ICMASE 2026

SOLVING GENERAL FRACTIONAL OSCILLATION RELAXATION EQUATION BY ROTHE'S APPROACH AND NIM

Yogita Mahesh Mahatekar[1,*],

[1]*Assistant Professor, COEP Technological University, Pune-411005, India*

ABSTRACT

Abstract Fractional differential equations (FDEs) have gained significant attention due to their ability to model complex physical phenomena involving memory and non-local effects, particularly in fields such as fluid dynamics, biology, and engineering. However, obtaining exact solutions to such equations remains a challenging task, necessitating the development of efficient analytical and numerical methods. In this paper, we investigate a generalized fractional oscillation relaxation equation, also known as the Basset equation, formulated in a Banach space. The equation models the motion of a spherical particle in a viscous fluid under gravitational influence and incorporates fractional derivatives to capture hereditary properties of the system. We establish conditions for the existence and uniqueness of strong and classical solutions. To solve the problem, we develop a novel numerical algorithm by combining Rothe's approach with the New Iterative Method (NIM). The proposed scheme, termed the RN method, is based on temporal discretization using Rothe's technique along with an L1 approximation for the Riemann–Liouville fractional derivative. The resulting formulation transforms the original problem into a system suitable for iterative decomposition. The RN method is constructed as a three-step predictor–corrector scheme, involving two predictor stages followed by a correction stage derived from truncated NIM series expansion. This approach effectively handles the nonlinear term and improves computational efficiency while maintaining accuracy. An illustrative example from fluid dynamics is presented to demonstrate the applicability and effectiveness of the proposed method. The results indicate that the RN method provides a reliable and efficient approximation for solving fractional oscillation relaxation equations. The proposed framework offers a promising tool for analyzing fractional models and can be extended to a broader class of fractional differential equations arising in applied sciences.

***K*eywords** Fractional Differential Equations · New Iterative Method · Rothe's Approach · Basset Equation

References

[1] F. Anjara and J. Solofoniaina, Solution of general fractional oscillation relaxation equation by Adomian's method, Gen. Math. Notes, Vol. 20, No. 2, pp. 1–11, 2014.

[2] V. Daftardar-Gejji and H. Jafari, An iterative method for solving nonlinear functional equations, Journal of Mathematical Analysis and Applications, Vol. 316, No. 2, pp. 753–763, 2006.

[3] R. Devi and D. N. Pandey, Approximation of solution for generalized Basset equation with finite delay using Rothe's approach, Malaya Journal of Matematik, Vol. 11, No. 1, pp. 25–42, 2023.

[*]*Corresponding Author's E-mail: yogitasukale25@gmail.com*