

# Abstract

In this thesis, we have presented the heat and mass transfer models for non-Newtonian fluids with fractional derivatives. The fluid flow models discussed here are Maxwell, Jeffery, and Oldroyd-B fluids. These models are considered under different geometry regimes controlled by various system parameters. The first problem we have discussed the analytical study of combined heat and mass transfer on the MHD free convective flow of Maxwell fluid. Moreover, the fluid dynamics are controlled by the arbitrary motion of the plate with varying temperatures and concentrations. Several cases of generalized boundary conditions are investigated and their impacts in engineering and applied science are highlighted.

Next, we have analyzed the problem using fractional calculus modelling employing the non-integer order derivative operators in the sense of Caputo, Caputo-Fabrizio, and Atangana-Baleanu.

Continuing our study, we have investigated the heat transfer phenomenon of mixed convective flow of Maxwell fluid via fractional calculus modelling. The flow phenomenon is taking place on the vertical plate that is moving with sinusoidal velocity. Next, exact solutions for the Jeffery fluid flow phenomenon with the power-law kernels are derived. The fluid flow model of MHD fractionalized Jeffery fluid between two vertical plates immersed in a porous medium with one plate is assumed to be moving with time-dependent velocity in its plane while the other plate is at rest.

Finally, the unsteady flow of incompressible MHD Oldroyd-B fluid on an infinite vertical plate in the presence of thermal radiation and ramped wall conditions is investigated. The problem is modeled with the non-integer order derivative operators

in the sense of Caputo and Caputo Fabrizio and a comparative study is performed. The semi-analytic solutions for velocity, temperature, and shear stress are obtained by Laplace integral transform and numerical algorithms. All fluid models satisfy all imposed initial and boundary conditions. Graphical analysis is used to highlight the important properties of different parameters. It is worth mentioning that the considered problem in the settings of fractional order derivatives have not been found in the literature.

Interesting results are revealed by this investigation due to their vast application in engineering and applied sciences. The results for integer-order derivative are derived in a limiting sense and the comparison with other models.