Boundary layer flow and heat transfer over a permeable exponentially stretching/shrinking sheet with generalized slip velocity

ABSTRACT

In this paper, the steady laminar boundary layer flow and heat transfer over a permeable exponentially stretching/shrinking sheet with generalized slip velocity is studied. The flow and heat transfer induced by stretching/shrinking sheets are important in the study of extrusion processes and is a subject of considerable interest in the contemporary literature. Appropriate similarity variables are used to transform the governing nonlinear partial differential equations to a system of nonlinear ordinary (similarity) differential equations. The transformed equations are then solved numerically using the bvp4c function in MATLAB. Dual (upper and lower branch) solutions are found for a certain range of the suction and stretching/shrinking parameters. Stability analysis is performed to determine which solutions are stable and physically realizable and which are not stable. The effects of suction parameter, stretching/shrinking parameter, velocity slip parameter, critical shear rate and Prandtl number on the skin friction and heat transfer coefficients as well as the velocity and temperature profiles are presented and discussed in detail. It is found that the introduction of the generalized slip boundary condition resulted in the reduction of the local skin friction coefficient and local Nusselt number. Finally, it is concluded from the stability analysis that the first (upper branch) solution is stable while the second (lower branch) solution is not stable.

Keyword: Boundary layer; Heat transfer; General slip; Stretching/shrinking; Numerical solution; Dual solutions; Stability analysis