Preface

The useful applications of mathematics have been in the study of fluid flow. Fluid is defined as a substance that deforms continuously under the action of shearing stresses of any magnitude. Fluids can be characterized as Newtonian and non-Newtonian fluids. For Newtonian fluids the shearing stress is linearly related to the rate of strain, but for non-Newtonian fluids shearing stress is not linearly related to the rate of strain. The generalization of the linear relationship between stress and rate of strain tensor is made non-linear from the general idea of fluidity by Stokes (1845). The linearity relation between stress and rate of strain tensors led to a great deal of creative works in non-Newtonian fluid flow theory. Numerous flow problems have been discussed to investigate the flow patterns and observe their behavior under different legitimate and appropriate boundary conditions. The results suggest various aspects of the additional terms in the constitutive equation as compared to Newtonian fluid. For an incompressible & isotropic fluid, Reiner (1945) and Rivlin (1947) derived a particular constitutive equation approximating it to suit a particular fluid and the fluid governed by this equation is termed as the Reiner-Rivlin fluid.

One of the fundamental results in low Reynolds-number hydrodynamics is the Stokes solution for steady flow past a small sphere. Stokes obtained the solution for the pressure and velocity field for the slow motion of a viscous fluid past a sphere. In his analysis, Stokes neglected the inertia terms of Navier-Stokes equations.

The present research work is the analytical study of some such problems on Stokes flow in micropolar fluids and Newtonian fluids flow over the different geometries of Reiner-Rivlin fluids both in unbounded and confined medium. The micropolar fluids are non-Newtonian viscous fluids having some additional coefficients of viscosity as compared to usual Newtonian fluids. In the microp-
Olar fluid theory by [Eringen](1964, 1966), in addition to the usual classical field of velocity, there is one more supplementary field variable, the micro-rotation $\omega$ (or spin) which has been introduced to elucidate the kinematics of micromotions. A micropolar fluid contains rotating micro-constituents that cause the fluid to exhibit non-Newtonian behavior. Micropolar fluid model has been found useful in the study of flows of exotic lubricants, colloidal suspensions, polymeric fluids, liquid crystals, additive suspensions, body fluids, turbulent shear flows and flows in container and micro channels.

The study investigates the analytical solution of few problems for slow, steady, incompressible and axisymmetric flow of Newtonian fluids and non-Newtonian fluids. The body couples are neglected in case of micropolar fluids flow. The stream functions have been used to reduce the governing field equations of motion into partial differential equations. The resulting equations are, then, solved by the method of separation of variables. The appropriate boundary conditions, mathematically consistent and physically realistic, are employed to determine the arbitrary constants appearing in the solution. The numerical results have been deduced and shown both in tabular as well as in graphical forms. It has been concluded that our analytical scheme works well to solve various flow problems of Newtonian and micropolar fluids, as the result obtained here are in good agreement with the results existing in the literature.