ISSN:2828-6235
Impact factor:13.77

International Journal of Literature and Language Studies(IJLLS)

THE USE OF DIFFERENTIAL EQUATIONS IN MATHEMATICAL MODELING

O.M.Mamalatipov

A. Solijonov

mamalatipovodiljon5@gmail.com.

Abstract: This article examines the concept of mathematical modeling, its significance in solving practical and scientific problems, and the role of differential equations within the mathematical modeling process. It addresses the modeling of dynamic processes using ordinary differential equations, the importance of initial and boundary conditions, and the assessment of how well a mathematical model corresponds to the actual process.

Keywords: mathematical modeling, differential equation, mathematical model, ordinary differential equation, initial condition, boundary condition, mathematical analysis, modeling, dynamic process.

Аннотация: В статье рассматриваются понятие математического моделирования, его значение для решения практических и научных задач, а также роль дифференциальных уравнений в процессе математического моделирования. Особое внимание уделяется моделированию динамических процессов с использованием обыкновенных дифференциальных уравнений, важности начальных и граничных условий, а также оценке соответствия математической модели реальному процессу.

Ключевые слова: математическое моделирование, дифференциальное уравнение, математическая модель, обыкновенное дифференциальное уравнение, начальное условие, граничное условие, математический анализ, моделирование, динамический процесс.

Annotatsiya: Ushbu maqolada matematik modellashtirish tushunchasi, uning amaliy va ilmiy masalalarni hal etishdagi ahamiyati hamda matematik modellashtirish jarayonida differensial tenglamalarning tutgan o‘rni ko‘rib chiqiladi. Unda oddiy differensial tenglamalar yordamida dinamik jarayonlarni modellashtirish, boshlang‘ich va chegara shartlarining ahamiyati hamda matematik modelning real jarayonga qay darajada mos kelishini baholash masalalari yoritiladi.

Kalit so'zlar: matematik modellashtirish, differensial tenglama, matematik model, oddiy differensial tenglama, boshlang'ich shart, chegara sharti, matematik tahlil, modellashtirish, dinamik jarayon.

INTRODUCTION

Today, the rapid development of science and technology necessitates the in-depth study of various processes, the identification of the laws governing their evolution, and the forecasting of their future states. Mathematical modeling serves as a crucial scientific tool in addressing such issues. Mathematical modeling is the process of representing the essential characteristics of a real-world object or process using mathematical formulas, equations, and functions. Through a mathematical model, it is possible to theoretically investigate complex processes without conducting experiments, determine outcomes under various conditions, and seek optimal solutions.[1]

In many real-world processes, it is necessary to account for how quantities change over time or across space. Differential equations play a vital role in describing precisely such processes. A differential equation expresses the relationship between an unknown function and its derivatives.

THE CONCEPT OF MATHEMATICAL MODELING. Mathematical modeling is a method of representing and studying real-life processes using mathematical tools. A model reflects not all the characteristics of a real object, but rather the key features necessary to solve the problem at hand.[2]

Creating a mathematical model typically involves the following stages:

- Identifying the object or process under study;
- Defining the key parameters and variables;
- Determining the relationships between them;
- Representing the process via a mathematical equation or system of equations;
- Specifying initial or boundary conditions;
- Solving the mathematical problem;

Analyzing the results obtained and comparing them with the real-world process. The primary advantage of a mathematical model is that it enables the study of a complex process in a simplified form.[3]

EVALUATING THE ACCURACY OF A MATHEMATICAL MODEL.

Any mathematical model is based on a certain degree of simplification. Therefore, it is important to compare the model's results with those obtained from actual observations or experiments.

The accuracy of the model can be influenced by the following factors:

- the accuracy of the initial data;
- the correct selection of the mathematical model;
- the accuracy of the parameters;
- measurement errors;
- the accuracy of the computational method;
- the assumptions adopted in the model.

For this reason, in mathematical modeling, it is important not only to formulate the equation but also to analyze the results and align the model with the real-world process.[4]

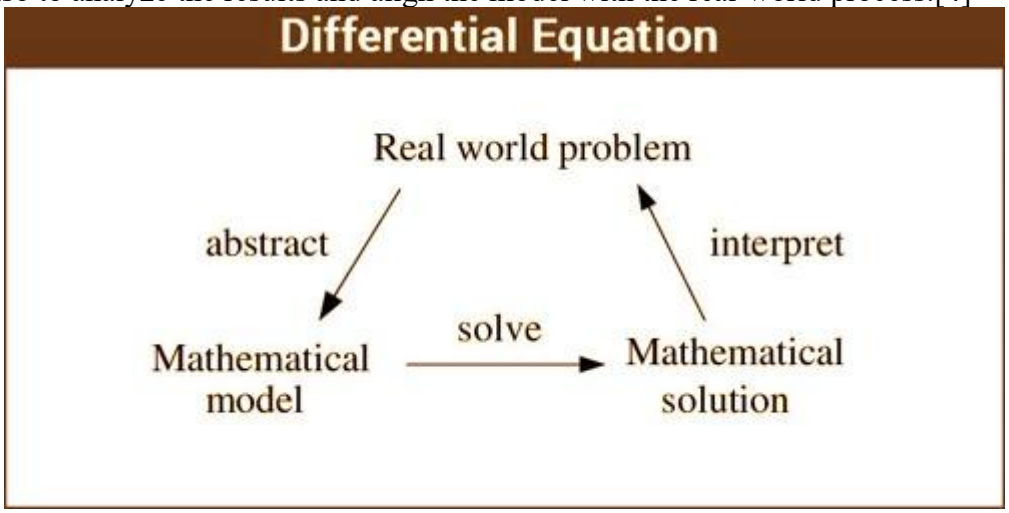


Figure-1 Differential equation

Differential equations are widely used to model dynamic systems in which the current state of a process depends on its previous state or on the interaction between different variables. For example, population growth, the spread of diseases, the movement of physical objects, heat

transfer, fluid flow, chemical reactions, economic processes, and structural behavior can all be represented using differential equations. By solving these equations, researchers can obtain information about the behavior of a system and make predictions about its future development.[2]

Overall, the results confirm that differential equations significantly improve the ability to analyze dynamic systems. Their application allows researchers to identify relationships between variables, evaluate changes over time, predict future states, and test different scenarios without conducting costly or time-consuming real-world experiments. Therefore, differential equations can be considered one of the fundamental mathematical tools for developing reliable mathematical models in science and engineering.

Conclusion

In conclusion, the study demonstrates that differential equations play a fundamental role in mathematical modeling and provide an effective means of describing dynamic processes in the real world. They allow relationships between variables and their rates of change to be expressed mathematically, making it possible to analyze the current state of a system and predict its future behavior.

The analysis shows that differential equation models can be successfully applied to a wide range of fields, including physics, engineering, biology, economics, environmental science, and technology. Simple models, such as exponential and logistic growth equations, can describe basic dynamic processes, while more complex differential equations can be used to represent systems involving multiple variables and interacting factors. An important finding is that numerical methods and modern computer technologies significantly expand the possibilities of differential-equation-based modeling. When analytical solutions are difficult or impossible to obtain, numerical approaches such as the Euler and Runge–Kutta methods provide practical approximate solutions. Computer simulations also allow researchers to examine different initial conditions, parameters, and possible scenarios efficiently. At the same time, the accuracy of a mathematical model depends on the assumptions, parameters, and initial conditions used in its construction. Therefore, mathematical models should be validated using experimental or observational data whenever possible. A well-developed model should not only provide mathematical solutions but also adequately reflect the essential characteristics of the real system.

Thus, differential equations remain an essential tool for modern mathematical modeling. Their ability to describe change, predict system behavior, and support analysis and decision-making makes them highly valuable in scientific research and practical applications. Further development of computational methods, numerical algorithms, and mathematical modeling techniques will continue to increase the effectiveness and applicability of differential equations in solving complex real-world problems.

References

1. Boyce, W. E., DiPrima, R. C., & Meade, D. B. (2017). *Elementary Differential Equations and Boundary Value Problems* (11th ed.). John Wiley & Sons.
2. Zill, D. G. (2018). *A First Course in Differential Equations with Modeling Applications* (11th ed.). Cengage Learning.
3. Edwards, C. H., & Penney, D. E. (2014). *Differential Equations and Boundary Value Problems: Computing and Modeling* (5th ed.). Pearson.

4. Mamalatipov O., Shahobiddin K. STAGNATION IN THE RITZ AND GALYORKIN METHODS //International Bulletin of Engineering and Technology. – 2023. – Т. 3. – №. 5. – С. 17-22.
5. Yo‘ldoshaliyev A. S., Mamalatipov O. M. STRUCTURAL GEOLOGY AND TECTONICS //Journal of Universal Science Research. – 2024. – Т. 2. – №. 1. – С. 50-59.
6. .Murodilov K. T., Muminov I. I., Abdumalikov R. R. DESIGN PRINCIPLES FOR EFFECTIVE WEB MAPS //SPAIN" PROBLEMS AND PROSPECTS FOR THE IMPLEMENTATION OF INTERDISCIPLINARY RESEARCH". – 2023. – Т. 14. – №. 1.
7. Salimjon o‘g Y. A. et al. IMPROVEMENT OF METHODS OF GEOLOCATION MAP FOR MONITORING OF CLUSTER ACTIVITY OF REGIONS AND DEVELOPMENT OF THE BASIS OF WEB CARDS //" RUSSIAN" ИННОВАЦИОННЫЕ ПОДХОДЫ В СОВРЕМЕННОЙ НАУКЕ. – 2023. – Т. 9. – №. 1.