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RESEARCH OF INTERDISCIPLINARY RELATIONSHIPS OF PHYSICS AND SPECIAL OBJECTS OF THE SPECIALTY "MECHATRONICS AND ROBOTICS"

Abstract

The article deals with the tasks of interdisciplinary interaction between physics and special subjects of the direction "Mechatronics and Robotics". The problems of fulfilling the qualification requirements for general professional and special training are identified, the relationship of which disciplines and their individual topics provides an applied orientation of education. The basic physical concepts related to interdisciplinary and are widely used on the basis of special subjects of technical education are given.

Key words: physics, interdisciplinary communications, special subjects, concept formation, electronics, physical properties, mechatronics and robotics.

ИССЛЕДОВАНИЕ МЕЖДИСЦИПЛИНАРНЫХ СВЯЗЕЙ ФИЗИКИ И СПЕЦ ПРЕДМЕТОВ СПЕЦИАЛЬНОСТИ «МЕХАТРОНИКА И РОБОТОТЕХНИКА»

Аннотация

В статье рассматриваются задачи междисциплинарного взаимодействия физики и специальных предметов направления «Мехатроника и робототехника». Выявлены проблемы выполнения квалификационных требований к общепрофессиональной и специальной подготовке, взаимосвязь которых дисциплин и их отдельных тем обеспечивает прикладную направленность образования. Приведены основные физические понятия, относящиеся к междисциплинарным и широко используемые на базе специальных предметов технического образования.

Ключевые слова: физика, междисциплинарные связи, специальные предметы, формирование понятий, электроника, физические свойства, мехатроника и робототехника.

FIZIKA FANI VA “MEXATRONIKA VA ROBOTOTEXNIKA” YO‘NALISHI MAXSUS FANLARINING FANLARARO ALOQALARINI TADQIQ QILISH

Annotatsiya

Maqolada fizika va "Mexatronika va robototexnika" yo'nalishidagi maxsus fanlarning fanlararo o'zaro ta'siri vazifalari ko'rib chiqiladi. Umumiy kasbiy va maxsus tayyorgarlikning malaka talablarini bajarish muammolari, qaysi fanlar va ularning alohida mavzularining o'zaro bog'liqligi ta'limning amaliy yo'nalishini ta'minlashiga alohida e’tibor qaratilgan. Fanlararo bog`liqlik va texnik ta`limning maxsus fanlari asosida keng qo`llaniladigan asosiy fizik tushunchalar keltirilgan.

Kalit so'zlar: fizika, fanlararo aloqalar, maxsus fanlar, tushunchalarni shakllantirish, elektronika, fizik xususiyatlar, mexatronika va robototexnika.

Introduction. A graduate of a modern school, in addition to solid basic knowledge, must have the ability to analyze, to understand the essence of emerging problems and solve problems in the broadest sense. These qualities are signs of scientific thinking, mastering at least elements of which becomes a competitive advantage. Physics as an academic subject can provide the richest opportunities for achieving this goal. The task of developing modern scientific thinking requires the use of situations in teaching that are close to scientific, forming ideas about the methodology of modern physics and the ability to act on its basis, including making decisions in an uncertain, non-standard situation [1].

Modern science is interdisciplinary, therefore higher education provides for the interconnection and coexistence of the subjects taught. Interdisciplinary connections underlie the methodological development of each of the program subjects and are a factor in the effective assimilation of the taught material. In addition, interdisciplinary connections increase the scientific level of students' knowledge, develop their logical and critical thinking, and help develop creative abilities. Interdisciplinary connections and their successful implementation in the educational process reduce duplication in the study of new material, lead to significant time savings, and also form the skills and abilities of students to apply general educational knowledge in practice.

Using robots and mobile devices in education can serve as a foundation for hands-on studies encompassing many different disciplines including computer and electrical engineering, computer science, mathematics, and physics. Educational robots and mobile technology have been shown to be successful in promoting student interest in these and other STEM (Science, Technology, Engineering, and Mathematics) disciplines.

The formation of students' holistic ideas about the world around us requires a generalized approach to the analysis of knowledge of interdisciplinary content. The integrity of the process of educational cognition is determined by the interconnection of elements of knowledge (concepts, laws, theories) of interdisciplinary content, the generality of methods of scientific cognition (empirical, theoretical); forms,

methods, means used both in physics and in general technical, as well as specialized subjects.

Literature review. Many domestic and foreign scientists identify a number of interpretations that contribute to the strengthening of interdisciplinary ties. For example, academician I.D. Zverev paid great attention to the problem of integration and coordination, revealed the content of school subjects and the connections between them, educational and developmental functions of interdisciplinary connections, ways of their implementation, gave a general scheme of connections between subjects. Since the 50s, in studies of various levels (articles, dissertations, monographs) on didactics and private methods devoted to the study of various aspects of the problem, a number of authors have attempted to interpret the concept of "interdisciplinary connections". But to this day there is no single, scientifically grounded definition of this concept, covering its essence and variety of functions in the educational process. Some scholars interpret interdisciplinary connections as a didactic condition that activates cognitive interests, mental activity (N.M. Cherkez-Zade. V.N. Fedorova. D.M. K. P. Korolev. N. G Kulagin. I. D. Zverev and others), the third - as a means (V. P. Schuman. N. S. Antonov and others), the fourth - as an independent didactic principle (N A. Loshkareva. S. A. Roshkova. V. I. Zagvyazinsky. N. G. Ogurtsov. V. N. Maksimova) [2,7].

According to Yu.V. Loginova by identifying the main components, one can see not only the lines of interconnection between subjects, but also how it is possible in the educational process to ensure the fulfillment of qualification requirements for general professional and special training, the interconnection of which disciplines and their individual topics provides an applied orientation of education. This makes it possible to objectively substantiate the presence of an integration relationship between physics and the disciplines of general professional and special training, capable of providing an applied orientation of training a specialist in the field of technology and served as the basis for drawing up a structural and logical diagram of the relationship of the discipline "Physics" with special and general professional disciplines[2,3].

Research methodolgy. Common to all material systems are certain regularities, which are called physical laws. Physics is often called a fundamental science, since other natural sciences (biology, chemistry, geology) describe only specific classes of material systems that obey physical laws.

Physics is closely related to mathematics, since it provides a mechanism by which physical laws can be formulated as precisely as possible. All physical laws are almost always formulated as equations. Moreover, in this case, the most complex sections of mathematics are used, rather than in other sciences. Conversely, the needs of physical science stimulated the development of most areas of mathematics.

The importance of physics in the modern world is very great. Everything that distinguishes today's society from the society of past centuries has arisen as a result of the application of physical discoveries. Research in the field of electromagnetism led to the emergence of fixed and mobile phones. Thanks to the discoveries of thermodynamics, it was possible to create a car, and the development of electronics provoked the emergence of computer technology. Photonics makes it possible to create fundamentally new computers and photonic equipment that are rapidly replacing modern electronic equipment and devices. And the development of gas dynamics gave birth to airplanes and helicopters. Knowledge of the physical processes that constantly occur in nature is deepened and expanded. Most of the new and modern discoveries receive technical and economic applications, often in industry.

Today, mechatronics and robotics is considered one of the most advanced areas of science and technology, which leads to a new interdisciplinary direction of education that integrates knowledge from the field of mechanics, electronics and microprocessor technology, computer science and computer control of the movement of machines and units.

This definition emphasizes the triune essence of mechatronic systems (MS), which are based on the idea of a deep interconnection of mechanical, electronic and computer elements [5].

With the rapid and continued advancement in integrated circuit technology, more and more devices have the capability to sense the environment, make decisions based upon coded instructions, and take some physical action within the environment. Machines with this flexible control capability can be classed as mechatronic systems. Therefore, it is important to produce engineers who are versed in all of the contributing disciplines necessary to create such integrated devices.

In recent years, a physical interpretation of mechatronics has been proposed as "a means of making a decision on controlling the functioning of physical systems" or as a computer control of the transfer of physical energy in controlled technical systems "(here energy acts as a quantitative measure of the movement and interaction of all types of matter - mechanical, thermal, electromagnetic, nuclear, plasma, gravitational, etc.) [6].

Subjects are taught in the specialty "Mechatronics and Robotics" such as - "Fundamentals of Engineering Materials", "Fundamentals of Circuitry and Electronics", "Fundamentals of Mechatronics", "Instrumentation and Systems", "Industrial Electronics", "Control Theory", " Fundamentals of Thermodynamics and Heat Transfer ”and their interdisciplinary connections with physics as didactic conditions for optimizing the learning process of students, contribute to improving the quality of the formation of concepts, skills, scientific worldview. They are a prerequisite for reducing student workload by eliminating duplication. Interdisciplinary communications can be carried out at the level of facts: concepts, laws, theories, methods of educational cognition [4,8]. However, the level of concepts and methods of educational knowledge for physics and the above subjects is the most significant (Fig. 1).

Among the many physical concepts there are those that can be attributed to interdisciplinary: quantity, function, functional dependence of quantities, vector, scalar, voltage, power, sensor, regulation, etc. They are widely used in the disciplines of the natural cycle, especially in the above subjects. Methods of scientific (educational) cognition such as analytical, graphic, statistical, etc. allow revealing the essence of concepts and the nature of integrative relationships on a scientific basis.

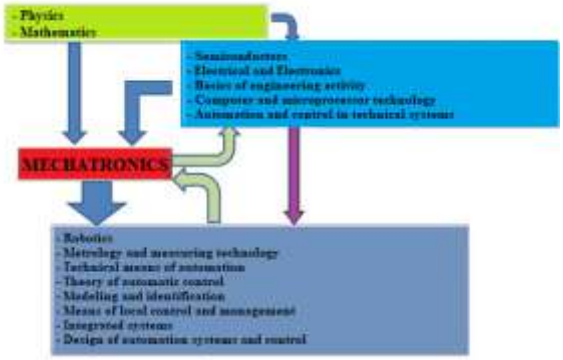

Fig.1. Interaction of disciplines

Analysis and results. As a result of studying the general professional module GPM.2.05 "Control and measuring devices and systems", taking into account the specifics of technological processes, the student must:

have practical experience:

to measure the physical quantities of simple automation systems and simple functional blocks of mechatronic devices and systems;

be able to:

to draw up structural and functional diagrams of various automation systems, components of mechatronic devices and control systems; apply development and debugging tools for specialized software for controlling technological equipment, automated and mechatronic systems;

know:

physical purpose and physical properties of the main elements of functional blocks of modules of mechatronic devices and systems, determination of the initial requirements for materials and their physical properties, as well as ways of regulating the elements of mechatronic devices based on their physical properties, etc.

In connection with the inclusion of elements of mechatronics and robotics in the educational process, appropriate training of engineering personnel with systemic knowledge in this area is required.

Since the formation of professional competencies with the use of mechatronic and robotic systems requires knowledge testing, the development of skills and practical skills in several related disciplines, our institute uses an innovative direction - interdisciplinary integration, in connection with which the coordinated work of teachers of mathematics, physicochemical and general natural science cycle and teachers of the professional cycle.

Interdisciplinary integration resolves the contradiction existing in the subject system between the disparate assimilation of knowledge and the need for their synthesis, complex application in practice and modern production. This technology improves the quality of education, contributes to the formation of professional competencies of graduates, and increases the level of their competitiveness in the labor market.

Methodological methods of teaching the elements of mechatronics within the framework of the discipline "Physics" and the professional module involve the use of the following organizational forms in the educational process:

- extracurricular independent work in physics - involves in-depth mastering of knowledge and skills in physics to apply the acquired knowledge in solving professional problems with elements of mechatronics;

- holding binary events (training sessions, workshops, round tables, etc.) "Physics and mechatronics" in order to form the students' perception of the unity of physical laws as an element of mechatronics;

- holding joint meetings of subject-cycle commissions in order to develop or adjust the work programs of academic disciplines and professional modules;

- holding extracurricular interdisciplinary events within the subject weeks;

- organization of interdisciplinary seminars for teachers and students;

- popular science lectures, etc.

With such a methodical approach to the development of professional training of students from a lower level of work with adapted material in the academic discipline to a higher level of mastering the professional module, the possibility of maximum immersion in the specialty is realized, which will contribute to a deeper interest in future professional activities.

Let us consider as an example the relationship between the sections of the course of physics and the main components of mechatronics.

Table. 1

The relationship between the sections of the course of physics and the main components of mechatronics.

Sections of the physics course / Main Components of Mechatronics	Macroscopic physics				Microscopic physics						
	Mechanics	Thermodynamics	Optics	Fluid dynamics	Atomic physics	Statistical physics	Condensed matter physics	Quantum physics	Nuclear physics	High energy physics	Particle physics
	classical mechanics, relativistic mechanics, and continuum mechanics (elasticity, hydrodynamics, solid state mechanics)	Nonequilibrium thermodynamics physical	Optics, crystal optics, molecular and nonlinear optics	Magnetohydrodynamics, electrohydrodynamics, and electrodynamics of continuous		Statistical mechanics, physical kinetics, and also relativistic field theory	Physics of liquids and solids, physics of nanostructures and physics of molecules and atoms	Quantum field theory, quantum mechanics, quantum electrodynamics, quantum electrodynamics, and atomic			
Mechanics											
Electronics											
Microprocessor technology											
Informatics											
Computer control of the movement of machines and units											

The table shows that all the main components of mechatronics, or all the main constituent objects that are synergistically interconnected, are directly tightly connected with a large part of the sections of physics. From this it should be concluded that the entire foundation of technical subjects is built on physics and mathematics.

Conclusion/Recommendations. Thus, the educational process of teaching requires the use of interdisciplinary connections of physics and special subjects of the direction "Mechatronics and Robotics", namely: a combination of theoretical methods for studying physics with experimental methods based on the available concepts of elementary mathematics, mechanics, electronics and electrical engineering, computer science, etc. This approach simultaneously ensures the achievement of a high level of assimilation of special subjects, forms the critical and logical thinking of students, and also contributes to understanding the unity of the material world. Students have an understanding that the laws of physics as well as mathematical formulas and equations are actually implemented in technological processes.

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