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SOLVING FRACTIONAL VOLTERRA INTEGRO-DIFFERENTIAL EQUATIONS BY USING ALTERNATIVE LEGENDRE FUNCTIONS

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Abstract. This paper mainly focuses on numerical technique based on a new set of functions called fractional alternative Legendre for solving the Volterra integro-differential equations of fractional order. Also, the convergence analysis of the proposed method is investigated. Finally, some examples are included to demonstrate the validity and applicability of the proposed technique.

Keywords. Volterra integro-differential equations, Alternative Legendre polynomials, Caputo fractional derivative, Operational matrix.

AMS (MOS) subject classification: 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 at the time instant but also on the previous time history can be successfully achieved by using fractional calculus [6].

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 the recent years [7].

Some fundamental works on various aspects of the fractional calculus are given by Abbasbandy [8], Caputo [13], Debanth [14], Diethelm et al. [15], Hayat et al. [16], Jafari and Seifi [17, 18], Kemple and Beyer [19], Kilbas and Trujillo [20], Kiryakova [21], Momani and Shawagfeh [22], Podlubny [5], etc. Several numerical schemes have been presented for solving these problem such as: Mittal and Nigam [23] used the Adomian decomposition method for solving:

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