



# A NOVEL NONLOCAL BOUNDARY VALUE PROBLEM FOR FUZZY FRACTIONAL VOLTERRA INTEGRO- DIFFERENTIAL EQUATIONS: THEORETICAL ANALYSIS AND NUMERICAL SIMULATIONS

YOUSSEF H. AL-GARADI<sup>1,2</sup>

<sup>1</sup>Department of Mathematics, Mahrah University, Mahrah, Yemen  
(E-mail: [y.algaradi@mhru.edu.ye](mailto:y.algaradi@mhru.edu.ye))

AMOL D. KHANDAGALE<sup>2</sup>

<sup>2</sup>Department of Mathematics, BAMU, Chh. Sambhajinagar, India  
(E-mail: [kamoldsk@gmail.com](mailto:kamoldsk@gmail.com))

and

ABDULRAHMAN SHARIF<sup>2,3</sup>

<sup>3</sup>Department of Mathematics, Hodeidah University, AL-Hudaydah, Yemen  
(E-mail: [abdul.sharef1985@hoduniv.net.ye](mailto:abdul.sharef1985@hoduniv.net.ye))

**Abstract.** This paper studies a class of fuzzy fractional integro-differential equations of Volterra type with a mixed nonlocal boundary condition that combines end-point state feedback and a Riemann–Liouville memory term. The formulation relies on generalized Hukuhara differentiability and the Caputo fractional derivative. The main contributions are threefold: we first establish an equivalent system of fuzzy integral equations; we then derive existence and uniqueness results using the Banach fixed-point theorem and a general existence result via Schauder’s fixed-point theorem; finally, we analyze Ulam–Hyers–Rassias stability. An illustrative example and numerical simulations are provided to verify the theoretical assumptions and demonstrate the effectiveness of the proposed.

---

Communicated by Editors; Received July 6, 2026

AMS Subject Classification: 26A33, 34A08, 03E72.

Keywords: Caputo–Hukuhara fractional derivative, Fuzzy boundary condition, Fixed point method, Ulam–Hyers–Rassias stability.