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A Cubic B-Spline Galerkin Approach for Solving the Time Fractional Telegraph Equation

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Abstract

In the current study, the finite element method is employed to obtain numerical solutions of the time fractional telegraph equation. Cubic B-splines, renowned for their advantages over traditional B-splines, are employed as the foundation of the numerical algorithm. Spatial discretization of the model's time-fractional partial differential equation is achieved using the cubic B-spline Galerkin method. A transformation process is employed to establish a correspondence between global and local coordinate systems. The Caputo formula, encompassing both singular and non-singular kernel types, is utilized to define the fractional time derivative. Discretization of the fractional time derivative is achieved through the standard finite difference approach, while the Crank-Nicolson scheme is applied to discretize the unknown functions. The current scheme is analyzed for stability and found to be unconditionally stable. The proposed numerical scheme is verified through simulations of various sample problems. A comparison of the obtained numerical solutions with existing literature is conducted.

Keywords: Fractional telegraph equation, cubic B-spline basis function, Galerkin method, finite element method, Caputo derivatives.

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