REALIZATION OF SCIENTIFIC AND EDUCATIONAL POTENTIAL OF TRAINING IN THE INVERSE PROBLEMS FOR THE DIFFERENTIAL EQUATIONS

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In article methodical aspects of training for the inverse problems for differential equations of students of higher education institutions of the physical and mathematical and natural-science directions of preparation are stated. The attention to expediency of development in students of scientific outlook allowing to acquire fundamental knowledge of methods and methodology of research of mathematical models of the inverse problems, to master the principles of the organization of theoretical and practical researches of the inverse problem, to create ideas of the inverse problems as universal tools of knowledge of world around is paid.

In article attention that development of scientific outlook in training activity to the inverse problems for differential equations allows students to deep understanding of idea of integrity of the world, assimilation of disciplines of applied mathematics, disciplines from other data domains is paid. It is marked that in the course of such training in students lines of humanitarization take root. Students acquire skills to analyze the received solutions of the inverse problems for differential equations, to formulate logical outputs about an ecological status of air space, earth's environment or the water environment, to apply results of solutions of the inverse problems for differential equations in the humanitarian analysis of applied researches.

Key words: training for the inverse problems for differential equations, scientific and educational potential of training for the inverse problems for differential equations, the humanitarian potential of training for the inverse problems for differential equations, development of fundamental knowledge in the field of applied mathematics, the student

In case of research of applied tasks the situation when the interesting characteristics of object are unavailable or remote for direct supervision is typical (for example, deep properties of Earth and the World Ocean, the astrophysical phenomena, a problem of nondestructive quality control of products and designs, detection of defects in the working object, the medical researches directed to detection of pathologies of internals of the person, and many other researches). Carrying out the experiment can be impossible because it either is forbidden, or is too dangerous, or the researched object exists in the single copy. Experiment can be connected with very big finance costs. In this case indirect information on the researched object gathers. This information is determined by the nature of the researched object and the experimental complex used at the same time.

As fundamental laws of the nature are expressed, as a rule, in language of the differential equations, the initial task is reduced to a task of determination of coefficients of the differential equations (ordinary or in private derivatives), the right part, entry conditions on some known functionalities of their decision. Such tasks, unlike regular tasks the differential equations when the equation is set, and are required to find its decision (direct tasks), have received the name of the inverse problems for differential equations — the

inverse in the cause and effect relation (recovery of the unknown reasons of well-known consequences). At the same time «reasons» are concretized in the form of unknown coefficients, the right part, entry conditions. Functionalities from the solution of the differential equation act as «consequences».

Bases of the theory and practice of research of the inverse problems for differential equations are put and developed by fundamental works of A.S. Alekseev, V.A. Ambartsumyan, G. Borg, I.M. Gelfand, M.G. Crane, M.M. Lavrentyev, B.M. Levitan, A.I. Prilepko, V.S. Rogozhin, V.G. Romanov, A.N. Tikhonov and other scientists. The theory of the inverse problems for differential equations finds the development in researches A.K. Amirov, Yu.E. Anikonov, A.V. Bayev, M.I. Belishev, A.S. Blagoveschensky, A.L. Bukhgeym, P.N. Vabishevich, A.O. Vatulyan, V.V. Vasin, A.V. Goncharsky, A.M. Denisov, S.I. Kabanikhin, V.I. Priymenko, A.M. Fedotov, V.A. Cheverda, V.G. Cherednichenko, V.A. Yurko, A.G. Yagola, V.G. Yakhno, G. Anger, H.D. Bui, Y. Chen, D. Colton, R. Durridge, J. Gottlieb, M. Grasselli, G.Q. Xie, G. Kunetz, A. Lorenzi, R.D. Murch, A. Roger, M. Sondhi, G. Stoyan, M. Yamamoto and other scientists (see. for example, [3; 4; 6; 9; 18—20]).

By means of the theory and methodology of the inverse problems for differential equations applied problems of physics, geophysics, seismology, sea natural disasters, chemistries, processings of facsimiles, medicine, economies, ecology, the industry, astronomy, astrophysics and other areas can successfully be researched. The inverse problems for differential equations are widely applied in applied mathematics, in such sections as algebra, the analysis, geometry, ordinary differential equations, differential equations in private derivatives, integrable equations, the operator equations, optimum control and other sections of applied mathematics.

According to V.G. Romanov, stated to them in 1971, the theory of the inverse problems, is information and assumes information and mathematical information processing about the solution of the researched application-oriented task. Therefore the knowledge of bases of the theory and methodology of the inverse problems for differential equations is an important factor of formation and development of information thinking in students of higher education institutions of the physical and mathematical and natural-science directions of preparation.

Not casually, now in many higher educational institutions of Russia on the physical and mathematical and natural-science directions of preparation for bachelors and undergraduates special courses on the inverse problems for differential equations are taught (see, for example, [1—4; 7; 13—18]). Among such higher education institutions — Lomonosov Moscow State University, the Moscow city pedagogical university, Novosibirsk national research state university, the Rostov state university, St. Petersburg State University, the Siberian federal university, the Ural state university and other higher education institutions.

In the course of training of the inverse problems for differential equations students get acquainted with various mathematical models of the inverse problems for differential equations (the ordinary differential equations, the equations in private derivatives), master methods of their research realizing interdisciplinary communications of such subject matters as the analysis, algebra, geometry, the differential equations (ordinary or in private

derivatives), the integrated equations, numerical methods, informatics and other subject matters.

The inverse problems for differential equations, as a rule, have mathematical features (nonlinearity, non-uniqueness, an incorrectness), are subdivided into types (coefficient, boundary, geometrical, evolutionary inverse problems and others), possess identity (the inverse problems for ordinary differential equations, the inverse problems for differential equations in private derivatives of the first order, the inverse problems for linear hyperbolic systems of the first order, one-dimensional inverse problems for equations in private derivatives of the second order, multidimensional inverse problems for equations in private derivatives of the second order, the inverse problems for system of the equations of Maxwell, the inverse problems for differential equations of elasticity and other inverse problems for differential equations).

Research of the inverse problems for differential equations in many respects depends on in what place of the differential equation there are required functions. Required functions can belong to various functional spaces. Additional information on the solution of a direct task and sources can have various appearance. Required coefficients can depend not only on physical coordinates, but also on temporary coordinate.

The listed notes assume when training of the inverse problems for differential equations implementation of effective methods of such training. It is important to inform of data that in research of the inverse problems for differential equations the real sense of mathematical object not always completely follows from formal determination understanding of students. The mathematical model of the inverse problems is determined by real object ambiguously. Even when preserving the schematic diagram of model the real object can be described with various degree of accuracy and disaggregation that gives the chance to change and the corresponding mathematical inverse problems in process of its research. According to a role of real factors in mathematical model of the inverse problems various simplifications and modifications in the cases which are of the greatest practical interest can become.

On the research course, taking into account the purposes and real interpretation of the studied mathematical model of the inverse problem the additional assumptions (for example, about parity of required coefficient) simplifying mathematical research or this research allowing to conduct can be entered on a more substantial scale.

When training of the inverse problem in students it is expedient to pay attention that in the field of the inverse problem for differential equations where statements often have not so unambiguous character, but rather high degree of reliability it is equivalent full, the reasonable analogy supported with other rational reasons can serve as the proof. In such way often it is possible to distribute statements, fair for one-dimensional inverse problems, to two-dimensional, three-dimensional and multidimensional inverse problems for differential equations in private derivatives. When carrying out such analogies, it is important to students to imagine distinctly the features distinguishing the considered case from the known analogies; these specifics can be clear on the basis of the analysis of model inverse problems.

A similar role is played by the arguments based on physical or computing experiment. The consent of the solution of the inverse problem for differential equations with

supervision or physical experiment serves as the important argument proving a hypothesis in typical situations. In this way it is possible to receive conclusions about quality of a computing method of the solution of the inverse problem.

As the solution of the inverse problem for differential equations includes the whole chain of rational reasonings, such as physical hypotheses, creation of mathematical model, working hypotheses at her research, various simplifications, the choice of an approximate method, realization of calculations, etc., the divergence of the solution of the inverse problem with physical experiment can say or that, one of these transitions is unreasonable, or that though each transition and is reasonable separately, but their errors, having collected, have removed an error of the general result for an admissible framework. Physical experiment can be rationally included as one of stages of the solution of the inverse problem.

Realization of interdisciplinary communications when training of the inverse problems for differential equations allows students not only to master scientific methods of research of the inverse problems for differential equations, but also to develop scientific outlook, to acquire fundamental knowledge of different disciplines of natural sciences. As a result of such training, students acquire not only skills of research of the inverse problems for differential equations, mastering mathematical methods and methodology of their research, but also acquire fundamental knowledge in the field of applied mathematics.

In the course of such training students acquire fundamental knowledge of methods and methodology of research of mathematical models of the inverse problems, forming ideas of them as about a universal remedy of knowledge of world around. Students in the course of training of the inverse problems for differential equations master also such important scientific concepts as formalization, algorithmization, modeling, syntax, semantics, form motivation and aspiration to knowledge, desire to knowledge of surrounding reality, formation of outlook and other creative abilities (see, for example, [2; 5; 8—12; 17]).

At the solution of the inverse problems students operate with such basic concepts as the generalized function derivative of the generalized function, norm of function, functional space, the operator and other mathematical concepts. Use the principle of the squeezing displays, a method of consecutive approximations, prove convergence of functional ranks, apply methods of differential and integral calculus, methods of integrated geometry, methods of mathematical physics, methods of calculus of variations, numerical methods, information and communication technologies, methods of rational reasonings, other methods.

At the final stage of research of the inverse problems students analyze the received results and draw logical conclusions of application-oriented and humanitarian character. Such students in the course of the professional activity are capable not only to apply the gained fundamental knowledge of applied mathematics, but also to develop independently and to competently realize the high, nature protection technologies in practice.

In training activity to the inverse problems for differential equations students acquire fundamental knowledge not only in the field of mathematical methods of research of similar application-oriented tasks. In the course of such training in students lines of humanitarization take root. Students acquire skills to analyze the received solutions of

the inverse problems for differential equations, to formulate logical outputs about an ecological status of air space, earth's environment or the water environment, to apply numerical results of solutions of the reverse tasks in the humanitarian analysis of applied researches.

On studies according to the inverse problems for differential equations from students, by results of the solution of the inverse problem, it is required to draw logical conclusions of application-oriented and humanitarian character, to overcome moral contradictions, to make a reasonable choice of the correct line item in society. Similar occupations can be realized on the basis of design of the humanitarian oriented studies according to the inverse problems for differential equations based on the mathematical and didactic analysis of maintenance of a training material, selection of system of the inverse problems, setting of the educational purposes and planning of system of studies according to the reverse tasks. Similar occupations can acquaint students, as with a problem of humanitarization of application-oriented mathematical education, and with a problem of moral responsibility before society for consequences of practical implementation of applied researches for which the humanitarian analysis with involvement of experts-humanists is necessary.

Similar logical reflections in the course of training of the inverse problems for differential equations promote formation at students of skills in the humanitarian analysis of nature of pollution of earth's environment and air space, system of knowledge of a role of the return tasks for the differential equations in the humanitarian analysis of properties of the water environment, earth's environment and air space.

It is obvious that in training activity to the inverse problems for differential equations students master not only methods and receptions of their decision and analysis, but also acquire new fundamental knowledge and create mathematical competences on different subject matters of applied and calculus mathematics, physics, informatics and other data domains, acquire skills of research of a correctness of mathematical models of the reverse tasks, the logical analysis of the received results of research of application-oriented mathematical tasks.

Fundamental knowledge in the field of applied mathematics, including in the field of the inverse problems for differential equations, skills of use of this knowledge in the professional activity, the possession of humanitarian culture, realization of the humane relations of the application-oriented activities with environment and society promotes formation at students of spirituality, to development of outlook and realization of participation in civilized development of society.

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РЕАЛИЗАЦИЯ НАУЧНО-ОБРАЗОВАТЕЛЬНОГО ПОТЕНЦИАЛА ОБУЧЕНИЯ ОБРАТНЫМ ЗАДАЧАМ ДЛЯ ДИФФЕРЕНЦИАЛЬНЫХ УРАВНЕНИЙ

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В статье излагаются методические аспекты обучения обратным задачам для дифференциальных уравнений студентов вузов физико-математических и естественно-научных направлений подготовки. Обращается внимание на целесообразность развития у студентов научного мировоззрения, позволяющее приобретать фундаментальные знания о методах и методологии исследования математических моделей обратных задач, освоить принципы организации теоретических и практических исследований обратных задач, сформировать представления об обратных задачах как универсальном инструментарии познания окружающего мира.

Автор подчеркивает, что развитие научного мировоззрения в процессе обучения обратным задачам для дифференциальных уравнений позволяет студентам глубокому пониманию идеи целостности мира, усвоению дисциплин прикладной математики, дисциплин из других предметных областей. Отмечается, что в процессе такого обучения студентам прививаются черты гуманитаризации. Студенты приобретают умения и навыки анализировать полученные решения обратных задач для дифференциальных уравнений, формулировать логические выводы об экологическом состоянии воздушного пространства, земной среды или водной среды, применять результаты решений обратных задач для дифференциальных уравнений в гуманитарном анализе прикладных исследований.

Ключевые слова: обучение обратным задачам для дифференциальных уравнений, научный и образовательный потенциал обучения обратным задач для дифференциальных уравнений, гуманитарный потенциал обучения обратным задачам для дифференциальных уравнений, развитие фундаментальных знаний в области прикладной математики, студент

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