PREFACE
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Fluid mechanics is one of the oldest branches of physics and the foundation for the understanding of many other aspects of the applied sciences and engineering, concerns itself with the investigation of the motion and equilibrium of fluids. It is a subject of widespread interest in almost all fields of engineering as well as in astrophysics, biology, biomedicine, meteorology, physical chemistry, plasma physics and geophysics. Since the nineteenth century when the study of hydraulics as a science was associated with the growth of the fields of civil engineering and naval architecture, the scope of fluid mechanics has steadily broadened. The designs of aeroplanes and ships for air and ocean transportation are based on the theory of fluid mechanics. The flight of birds in the air and the motion of fish in the water are governed by the laws of fluid mechanics. We live in an environment of air and of water to a great extent, so that almost everything we do is connected in some way to the science of fluid mechanics.

In physics, fluid dynamics is a sub-discipline of fluid mechanics that deals with fluid flow. It has several sub disciplines itself, including aerodynamics and hydrodynamics. Aerodynamic forces depend in a complex way on the viscosity of the fluid. As the fluid moves past the object, the molecules right next to the surface stick to the surface. The
molecules just above the surface are slowed down in their collisions with the molecules sticking to the surface. These molecules in turn slow down the flow just above them. The farther one moves away from the surface, the fewer the collisions affected by the object surface. This creates a thin layer of fluid near the surface in which the velocity changes from zero at the surface to the free stream value away from the surface. Engineers call this layer the boundary layer because it occurs on the boundary of the fluid.

The concept of boundary layer was first defined by French mathematician Ludwig Prandtl in a paper presented on August 12, 1904 at the third International Congress of Mathematicians in Heidelberg, Germany. It is the great achievement of Ludwig Prandtl which, at the beginning of the twentieth century introduced the concept of a boundary layer and analyzes the flow in the boundary layer. Subsequently, the boundary layer equations have been well investigated for many engineering problems and the results play a very important role in the fluid dynamics of a viscous fluid. The transition from laminar to boundary flow, important for all fluid mechanics, was first examined in pipe flow at the end of the nineteenth century by O.Reynolds (1883). Using the flow about a sphere, in 1914 Prandtl was able to show experimentally that the boundary layer also can be either laminar or turbulent and that the process of separation and thus the drag problem are controlled by this laminar-turbulent transition. The theoretical investigations into this transition assume Reynold’s idea of the instability of the laminar flow and it was treated by Prandtl in 1921. After some futile attempts, W.Tollmien (1929) and H.Schlichting (1933) were able to calculate theoretically the indifference Reynolds number for the flat
plate at zero incidences. Boundary layers may be either laminar or turbulent depending on the value of the Reynolds number. For lower Reynolds number, the boundary layer is laminar and the streamwise velocity changes uniformly as one moves away from the wall. For higher Reynolds numbers, the boundary layer is turbulent and the streamwise velocity is characterized by unsteady swirling flows inside the boundary layer.

Boundary-layer theory has been the working horse of modern fluid mechanics since its introduction to the engineering world which was given by Prandtl (1904). Over the past century, many engineering fluid mechanical problems have been solved using analytical and numerical methods. Specifically the flow of an incompressible boundary layer flow and heat transfer over a stretching sheet has important industrial applications, for example extrusion of plastic sheet, glass blowing, drawing plastic film, paper production, metal spinning and cooling of the metallic plate in a bath. Many authors investigated some mathematical results in the heat transfer problem. On this regard Sakiadis (1961) has studied boundary layer problem generated by a continuous solid surface moving with a constant velocity. Crane (1970) seemed to initiate the study of boundary layer flow due to a stretching surface in an otherwise ambient fluid. He gave a similarity solution in a closed analytical form for the steady boundary layer flow by stretching of a sheet which moves in its own plane with a velocity varying linearly with the distance from a fixed point. Chakrabarti and Gupta (1979) have discussed the hydromagnetic flow and heat transfer case for linearly stretching plate. Debnath (1979) studied the effect of Hall current on unsteady hydromagnetic flow past a porous plate in a rotating fluid system.
and structure of the steady and unsteady flow fields is investigated. D.R.V. Prasada Rao and D.V.Krishna (1981) studied the hall effect on non torsionally generated unsteady hydromagnetic flow in a semi-infinite expanse of an electrically conducting rotating, viscous fluid bounded by an infinite non conducting plate. The exact solution of the boundary layer equations obtained by applying the Laplace transform treatment. Carragher et al. (1982) investigated the flow and heat transfer over a stretching surface when the temperature difference between the surface and an ambient fluid is proportional to a power of distance from a fixed point. Grubka and Bobba (1985) analyzed heat transfer studies by considering the power law variation of surface temperature when subject to a uniform heat flux. Andreson et al. (1992) extended the work of Crane (1970) to non-Newtonian power law fluid over a linear stretching sheet. Cortell (2005) studied the magnetohydrodynamics flow of a power-law fluid over a stretching sheet under the assumption, that the flow of an electrically conducting power-law fluid in the presence of a uniform transverse magnetic field. The solution of the boundary layer equations is obtained by using a Runge-Kutta algorithm for high-order initial value problems. Abel et al. (2008, 2008) extended the work and studied the viscoelastic MHD flow and heat transfer over a stretching sheet with non-uniform heat source and radiation. Thermal boundary layer equation takes into account the viscous dissipation and Ohmic dissipation due to transverse magnetic field and electric field. Highly non-linear momentum boundary layer equation and thermal boundary layer equation are converted into similarity equations and then solved numerically by employing fifth order Runge-Kutta-Fehlberg method with shooting. The results are analyzed
for the situation when stretching boundary is prescribed by non-isothermal temperature, namely, prescribed surface temperature (PST) which varies quadratically with the flow directional coordinate $x$. Tsai et al. (2008) studied an unsteady flow over a stretching surface with non-uniform heat source. The governing boundary layer equations are transformed by using similarity analysis to be a set of ordinary differential equations. The velocity and temperature fields are solved using the Chebyshev finite difference method (ChFD). Ishak et al. (2009) obtained the solution to unsteady laminar boundary layer over a continuously stretching permeable surface. Chen (2009) analyzed mixed convection of a power law fluid past a stretching surface in the presence of thermal radiation and magnetic field. Abdul Aziz (2009) obtained the numerical solution for laminar thermal boundary over a flat plate with a convective surface boundary condition using the symbolic algebra software Maple. S.P.Anjali Devi et al. (2010) have discussed the dissipation effects on MHD nonlinear flow and heat transfer past a porous surface with prescribed heat flux. The analytic solutions of the resulting nonlinear non-homogeneous boundary value problem in the case when the plate stretches with a velocity varying linearly with distance, expressed in terms of confluent hypergeometric functions.

In nature, the fluid in pure form is rarely available. Air and water contains impurities like dust particles and foreign bodies. Therefore, the study of two-phase flows in which solid spherical particles are distributed in a clean fluid are of interested in practical applications like petroleum industry, purification of crude oil, physiological flows and other engineering problems. On these applications Saffman (1962) has formulated the
basic equations of motion of fluid carrying small dust particles in which dust particles are uniformly distributed and also he discussed the stability of laminar flow of a dusty gas in which the dust particles are uniformly distributed. Other important applications involving dust particles in boundary layers include soil salvation by natural winds, lunar surface erosion by the exhaust of a landing vehicle and dust entrainment in a cloud formed during a nuclear explosion.

On the basis of the above applications Chakrabarti (1974) analyzed the boundary layer in a dusty gas. Chakrabarti and Gupta (1979) have discussed the hydromagnetic flow and heat transfer over a stretching sheet. Datta and Mishra (1982) have investigated boundary layer flow of a dusty fluid over a semi-infinite flat plate. Both the drag force due to slip and the transverse force due to slip-shear have been considered in boundary layer equations. The solution has been found in a power series of non-dimensional $x$, $x$ being the distance in the down-stream direction. Solutions for high slip region and small slip region characterized by $x \leq 1$ and $x \geq 1$ respectively. R.Tiwari and Kamal Singh (1983) have obtained solution for an asymptotic analysis of an unsteady hydromagnetic boundary layer flow generated impulsively in compressible viscous conducting fluid with uniform distribution of dust particle bounded by semi-infinite plate. The solution of boundary layer equations are solved by applying the laplace transform technique. Agranat (1988) has studied dusty boundary layer flow and heat transfer, with the effect of pressure gradient. Vajrevelu and Nayfeh (1992) analyzed the hydromagnetic flow of dusty fluid over a stretching sheet with the effect of suction. The equations of motion are reduced
to coupled non-linear ordinary differential equations by similarity transformations. These coupled non-linear ordinary differential equations are solved numerically on an IBM 4381 with double precession, using a variable order, variable step-size finite-difference method. The numerical solutions are compared with their approximate solutions, obtained by a perturbation technique. For small values of $\beta$, the exact solution is in close agreement with that of the obtained approximate solution. Evgeny and Sergei (1998) have discussed the stability of a dusty gas laminar boundary layer on a flat plate. The particles are assumed to be under the action of the Stokes drag only. The problem is reduced to the solution of the modified Orr Sommerfeld equation (Saffman 1962). This is solved numerically using two approaches: directly by orthonormalization method, and by perturbation method at small particle mass content. The stability characteristics are calculated for both mono- and polydisperse particles. Further XIE Ming-liang, LIN Jian-zhong and XING Fu-tang (2007) have extended work of (1982) and studied the hydrodynamic stability of a particle-laden flow in growing flat plate boundary layer. Palani and Ganesan (2007) have studied heat transfer effects on dusty gas flow past a semi-infinite inclined plate. The non-dimensional governing equations are solved by an implicit finite difference scheme of Crank-Nicolson method, which is fast convergent and unconditionally stable.

On the basis of these observations we have studied the flow and heat transfer of a dusty fluid and obtained both the analytical and numerical solutions. The thesis consists of following SIX chapters.
The FIRST chapter includes introduction and some basic definitions of fluid mechanics, boundary layer theory, heat transfer analysis, and about dust fluid, dimensionless parameters. Further the information about the analytical and numerical solution is also given in detail.

SECOND chapter consists of two cases, the first case about unsteady hydromagnetic boundary layer flow of a rotating dusty fluid and in second case we extended the work by taking the time dependent pressure gradient. The exact solutions of the boundary layer equations are obtained by asymptotic behaviour of Laplace transform treatment i.e., the error function method. The velocity distribution of the fluid and dust phase and the associated boundary layer is investigated. Further, the effect of various physical parameters like magnetic parameter, Ekman number and Hall current parameter on velocity of both fluid and dust phase are depicted graphically.

In THIRD chapter we have studied two cases, in first case we analyzed the magnetic effect on the boundary layer flow of a dusty fluid over a stretching sheet, where as in the second case we have discussed the effect of suction and viscous dissipation on heat transfer analysis. The governing boundary layer equations are transformed into ordinary differential equations by using suitable similarity transformations. Obtained highly non-linear equations are solved numerically using Runge Kutta Fehlberg fourth-fifth order method. The effect of various physical parameters like fluid particle interaction parameter, magnetic parameter, suction parameter, Prandtl number and Eckert number on velocity and temperature of both fluid and dust phase are analyzed. The skin friction and heat
transfer coefficients are tabulated for a range of values of the parameters.

The FOURTH chapter is devoted to study the convective heat transfer characteristics of an incompressible dusty fluid past a vertical stretching sheet. The transformed equations are solved numerically by applying RKF45 method with the help of algebraic software MAPLE. Here an attempt is made to obtain a non-dimensional velocity and temperature profiles for both fluid and dust phases to study the effect of different physical parameters. Comparison work of the present numerical results were made with previously published results and found them in good agreement.

Steady magneto-hydrodynamic boundary layer flow of an incompressible electrically conducting dusty fluid near a stagnation point on stretching surface is studied in FIFTH chapter. Here we notice that the velocity profiles increases due to the effect of Hartmann number for $\lambda > 1$, and it decreases for $\lambda < 1$ due to formation of inverted boundary layer. Numerical computations are shown graphically and discussed in detail.

The SIXTH chapter deals with the study of unsteady stagnation point flow of a dusty fluid towards stretching sheet. Further the work is extended to a vertical stretching sheet in a porous media. Here the flow is under the influence of magnetic field and the solutions of the governing equations are obtained numerically and depicted graphically. From these figures one can observed that the velocity and temperature profiles are decreases with the increase of the unsteady parameter $A$ for both fluid and dust phases. The effect of magnetic parameter $M$ decreases the fluid and dust phase velocity profiles. It is noted that the thickness of boundary layer decreases with increasing values of $A$. 