

**A SYSTEMATIC APPROACH TO TEACHING PHYSICS IN HIGHER  
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**ABSTRACT:** This article discusses some issues of applying the systematic analysis method to teaching physics in higher education institutions. The article presents possibilities for explaining certain phenomena within the field of physics through general approaches, laws, and concepts. It is emphasized that a systematic approach to studying natural phenomena can ensure that students acquire complete and comprehensive knowledge and that their creative abilities are enhanced. The essence and principles of a systematic approach to teaching physics are revealed. Examples of applying the systematic approach method in studying certain topics are provided.

**KEYWORDS:** systematic approach, system, system elements, wholeness, generality, consistency.

**INTRODUCTION**

As a result of the development of modern sciences, the volume of knowledge that must be mastered and the flow of information are rapidly increasing. High technologies are rapidly entering production, science, engineering, medicine, and other fields. In such circumstances, specialists must possess very broad modern fundamental and technical knowledge, practical skills, and the ability for systematic analysis and reflection. Training modern specialists requires a fundamental reform of educational institutions' activities and the application of advanced pedagogical technologies, ideas, and practices to the learning process. Modern educational approaches—including information, integrative, systems analysis, synergetic, and interactive technologies—as well as problem-based teaching methods are being applied to the learning process. In traditional teaching, the branches of physics are taught separately: for example, mechanics is taught separately from electrodynamics, wave processes from quantum physics, and laboratories are conducted separately from lectures. As a result, the acquired knowledge became fragmented and did not provide sufficient opportunity to create a unified scientific picture of the Universe. Below, we examine the issues of applying a systematic analysis method to the teaching of physics in higher and secondary education institutions.

## MAIN PART

In modern scientific literature, the systematic approach is often regarded as a direction in the methodology of scientific knowledge and social practice based on viewing the objects under study as systems. The systems approach directs researchers' attention to the object's wholeness and its various interconnections, enabling them to draw a single theoretical conclusion.

The essence of the systemic approach is that when studying a system's functioning, its constituent elements are not viewed in isolation but are always considered to be in interaction, development, and motion. When any component or element of a system changes, the others also change in relation to it.

The systems approach is based on studying objects or processes as a whole and is considered the most universal method for researching and analyzing complex systems. In this approach, objects are viewed as systems composed of elements that are functionally related and bound together by certain laws. A systems approach is a method for systematizing and integrating knowledge about things by identifying the important relationships between them.

Systems analysis is a methodological approach that allows for examining objects, phenomena, and processes as systems composed of interrelated elements. Implementing a systematic approach to teaching physics in educational institutions helps students understand not only the formulas and laws individually but also their interrelationships. It helps students understand how the unified scientific picture of the world is formed. A systematic approach makes it possible to draw comprehensive, general conclusions about objects or phenomena by systematizing the knowledge accumulated through the study of physical phenomena and processes.

Systematic analysis in physics instruction provides the following opportunities. First, it helps students develop a holistic understanding of nature, since physics studies all phenomena and processes occurring at the micro, macro, and mega-universe scales. A systematic approach helps reveal the general principles common to various branches of physics. Secondly, it helps develop students' scientific thinking skills. Systemic analysis teaches how to distinguish system elements (objects, environments, parameters), establish cause-and-effect relationships, identify key factors, and create models. These skills are of great importance for physics, engineering, mathematics, computer science, and other scientific fields. Thirdly, it enhances the student's ability to understand problems. Instead of using a ready-made formula, the student learns to understand the situation, identify laws and rules, create a physical model, and interpret the results.

How to apply systems analysis in physics lessons. Before solving a problem, one must analyze the physical system.

Before calculating by formula, students must describe the system boundaries, its elements, the input and output parameters, and the interactions. For example, when analyzing the motion of a body, one treats the body as a system and considers the external forces—gravity, friction, and elastic forces—as input parameters, along with velocity and position. Describing quantities such as mass, it is possible to determine the acceleration and the motion trajectory.

From a systematic perspective, the mechanical motion that describes a body's change in position in space over time can be viewed as a system of three types of motion: translation, rotation, and oscillation. The physical quantities and laws characterizing these motions are general. When the body's position is given by coordinates and an angle of rotation, the rates of motion are characterized by linear and angular velocities, while the rates of change of the velocities are characterized by linear and angular accelerations. There are interrelationships among these quantities, and their mean and instantaneous values are determined by the same rules. The time-dependent laws of change for these quantities also exhibit a general similarity. All motions are governed by Newton's second law, the fundamental law of dynamics. Based on this law, the mathematical relationships between the causes of motion (force, torque), a body's inertia (mass, moment of inertia), accelerations (linear and angular), or a body's momentum and angular momentum also have a common similarity and content. For these motions, the fundamental laws of nature—namely the laws of conservation of energy and its conversion, and the conservation laws of mechanical energy, momentum, and angular momentum—share a common essence. The differential equations of these motions also share common form and content. Thus, although translation, rotation, and oscillatory motions manifest in different geometric forms, they are governed by the same mathematical and physical laws. Therefore, it is most appropriate to view them not as separate phenomena but as different manifestations of a single mechanical system. Presenting topics based on systematic analysis develops students' logical thinking and comparison skills and ensures the coherence of the knowledge acquired.

The following example can be given for applying the systematic analysis method when covering the topic of studying the laws of harmonic oscillation.

To determine the dependence of the period of a spring pendulum—a mechanical harmonic oscillator—we consider it a system consisting of an elastic spring, the suspended mass, and the suspension point. The task is to explain to students from which quantities the pendulum's period depends. The mass of the load, the spring constant, and the displacement of

the load are the input parameters for this system. Among the interaction forces, one can highlight the elastic force, the gravitational force, and the forces of resistance from the medium. By applying Newton's second law and introducing certain notations, we derive the differential equation for the pendulum's oscillation. This equation is a second-order linear differential equation, which we adopt as our model. From the introduced notations, we obtain mathematical expressions for the oscillation frequency and period as output parameters. According to these expressions, the oscillation period of the spring pendulum is a quantity that depends on the mass of the load and the spring constant.

System analysis requires the creation of physical models of processes or phenomena. Mechanical schematics, electrical circuits, and mathematical equations can be regarded as models. If we regard the science of physics as a single system, it is important to identify the connections between its various branches. For example, the law of conservation of energy is a universal system principle common to all branches. Mechanical and electromagnetic oscillations share common characteristics, such as the law of harmonic oscillation, free, damped, and forced oscillations, their equations, the concept of resonance, and their characteristics: period, frequency, and amplitude. phase, and others are considered common aspects. A systematic approach requires interrelationship, interconnectedness, synthesis, and generalization among certain topics, sections, phenomena, and processes regarded as system elements. For example, within the field of physics one can observe the interrelationships, synthesis, and generalization tendencies among certain phenomena studied separately, the laws governing them, the sections that systematize them, and the types of activities conducted. For example, in the department of mechanics, one can observe the interrelationships, synthesis, and generalization trends between the gravitational field, which is the medium for the gravitational interaction occurring between all bodies, and in the department of electromagnetism, the electrostatic, magnetic and time-varying electromagnetic fields, and in the department of Nuclear and Particle Physics, the weak and strong interaction fields are studied separately.

After it was discovered that fields share common features—such as mechanisms of mutual interaction—theories unifying them emerged. According to these theories, the aforementioned fields are regarded as distinct manifestations of a single field. Wave processes observed in all linear systems in nature occur according to the same laws. Mechanical, electromagnetic, and de Broglie waves are expressed and interpreted using similar equations.

Students come to understand that physics is not a collection of topics but a network of interconnections and relationships.

## CONCLUSION

By applying the method of systematic analysis to the teaching of physics in higher education institutions, students gain a deeper understanding of the nature of physical phenomena and develop better skills in solving complex problems, modeling, and analysis. Students perceive physics not as a collection of diverse topics but as an integrated, interconnected system of concepts, laws, methods, and models. A systematic approach allows students to grasp the concepts of a unified scientific picture of the world. The distinctive features of modern sciences, based on the principles of systematic analysis, are not confined to narrow areas of knowledge, It helps to find new paths for the development of modern education that foster the cultivation of a multifaceted, creative individual capable of viewing the world as a whole and of functioning independently in professional and social spheres. Applying the systematic analysis method of teaching to the educational process enables students and learners to generalize and systematize the knowledge they have acquired, and to perceive the essence of a problem and its solution as a whole. Considering and applying the concepts of a systematic approach within a specific subject in the educational process ensures that the knowledge acquired by students is complete and comprehensive, and enhances their creative abilities.

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