic with periodic one. Hence, problem arises of constructing equivalent in some sense of former periodic characteristic of differentiation operator. Such basic task of Project goal is solvable by considering it in broader space of generalized functions. Thus, two types of models of the same multiperiodic process are identified, considered as motion of continuous medium and particles, in the first case, and as motion of individual particles of medium emanating from arbitrary point in space, in the second case. In the Project, non-periodic characteristic is replaced by its periodic equivalent and study is conducted using method based on such replacement. The development of new project method ends with proposal on condition of multiperiodicity of solutions of systems with diagonal differentiation operator. Further, this method is used to study the problems of the existence of multiperiodic solutions of homogeneous linear systems. The structure of the solution of homogeneous linear system is determined by its reducibility in sense of Lyapunov-Floquet to system with coefficients constant along periodic characteristic. On their basis, the conditions for the existence of multiperiodic solutions of quasi-linear systems with diagonal differentiation operator are presented. Along with them, as application of newly developed method, similar problems are investigated for other related systems and equations given in the research plan. The implementation of results obtained is planned in the following forms: 1) 3 (three) articles in peer-reviewed scientific publications in the scientific direction of the project, indexed in the Science Citation Index Expanded and included in the 1st (first), 2nd (second) and (or) 3rd (third) quartile by impact factor in the Web of Science database and (or) having a CiteScore percentile in Scopus database of at least 50 (fifty) (for example Mathematics (MDPI) (86%, Q1); Journal of Differential Equations (Q1); Mathematical Problems in Engineering (77%)); 2 (two) articles in a peer-reviewed foreign or domestic publication recommended by the KOKSNVO (for example Bulletin of Karaganda University. Series "Mathematics"; "Journal of Mathematics, Mechanics and Informatics"); 2) 1 (one) monograph devoted to multiperiodic oscillations in diagonal differentiation systems; 3) the research product is not an object of technical nature; 4) development is not related to technical and design documentation; 5) dissemination of the Project results among specialists can be carried out by reports and reports at scientific seminars and conferences planned in the application; 6) other measurable characteristics of the Project results: • the scope of application is in science - mathematical theory of oscillations and in learning system - innovative and special courses for students; • The influence of expected results on development of

	scientific directions is in development of theoretical issues of multiperiodic and quasi-periodic solutions of systems that are differential and functional models of oscillatory processes. In the Project, in parallel with the main issue, the influence of method on adjacent systems with four differentiation operators, which were given in the calendar plan, is being studied; • The applicability of the method in the mathematical theory of oscillations is wide, and therefore, it will be applied in life and engineering practice, but over time. Commercialization is related to the needs of practice, its possibility is undoubtedly, but it is also a matter of time, it can be planned in subsequent stages; • the effect of the results of scientific nature in the theory of oscillations in differential systems will undoubtedly be, especially in connection with quasi-periodic development of movements in the form of their application in these areas of sciences.
Research group	Supervisor – Main researcher*:* Sartabanov Zhaishylyk, d.ph.-m.s., professor, H index = 6 (Web of Science ResearcherID – AAC-7803-2020, Author ID в Scopus – 55588115900). https://www.webofscience.com/wos/author/record/1935066,46561424 https://www.scopus.com/authid/detail.uri?authorId=57194563252 Abdikalikova Galiya – c.ph.-m.s., assoviate professor, H index =1 (Web of Science ResearcherID – AAZ-4785-2020, Author ID в Scopus – 56368309300;). https://www.webofscience.com/wos/author/record/2081420 https://www.scopus.com/authid/detail.uri?authorId=56368309300 Omarova Bibigul, PhD, H index =2 (Web of Science ResearcherID – AAE-3865-2019, Author ID в Scopus – 57203507845). https://www.webofscience.com/wos/author/record/1892953 https://www.scopus.com/authid/detail.uri?authorId=57203507845 Zhumagaziyev Amire, PhD, H index =1 (Web of Science ResearcherID – E-2909-2016, Author ID в Scopus – 57559112200) https://www.webofscience.com/wos/author/record/1098269 https://www.scopus.com/authid/detail.uri?authorId=57559112200 Aitenova Gulsezim, PhD, H index =1 (Web of Science ResearcherID – EJB-6443-2022, Author ID в Scopus – 57680771600) https://www.scopus.com/authid/detail.uri?authorId=57680771600 https://www.webofscience.com/wos/author/record/18646844 Saktapbergenova Gulmira – postgraduate student 7M5401-Математика

Publications in scientific publications	1. Ж.А. Сартабанов Периодичность характеристик оператора дифференцирования по диагонали // Вестник КазНПУ им. Абая, серия «Физико-математические науки». 82, №2. 2023. 2. Zh.A. Sartabanov, G.M. Aitenova Bounded on the semi-axis multiperiodic solution of a linear finite-hereditarity integro-differential equation of parabolic type // Bulletin of the Karaganda university. Mathematics series. № 3(111). 2023. – C.109-121.