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Analytical solution of extended fractional space-time cable equation associated with Hilfer and Riemann-Liouville fractional derivatives

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Dedicated to Prof. Hari M. Srivastava on his 75^{th} ***birth anniversary***

Abstract: In this paper, we present a systematic investigation of a of the solution of generalized space-time fractional cable equation defined by (2.1) containing Riemann-Liouville and Hilfer fractional derivatives as the time derivatives and Riesz-Feller fractional derivative as the space derivative. The results are derived by the application of joint Laplace and Fourier transforms. The results are obtained in terms of the familiar H-function in a closed form. The moments of the solutions and their asymptotic behavior for small and large values of the argument are also obtained. The results are obtained in a compact form in terms of the Mittag-Leffler function and H-function. The results obtained by Can et al. [5] follow as special cases of our findings.

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Keywords: Mittag-Leffler function, Riesz-Feller space fractional derivative, Caputo fractional derivative, telegraph equation, Laplace transform, and Fourier transform.

1 Introduction and preliminaries

In recent years interest is developed in deriving the solution of fractional cable equation. In this connection, one can refer to the recent works [1, 2, 3, 6, 8, 9, 12, 14, 15, 17, 18, 20, 22, 23, 24, 35, 36]. Fractional cable models for spiny dendrites are given by Henry et al. [10], Zheng et al. [41] and Liu et al. [19, 21]. Fractional cable equation models for anomalous electro-diffusion in nerve cells are discussed by Langlands et al. [16] and Wearne [39], has introduced fractional Nernst-Planck equations and derived fractional cable equations as macroscopic models for electro-diffusion of ions in nerve cells, when molecular is anomalous sub diffusion due to bindings, crowding or trapping.