 ISBN: 978-81-941253-2-7

USE OF LAPLACE TRANSFORMATION TECHNIQUE IN FLUID FLOW PROBLEMS

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ABSTRACT

Analytical and, numerical solutions of a non-linear MHD flow with heat and, mass transfer characteristics of an incompressible, viscous, electrically conducting and Boussinesq's fluid over a vertical oscillating plate embedded in a Darcian porous medium in the presence of thermal radiation effect have been presented. The fluid considered here is gray, absorbing/emitting radiating but, non-scattering medium. At time, t >0, the plate temperature and, concentration near the plate raised linearly with time t .The dimensionless governing coupled, non - linear boundary layer partial differential equations are solved by an efficient, accurate, extensively validated and, unconditionally stable finite difference scheme of the Crank-Nicolson type as well as by the Laplace Transform technique. An increase in porosity parameter (K) is found to depress fluid velocities and, shear stress in the regime. Also, it has been found that, when the conduction-radiation (R) increased, the fluid velocity and, the temperature profiles decreased. Applications of the study arise in materials processing and, solar energy collector systems.

INTRODUCTION

The Laplace transform is a widely used as a mathematical tool for integral transform with numerous applications in physics and engineering by simplifying many differential equations. It is very convenient with no homogeneous equations in which the forcing functions are not continuous. In mathematics, the Laplace transform, named after its inventor Pierre-Simon Laplace is an integral transform that converts a function of a real variable (t) to a function of a complex variable (s).This makes it a valuable tool for engineers and scientists dealing with "real-world" applications. Conceptually and computationally, it is probably the simplest .Inverse Laplace transform methods have a long history in the development of time-domain fluid line models.

The Laplace transform of a function f(t), defined for all real numbers $t \geq 0$, is the function F(s), which is a unilateral transform defined by :$F(s) = \int_0^{\infty} f(t)e^{-st}dt$,Where S is the complex number frequency parameter. $s = \sigma + i\omega$, with real numbers σ and, ω. An alternate notation for the Laplace transform is $\mathcal{L}\{f\}$ instead of F. Applying Laplace Transform to solve some Newtonian fluid flow problems, Solutions are compared with those of Sumudu Transforms [1] and similarity methods which reveal that the proposed method is very effective and simple.

The study of MHD with mass and heat transfer in the presence of radiation and diffusion has attracted the attention of a large number of scholars due to diverse applications. In astrophysics and geophysics, it is applied to study the stellar and solar structures, radio propagation through the ionosphere, etc. In engineering we find its applications in MHD pumps, MHD bearings, etc. Radiative flows are encountered in many industrial and environment processes, e.g., heating and cooling chambers, fossil fuel combustion energy processes, evaporation from large open water reservoirs, astrophysical flows, and solar power technology and space vehicle re-entry. Also hydro magnetic free convective flows with heat and mass transfer through a porous medium have many important applications such as oil and gas production, geothermal energy, cereal grain storage, in chemical engineering for filtration and purification process, in agriculture engineering to study the underground water resources and porous insulation. In view of these applications, the unsteady MHD incompressible viscous flows past an infinite vertical plate thorough a porous medium have received much attention**. Muthucumaraswamy and Meenakshisundaram** [2] studied chemical reaction effects on a vertical oscillating plate with variable temperature. Their dimensionless governing equations were solved by the usual Laplace transform technique. **Das *et al.* [3]** analyzed radiation effects on flow past an impulsively started infinite isothermal vertical plate. The governing equations were