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Chemical Reaction And Heat Generation Effects On Mhd Free Convective Flow Over A Porous Plate With Varaible Tempareture And Variable Concentration

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ABSTRACT:
This Work Is Aimed At Describing The Chemical Reaction And Heat Generation Effects On MHD Free Convective Flow Over A Porous Plate With Varaible Tempareture And Variable Concentration.Analytic Solution Is Carried Out Under Finite Difference Method Of Dufort – Frankel Type. The Analytical Solution Has Been Derived For The Velocity, Temperature And Concentration. The Results For Velocity, Temperature And Concentration Are Analyzed By Plotting Graphs And Discussed In Detail. We Notice That The Velocity Reduces By Increase In Chemical Reaction Parameter, Heat Generation Parameter And Prandtl Number. We Observe That When Increase In Chemical Reaction Parameter, The Result In Concentration Profile Reduces And Also We Observe That Temperature Of The Fluid Decreases By Increase In Heat Generation Parameter.

Key-Words: Chemical Reaction, MHD, Temperature, Concentration, Porous Plate, Finite Difference Method Of Dufort – Frankel.

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I. INTRODUCTION

There Are Many Transport Processes, Which Occur Naturally, And Artificially In Which Flow Is Modified Or Driven By Density Differences Caused By Temperature, Chemical Composition Differences And Gradients, And Material Or Phase Constitution. The Periodic Heat And Mass Transfer To The Chemically Reacting MHD Free Convection On An Infinite Vertical Porous Plate Has Received A Growing Interest During The Last Decades. This Is Due To Its Importance In Several Engineering, Industrial Geophysical And Astrophysical Applications, Such As Polymer Production, Manufacturing Of Ceramic, Packed-Bed Catalytic Reactors, Food Processing, Cooling Of Nuclear Reactors, Enhanced Oil Recovery, Underground Energy Transport, Magnetized Plasma Flow, High-Speed Plasma Wind, Cosmic Jets And Stellar Systems. A Clear Understanding Of The Nature Of Interaction Between Thermal And Concentration Buoyancies Is Necessary To Control Those Processes. The Problems Of Infinite And Semi-Infinite Vertical Plate With And Without Chemical Reaction Have Been Studied Extensively By Different Scholars.

Dekha Et Al. [7] Investigated The Effect Of The First Order Homogeneous Chemical Reaction On The Process Of An Unsteady Flow Past A Vertical Plate With A Constant Heat And Mass Transfer. Muthucumaraswamy [14] Presented The Heat And Mass Transfer Effects On A Continuously Moving Isothermal Vertical Surface With Uniform Suction By Taking Into Account The Homogeneous Chemical Reaction Of First Order. Muthucumara swamy And Meenakshi sundaram [15] Investigated Theoretical Study Of Chemical Reaction Effects On Vertical Oscillating Plate With Variable Temperature And Mass Diffusion.The Study Of Magnetohydro dynamics (MHD) Flow Of Electrically Conducting Fluids In Electric And Magnetic Fields Is Of Considerable Interest In Modern Metallurgical And Metal Working Process. The Formulation Of The Electromagnetic Theory In A Mathematical Form Is Known As Maxwell's Equation. Thus Hartmann Flow Is A Classical Problem That Has Important Applications In MHD Power Generators And Pumps, Accelerators, Aerodynamic Hearing, Electrostatic Precipitation, Polymer Technology, The Petroleum Industry, Purification Of Crude Oil And Design Of Various Heat Exchangers. Another Important Application Of Hydromagnetic To Metallurgy Lies In Purification Of Molten Metal From Non-Metalic Inclusion By The Application Of Uniform Magnetic Field. Hartmann And Lazarus [9] Studied The Influence Of Transverse Uniform Magnetic Field On The Flow Of A Viscous Incompressible Electrically Conducting Fluid Between Two Infinite Parallel Stationary

And Insulating Plates. The Problem Was Then Extended In Numerous Ways As Chakrabarty And Gupta [4], Singh And Cowling [21], Reliey [16], Chaim [3] And Abd El-Aziz And Salem [1].

Several Authors Have Analyzed Physical Problems In This Field. Ananda Rao And Prabhakar Reddy [2] Have Studied Numerical Solution Of Mass Transfer In MHD Free Convective Flow Of A Viscous Fluid Through A Vertical Channel. Chamkha [6] Investigated The Unsteady MHD Convective Heat And Mass Transfer Past A Semi-Infinite Vertical Permeable Moving Plate With Heat Absorption. Hossain And Mandal [10] Discussed The Effects Of Mass Transfer And Free Convection On The Unsteady MHD Free Past A Vertical Porous Plate With Constant Suction. Kim [12] Studied The Unsteady MHD Convective Heat Transfer Past A Semi-Infinite Vertical Porous Moving Plate With Variable Suction. Sahin Ahmed [18] Examined The Effects Of Viscous Dissipation And Chemical Reaction On Transient Free Convective MHD Flow Over A Vertical Porous Plate.The Heat Source/Sink Effects In Thermal Convection Are Significant Where There May Exist High Temperature Differences Between The Surface (E.G. Space Craft Body) And The Ambient Fluid. Heat Generation Is Also Important In The Context Of Exothermic Or Endothermic Chemical Reaction. Tania Et Al. [23] Has Investigated The Effects Of Radiation, Heat Generation And Viscous Dissipation On MHD Free Convection Flow Along A Stretching Sheet. Furthermore, Moalem[13] Studied The Effect Of Temperature Dependent Heat Sources Taking Place In Electrically Heating On The Heat Transfer Within A Porous Medium. Vajravelu And Nayfeh [24] Reported On The Hydro Magnetic Convection At A Cone And A Wedge In The Presence Of Temperature Dependent Heat Generation Or Absorption Effects. Moreover, Chamkha [5] Studied The Effect Of Heat Generation Or Absorption On Hydro Magnetic Three-Dimensional Free Convection Flow Over A Vertical Stretching Surface. Satyanarayana And Venkataramana [20] Analyzed The Hall Current Effect On Magnetohydrodynamics Free-Convection Flow Past A Semi-Infinite Vertical Porous Plate With Mass Transfer.Sahoo Et Al. [19] Have Studied Magneto-Hydrodynamic Unsteady Free Convection Flow Past An Infinite Vertical Plate With Constant Suction And Heat Sink. Gireesh Kumar Et Al. [8] Tackled The Effects Of Chemical Reaction And Mass Transfer On MHD Unsteady Free Convection Flow Past An Infinite Vertical Plate With Constant Suction And Heat Sink.

Ibrahim Et Al. [11] Analytically Derived The Heat And Mass Transfer Of A Chemical Convective Process Assuming An Exponentially Decreasing Suction Velocity At The Surface Of A Porous Plate And A Two Terms Harmonic Function For The Rest Of The Variables. Rushi Kumar [17] Studied The Effect Of Heat Generation And Radiation On MHD Boundary Layer Flow In A Porous Vertical Flat Plate. Vijaya Kumar Et Al. [25] Analyzed The Thermal Diffusion And Radiation Effects On Unsteady MHD Flow, Through Porous Medium With Variable Temperature And Mass Diffusion In The Presence Of Heat Source/Sink. Sudheerbabu [22] Studied The Radiation And Chemical Reaction Effects On An Unsteady MHD Convection Flow Past A Vertical Moving Porous Plate Embedded In A Porous Medium With Viscous Dissipation. Vijaya Kumar Et Al. [26] Looked The Effect Of Chemical Reaction On Unsteady Heat And Mass Transfer Flow Past An Exponentially Accelerated Vertical Plate With Variable Temperature And Mass Diffusion.

II. FORMULATION OF THE PROBLEM

We Consider The Transient MHD Free Convective Flow Of An Electrically Conducting, Incompressible Fluid Over An Infinite Vertical Porous Plate With Homogeneous Chemical Reaction Of First Order In The Presence Of Heat Generation And Viscous Dissipation. The x' - Axis Is Assumed To Be Taken Along The Plate And The y' – Axis Normal To The Plate. Since The Plate Is Considered Infinite In x' – Direction, Hence All Physical Quantities Will Be Independent Of x'. Under These Assumption, The Physical Variables Are Functions Of y' And t' Only. The Wall Is Maintained At Constant Temperature T_w' And Concentration C_w' Higher Than The Ambient Temperature T_∞' And Concentration C_∞' Respectively. The Joule Heating Effects Are Assumed To Be Negligible In The Energy Equation. Also, It Is Assumed That There Exists A Homogeneous Chemical Reaction Of First Order With Rate Constant Kr' Between The Diffusing Species And The Fluid. A Uniform Magnetic Field Of Magnitude B_0 Is Applied Normal To The Plate. Under The Boussinesq Approximation And Boundary Layer Theory, The Governing Equations For The Problem Under Consideration Are:

$$\frac{\partial u'}{\partial y'} = 0 \qquad (1)$$

$$\frac{\partial u'}{\partial t'} + v'\frac{\partial u'}{\partial y'} = g\beta(T' - T'_\infty) + g\beta^*(C' - C'_\infty) + v\frac{\partial^2 u'}{\partial y'^2} - \frac{\sigma B_0^2}{\rho}u' \qquad (2)$$

$$\frac{\partial T'}{\partial t'} + v'\frac{\partial T'}{\partial y'} = \frac{\kappa}{\rho C_p}\frac{\partial^2 T'}{\partial y'^2} - Q_0(T' - T'_\infty) + \frac{v}{C_p}\left(\frac{\partial u'}{\partial y'}\right)^2 \qquad (3)$$

$$\frac{\partial C'}{\partial t'} + v'\frac{\partial C'}{\partial y'} = D\frac{\partial^2 C'}{\partial y'^2} - Kr'(C' - C'_\infty) \qquad (4)$$

Wherex', y' And t' Are The Dimensional Distances Along And Perpendicular To The Plate And Dimensional Time, Respectively, u' And v' Are The Components Of Dimensional Velocities Along x And y Directions Respectively. T' And C' Are The Dimensional Temperature And Concentration, ρ Is The Fluid Density, υ Is The Kinematic Viscosity, C_p Is The Specific Heat At Constant Pressure, σ Is Fluid Electrical Conductivity, G Is The Acceleration Due To Gravity, β And β^* Are

$$\frac{\partial U'}{\partial t'} - v_0\left(1 + \varepsilon A e^{i\omega' t'}\right)\frac{\partial u'}{\partial y'} = g\beta(T' - T'_\infty) + g\beta^*(C' - C'_\infty) + v\frac{\partial^2 u'}{\partial y'^2} - \frac{\sigma B_0^2}{\rho}u' \qquad (6)$$

$$\frac{\partial T'}{\partial t'} - v_0\left(1 + \varepsilon A e^{i\omega' t'}\right)\frac{\partial T'}{\partial y'} = \frac{\kappa}{\rho C_p}\frac{\partial^2 T'}{\partial y'^2} - Q_0(T' - T'_\infty) + \frac{v}{C_p}\left(\frac{\partial u'}{\partial y'}\right)^2 \qquad (7)$$

$$\frac{\partial C'}{\partial t'} - v_0\left(1 + \varepsilon A e^{i\omega' t'}\right)\frac{\partial C'}{\partial y'} = D\frac{\partial^2 C'}{\partial y'^2} - Kr'(C' - C'_\infty) \qquad (8)$$

The Corresponding Initial And Boundary Conditions Of The Problems Are:

$$\left.\begin{array}{llll} t' \leq 0: u' = 0, & T' = T'_{\infty}, & C' = C'_\infty & for\,all\,y' \\ t' > 0: u' = 0, T' = T'_w + (T'_w - T'_\infty)e^{iw't'}, & & C' = C'_w + (C'_w - C'_\infty)e^{iw't'} & at\,y' = 0 \\ u' \to 0, & T' \to T'_{\infty}, & C' \to C'_\infty & as\,y' \to \infty \end{array}\right\} \quad (9)$$

In Order To Write The Governing Equations And The Boundary Conditions In Dimensionless Form, The Following Non-Dimensional Quantities Are Introduced

$$\left.\begin{array}{c} y = \frac{v_0 y'}{\upsilon}, u = \frac{u'}{v_0}, t = \frac{t' v_0^2}{4\upsilon}, \omega = \frac{4\omega' \upsilon}{v_0^2}, M = \frac{\sigma B_0^2 \upsilon}{\rho v_0^2} \\ \theta = \frac{T' - T'_\infty}{T'_w - T'_\infty}, \Phi = \frac{C' - C'_\infty}{C'_w - C'_\infty}, Gr = \frac{\upsilon g\beta(C'_w - C'_\infty)}{v_0^2}, Gc = \frac{\upsilon g\beta^*(C'_w - C'_\infty)}{v_0^2} \\ Q = \frac{\upsilon Q_0}{\rho C_p u_0^2}, \Pr = \frac{\mu C_p}{\kappa}, Sc = \frac{\upsilon}{D}, Kr = \frac{\upsilon Kr'}{v_0^2}, E = \frac{\upsilon}{v_0 C_p(T'_w - T'_\infty)} \end{array}\right\} \quad (10)$$

The Mass Diffusion Equation (13) Can Be Adjusted To Represent A Destructive Reaction (Means Endothermic I.E. Heat Is Absorbed) If Kr > 0 And Generative (Means Exothermic I.E. Heat Generated) If Kr < 0.

III. SOLUTION OF THE PROBLEM

The Unsteady, Non-Linear, Coupled Partial Differential Equations (11), (12) And (13) Along With The Boundary Conditions (14) Have

Been Solved Numerically Using An Unconditionally Stable Explicit Finite Difference Method Of Dufort – Frankel Type Is Employed.

Here, Index I Refers To Y And J Refers To Time, The Mesh System Is Divided By Taking $\Delta y = 0.1$.

The Thermal And Concentration Expansion Coefficients, B_0 Is The Magnetic Induction, D Is The Chemical Molecular Diffusivity, Kr' Is The Chemical Reaction Parameter And κ Is The Fluid Thermal Conductivity. The First And Second Terms On The Right Hand Side Of The Momentum Equation (2) Denote The Thermal And Concentration Buoyancy Effects Respectively.

From (1) Asserts That, The Suction Velocity Is Either A Constant Or A Function Of Time. Hence The Suction Velocity Normal To That Plate Is Assumed In The Form

$$v' = -v_0\left(1 + \varepsilon A e^{i\omega' t'}\right) \qquad (5)$$

Where A Is Real Positive Constant And ε Is Small Such $\varepsilon \ll 1$, $\varepsilon A \ll 1$ And v_0 Is Non-Zero Positive Constant. The Negative Sign Indicates That The Suction Velocity Is Directed Towards The Plate.

Using (5) The Equations (2), (3) And (4) Becomes

In View Of The Equation (10) The Equations (6), (7) And (8) Reduce To The Following Non-Dimensional Form

$$\frac{\partial u}{\partial t} - \left(1 + \varepsilon A e^{i\omega t}\right)\frac{\partial u}{\partial y} = \frac{\partial^2 u}{\partial y^2} + Gr\theta + Gc\Phi - Mu \qquad (11)$$

$$\frac{\partial \theta}{\partial t} - \left(1 + \varepsilon A e^{i\omega t}\right)\frac{\partial \theta}{\partial y} = \frac{1}{Pr}\frac{\partial^2 \theta}{\partial y^2} - Q\theta + E\left(\frac{\partial u}{\partial y}\right)^2 \qquad (12)$$

$$\frac{\partial \Phi}{\partial t} - \left(1 + \varepsilon A e^{i\omega t}\right)\frac{\partial \Phi}{\partial y} = \frac{1}{Sc}\frac{\partial^2 \Phi}{\partial y^2} - k\Phi \qquad (13)$$

The Initial And Boundary Conditions Are Transformed To The Following Form:

$$\left.\begin{array}{lll} t \leq 0: u = 0, & \theta = 0, & \Phi = 0\,for\,all\,y \\ t > 0: u = 0, \theta = 1 + \varepsilon e^{i\omega t}, & & \Phi = 1 + \varepsilon e^{i\omega t}\,at\,y = 0 \\ u \to 0 & \theta \to 0, & \Phi \to 0 \quad as\,y \to \infty \end{array}\right\} \quad (14)$$

The Equivalent Finite Difference Scheme Of Equations For (11), (12) And (13) Are As Follows:

$$\frac{u_{i,j+1} - u_{i,j}}{\Delta t} - \left(1 + \varepsilon A e^{iwt}\right)\frac{u_{i+1,j} - u_{i,j}}{\Delta y} = \frac{u_{i+1,j} - 2u_{i,j} + u_{i-1,j}}{(\Delta y)^2} + Gr\theta_{i,j} + Gc\Phi_{i,j} - MU_{i,j} \qquad (15)$$

$$\frac{\theta_{i,j+1} - \theta_{i,j}}{\Delta t} - \left(1 + \varepsilon A e^{iwt}\right)\frac{\theta_{i+1,j} - \theta_{i,j}}{\Delta y} = \frac{1}{Pr}\left[\frac{\theta_{i+1,j} - 2\theta_{i,j} + \theta_{i-1,j}}{(\Delta y)^2}\right] - Q\theta_{i,j} + E\left[\frac{u_{i+1,j} - u_{i,j}}{\Delta y}\right]^2 \qquad (16)$$

$$\frac{\Phi_{i,j+1} - \Phi_{i,j}}{\Delta t} - \left(1 + \varepsilon A e^{iwt}\right)\frac{\Phi_{i+1,j} - \Phi_{i,j}}{\Delta y} = \frac{1}{Sc}\left[\frac{\Phi_{i+1,j} - 2\Phi_{i,j} + \Phi_{i-1,j}}{(\Delta y)^2}\right] - k\Phi_{i,j} \qquad (17)$$

From The Initial Conditions In (14) We Have The Following Equivalent

$u(i,0) = 0, \theta(i,0) = 0, \Phi(i,0) = 0 \; for \; all \; i$

(18)

The Boundary Conditions From (14) Are Expressed In Finite-Difference Form As Follows

$$U(0,j) = 1, \qquad \theta(0,j) = 1 + \varepsilon e^{iwt},$$
$$\phi(0,j) = 1 + \varepsilon e^{iwt} \; for \; all \; j$$
$$U(i_{max}, j) = 0, \; \theta(i_{max}, j) = 0, \; \phi(i_{max}, j) = 0 \; for \; all \; j$$

(19)

Here Infinity Is Taken As Y = 4.1. First The Velocity At The End Of The Time Step Namely $U(i, j+1)$, I = 1 To 200 Is Computed From The Equation (15) And Temperature $\theta(i, j+1$, I = 1 To 200 From Equation (16) And Concentration $\varphi(i, j+1)$, I = 1 To 200 From Equation (17). The Procedure Is Repeated Until T = 1 (I.E., J = 400). During Computation Δt Was Chosen As 0.0025. These Computations Are Carried Out For Pr = 0.71, 1.0, 7.0; Sc = 0.66, 0.94, 2.62; Kr = -2.0, -5.0, 2.0, 5.0; Gr = 5.0, 10.0, 15.0, 20.0; Gc = 5.0, 10.0, 15.0, 20.0; E = 0.01, 1.00, 10.0. To Judge The Accuracy Of The Convergent Of The Finite Difference Scheme, The Same Programmed Was Run With Similar Values Of Δt I.E., Δt = 0.0009, 0.001, And No Significant Change Was Observed. Hence We Conclude That This Finite-Difference Scheme Is Stable And Convergent.

IV. NUMERICAL RESULTS AND DISCUSSION

The Problem Of Unsteady Free Convective Flow Considering The Effects Of Chemical Reaction And Heat Generation On Uniform Magnetic Field Addressed In This Study. To Have A Physical Feel Of The Problem We Present Results To Show How The Material Parameters Of The Problem Affect The Velocity, Temperature And Concentration Profiles. The Thermal Grashof Number Gr And The Eckert Number Ec Take Positive Values Corresponds To Cooling Of The Plate By Free Convection Currents. To Be Realistic, The Values Of The Schmidt Number Sc, So Chosen To Represent The Presence Of Various Species Oxygen (Sc = 0.66), Carbon Dioxide (Sc = 0.94) And Propel Benzene At 20^0C (Sc = 2.62).

Figs. 1.1(A) And 1.1(B) Display The Influence Of Chemical Reaction Parameter (Kr) On The Transient Velocity (U) And Concentration (Φ) In Air For Oxygen. It Is Clear That Increasing The Chemical Reaction Parameter Tends To Decrease The Velocity As Well As Species Concentration Of The Fluid. This Means That In The Case Of Suction, The Chemical Reaction Decelerates The Fluid Motion. In Turn, This Causes The Concentration Buoyancy Effects To Decrease As K Increases. Consequently, Less Flow Is Induced Along The Plate Resulting In Decrease In The Fluid Velocity In The Boundary Layer. It Is Interesting To See That, The Transient Velocity Is Increased By The Presence Of Generative Chemical Reaction (Kr > 0) And Decrease In Destructive Chemical Reaction (Kr < 0).For Different Values Of Heat Generation Parameter Q, The Velocity Profiles Are Plotted In Fig. 1.2(A). Here We Find That, As The Values Of Heat Generation Parameter Q Increases The Velocity Decreases, With An Increasing In The Flow Boundary Layer Thickness. The Effects Of Heat Generation Parameter Q On The Temperature Profiles Are Presented In Fig. 1.2(B). From This Figure We Observe That, As The Value Of Heat Generation Parameter Q Increases The Temperature Profiles Decreases, With An Increasing In The Thermal Boundary Layer Thickness. Figs. 1.3(A) And 1.3(B) Are Shown That The Behavior Of The Transient Velocity (U) And Temperature (θ) For Different Values Of The Prandtl Number Pr. The Numerical Results Show That The Effect Of Increasing Values Of Prandtl Number Pr Results In A Decreasing Velocity. From Fig. 1.3(B), It Is Observed That An Increase In Prandtl Number Pr Results In A Decrease Of The Thermal Boundary Layer Thickness And In General Lower Average Temperature Within The Boundary Layer. The Reason Is That Smaller Values Of Prandtl Number Pr Are Equivalent To Increase In The Thermal Conductivity Of The Fluid And Therefore Heat Is Able To Diffuse Away From The Heated Surface More Rapidly For Higher Values Of Prandtl Number Pr.The Effects Of Viscous Dissipative Heat Parameter I.E., Eckert Number (Ec) On The Transient Velocity (U) As Well As Temperature (θ) Have Been Plotted In Figs. 1.4(A) And 1.4(B). It Is Noticed That An Increase In Viscous Dissipative Heat Leads To Increase In Both The Transient Velocity As Well As The Temperature. Fig: 1.5(A) And 1.5(B) Illustrates The Transient Velocity (U) And Concentration Profiles (Φ) For Schmidt Number (Sc). It Is Noticed That Effect Of Increasing Value Of Schmidt Number Sc Is To Decrease Transient Velocity As Well As Concentration Profiles. This Is Consistent With The Fact That, Increase In Sc Means Decrease Of Molecular Diffusivity D Those Results In Decrease Of Fluid Motion And Concentration Boundary Layer. Hence Transient Velocity And Concentration Of Species Is Higher For Small Values Of Sc And Lower For Larger Values Of Schmidt Number Sc.The Transient Velocity (U) Profiles For Different Values Of The Thermal Grashof Number Gr Are Described In Fig. 1.6(A). It Is Observed That An Increase In Thermal Grashof Number Gr Leads To Rise In The Values Of Velocity. For The Case Of Different

Values Of The Modified Grashof Number Gc, The Velocity Profiles Are Shown In The Fig. 1.6(B). It Is Observed That An Increase In Modified Grashof Number Gc Leads To A Rise In The Values Of Velocity.The Effects Of Magnetic Field (M) On The Transient Velocity (U) Are Presented In Fig. 1.7 And Under This Effect The Flow Velocity Leads To Decrease Whenever The Magnetic Parameter M Increase. The Presence Of Transverse Magnetic Field (M) Produces A Resistive Force On The Fluid Flow. This Force Is Called The Lorentz Force, Which Leads To Slow Down The Motion Of Electrically Conducting Fluid And Therefore, This Leads To Decrease The Transient Velocity.

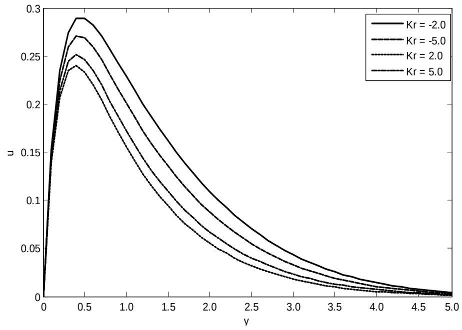

Fig: 1.1(A) – Velocity Profile For Different Values Of Chemical Reaction Parameter 'Kr' When
Gr = 5, Gc = 5, Ec = 0.001, Pr = 0.71, Sc = 0.66, M = 5.0, Q = 1.0.

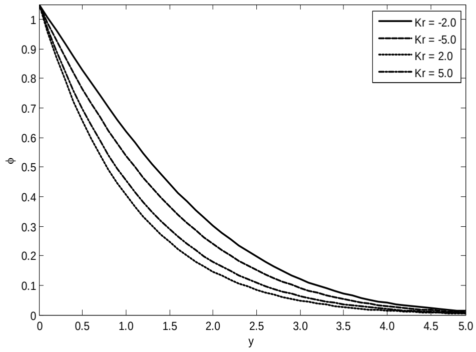

Fig: 1.1(B) – Concentration Profile For Different Values Of Chemical Reaction Parameter 'Kr' When
Gr = 5, Gc = 5, Ec = 0.001, Pr = 0.71, Sc = 0.66, M = 5.0, Q = 1.0,Sc = 0.66

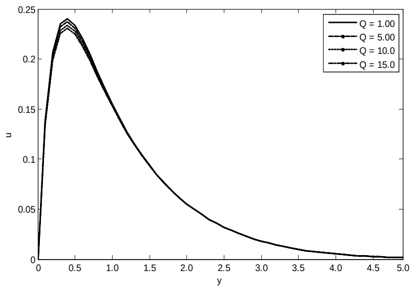

Fig: 1.2(A) – Velocity Profile For Different Values Of Heat Generation Parameter 'Q' When
Kr = 2.0, Gr = 5, Gc = 5, Ec = 0.001, Pr = 0.71, Sc = 0.66, M = 5.0

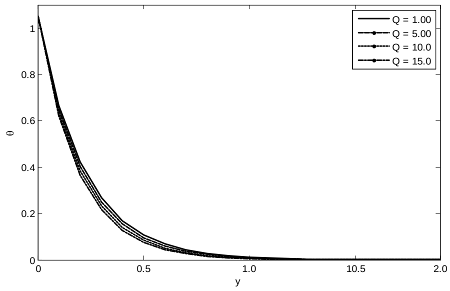

Fig: 1.2(B) – Temperature Profile For Different Values Of Heat Generation Parameter 'Q' When
Kr = 2.0, Gr = 5, Gc = 5, Ec = 0.001, Pr = 0.71, Sc = 0.66, M = 5.0,Ec = 0.001, Pr = 0.71.

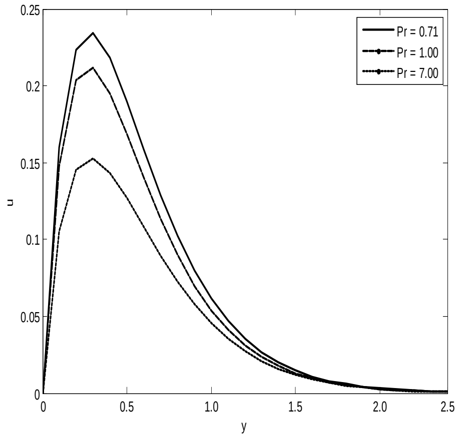

Fig: 1.3(A) – Velocity Profile For Different Values Of Prandtl Number 'Pr' When Kr = 2.0,
Gr = 5, Gc = 5, Ec = 0.001, Q = 1, Sc = 0.66, M = 5.0

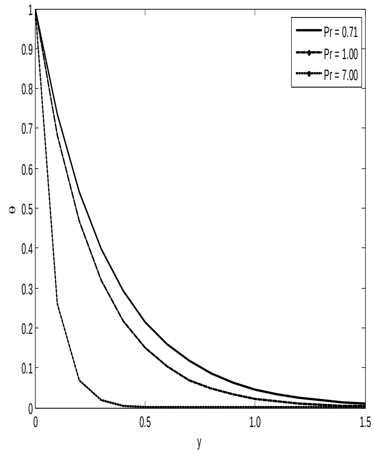

Fig: 1.3(B) – Temperature Profile For Different Values Of Prandtl Number 'Pr' When
Gr = 5, Gc = 5, Ec = 0.001, Q = 1, Sc = 0.66, M = 5.0, Ec = 0.001, Q = 1.0.

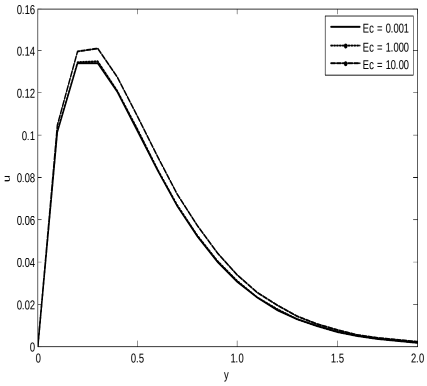

Fig: 1.4(A) – Velocity Profile For Different Values Of Eckert Number ‘Ec’ When Kr = 2.0, Gr = 5, Gc = 5, Pr = 0.71, Q = 1, Sc = 0.66, M = 5.0

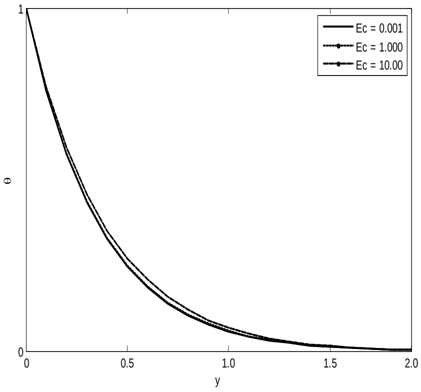

Fig: 1.4(B) – Temperature Profile For Different Values Of Eckert Number ‘Ec’ When Kr = 2.0, Gr = 5, Gc = 5, Pr = 0.71, Q = 1, Sc = 0.66, M = 5.0, Q = 1.0, Pr = 0.71.

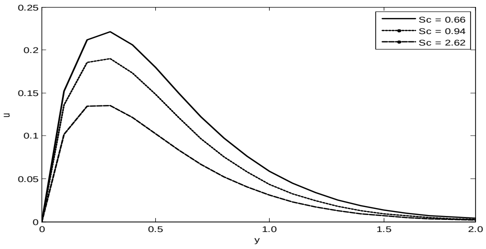

Fig: 1.5(A) – Velocity Profile For Different Values Of Schmidt Number ‘Sc’ When Kr = 2.0, Gr = 5, Gc = 5, Pr = 0.71, Q = 1, M = 5.0, Ec = 0.001.

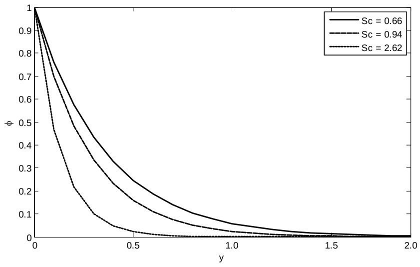

Fig: 1.5(B) – Concentration Profile For Different Values Of Schmidt Number ‘Sc’ When Kr = 2.0, Gr = 5, Gc = 5, Pr = 0.71, Q = 1, M = 5.0, Ec = 0.001.

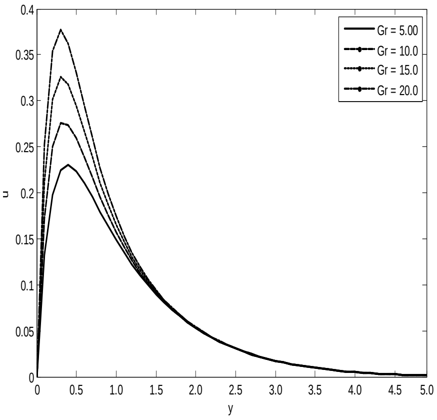

Fig: 1.6(A) – Velocity Profile For Different Values Of Thermal Grashof Number ‘Gr’ When Kr = 2.0, Sc = 0.66, Gc = 5, Pr = 0.71, Q = 1, M = 5.0, Ec = 0.001.

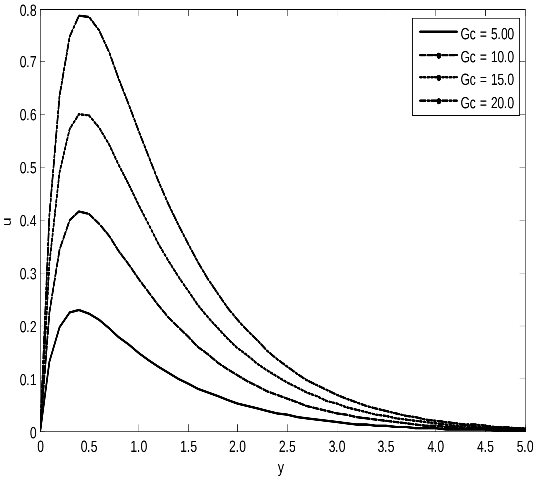

Fig: 1.6(B) – Velocity Profile For Different Values Of Modified Grashof Number ‘Gc’ When Kr = 2.0, Sc = 0.66, Gr = 5, Pr = 0.71, Q = 1, M = 5.0, Ec = 0.001.

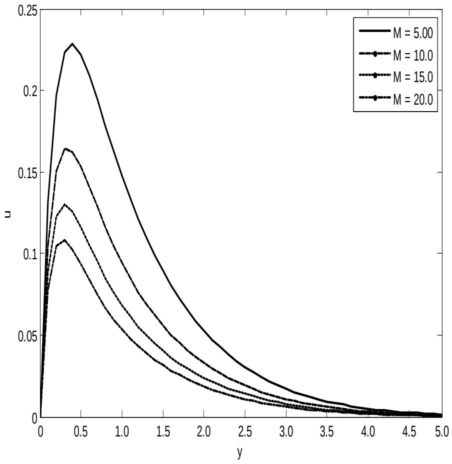

Fig: 1.7 – Velocity Profile For Different Values Of Thermal Magnetic Parameter ‘M’ When

Kr = 2.0, Sc = 0.66, Gc = 5, Pr = 0.71, Q = 1, Gr = 5.0, Ec = 0.001.

V. CONCLUSIONS

a) The Velocity Of The Fluid Reduces By Increase In Chemical Reaction Parameter, Heat Generation Parameter, Prandtl Number And Schmidt Number.
b) The Velocity Of The Fluid Increases By Increase In Eckert Number, Grashof Number And Magnetic Parameter.
c) Temperature Of The Fluid Decreases By Increase In Heat Generation Parameter And Prandtl Number.
d) Temperature Of The Fluid Rises By Increase In Eckert Number.
e) Concentration Distribution Reduces By Increase In Chemical Reaction Parameter And Schmidt Number.

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