Abstract

In the present thesis, we will present the analytical studies of some fluid flow models. We wish to analyze two main scenarios, one of which deals with non-fractional (ordinary) models and the other with fractional models for the flow of non-Newtonian fluids. We use classical computational techniques capable of accurately operating in order to obtain exact analytical solutions. Our studies include Couette flows of a Maxwell fluid under slip conditions between the fluid and walls. The motion of the bottom plate is assumed to be a rectilinear translation in its plane while, the upper plate is at rest. Two particular cases, namely translation with constant velocity and sinusoidal oscillations of the bottom plate are considered. Next, unsteady motions of Oldroyd–B fluids over an infinite plate between two side walls will be investigated. The motion of the fluid is due to the bottom plate that applies two types of shears to fluid. Extending our studies, we look at the unsteady magnetohydrodynamic (MHD) flow of fractional Oldroyd–B fluid between two side walls perpendicular to a plate. Expressions of the obtained solutions are presented in a series form in terms of the generalized G functions. Finally, the unsteady flow of an Oldroyd–B fluid with fractional derivative model between two infinite coaxial circular cylinders is studied. The motion of the fluid is produced by the inner cylinder that, at time $t = 0^+$, applies a time dependent longitudinal shear stress to the fluid. Expressions of the obtained results are presented in a series form in terms of the generalized G and R functions.

In all the flow models, we obtained the exact analytical solutions for motions with technical relevance, both for the velocity field and the shear stress(es). These solutions corresponding to some flows in which either velocity or the shear stress is given

on the boundary are established for different kinds of non-Newtonian fluids as well as for fractional models. The exact analytical solutions that have been presented in all the fluid flow models satisfy all imposed initial and boundary conditions. Further on, the flow properties of models and the comparison to other models are highlighted with graphical illustrations.