Lie Group Analysis and Numerical Solution of Magnetohydrodynamic Free Convective Slip Flow of Micropolar Fluid Over a Moving Plate With Heat Transfer

M.J. Uddin[a, b], M.N. Kabir[c], Y.M. Alginahi[d]

[a] Mathematics Department, American International University-Bangladesh, Banani, Dhaka 1213, Bangladesh

[b] School of Mathematical Sciences, Universiti Sains Malaysia, 11800 USM, Penang, Malaysia

[c] Faculty of Computer Systems and Software Engineering, University Malaysia Pahang, 26300 Gambang, Pahang, Malaysia

[d] Deanship of Academic Services, Department of Computer Science, Taibah University, P.O. Box 344, Madinah, Saudi Arabia

ABSTRACT

In this paper, we investigate magnetohydrodynamic free convective flow of micropolar fluid over a moving flat plate using the Lie group transformations and numerical methods. Instead of using conventional no-slip boundary conditions, we used both the velocity and thermal slip boundary conditions to achieve physically realistic and practically useful results. The governing boundary layer equations are non-dimensionalized and transformed into a set of coupled ordinary differential equations (ODEs) using similarity transformations generated by the Lie group, before being solved numerically using Matlab stiff ODE solver *ode15s and* Matlab trust-region-reflective algorithm *lsqnonlin*. The effects of governing parameters on the dimensionless velocity, angular velocity, temperature, skin friction and heat transfer rate are investigated. Our analysis revealed that the dimensionless velocity and angular velocity decrease whilst the dimensionless temperature increases with the velocity slip parameter. Thermal slip reduces the dimensionless velocity and temperature but raises the dimensionless angular velocity. Magnetic field suppresses the velocity but elevates the temperature and angular velocity. Results reported in this paper are in good agreement with the ones reported by the previous authors.

KEYWORDS: Heat transfer; MHD; Micropolar fluid; Moving plate; Lie group; Velocity and thermal slip boundary conditions

DOI: 10.1016/j.camwa.2015.06.002