



An Accurate Method for Solving Fractional Integro-Differential Equations

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Abstract

This talk presents analytical and numerical techniques for solving a class of fractional integro-differential equations. A modified operational matrix method is then developed to approximate the solution by constructing operational matrices for the fractional differential and integral operators and transforming the original problem into a system of algebraic equations. The proposed approach eliminates the need for projection procedures while providing high computational efficiency and accuracy. Several numerical examples are included to validate the performance of the method. The numerical solutions exhibit excellent agreement with the corresponding exact solutions, and the approximate fractional solutions converge to the classical integer-order solutions as the fractional order approaches one. The accuracy of the proposed algorithm is assessed using absolute and L_2 -norm errors, demonstrating errors of very small magnitude. In addition, the influence of the fractional-order parameter on the solution behavior is investigated. Finally, the Laplace transform is employed to derive exact solutions for several classes of homogeneous fractional integro-differential equations. The analytical results further confirm that the fractional solutions continuously approach the corresponding classical solutions as the fractional order tends to one, thereby validating both the theoretical analysis and the proposed numerical method.

Keywords: Fractional integro-differential equations, operational matrix method, Laplace transform.