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Numerical Solution of Steady Magnetohydrodynamic Boundary Layer Flow Due to Gyrotactic Microorganism for Williamson Nanofluid over Stretched Surface in the Presence of Exponential Internal Heat Generation

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Abstract : This paper focuses on the study of two dimensional magnetohydrodynamic (MHD) steady incompressible viscous Williamson nanofluid with exponential internal heat generation containing gyrotactic microorganism over a stretching sheet. The governing equations and auxiliary conditions are reduced to a set of non-linear coupled differential equations with the appropriate boundary conditions using similarity transformation. The transformed equations are solved numerically through spectral relaxation method. The influences of various parameters such as Williamson parameter γ, power constant λ, Prandtl number P_r, magnetic field parameter M, Peclet number P_e, Lewis number Le, Bioconvection Lewis number Lb, Brownian motion parameter Nb, thermophoresis parameter Nt, and bioconvection constant σ are studied to obtain the momentum, heat, mass and microorganism distributions. Moment, heat, mass and gyrotactic microorganism profiles are explored through graphs and tables. We computed the heat transfer rate, mass flux rate and the density number of the motile microorganism near the surface. Our numerical results are in better agreement in comparison with existing calculations. The Residual error of our obtained solutions is determined in order to see the convergence rate against iteration. Faster convergence is achieved when internal heat generation is absent. The effect of magnetic parameter M decreases the momentum boundary layer thickness but increases the thermal boundary layer thickness. It is apparent that bioconvection Lewis number and bioconvection parameter has a pronounced effect on microorganism boundary. Increasing brownian motion parameter and Lewis number decreases the thermal boundary layer. Furthermore, magnetic field parameter and thermophoresis parameter has an induced effect on concentration profiles.

Keywords : convection flow, similarity, numerical analysis, spectral method, Williamson nanofluid, internal heat generation
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