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A MATHEMATICAL, THEORETICAL, AND NUMERICAL ANALYSIS OF THE BURGERS' EQUATION UNDER CAPUTO–FABRIZO DERIVATIVES

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Abstract. Burgers' equation describes the relationship between diffusion and convection processes and is important for modeling phenomena such as shock wave formation, acoustic wave propagation, and traffic flow dynamics. Its fractional form, which incorporates memory effects, provides a more accurate representation of many physical systems. In this study, we investigate the fractional Burgers' equation using the Caputo–Fabrizio fractional derivative, which eliminates singular kernels and more effectively captures non-local behavior. To obtain solutions, we employ the Shehu transform decomposition method (STDM), which is a hybrid approach that integrates the Adomian decomposition method (ADM), Adomian polynomials, and the Shehu transform. The significance of this work lies in demonstrating the method's capability to produce accurate

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and stable solutions without the need for linearization or perturbation techniques. To verify the efficiency and precision of the proposed method, we compare the approximate solutions with exact results and other established techniques. Numerical and graphical results confirm that STDM is a powerful and reliable tool for solving nonlinear fractional partial differential equations, offering advantages over existing methods in terms of convergence, accuracy, and computational simplicity.