Newton (1687) proposed a linear relationship between the extra stress tensor and the strain rate tensor for isotropic viscous incompressible fluids. The freedom from the bondage of linearity of relationship between stress and strain rate tensors led to a great deal of creative work in non-Newtonian fluid flow theory. The solutions of problems of engineering interests in the flow of non-Newtonian fluids require that method be developed for studying the properties of such fluids in configurations other than the classical viscometric fluid flows. Many rheological models have been proposed to describe the mechanical behaviours of non-Newtonian materials but in this study, we have chosen the models of incompressible second-order fluid and Walters liquid (Model B') with short memories to investigate the flow behaviours in specific problems for different geometries. The thesis consists of six chapters.

In chapter I, the outline of various theories proposed to explain the non-linear effects such as normal stress effect, Merrington effect, Weissenberg effect etc., and their advantages and defects are given. A brief deductions of the constitutive equations of second-order fluid and Walters liquid (Model B') have been done. The equations of motion in cartesian, cylindrical polar and spherical polar coordinates, a brief review of the relevant literature and the motivation of the present work are given in last sections.

The rheometrical flow system has been discussed in chapter II. Here, we have considered the flow of Walters liquid (Model B') between two infinite disks which are rotating with different angular velocities about different axes of rotation. The solution is obtained by expanding the velocity components in terms of a suitable small parameter
when the inertia effects are also assumed to be small. The force on one of the disks has been calculated and it is observed that the two components of the force can be used to determine the visco-elastic parameter of the fluid.

In chapter III, flow of Walters liquid (Model B') through an annulus has been studied. The inner surface of the annulus is a smooth rigid cylinder while the outer surface is a flexible cylinder whose radius is varying with time as well as with axial distance. Perturbation technique has been employed to obtain the solution of the problem, taking variation in the outer surface as perturbation parameter. The boundary conditions of the outer surface are suitably amended with the use of Taylor's series expansion. The dimensionless shearing stress and volume rate of flow have been obtained at various sections of the annulus. The obtained results have been numerically worked out for different values of the elastico-viscous parameter with the combination of other flow parameters and the results are expressed in tabular forms.

Chapter IV deals with the analysis of the laminar boundary layer along a flat plate in a non-Newtonian second-order fluid in presence of a magnetic field acting perpendicular to the plate. The problem is solved by the application of steepest descent method used by Meksyn. The non-Newtonian effect on the component of velocity which is parallel to the length of the plate and also on the displacement thickness are studied in details. The velocity component $u$ as a function of $\eta$ has been presented graphically for various values of non-Newtonian parameter.

In chapter V, the steady two-dimensional free convection flow of a Walters fluid (Model B') in a vertical channel one of whose walls is wavy, has been investigated analytically. The governing equations of the fluid and the heat transfer have been solved subject to
the relevant boundary conditions by assuming that the solution consists of two parts: a mean part and disturbance or perturbed part. To obtain the perturbed part of the solution, the long wave approximation has been used and to solve the mean part, a well-known approximation used by Ostrach has been utilised. The relevant flow and the heat transfer characteristics, namely the skin friction and the rate of heat transfer at both the walls have been discussed in details.

In chapter VI, the flow and heat transfer in an elastico-viscous fluid between two co-axial infinite porous rotating discs is considered for small cross flow Reynolds number. The discs are rotating with different angular velocities and the rate of injection of the fluid at one disc is different from the rate of suction at the other disc. The governing equations have been solved by perturbation method, taking cross flow Reynolds number as perturbation parameter. The analytical expressions for radial, transverse, axial velocity components and temperature have been obtained and these results have been numerically worked out for different values of parameters involved in the solution. The Nusselt number and the Skin friction coefficient for various cases have also been calculated at both the discs and the results are expressed in a tabular form. The first-order velocity components have been presented graphically for various visco-elastic parameters.

The thesis is appended with a wide range of bibliography on the subjects dealt in various chapters.