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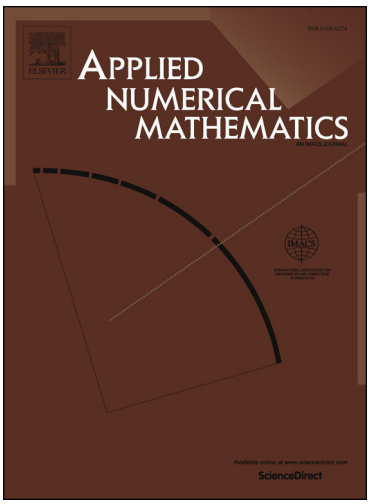

An efficient technique based on finite difference/finite element method for solution of two-dimensional space/multi-time fractional Bloch–Torrey equations

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An efficient technique based on finite difference /finite element method for solution of two–dimensional space/multi–time fractional Bloch–Torrey equations

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Abstract

The main aim of the current paper is to propose an efficient numerical technique for solving two-dimensional space-multi-time fractional Bloch-Torrey equations. The current research work is a generalization of [6]. The temporal direction is based on the Caputo fractional derivative with multi-order fractional derivative and the spatial directions are based on the Riemann-Liouville fractional derivative. Thus, to achieve a numerical technique, the time variable is discretized using a finite difference scheme with convergence order $\mathcal{O}(\tau^{2-\alpha})$. Also, the space variable is discretized using the finite element method. Furthermore, for the time-discrete and the full-discrete schemes error estimate has been presented to show the unconditional stability and convergence of the developed numerical method. Finally, four test problems have been illustrated to verify the efficiency and simplicity of the proposed technique on irregular computational domains.

Keywords: Space fractional equation, Bloch-Torrey equations, fractional derivative, convergence analysis, error estimate, Caputo derivative, Riemann-Liouville fractional, finite element method.

***AMS subject Classification*:** 65M70, 34A34.

1 Introduction

The fractional PDEs play important and basic role in modeling and simulating of natural and practical phenomena [14]. In the meantime, the fractional equations based on the space fractional type are important and have more difficulty for simulating and analysis.

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