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Numerical simulation of time fractional dual-phase-lag model of heat transfer within skin tissue during thermal therapy

Dinesh Kumar*and K. N. Rai†

Abstract

In this paper, we investigated the thermal behavior in living biological tissues using time fractional dual-phase-lag bioheat transfer (DPLBHT) model subjected to Dirichelt boundary condition in presence of metabolic and electromagnetic heat sources during thermal therapy. We solved this bioheat transfer model using finite element Legendre wavelet Galerkin method (FELWGM) with help of block pulse function in sense of Caputo fractional order derivative. We compared the obtained results from FELWGM and exact method in a specific case, and found a high accuracy. Results are interpreted in the form of standard and anomalous cases for taking different order of time fractional DPLBHT model. The time to achieve hyperthermia position is discussed in both cases as standard and time fractional order derivative. The success of thermal therapy in the treatment of metastatic cancerous cell depends on time fractional order derivative to precise prediction and control of temperature. The effect of variability of parameters such as time fractional derivative, lagging times, blood perfusion coefficient, metabolic heat source and transmitted power on dimensionless temperature distribution in skin tissue is discussed in detail. The physiological parameters has been estimated, corresponding to the value of fractional order derivative for hyperthermia treatment therapy.

Keywords : Time fractional DPLBHT model, hyperthermia, finite element Legendre wavelet Galerkin approach and block pulse function, Caputo fractional derivative.

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