# Abstract

In this thesis an analytical study has been carried out and some new results are given regarding the flow behavior of Newtonian, second grade, Maxwell and generalized Maxwell fluid through different channels and under different initial and boundary conditions. Different chapters are constructed to present the material easy understandable for the reader. The first chapter is devoted to give some preliminaries and explain some basic concepts regarding the fundamentals of fluid motion and some integral transforms.

In chapter 2, attention has been focused to study the slip effects on free convection flow of a viscous fluid near a moving vertical plate with Newtonian heating. At time $t = 0^{+}$, the vertical plate is set in motion with a constant velocity $U$ and so the motion is produced in the fluid. The Laplace transform tool is employed to find exact analytic solutions. The solutions corresponding to non-slip condition are obtained as limiting cases of the general solutions when the slip parameter $\gamma \rightarrow 0$.The effects of different parameters like slip condition, Grashof number and Prandtl number on the velocity and temperature is underlined by graphs.

Chapter 3 particularly deals with the flow due to a plate, between two side walls, that applies an accelerated shear stress to second grade fluid. With the use of Laplace and double Fourier cosine and sine transforms the expressions for velocity and shear stress are established. When the plate is pulled in its plane with the shear $ft^{a}$ the motion is produced in the fluid. Solutions are obtained as particular cases when a constant shear, constantly accelerating shear and accelerating shear is applied to the fluid by the plate and presented in the simplest forms using the complementary error

function. In the absence of side walls namely $h \to 0$, solutions corresponding to the motion over an infinite plate are obtained as limiting cases of the general results. A comparison is given by graphs among the Newtonian and second grade fluids in both cases, with walls and without walls and, as expected, the Newtonian fluid flows faster than the second grade fluid.

In the chapter 4, the influence of side walls, on the oscillating motion of a Maxwell fluid over an infinite plate is studied. Motion of the fluid is produced due to the plate which at time $t = 0^+$, applies to the fluid a shear stress $f sin(\omega t)$ or $f cos(\omega t)$. The general expressions of starting solutions are presented in integral and series form. When the relaxation time $\lambda \to 0$ the solutions corresponding to Newtonian fluid is obtained as limiting case of the general expressions. In the absence of side walls, namely when $h \to 0$, the general solutions reduce to the that over an infinite plate corresponding to Maxwell and Newtonian fluids. Finally, the distance between walls for which the velocity of the fluid in the middle of the channel in unaffected by their presence and the required time to reach the steady-state are numerically determined.

Chapter 5 concerns with the exact solutions for the rotational flow of a Maxwell fluid with fractional derivatives, between two circular cylinders. The motion of the fluid is produced by the rotation of cylinders around their common axis. The motion is studied by means of Laplace and finite Hankel transforms. The solutions that have been obtained, written in integral and series form in terms of the generalized $G_{a,b,c}(\cdot, t)$-functions, are presented as a sum of the Newtonian solutions and the corresponding non-Newtonian contributions. For $\lambda \to 0$ the general solutions reduce to the solutions corresponding to the Newtonian fluids performing the same motion. Furthermore, the corresponding solutions for ordinary Maxwell fluids are also obtained for the fractional parameter $\beta = 1$. Finally, in order to reveal some relevant physical aspects of the obtained results, the diagrams of the velocity field $\omega(r, t)$ have been depicted for different values of the material and fractional parameters.