Abstract

In this thesis some results regarding the flow behavior of second grade fluid with fractional derivatives and ordinary Oldroyd-B fluid under different circumstances have been studied. Firstly, some basic concepts regarding fluid motion and integral transforms have been discussed. Then the fluid motion of fractional second grade and ordinary Oldroyd-B fluids through a cylinder and annulus is studied.

In chapter 2, the motion of fractional second grade fluid through an infinite circular cylinder has been studied. After time $t = 0^+$ the fluid motion is produced by rotating the circular cylinder about its axis. Laplace and finite Hankel transforms are used to find exact solutions. The similar solutions for Newtonian and ordinary second grade fluids are obtained as limiting cases of general solutions by making $\kappa \to 1$ and $\alpha_1 \to 0$, respectively $\kappa \to 1$.

Chapter 3 intends to establish exact solutions for the unsteady flow of a fractional second grade fluid between two infinite coaxial circular cylinders. The general expressions for velocity and shear stress are obtained by using Laplace and finite Hankel transforms. The motion of the fluid is produced by the inner cylinder which is rotating around its axis due to a time-dependent torque per unit length $2\pi R_1 a t^2$. The solutions that have been obtained satisfy all imposed initial and boundary conditions. For $\kappa \to 1$, respectively $\kappa \to 1$ and $\alpha_1 \to 0$, the corresponding solutions for ordinary second grade and Newtonian fluids, performing the same motion, are obtained as limiting cases.

In chapter 4 the unsteady helical flow of an Oldroyd-B fluid through an infinite circular cylinder is studied. The motion of the fluid is produced by cylinder that,

after time $t = 0^+$, is subject to both torsional and longitudinal time dependent shear stresses. The general solutions are presented in series form in terms of Bessel functions $J_0(\bullet)$, $J_1(\bullet)$ and $J_2(\bullet)$, and satisfy all imposed initial and boundary conditions. The corresponding solutions for Newtonian, second grade and Maxwell fluids are obtained as limiting cases of general solutions. Finally, the obtained solutions are compared by graphical illustrations and the influence of material parameters on the fluid motion is also underlined.

Chapter 5 concerns with the unsteady Taylor-Couette flow of an Oldroyd-B fluid in an annulus due to a time-dependent torque applied to the inner cylinder. Motion is studied by means of finite Hankel transforms. The exact solutions are presented in series form in terms of usual Bessel functions, satisfy both the governing equations, and all imposed initial and boundary conditions. Similar solutions for Newtonian, second grade and Maxwell fluids performing the same motion are obtained as limiting cases of general solution. Finally, some characteristics of the fluid motion, as well as the influence of pertinent parameters on the behavior of the fluid motion, analyzed by graphs.