

# Preface

---

MHD (Magnetohydrodynamics) is an important discipline that deals with the conjoint collaboration between the magnetic fields and moving conducting fluid. Earlier work done in this field is mostly numerical, also approach is steady-state. But it is known fact that the unsteady fluid flow is important in real world problems. The governing equations in unsteady flow problems are complex compared to Steady-state approach.

Laplace transformation is one of the most sophisticated analytical techniques, which can solve many problems arising in the study of fluid mechanics. Also, Laplace transform technique is the best compatible for time dependent initial and boundary value problems. Moreover, the solution of MHD problem using Laplace transform technique is rarely seen in the literature. This is the motivation for the present study.

In this thesis, study of unsteady free convective MHD flow of non-Newtonian fluid specifically Micro-polar, second grade and Casson fluid has been discussed with Heat and Mass transfer in porous medium.

**Chapter 1** is taken in order to build up a stronger structure in logical manner to provide knowledge of fundamentals of MHD flow, basic concept of non-Newtonian fluid specially discussed about micro-polar fluid, Second grade fluid and Casson fluid in details, heat and mass transfer effects, radiation effects, reaction effects, Heat generation effects, Soret effects, Hall current effects and ramped boundary conditions, which is an essential part of the study to have a better understanding to study of MHD flow with heat and mass transfer through porous media. This chapter also includes an overview of the Laplace transform and inverse Laplace transform technique for finding system of linear partial differential equations with initial and boundary conditions. A brief history of the development of the subject is also obtained in review of relevant literature.

**Chapter-II** deals with Heat transfer effects on unsteady free convective MHD micro-polar fluid flow between two vertical walls for asymmetric and symmetric wall temperature. The governing non-dimensional equations of momentum, angular momentum and energy equations of micro polar fluid are solved numerically using Matlab Software. Analytic solution of this problems for steady state conditions are obtained and also expressions of velocity, micro-rotation and temperature profiles are derived. In this chapter deals comparison of analytic and numerical results for velocity, micro-rotation and temperature profiles through graphs and tabular form.

**Chapter-III** deals with study of heat and mass transfer effects on unsteady free convective MHD flow through porous medium. This chapter consists of two section. In first section, heat and mass transfer effects on MHD Casson fluid flow past an oscillating vertical plate through porous medium considering both ramped wall temperature as well as isothermal temperature is elaborated whereas second section, heat and mass transfer effects on unsteady free convective MHD Second grade fluid flow past an infinite vertical plate through porous medium is taken in consideration. In both sections, governing non-dimensionalized equations are solved using Laplace transform technique and exact expressions for velocity, temperature and concentration profiles are obtained. With the help of the velocity, temperature and concentration profiles the expressions for Skin friction, Nusselt number and Sherwood number are derived.

**Chapter-IV** deals with study of radiation and reaction effects on unsteady free convective MHD flow through porous medium. This chapter consists of two section. In first section, thermal radiation and chemical reaction effects on MHD Casson fluid flow past an oscillating vertical plate embedded in porous medium is considered with ramped wall temperature whereas the second section discussed radiation and reaction effects on MHD Casson fluid flow past over an exponentially accelerated vertical plate in porous medium with ramped wall temperature and ramped surface concentration. In both sections, governing non-dimensional equations are converted to a system of linear partial differential equations with initial and boundary conditions. The Laplace transform technique is applied to said problems and obtained exact expression of velocity, temperature and concentration profiles. To get perfect understanding of the effects of radiation and reaction on velocity, temperature and concentration profiles, Numerical values are presented graphically. Expressions for Skin friction, Nusselt number and Sherwood number are derived and presented in tabular form.

**In Chapter-V**, presents analytical expressions for heat generation and chemical reaction effects on unsteady free convective MHD Casson fluid flow over an exponentially accelerated vertical plate embedded in porous medium with ramped boundary conditions. In this section, analytical expressions for velocity, temperature and concentration profiles are derived using Laplace transform technique. For crystal clear understanding of the effects of ramped boundary conditions, the solution is found for said problem with isothermal boundary conditions to compared results with ramped boundary conditions. Expressions for Shear stress, temperature gradient as well as concentration gradient are derived and presented in tabular form.

**Chapter-VI** deals with thermo-diffusion and heat generation effects on MHD flow of chemically reactive and radiating fluid in porous medium. This chapter contains two section. First section deals with Soret and heat generation effects on MHD flow of radiating and reactive Casson fluid flow past an oscillating vertical plate in porous medium with ramped boundary conditions whereas, second section contains parabolic and thermo-diffusion effects on MHD Second grade fluid flow in presence of radiation and reaction with ramped wall temperature and ramped surface concentration in porous medium. In this problems, governing non-dimensional momentum, energy and concentration equations are solved using Laplace transform technique. Skin friction, Nusselt number and Sherwood number are presented in tabular form.

**In Chapter-VII**, Hall current effects on MHD flow in rotating system through porous medium has been considered. This chapter involves two different section. First section deals with Hall current and Heat generation effects on MHD flow of chemically reactive and radiating Casson fluid past an oscillating vertical plate in rotating systems through porous medium with ramped boundary conditions. In second section, discussed Soret and Hall current effects on MHD Casson fluid flow past an exponential vertical plate in rotating frame with ramped temperature and ramped surface concentration. In both the sections, Mathematical modeling of the problem result in linear partial differential equations with initial boundary conditions. Expressions for primary velocity, secondary velocity, heat transfer, mass transfer, Shear stress, rate of heat transfer and mass transfer have been obtained using Laplace transform technique.