World Academy of Science, Engineering and Technology
International Journal of Mathematical and Computational Sciences
Vol:13, No:02, 2019

B Spline Finite Element Method for Drifted Space Fractional Tempered Diffusion Equation

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Abstract : Off-late many models in viscoelasticity, signal processing or anomalous diffusion equations are formulated in fractional calculus. Tempered fractional calculus is the generalization of fractional calculus and in the last few years several important partial differential equations occurring in the different field of science have been reconsidered in this term like diffusion wave equations, Schr$\ddot{o}$dinger equation and so on. In the present paper, a time-dependent tempered fractional diffusion equation of order $\gamma \in (0,1)$ with forcing function is considered. Existence, uniqueness, stability, and regularity of the solution has been proved. Crank-Nicolson discretization is used in the time direction. B spline finite element approximation is implemented. Generally, B-splines basis are useful for representing the geometry of a finite element model, interfacing a finite element analysis program. By utilizing this technique a priori space-time estimate in finite element analysis has been derived and we proved that the convergent order is $\mathcal{O}(h^2+T^2)$ where h is the space step size and T is the time. A couple of numerical examples have been presented to confirm the accuracy of theoretical results. Finally, we conclude that the studied method is useful for solving tempered fractional diffusion equations.

Keywords : B-spline finite element, error estimates, Gronwall's lemma, stability, tempered fractional
Conference Title : ICAM 2019 : International Conference on Applied Mathematics
Conference Location : Mumbai, India
Conference Dates : February 07-08, 2019