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ON LOCAL EXISTENCE OF SOLUTION FOR NONLINEAR HILFER FRACTIONAL DIFFERENTIAL EQUATION

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Abstract. The objective of the present paper is to study the existence and uniqueness of solution to singular initial value problem for differential equations with Hilfer fractional derivative. The results are obtained via properties of beta-gamma functions and the Picard iterative technique. Finally, an example is given in the support of our obtained results.

Keywords. Hilfer derivative; Picard iterative technique; singular fractional differential equation; ratio test.

AMS (MOS) subject classification: 26A33; 26D10; 40A30; 34A08.

1 Introduction

Fractional order calculus (FC) is an active branch of applied mathematical analysis, and its foundations were laid by Leibnitz and L'Hospital (in 1695) almost at the time when classical integer order calculus developed by Newton and Leibnitz. It is worth saying that fractional calculus explores many physical processes more accurately due to its nonlocal behaviour over the classical integer order calculus. Among various fractional differential operators present in the literature, the Riemann-Liouville (R-L) and Liouville-Caputo (L-C or Caputo) became more famous in a generalization of classical calculus. The R-L fractional differential problems lack widespread practical applications because of the need for fractional-order initial conditions, whereas the Caputo fractional differential problems lack applications to real materials in rheology, for example, for viscoelastic materials [21]. To overcome these difficulties, R. Hilfer in [15] 2010 defined new differential operator (generalized R-L) in fractional sense which interpolates both R-L and Caputo definitions for its different values of interpolating parameter (see Remark 1). Further, he studied some time evolution problems and dielectric phenomena using this generalized operator.

Fractional differential equations (FDEs) have been a focus of research in applied mathematics over the last few decades. Using numerous FDEs,