Title: **Comparative Analysis with Data Prediction of Non-linear Radiative Nano Second-Grade and Newtonian Fluid in Presence of Sinusoidal Magnetic Force**

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Abstract : This study aims to enhance the comprehension of the fundamental fluid behavior by comparing Newtonian fluid with second-grade fluid under the influence of periodic magnetic fields, nonlinear radiative nanomaterial, and a porous stretched surface featuring a heat source. The governing equations' dimensionless forms are generated by applying the proper transformations, and the explicit finite difference (EFD) method is used to solve the numerically-derived solution while carefully maintaining stability and convergence standards. The results include velocity, heat, and mass transfer oscillation profiles; streamlines, and isothermal lines. Nusselt and Sherwood numbers are correlated with different factors according to tabular studies, and data prediction and regression are done using graphical representations. This study revealed that, in contrast to Newtonian fluid, second-grade fluid flow elevates velocity profiles with variations in chemical reaction parameters and mass Grashof numbers. Conversely, the thermal non-linear radiation and heat source in second-grade fluid particles effectively enhance the temperature field, although the temperature increase is more pronounced in Newtonian fluid compared to second-grade fluid. Also, second-grade fluid flow exhibits a lower mass transmission rate but higher stress sharing and heat transmission rates compared to Newtonian fluid flow. The implications of this research may impact prostate cancer treatment, as cancer patients have already benefited from the use of magnetic fields to regulate drug release from nanoparticles. Although the greater stress sharing and heat transmission rates may be used for targeted therapy, the lower mass transmission rate raises the possibility of benefits in controlled release scenarios.

Key words: Newtonian FluidSecond-Grade Fluidperiodic MHDNonlinear RadiationHeat and Mass TransferData Prediction

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