Abstract

The work in this thesis presents some new results concerning the flow behavior of some non-Newtonian fluids through a cylinder and in annular regions. First of all in preliminaries a brief discussion about Newtonian and non-Newtonian fluids, constitutive equations, equation of motion, continuity equation and integral transforms are given. In the following chapters some new exact solutions for fractional second grade, fractional Maxwell, ordinary Oldroyd-B and fractional Oldroyd-B fluids are established.

In chapters 2 and 3 we study the motion of second grade fluid with fractional derivatives. In chapter 2 we obtained the exact solutions for the flow of a second grade fluid with fractional derivatives in an annular region between two infinite coaxial circular cylinders and in chapter 3 obtained exact solutions for the same fluid through a straight circular cylinder, by means of the Laplace and finite Hankel transforms. These solutions are specialized to give the similar solutions for ordinary second grade and Newtonian fluids performing the same motion. The required time to reach the steady-state is obtained by graphical illustrations at the end of chapter 2. Also, in the last part of the chapter 3, the influence of the material constants and of the fractional parameter on the velocity and shear stress variations is underlined by graphical illustrations.

In chapter 4, the axial Couette flow of a Maxwell fluid with fractional derivatives is discussed. The velocity field and the shear stress corresponding to the flow in an infinite circular cylinder are obtained by means of Laplace and Hankel transforms.

The motion is caused by the infinite cylinder which applies a longitudinal time dependent shear stress to the fluid. Both solutions are written in terms of the generalized $R_{a,b}(\cdot, t)$ and $G_{a,b,c}(\cdot, t)$ functions. The solutions for ordinary Maxwell and Newtonian fluids are obtained as limiting cases of general solutions. Finally, in this chapter the influence of material and fractional parameters on the fluid motion is brought to light by graphical illustrations.

Chapter 5 deals with the motion of an ordinary Oldroyd-B fluid in an infinite circular cylinder subject to a time-dependent couple. At time $t = 0^+$ the cylinder is set in rotation about its axis by a time-dependent torque per unit length. The exact solutions for the velocity field and the shear stress are established by means of the Hankel transform. The similar solutions for Maxwell, second grade and Newtonian fluids are obtained as limiting cases of general solutions. The influence of the material parameters on the velocity and the shear stress is spotlighted by means of graphical illustrations.

Chapter 6 concerns with the unsteady flow of an Oldroyd-B fluid with fractional derivative model through an infinite circular cylinder. The fluid motions is studied by means of finite Hankel and Laplace transforms. The motion is produced by the cylinder, that at time $t = 0^+$, is subject to a time-dependent rotational shear stress. The solutions that have been obtained, presented under series form in terms of the generalized $G_{a,b,c}(\cdot, t)$ functions, satisfy all imposed initial and boundary conditions. The solutions for fractional Maxwell fluids as well as those for ordinary fluids are obtained as limiting cases of general solutions. Finally, the influence of the material constants and fractional parameters on the velocity and shear stress variations is discussed by graphical illustrations.