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Analytical Solutions of the Fuzzy Fractional Generalized Bagley–Torvik Equation via Fuzzy ψ-Caputo gH-Differentiability

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Authors:
M'hamed Elomari
Aziz El Ghazouani
Aissam Ghafari

Fp, Beni Mellal , Morocco
Fst , Beni Mellal, Morocco
Fst, Beni Mellal, Morocco

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Abstract

The fractional generalized Bagley–Torvik equation (FGB-TE) describes the motion of an immersed plate in a Newtonian fluid, incorporating two independent fractional orders to model both viscous and elastic effects [1]. Analytical study of such systems is challenging, particularly under uncertain initial conditions. In this work, we develop an efficient analytical approach to solve the fuzzy fractional generalized Bagley–Torvik equation (FFGB-TE) by combining the fuzzy Laplace transform (FLT) with the concept of fuzzy ψ-Caputo generalized Hukuhara (gH) differentiability [2,4]. The method produces closed-form fuzzy solutions for both homogeneous and non-homogeneous cases, expressed in terms of the Mittag–Leffler function [3]. Key theoretical results are rigorously derived, and illustrative examples demonstrate the effectiveness and applicability of the proposed approach for modeling fuzzy fractional dynamical systems. This study extends the analytical treatment of fuzzy fractional differential equations and provides a practical tool for complex viscoelastic modeling.

References

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