MATHEMATICAL MODELS ANALOGICAL METHOD IN CONSTRUCTION

[1]Primov Tulkin Islamovich, [2]Qurbonov Shuhrat Zarifovich, [3]Jamolov Shahboz Jamil o'g'li
Senior Lecturer, Shahrisabz Branch of the Tashkent Institute of Chemical Technology[1], Assistant of Shahrisabz branch of Tashkent Institute of Chemical Technology[2], Assistant of Shahrisabz branch of Tashkent Institute of Chemical Technology[2],
tprimov_197070@mail.ru[1] , shuhratqurbonov544@gmail.com[2] , shahbozjamolov21@mail.ru[2]

ANNOTATION

Mathematical modeling, mathematical model of an object, systems of units of measurement, principles of variation, elements of the system, physical, biological or social phenomena and their descriptive properties.

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ANALOGY METHOD

Mathematical modeling is the most versatile, highest form of modeling method successfully applied in science. Physical modeling has long been known as a means of knowing and constructing natural phenomena. As the simplest form of physical modeling, mechanical modeling can be obtained, as the study of the object of interest to us is replaced by the study of its smaller or larger-scale model in the laboratory. For example, if the geometric and dynamic similarity criteria are met, the flow around the abbreviated model of the aircraft in the wind tunnel will replicate the image of the aircraft flying in the atmosphere with sufficient accuracy. A more complex type of physical modeling is analog modeling, in which a similarity is established between two different physical processes (e.g., a similarity between thermal conductivity and electrical conductivity) and a single natural process. modeled by other physical nature processes.

This similarity is also relevant in mathematical modeling, which is characterized by the fact that a relatively small number of simple mathematical models are the key to understanding and studying a large number of different phenomena. For example, the potential of an electric field is defined by the same differential equation as the temperature field in a body where the conductors are formed as a result of charges on the surface and the surface has a certain temperature. Different physical processes can be covered by a relatively small number of mathematical models, which is one of the reasons for the success of mathematical modeling, based on the universality of the first assumptions about the process and the conclusion about the universality of the second.

In many cases, in trying to create a model of an object, it is not possible to show either the laws of direct storage or the variational principles that govern it, or to recognize such laws that recognize a mathematical formula in terms of our current knowledge. there is no certainty of its existence at all. Such objects include, for example, systems in which there is significant human intervention, particularly economic systems.

One of the most effective approaches in constructing models of this type of object is to use similarities with the phenomena already studied: the methods and results developed and collected in mathematical modeling of some phenomena are transferred by analogy to different processes in a wide range of classes. is carried out. For example, mechanical and economic similarities are known (using the idea of "saturation": the rate of growth of any quantity over time is the difference between the limit value of the product and the current value of that quantity. use of the laws of proportionality, the transition from the micro to the macro level), thermodynamic and economic similarities (ideas about the transition from stationary processes, equilibrium states, discrete to continuous models), etc. The use of such similarities provides a deeper understanding of the basic properties of objects that are difficult to formalize.

HIERARCHY OF MODELS

The development of science in the 20th century has shown the need to create different models to describe a single event or object, to create alternatives to reality. The level of optimally selected modeling depends significantly on its objectives: if there is no practical need for it, it is not necessary to use a high-level model, which is more expensive in terms of computer resources. But even in another case, it is not justified to construct mathematical models in "completeness" at the same time, taking into account all the factors necessary for his behavior.

An approach that implements the "simple to complex" principle is more effective because, after a sufficiently detailed study of a less complex model, the next step is to reject one or more simplified assumptions that idealize the object under study. In this case, an increasingly complete chain (hierarchy) of models emerges, each of which generalizes the previous ones, including them as a separate case. The "simple to complex" path allows for a more step-by-step study of more realistic models and a comparison of their features.

The hierarchy of mathematical models is often built on the opposite principle of "from complex to simple", "from general to specific". In this case, the "top-down" path is an increasingly simple (but applicable) model from a very general and complex model with correspondingly simplified assumptions and concretization of the object under consideration, defined by the processes taking place in it, its geometry, and so on. decreasing range) models. This approach allows you to immediately establish some common features of an object, concretize and supplement them in specific situations. In this case, the length of the chain formed can be very important.

Most of the real processes and the mathematical models that correspond to them are not linear. However, linear models derived from nonlinear models based on specific simplified assumptions (linearization) and applicable only to describe small changes in object properties should be included in the hierarchy of mathematical models because they are easy to study and the first to approach reality. phase function. For example, assuming that the thickness of the net is much less than its length, that it has a constant linear density, the amplitude of oscillation is much less than the length of the net, and that if we ignore the longitudinal displacements and velocities of the narrow sections, we achieve the model. Of course, the linear model does not give a complete view of the process, but it is possible to obtain a number of data that are useful for a more complete study. Thus, linear and nonlinear models in hierarchical chains, stationary and non-stationary models, models that differ in the type of differential equations used in them (equations of hyperbolic, parabolic, elliptic type, as well as mixed types), multidimensional and one-dimensional models and so on. Additional variations of the built models are related to the different options of boundary conditions and other initial data. In constructing and analyzing any model, it is always useful to know its place in the general hierarchy of object models under study [5]. This allows for a more accurate assessment of the scope and a clearer understanding of the relationships with models at other levels, i.e., a deeper understanding of the phenomena being studied.

STUDY THE MODEL

One of the important aspects is to study the model that is formed. The resulting models are, as a rule, a system of complex equations that allow only a combination (solution in a limited form). Only in exceptional cases is it vital to develop methods of investigating them. Here we can highlight the qualitative methods that make up a large part of modern mathematics - a set of methods, drawing certain conclusions about decisions without knowing the exact expression of the decisions. These include methods for studying the availability and specificity of a solution, its stability, asymptotic behavior, dimensional analysis, group analysis of models, and more. Such theoretical analysis allows the development of qualitative numerical methods and the prediction of the properties of a digital solution in the next stage of modeling - in the design of computational algorithms.

The use of computers in the search for analytical expressions of a solution and in the performance of analytical calculations in general significantly expands the possibilities of studying mathematical models. To date, dozens of special software systems (Reduce, Maple, Mathematica, etc.) have been created to make any analytical changes.

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