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Alternative Legendre Functions for Solving Nonlinear Fractional Fredholm Integro-Differential Equations

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Abstract: This paper mainly focuses on the numerical technique based on a new set of functions called the fractional alternative Legendre functions for solving the nonlinear Fredholm integro-differential equations of fractional order. Also, the convergence analysis of the proposed technique is carried out. Finally, an example is included to demonstrate the validity and applicability of the proposed technique.

Keywords: *Fredholm integro-differential equations, alternative Legendre polynomials, Caputo fractional derivative, operational matrix.*

Mathematics Subject Classification (2010): 26A33, 45J05, 35C11.

1 Introduction

In recent years, fractional calculus and differential equations have found enormous applications in mathematics, physics, chemistry and engineering because of the fact that a realistic modeling of a physical phenomenon having dependence not only on the time instant but also on the previous time history can be successfully achieved by using fractional calculus. The developed analytical solutions are very few and are restricted to the solution of simple fractional Volterra integro-differential equations, therefore the development of effective and easy to use numerical schemes for solving such equations has acquired an increasing interest in recent years. Some fundamental works on various aspects of the fractional calculus are given by [2, 3, 9, 12, 15–20, 22].

Several numerical schemes have been presented for solving these problems, for example,
Mittal and Nigam [21] used the Adomian decomposition method for solving

$$D^{\alpha}u(x) = f(x)u(x) + g(x) + \int_0^x k(x,s)G(u(s))ds, \quad 0 < \alpha < 1.$$

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