SCIENTIFIC AND METHODICAL ASPECTS OF FORMATION OF SUBJECT CONTENT OF TRAINING COURSES FOR INVERSE PROBLEMS FOR DIFFERENTIAL EQUATIONS

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The article presents scientific and methodical aspects of forming the content of education inverse problems for differential equations for students of higher educational institutions of physical, mathematical and natural science training areas. The goals are formulated and the principles of training are the content of learning inverse problems for differential equations. Attention is drawn to the particular issues of teaching courses inverse problems. Describes the classification criteria and target modules that play the role of tools to create and analyze the model and curriculum, forming learning content inverse problems for differential equations. The content classification features and target modules. Formulate conclusions that learning the inverse problems for differential equations has scientific, educational and humanitarian potential of students and as a result of this training they gain the fundamental knowledge in the applied and computational mathematics, and also develop scientific worldview, applied, environmental, information thinking.

Key words: training in the inverse problems for differential equations, structuring the content of training, classification signs, tools for the analysis of content of training, applied mathematics, humanitarization of the higher mathematical education, the student

Efficiency and effectiveness of pedagogical activities in training process to the inverse problems for the differential equations of students of higher education institutions of the physical and mathematical and natural-science directions of preparation depends on the formulated purposes and the realized principles of training, content of training, the applied pedagogical technologies of training, forms of the organization of studies (see, for example [1; 4; 6—18]). We will formulate the purposes and the principles of training in the inverse problems for the differential equations.

The training purpose — to acquaint students with the theory and methodology of the inverse problems for differential equations and mathematical methods of their decision; to develop skills of a mathematical research of application-oriented tasks of restoration of unknown properties of processes and the phenomena and interpretation of results of scientific research; to realize the humanitarian and scientific and educational potential of training; to create bases of the humanitarian analysis of applied researches; to justify a role of applied mathematics in the modern world. The basic principles of training — the principles of visualization, accessibility, a professional directivity, scientific character, systemacity, connection of the theory with practice, interdisciplinary communications. In training activity students get acquainted with various inverse problems for differential equations.

The developed maintenance of a training course of the inverse problems includes the following sections.

1. The inverse problems for the ordinary differential equations. Inverse problems of determination of coefficients of the linear differential equations and analysis of approaches

and ideas of restoration of the unknown reasons of well-known consequences. Inverse problems of determination of coefficients of the nonlinear differential equations and assessment of beauty of mathematical methods of their decision. Inverse problems of definition of the right part of the differential equations and assessment of a contribution of methods of their decision to development of mathematical methods of the solution of the differential equations. The inverse problems of the theory of management and assessment of the ideas and approaches used for restoration of properties of the objects remote or inaccessible for the person.

2. The inverse problems for the differential equations in private derivatives of the second order. One-dimensional inverse problems for the hyperbolic equations and the analysis of features of rational reasonings in case of the solution of the inverse problems. Multidimensional inverse problems for the hyperbolic equations and their humanitarian role in the analysis of nature of pollution of the air basin. One-dimensional inverse problems for the parabolic equations and their application in the ecological analysis of the environment. Multidimensional inverse problems for the parabolic equations and their value in the analysis of influence of the functioning objects on health of the person. The inverse problems for the elliptic equations and their application in the humanitarian analysis of stationary processes. The inverse problems for system of the equations of Maxwell and their application in the humanitarian analysis of properties of earth's environment. The inverse return kinematic problems of seismicity and their value in development of ideas of an internal structure of Earth.

3. Tasks of determination of function on values of integrals. A task of determination of function of one variable on values of its integrals and assessment of mathematical methods of its decision for the theory of the integrated equations of Fredholm. Tasks of a computer tomography, their informational content and humanitarian value. A task about search of function on its spherical averages and assessment of a contribution of mathematical methods of its decision to the theory of the integrated equations of Voltaire. Tasks of integrated geometry and their communication with the return tasks for the differential equations.

4. Approximate methods of the decision of the inverse problems for differential equations. Approximate methods of the decision of the inverse problems for ordinary differential equations. Approximate methods of the decision of one-dimensional inverse problems for the hyperbolic equations. Approximate methods of the decision of one-dimensional inverse problems for the parabolic equations. Approximate methods of the decision of one-dimensional inverse problems for elliptical equations. Use of numerical results of decisions of the inverse problems in the humanitarian analysis of applied researches.

The training material on the inverse problems includes difficult mathematical models which describe various physical processes and the phenomena and is designed, more for students of the higher education institutions studying at the physical and mathematical or natural-science directions of preparation. Therefore when developing such content of training the professional orientation of training of such students has to be considered (see, for example [1—5; 20; 21]). The inverse problems for the differential equations have mathematical features (nonlinearity, non-uniqueness, an incorrectness), belong to various types (coefficient, boundary, geometrical, evolutionary and other types). Besides, the

inverse problems for the differential equations are individual as required functions (coefficients of the differential equations, the right parts of the differential equations, entry or boundary conditions, etc.) can be functions both one-dimensional, and multidimensional; the source initiating the studied physical process can be modelled by various special functions including generalized by functions (for example, Dirac's delta function, etc.) (see, for example [2; 3; 5; 20; 21]).

On a practical training as educational jobs it can be offered to students, for example: to construct the integrable equation for the decision of the direct problem; to prove the local existence theorem and uniqueness or the theorem of the conditional stability of the decision of the inverse problem; to explain the idea of finding of approximate solution of the inverse problem; to construct the difference analog of the inverse problem for a differential equation; to construct a computing algorithm of finding of approximate solution of the inverse problem and to analyze its properties, to prove convergence of approximate solution of the inverse problem to the exact decision and other educational jobs. Presentation of the idea of the proof of a correctness (the conditional correctness) of the decision of the inverse problem for differential equations and other educational jobs or, for example, according to the found solution of the inverse problem to formulate logical outputs of application-oriented or humanitarian character can be offered to students (see, for example [2; 3; 5; 20; 21]).

In the course of execution of such educational jobs students not only master the theory of the inverse problems for differential equations, methodology of a research of application-oriented tasks, but also acquire new knowledge in the field of applied mathematics and natural sciences. Such educational inverse problems have scientific and educational potential and are didactic units of assimilation of content of such training.

Stating the theory of the inverse problems for the differential equations, it is expedient to acquaint students first of all with simple educational inverse problems. At the same time it is desirable to explain and state stages of their research, in detail to state mathematical methods of their decision. And, in a further statement of a training material to consider more complex inverse problems which solution is based on earlier stated mathematical methods. It is important to inform data of students of the fact that by consideration of the inverse problems in the generalized statements (existence in statement of the return problem of the pulse sources simulated by the generalized functions) it is important to seek to allocate a singular part at the solution of the corresponding direct task, and, further to investigate the corresponding inverse problems constructed for her regular part.

In this connection, when developing a training material it is expedient to use criteria of unity of a training material, scientific character, systemacity, presentation, the didactic importance, the methodological importance and other criteria. It is necessary to carry out also the analysis of the created contents. The similar analysis can be realized, for example, with use of the classification signs and target modules playing a tools role for drawing up and the analysis of training programs, formation of maintenance of training courses of the inverse problems for the differential equations.

Before explaining classification signs and target modules, we will formulate basic provisions of training in the inverse problems for differential equations:

1) in the content of training in the inverse problems for differential equations the mathematical models describing various processes and the phenomena are researched;

2) the inverse problems for differential equations — unity of the theory and an experiment;

3) content of training in the inverse problems for differential equations can't be determined from purely pragmatical point of view based only on specifics of future specialty of students without internal logic of the most training course;

4) training in the inverse problems for differential equations shall be clear and be based on the level of reasonable severity;

5) the ideas and methods of the theorem proving of existence, uniqueness and stability of the decision of the inverse problems for differential equations are important for applied mathematical education.

Now we will enter the marked classification signs and target modules mentioned above. We will refer application-oriented knowledge, methods of a research of the inverse problems for differential equations to classification signs, the data on their teaching received as a result of cognitive, practical and pedagogical activity. We will understand program items of course of the inverse problems for the differential equations representing set of the selected classification signs as target modules.

Target modules contain qualification signs difinienda the purposes of training in the inverse problems for differential equations:

1) the theory and a technique of training in the inverse problems for differential equations — the scientific field of pedagogical science;

2) the inverse problems for differential equations — the scientific field of applied mathematics;

3) physical sense of the studied processes and the phenomena are a categorial conceptual framework of methodology of a research of the inverse problems for the differential equations.

The module of a scientific method includes qualification signs, mathematical features, types, identity, mathematical methods of a research of the inverse problems for the differential equations.

Content of target modules

Classification signs of the target module 1 are the most important pedagogical components of training in the inverse problems for the differential equations: training purposes; principles of training; forms of the organization of studies; training methods; tutorials; independent work of students; experimental and pedagogical methods of an examination, skills; professional orientation of training; information technologies of training; intra subject and cross-disciplinary communications of content of training; ways of activization of cognitive activity and creative activities of students; study planning.

Classification signs of the target module 2 are scopes of the inverse problems for the differential equations: geophysics, seismology, a tomography, thermonuclear synthesis, photometry, remote optics, the quantum theory of dispersion, underwater acoustics, quasioptics, diffraction, the theory of molecular vibrations, a georadar-location, a geophysical neytronometriya, a grafimetriya, astrophysics, a subsurface radar-location at small depths, mechanics, ecology, biology, medicine, mechanics of materials, a magnetometry, radio engineering, meteorology and others.

Classification signs of the target module 3 are the principles of creation and the organization of researches of application tasks (the principle of interdisciplinary approach, the principle of structurally functional and dynamic unity, the principle of a multilevelness, the principle of causes and effect relationships).

Maintenance of the module of a scientific method

Classification signs of the module of a scientific method are:

1) mathematical features of the inverse problems for the differential equations (nonlinearity, non-uniqueness, an incorrectness);

2) types of the inverse problems for the differential equations (coefficient, boundary, geometrical, evolutionary);

3) identity of the inverse problems for the differential equations as required functions (coefficients of the differential equations, the right parts of the differential equations, entry or boundary conditions, etc.) can be functions both one-dimensional, and multidimensional; the source initiating the studied physical process can be modelled by various special functions including generalized by functions (for example, Dirac's delta function, etc.) (see, for example [2; 3; 5; 20; 21]);

4) mathematical methods of a research of the inverse problems for the differential equations (analytical, approximate).

Training in the inverse problems for differential equations promotes humanitarization of training of students in the field of applied mathematics as such training has the high humanitarian potential involving extension of outlook of students, development of logical culture of thinking, ability it is correct to establish causes and effect relationships of physical processes, implementation of interdisciplinary communications and an application-oriented directivity of training. In turn, it promotes more deep assimilation by students of disciplines of applied mathematics and other data domains, creates fundamental knowledge of ways of acquisition by mankind of knowledge of the world around and development of methods of knowledge at students.

Scientific bases for designing of the humanitarian oriented studies on the inverse problems for the differential equations promote forming and development in students of the humane relation to the environment, acquaint future specialists in the field of applied mathematics with a problem of moral responsibility before society for consequences of practical implementation of applied researches. Noted influence is reached thanks to forming of specific content of training and selection of system of the inverse problems among which the return tasks of geophysics, the inverse extreme problems of the theory of distribution of impurity, the inverse problems of distribution of a sound in underwater acoustics, the inverse problems for the cable equation and others, to statement of the educational purposes and planning of system of the studies on the inverse problems oriented to creation of the situations demanding from the student of abilities to make decisions on questions, important for mankind, is proved to take the correct position in society, to overcome moral contradictions.

The informatization of training in the inverse problems for the differential equations based on use of computer technologies promotes increase in efficiency of training of students in the field of applied mathematics. It is caused by sales opportunity of the didactic principles of training among which, the principles of creativity and an initiative

of students, collective nature in combination with development of specific features of the identity of each student, scientific character, systemacity, presentation, cross-disciplinary communications. It promotes forming of high standard of knowledge, the skills necessary for the solution of the return tasks, the analysis, comparison, generalization of the received results.

Fundamental knowledge in the field of the theory and methodology of the inverse problems for the differential equations helps to comprehend such important concepts as information, formalization, universality, a correctness of mathematical model, its informative potential, and also to purchase an effective remedy of obtaining, handling and analysis of various information in the form of mathematical methods of the theory of the inverse problems.

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НАУЧНО-МЕТОДИЧЕСКИЕ АСПЕКТЫ ФОРМИРОВАНИЯ ПРЕДМЕТНОГО СОДЕРЖАНИЯ УЧЕБНЫХ КУРСОВ ПО ОБРАТНЫМ ЗАДАЧАМ ДЛЯ ДИФФЕРЕНЦИАЛЬНЫХ УРАВНЕНИЙ

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В статье излагаются научно-методические аспекты формирования содержания обучения обратным задачам для дифференциальных уравнений студентов высших учебных заведений физико-математических и естественно-научных направлений подготовки. Формулируются цели и принципы обучения, приводятся разделы содержания обучения обратным задачам для дифференциальных уравнений. Обращается внимание на частные вопросы преподавания учебных курсов обратных задач. Описываются классификационные признаки и целевые модули, играющие роль инструментария для составления и анализа типовых и учебных программ,

формирования содержания обучения обратным задачам для дифференциальных уравнений. Раскрывается содержание классификационных признаков и целевых модулей. Формулируются выводы о том, что обучение обратным задачам для дифференциальных уравнений обладает научно-образовательным и гуманитарным потенциалом и у студентов в результате такого обучения формируются фундаментальные знания по прикладной и вычислительной математике, а также развивается научное мировоззрение, прикладное, экологическое, информационное мышление.

Ключевые слова: обучение обратным задачам для дифференциальных уравнений, структурирование содержание обучения, классификационные признаки, инструментарий для анализа содержания обучения, прикладная математика, гуманитаризация высшего математического образования, студент

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