Interdisciplinary communications for engineering students

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Abstract. The question of interdisciplinary relations in technical higher educational institutions is considered. The necessity of integrating various courses of disciplines taught to students of engineering specialties is shown. It is proposed to modify the principle of presenting the material on the example of such disciplines as mathematics and physics. The necessity of integrating mathematics with physics is shown and the interweaving of these two disciplines is considered on the example of the implementation of this approach in the study of some sections. One of the options for solving the identified problem of integrating various courses is the creation of a base of interdisciplinary tasks. As a test of the effectiveness of the application of this type of problems, it is proposed to use testing, including the problems of various courses.

Keywords: Interdisciplinary relations between physics and mathematics; integration of taught courses; interdisciplinary tasks; an integrated approach; modification of the principle of presentation of the material; conical sections; stress tensors in mathematics and physics; moment of inertia; mathematical apparatus; physical and mathematical training.

Modern economic conditions determine the increasing requirements for specialists with higher education, the quality of their training. In addition to fundamental knowledge in the field of mathematics and physics, graduates of the natural science faculties of higher educational institutions should be able to use the acquired skills as a tool for solving various applied problems.

However, in connection with the past education reform, there was a reduction in classroom hours allocated for the study of subjects of the natural science block in universities and schools. Thus, a certain contradiction has appeared between the increasing requirements for mathematical and physical education and the reduction in the time allotted for studying both the course of higher mathematics and the course of general physics. One of the ways to resolve the noted contradiction is the reorganization of the independent work of students, and the integration of these courses also becomes relevant.

Studying a cycle of physical and mathematical disciplines often turns into a waste of time from the point of view of students. Even students in the areas of training directly related to the in-depth study of mathematics and physics do not see the connection between the subjects of the physics and mathematics cycle and their practical orientation. Only by working on the final qualifying work, students begin to realize the need for the disciplines studied earlier. "How would I study if I knew that I would need all this!" - From time to time we hear from students of graduation courses.

The traditional system of physics and mathematics education in higher education is least of all focused on giving the student a tool for solving specific problems.

Imagine that students of a radio engineering university until the last year are taught to assemble detector receivers, while the students are not able to turn on the TV on their own. The absurdity of this picture is obvious, but the teaching of physical and mathematical disciplines is often built according to this scheme. Having spent a lot of time studying mathematics, physics and computer disciplines, students turn out to be absolutely helpless in solving real problems.

In lectures and practical classes in physics and special disciplines, one has to make constant mathematical digressions in order to tell or remind students about the mathematical apparatus that will be used in presenting the material (a significant part of the lecture is often spent on mathematical transformations that obscure physical ideas). The problem is that students do not see the connection between the various disciplines being studied. In this regard, it is impractical to teach "pure" mathematics for technical specialties. The mathematical apparatus must be presented with a specific application in a particular practical area, although this is a certain difficulty for some teachers due to the limited time for teaching the discipline, while, according to new standards, it is also necessary to focus on the competencies that are prescribed for each of the taught disciplines. Thus, the physics course can be considered as an excellent field for the application and consolidation of the skills in applying mathematical methods.

The teaching of physics and special disciplines is often not coordinated. You may encounter a situation when, for example, the physical foundations of mechanics within the framework of the physics course and theoretical mechanics, electrodynamics and electrical engineering disciplines are taught simultaneously or almost simultaneously. At the same time, different terminology, different designations, different methods of solving essentially identical problems are used. The students get the impression that the physics course has nothing to do with real problems. Interdisciplinary connections are not traced due to a narrowly pragmatic view of the subject of teachers of special disciplines and an overly theorized approach to teaching physics. As a result, not only students do not see the point in studying a physics course, but also graduating departments, which leads to a systematic decrease in the number of hours devoted to studying a physics course for technical specialties.

As an experiment, an analysis of the content of courses in higher mathematics and general physics for students of engineering specialties was carried out, as a result of which some topics of sections of the course of higher mathematics and general physics were identified, in which the use of integrated approaches would be the most effective.

The presentation of certain topics of the physics course requires an adequate application of the mathematical apparatus. On the other hand, certain issues of the physics course can be viewed as the application of mathematics to solving physics problems. It makes sense to apply this approach in teaching in higher education. For this, it is necessary to modify the principle of presenting the material, both in mathematics and physics. Since in our time mathematics is the language of modern natural science, it is very important in the classroom in mathematics to provide an integrated connection with subjects such as physics. This can be achieved both by selecting the tasks of the physical content, and by clarifying the physical, geometric and mechanical meaning of the concepts used. A deeper intertwining of these two disciplines can be realized by studying the various sections. Let's take a look at some of them.

- Conical sections and motion of cosmic bodies in the course "Analytical geometry".

Conical sections play a certain role in physics, and not only in celestial mechanics, but also in optics. In astronomy, conical sections are obtained by studying the motion of celestial bodies. They are formed at the intersection of a straight circular cone with a plane. Conical sections include curves of the second order: ellipse, parabola and hyperbola. Thus, when studying conic sections in the course "Analytical Geometry", it is possible to consider the trajectories of motion of cosmic bodies as examples [1].

- Stress tensors in mathematics and physics.

A tensor in mathematics is a quantity that has components in each of a given set of coordinate systems, and the components, when passing from one coordinate system to another, are transformed according to a certain law. Tensor calculus, or "absolute differential calculus", allows scientists to formulate and consider general covariant physical laws that remain in force in the transition from one coordinate system to another. Tensors are defined in geometric spaces of any number of dimensions and play an important role in differential geometry, quantum mechanics, celestial mechanics, fluid mechanics, elasticity theory, and especially in general relativity. Vectors and scalars are special cases of tensors. Thus, one of the main tasks of tensor calculus is to find analytical formulations of the laws of mechanics, geometry, physics, independent of the choice of the coordinate system [2].

- Moment of inertia.

Moment is a mathematical concept that plays an important role in mechanics and probability theory. The first-order moment in mechanics is called the static moment, and the second-order moment is called the moment of inertia. The moment of inertia of a body characterizes the inertial properties of a body during rotational motion around its axis, like a mass that characterizes the inertial properties of a body during translational motion. The moment of inertia of a body has many values, depending on the axis of rotation. The concept of the moment of inertia is widely used in solving many problems of mechanics and technology. In mechanics, axial and centrifugal moments of inertia are distinguished. The moment of inertia of bodies of complex configuration is usually determined experimentally. So, for example, two methods of experimental determination of the moment of inertia can be used: by analyzing the oscillations of a physical pendulum, of which the investigated body is a component, and by studying the rotational motion of this body. In mathematics, we also meet the problem of finding the moments of inertia in the study of mechanical applications of double, triple, curvilinear and surface integrals [3].

On the above-mentioned topics, trial lectures were developed and conducted. Several articles have been published based on the materials of these lectures. In addition, active work is being done on the development of practical lessons on the topics of the lectures used. Problems of physical content are selected that can be solved in practical classes in higher mathematics.

Practical training is one of the most important components of the educational process in physics. They contribute to the introduction of students to independent work, teach to analyze the studied physical phenomena, to use the theoretical knowledge gained in practice. If this is supported by a mathematical basis, then the result will be very good.

Thus, it is necessary to create a base of interdisciplinary problems used in disciplines adjacent to mathematics in higher education. Problems with interdisciplinary content in didactics are usually understood as tasks whose solution and analysis requires the attraction and use of knowledge in various subjects of the general technical and special cycle. This type also includes tasks based on the material of one academic discipline, if they are used for a specific didactic purpose in teaching another discipline. The use of interdisciplinary problems in teaching physics and mathematics plays an essential role in the formation of students' abilities and skills in using the mathematical apparatus in practice and for studying other disciplines. They allow concepts, laws and formulas previously studied in other disciplines to be organically incorporated into the system of students' knowledge and to develop their skills and abilities for further application of this knowledge in order to deeply study subsequent disciplines. In addition, solving problems, the content of which is taken from other curricula of other disciplines, is one of the most effective methods that stimulate the activity of the cognitive process, allowing to control the thinking of students and contribute to the development of interest in the discipline [4].

The effectiveness of the implementation of such a teaching method is checked by creating various tests that include questions related to both physics and mathematics. Testing can be carried out, for comparison, in the group trained according to the new method and in the control group, which was trained according to the standard program. Based on the results of such testing, it will be possible to draw comprehensive conclusions.

The introduction of such an approach into the process of teaching mathematics and physics would increase the understanding of the material being studied by the trainees. Also, such an approach can provide additional knowledge that goes beyond the boundaries of the subject being studied, which in the future, undoubtedly, would make it possible to transfer the training of future specialists to a higher level.

References

1. Babaev V.S., Evgrafova I.V. Conical sections and motion of cosmic bodies in the course "Analytical geometry". International collection of scientific articles "Physics at school and university". Iss. 4. – SPb.: Publ. BRAS, 2006., P. 119-125.
2. Babaev V.S., Evgrafova I.V. Stress tensors in mathematics and physics. International collection of scientific articles "Physics at school and university". Iss. 5. – SPb.: Publ. BRAS, 2006, P. 26-34.
3. Babaev V.S., Evgrafova I.V. Study of the moment of inertia of bodies in physics and higher mathematics courses. International collection of scientific articles "Physics at school and university". Iss. 9. – SPb.: Publ. BRAS, 2008, P. 26-30.
4. Evgrafova I.V. Interdisciplinary problems in the study of mathematics, physics and electrical engineering. Proceedings of the international conference, Scientific research of the SCO countries: synergy and integration. Part 1. – Beijing. China, 2021, P. 19-23.