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Summary: We study an indirect finite element approximation for two-sided space-fractional diffusion equations in one space dimension. By the representation formula of the solutions $u(x)$ to the proposed variable coefficient models in terms of $v(x)$, the solutions to the constant coefficient analogues, we apply finite element methods for the constant coefficient fractional diffusion equations to solve for the approximations $v_h(x)$ to $v(x)$ and then obtain the approximations $u_h(x)$ of $u(x)$ by plugging $v_h(x)$ into the representation of $u(x)$. Optimal-order convergence estimates of $u(x) - u_h(x)$ are proved in both $L^2$ and $H^{\alpha/2}$ norms. Several numerical experiments are presented to demonstrate the sharpness of the derived error estimates.

MSC:
65N30 Finite element, Rayleigh-Ritz and Galerkin methods for boundary value problems involving PDEs
35B65 Smoothness and regularity of solutions to PDEs
41A10 Approximation by polynomials
33C45 Orthogonal polynomials and functions of hypergeometric type (Jacobi, Laguerre, Hermite, Askey scheme, etc.)
35R11 Fractional partial differential equations
26A33 Fractional derivatives and integrals
65N12 Stability and convergence of numerical methods for boundary value problems involving PDEs
35R05 PDEs with low regular coefficients and/or low regular data

Keywords:
fractional diffusion equation; finite element method; convergence estimate

Full Text: DOI

References:


Zhang, Y.; Benson, Da; Meerschaert, Mm; Labolle, Em, Space-fractional advection-dispersion equations with variable parameters: diverse formulas, numerical solutions, and application to the MADE-site data, Water Resour. Res., 43, W05439 (2007)

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