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Nanofluid Flow over a Stretching Surface in Presence of Chemical Reaction and Thermal Radiation: An Application of Lie Group Transformation

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This paper concerns with a steady MHD boundary layer flow of an electrically conducting nanofluid over a vertical permeable stretching surface with variable stream conditions. The transport model includes the effect of Brownian motion with thermophoresis in presence of chemical reaction and thermal radiation. The group theoretic method is used to find the symmetries of the governing partial differential equations. The reduced equations are solved numerically by employing a fourth order Runge-Kutta method and Shooting techniques to predict the heat and mass transfer characteristics of the nanofluid flow. Numerical results are presented through graphs and tables for several sets of values of the involved parameters of the problem and discussed in details from the physical point of view.

Keywords: nanofluid, Lie group transformation, magnetic field, chemical reaction, Brownian motion, thermal radiation.
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1. Introduction and preliminaries

In the last few years, heat transfer characteristics of nanofluids is a topic of major contemporary interest both in applied sciences and engineering. The term nanofluid refers to a liquid containing a suspension of submicronic solid particles (nanoparticles), diameter less than 50 nm, was first introduced by Choi [1]. Fluids such as water, toluene, ethylene glycol and oil are poor heat transfer fluids. The choice of base fluid-particle combination depends on the application for which the nanofluid is intended. Recent research on nanofluid showed that nanoparticles changed the fluid characteristics because thermal conductivity of these particles was higher than regular fluids. The common nanoparticles that have been used are copper, aluminum, iron and titanium or their oxides. Experimental studies [2–4] show that even with the small volumetric fraction of nanoparticles (usually less than 5%), the thermal conductivity of the base liquid can be enhanced by $5-20\%$. The enhanced thermal conductivity of nanofluid together with the thermal conductivity of the regular liquid and turbulence induced by their motion contributes to a remarkable improvement in the convective heat transfer coefficient. Various benefits of the application of nanofluids include: improved heat transfer, heat transfer system size reduction, micro-channel cooling and miniaturization of the system. There have been published several

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