METHOD OF UPPER-LOWER SOLUTIONS FOR NONLINEAR SYSTEM OF HILFER FRACTIONAL REACTION-DIFFUSION EQUATIONS

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Abstract. This paper aim to develop the method of upper-lower solutions for nonlinear system of Hilfer fractional reaction-diffusion equations. Method of upper-lower solutions is applied to prove the existence and uniqueness results for the solutions of system of fractional reaction-diffusion equations involving a Hilfer fractional derivative.

Keywords. Hilfer fractional derivative; Eigenfunction; Method of upper-lower solutions ; Monotone method.

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1   Introduction

The applications of fractional differential equations (FDEs) have been increasingly observed across various disciplines, particularly in mathematical modeling of systems and processes. These equations are instrumental in fields such as physics, chemistry, electrodynamics of complex media, aerodynamics, and polymer rheology, where systems of FDEs often govern the dynamics [11, 12, 14, 16, 27]. Additionally, FDEs find applications in control systems, viscoelasticity, electrochemistry, pharmacokinetics, and food science, among others [14]. Significant contributions to this area have been documented in the monograph by Kilbas et al. [12].

Several methods have been developed to analyze FDEs, including the power series method, monotone method, compositional method, and transform method [2, 5, 20, 23, 25]. Among these, the monotone method stands out as a widely utilized approach for investigating theoretical and constructive results in the domain [3]. McRae explored the qualitative properties of solutions for initial value problems involving Riemann-Liouville (R-L) FDEs using the monotone method [1, 17]. Denton et al. [6] extended this approach in 2011 by combining the monotone method with the method of lower and