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# MHD Second Grade Fluid Flow An Infinite Permeable Plate In A Porous Medium Presence Of Radiation And Chemical Reaction

R.Sakthikala

[1]Assistant Professor, Department of Mathematics, PSGR Krishnammal college for women,Coimbatore,Tamilnadu, INDIA

V.Lavanya

[2]Research Scholar, Department of Mathematics, PSGR Krishnammal college for women, Coimbatore,Tamilnadu, INDIA

**ABSTRACT**

A study has been examined about an unsteady free convective flow of second grade flow of a heat transfer by a laminar fluid within the presence of thermal and mass radiation with uniform temperature. The differential equations of the dimensionless parameter solved by analytical perturbation techniques.Some of the outcomes are shown as velocity, temperature, concentration and the skin friction, rate of mass and heat transfer are graphically.

**KEYWORDS:** Heat and mass transfer, free convection, rotating channel, porous medium.

## INTRODUCTION

Several decades during the past, thermal flux through porous media has been a major research interest due to engineering applications. Many researchers are in the presence of a heat source within a few decades with the interconnection of the convective flow. In the paper industry and some technological fields where applications of unstable flows.

Asghar et al [1]concentratedon a porous plate because of the motions brought about by the progressioncaused by the flow of non-Newtonian fluids. Choudhury and Das [2]investigation of the free convective motion of hydrodynamic elastic magnetic viscosity through porous media with radiation and chemical reaction of heat and mass transfer. Deka et al [3] have examined about constant heat flux for free deportation effects on MHD flow past an infinite vertical plate.Das et al [4] have investigated effects on free convective MHD stream of a viscous fluid bounded by an oscillating porous plate in the slip flow of mass transfer with heat source. Ellahi et al [5] and [6] discussed about blood flow of Prandtl fluid and a hybrid method through permeable walls that tapered stenosed arteries and which dependent on pseudo – spectral collocation by least – square technique that to examine non-Newtonian fluid flow of MHD. Hayat et al [7] the flow of a visco elastic fluid on oscillating plate has been considered and studied. Jhansi Rani and Murthy [8] discussed about unsteady convective flow of past a semi -infinite inclined permeable plate embedded in a porous medium with heat and mass exchange by the effect of radiation and absorption. Kalapana and Vijaya [9] explored the unsteady oscillatory second grade fluid flow with non-uniform wall temperature through a vertical channel taking hall current.Manna et al [10] they concentrated towards MHD the free flow portion of the unstable free load, which is a vertical oscillating porous plate embedded in a porous medium by the impact of radiation with the oscillating heat flow.

Oahimire and Olajuwon [11] discussed the effect of hall current on heat and mass transfer of MHD flow a micro – polar fluid through a porous medium. Prakash and Muthtamishan [12] have investigated MHD flow of micro polar fluid which transient the effect of radiation between porous channels of the third kind boundary conditions. Rashid et al [13] the influence of stream wise transverse magnetic fields in laminar regime is simulated under a numerical model for two-dimensional fluid flows. SadiqBasha, Nagarathna [14] havelearned about unsteady two dimensional MHD flow at blood in a porous article in a uniform magnetic field in a parallel plate which transverse the oscillating flow. Sheitholashan et al [15] have studied about the thermal radiation effect on MHD Nano-fluid flow between two horizontal rotating plates. Shan et al [16] thus investigated the stokes problem on Rayleigh of a passion generalized second grade fluid with fractional imitative model. Singh and Gupta [17] have studied free deportation flow at viscous fluid through a permeable medium bounded by a porous plate in slide flow. SudharsanReddy and ViswanathaReddy [18] have studied about the flow of an oscillatory convective MHD viscous conducting second grade fluid in a porous rotating in slip flow in the heat and mass transfer. Krishna et al [19 – 23] have discussed the MHD flows of an incompressible and electrically conducting fluid on unsteady oscillatory flow of blood through porous arteriole.

Thus above mentioned facts, an investigation of heat generating /absorbing permeable surface on second grade fluid that observed in boundary layer region as the porosity of the surface is carried out.

## MATHEMATICAL FORMULATION

Consider an unstable two-dimensional heat flux of viscous with heat and mass transfer as the heat drives a second-order liquid on an almost infinite columnar plate embedded in a uniform porous medium in the presence of a chemical reaction and radiation.

$$\frac{\partial u}{\partial x}+\frac{\partial u}{\partial y}=0 \quad (1)$$

$$\frac{\partial u}{\partial t}+w\frac{\partial u}{\partial z}-2\Omega v=-\frac{1}{\rho}\frac{\partial p}{\partial x}+v\frac{\partial^2 u}{\partial z^2}+\frac{\propto}{\rho}\frac{\partial^3 u}{\partial z^2\partial t}-\frac{\sigma B_0^2}{\rho}u-\frac{v}{k}u+g\beta_T(T-T_\infty)+g\beta_C(C-C_\infty) \quad (2)$$

$$\frac{\partial v}{\partial t}+w\frac{\partial v}{\partial z}+2\Omega u=-\frac{1}{\rho}\frac{\partial p}{\partial y}+v\frac{\partial^2 v}{\partial z^2}+\frac{\propto}{\rho}\frac{\partial^3 v}{\partial z^2\partial t}-\frac{\sigma B_0^2}{\rho}v-\frac{v}{k}v \quad (3)$$

$$\frac{\partial T}{\partial t}+w\frac{\partial T}{\partial z}=\frac{1}{\rho C_p}\left(k_1\frac{\partial^2 T}{\partial z^2}\right)-Q_0(T-T_\infty) \quad (4)$$

$$\frac{\partial C}{\partial t}+w\frac{\partial C}{\partial z}=D\frac{\partial^2 C}{\partial z^2}+K_C(C-C_\infty) \quad (5)$$

The temperature and concentration at the wall of the suction velocity in the porous plate with a invariable velocity budges in the direction of the fluid flow is varying exponentially with time and the boundary conditions are,

$$q=U_o,\ \ T=T_o+\varepsilon(T_w+T_\infty)e^{iwt},\ \ C=C_o+\varepsilon(C_w+C_\infty)e^{iwt}\quad \text{at}\ \ Z=0 \quad (6)$$

$$q\to U_\infty,\quad T\to T_\infty,\quad C\to C_\infty\quad \text{as}\ \ Z\to\infty \quad (7)$$

Equation (1) shows the suction velocity of the plate is constant or fraction of time then the $w_o$ is a non-zero constructive constant of the mean suction velocity and $\varepsilon$.

$$w=-w_0(1+\varepsilon A e^{iwt}) \quad (8)$$

The optimistic invariables are A and $\varepsilon$ that satisfies the condition $\varepsilon A\ll 1$. Then the suction indicates the negative sign is towards the plate.

Set $q=u+iv$ and $\xi=x-iy$ and combine the equation (1) and (2),

$$\frac{\partial q}{\partial t}+w\frac{\partial q}{\partial z}+2i\Omega q=-\frac{1}{\rho}\frac{\partial p}{\partial \xi}+v\frac{\partial^2 q}{\partial z^2}+\frac{\propto}{\rho}\frac{\partial^3 q}{\partial z^2\partial t}-\frac{\sigma B_0^2}{\rho}q-\frac{v}{k}q+g\beta_T(T-T_\infty)+g\beta_C(C-C_\infty) \quad (9)$$

The boundary layer of equation (9) follows,

$$-\frac{1}{\rho}\frac{\partial p}{\partial \xi}=\frac{\partial U_\infty}{\partial t}+\left[\frac{\sigma B_0^2}{\rho}+\frac{v}{k}\right]U_\infty \quad (10)$$

The non-dimensional variables are introduced,

$q^*=\frac{q}{w_0},w^*=\frac{w}{U_0},Z^*=\frac{U_o Z}{v},\quad U_\infty^*=\frac{U_\infty}{U_0},t^*=\frac{tU_0^2}{v},\quad \theta=\frac{T-T_\infty}{T_w-T_\infty},\phi=\frac{C-C_\infty}{C_w-C_\infty},M^2=\frac{\sigma B_0^2 v}{\rho U_0^2},k=\frac{kU_0^2}{v^2},P_r=\frac{v\rho C_p}{k_1}=\frac{v}{\propto},E=\frac{U_0^2}{\Omega v},G_r=\frac{v\beta g_T(T_w-T_\infty)}{U_0^3},G_C=\frac{v\beta g_C(C_w-C_\infty)}{U_0^2},\ \phi=\frac{vQ_0}{\rho C_p u_0^2},s=\frac{U_0^2\alpha}{\rho v^2},S_C=\frac{v}{D},k_C^*=\frac{k_C\gamma}{U_0^2}.$

Uses of non-dimensional variables then the equations are reduced to,

$$\frac{\partial q}{\partial t}+2iE^{-1}q-(1+\varepsilon A e^{iwt})=\frac{dU_\infty}{dt}+\frac{\partial^2 q}{\partial z^2}+S\frac{\partial^3 q}{\partial z^2\partial t}+\left(M^2+\frac{1}{k}\right)q+G_r\theta+G_C\phi \quad (11)$$

$$\frac{\partial \theta}{\partial t}-(1+\varepsilon A e^{iwt})\frac{\partial \theta}{\partial Z}=\frac{1}{P_r}\frac{\partial^2 \theta}{\partial z^2}-\phi\theta \quad (12)$$

$$\frac{\partial C}{\partial t}-(1+\varepsilon A e^{iwt})\frac{\partial C}{\partial Z}=\frac{1}{S_C}\frac{\partial^2 C}{\partial z^2}-k_C C \quad (13)$$

The boundary conditions are,

$$q=U_0,\quad \theta=1+\varepsilon e^{iwt},\ \ \phi=1+\varepsilon e^{iwt}\quad \text{at}\ Z=0 \quad (14)$$

$$q=0,\ \ \theta=0,\ \ \phi=0\quad \text{as}\ Z\to\infty \quad (15)$$

Using perturbation technique then the velocity, temperature and concentration are assumed by,

$$q=q_0(Z)+\varepsilon e^{iwt}q_1(Z)+O(\varepsilon^2) \quad (16)$$

$$\theta=\theta_0(Z)+\varepsilon e^{iwt}\theta_1(Z)+O(\varepsilon^2) \quad (17)$$

$$\phi=\phi_0(Z)+\varepsilon e^{iwt}\phi_1(Z)+O(\varepsilon^2) \quad (18)$$

In equations (11), (12) and (13) substitute in (16), (17) and (18) respectively, obtain the zeroth and first order such as,

$$\frac{d^2 q_0}{dZ^2}+\frac{dq_0}{dz}-\left(M^2+2iE^{-1}+\frac{1}{k}\right)q_0=-G_r\theta_0-G_C\phi_0 \quad (19)$$

$$\frac{d^2\theta_0}{dZ^2}+P_r\frac{d\theta_0}{dz}-P_r\phi\theta_0=0 \quad (20)$$

$$\frac{d^2\phi_0}{dZ^2} + S_C\frac{d\phi_0}{dz} - k_C S_C\phi_0 = 0 \quad (21)$$

$$(1+Siw)\frac{d^2q_1}{dZ^2} + \frac{dq_1}{dz} - \left(M^2 + 2iE^{-1} + \frac{1}{k}\right)q_1 = -G_r\theta_1 - G_C\phi_1 - A\frac{dq_0}{dz} - iw \quad (22)$$

$$\frac{d^2\theta_1}{dZ^2} + P_r\frac{d\theta_1}{dz} - P_r(iw+\phi)\theta_1 = -APr\frac{d\theta_0}{dz} \quad (23)$$

$$\frac{d^2\phi_1}{dZ^2} + S_C\frac{d\phi_1}{dz} + (1-k_C)S_C\phi_1 = -S_C\frac{dC_0}{dz} \quad (24)$$

The boundary conditions are,

$$q_0 = U_p,\ \ q_1 = 0, \theta_0 = 1, \theta_1 = 1, \phi_0 = 1, \phi_1 = 1 \quad \text{at } Z = 0 \quad (25)$$

$$q_0 = 0, q_1 = 0, \theta_0 = 0, \theta_1 = 0, \phi_0 = 0, \phi_1 = 0 \quad \text{at } Z \to \infty \quad (26)$$

Using equations (25) and (26) and solve equations (19) to (24) then,

$$q = ([U_P - (a_1 + a_2)]e^{-m_3 z} + (a_1)e^{-m_1 z} + a_2 e^{-m_2 z}) + \varepsilon[Ae^{-m_6 z} + a_5 e^{-m_4 z} + (a_6 + a_{10})e^{-m_1 z} + a_7 e^{-m_5 z} + (a_8 + a_{11})e^{-m_2 z} + a_9 e^{-m_3 z}]e^{iwt} \quad (27)$$

$$\theta = e^{-m_1 z} + \varepsilon(A_1 e^{-m_4 z} + a_3 e^{-m_1 z})e^{iwt} \quad (28)$$

$$\phi = e^{-m_2 z} + \varepsilon(Ae^{-m_5 z} + a_4 e^{-m_2 z})e^{iwt} \quad (29)$$

The non-dimensional skin friction at the plate $z = 0$ is given by,

$$\tau = \left(\frac{dq}{dz}\right)_{z=0} = \left(\frac{dq_0}{dz}\right)_{z=0} + \varepsilon\left(\frac{dq_1}{dz}\right)_{z=0} e^{iwt}$$

$$= (m_3[U_P - (a_1 + a_2)] + m_1(a_1) + m_2 a_2) + \varepsilon[m_6 A - m_4(a_5) - m_1(a_6 + a_{10}) - m_5 a_7 - m_2(a_8 + a_{11}) - m_3 a_9]e^{iwt} \quad (30)$$

The $\tau_{xz}$ and $\tau_{yz}$ be the skin friction components at the plate is given by,

$$\tau_{xz} = \left(\frac{du_0}{dz}\right)_{z=0} - \varepsilon\left(\frac{dv_1}{dz}\right)_{z=0} \ \text{ and } \ \tau_{yz} = \left(\frac{dv_0}{dz}\right)_{z=0} + \varepsilon\left(\frac{du_1}{dz}\right)_{z=0}$$

The non-dimensional form in which rate of heat transfer as Nusselt number $N_u$is given by,

$$N_u = \left(\frac{dT}{dz}\right)_{z=0} = \left(\frac{dT_0}{dz}\right)_{z=0} + \varepsilon\left(\frac{dT_1}{dz}\right)_{z=0} e^{iwt}$$

$$= -m_1 - \varepsilon(A_1 m_4 + a_3 m_1)e^{iwt} \quad (31)$$

The non-dimensional form in which rate of mass transfer as Sherwood number $S_h$ is given by,

$$S_h = \left(\frac{dC}{dz}\right)_{z=0} = \left(\frac{dC_0}{dz}\right)_{z=0} + \varepsilon\left(\frac{dC_1}{dz}\right)_{z=0} e^{iwt}$$

$$= -m_2 - \varepsilon(Am_5 + a_4 m_2)e^{iwt} \quad (32)$$

## RESULT AND DISCUSSION

An unsteady MHD flow of a second-grade fluid parameters through porous medium embedded in an infinite plate is analyzedwith parameters like Hartmann number, thermal Grashof number, modified Grashof number, permeability parameter, rotation parameter, second grade fluid, Prandtl number, chemical reaction parameter, Schmidt number, heat absorption parameter, radiation parameterand time t have an impact on second-grade fluid parameters and non-dimensional parameters. As a result, the velocity concentration and temperature profiles are depicted in the following figures (1-16).

Figure (1) shows the effect of the Lorentz force on the fluid flow when the maximum flow occurs in the absence of the field, which increases Hartmann's number, causing the fluid components u and v to increase.Figure (2) If the permeability of the porous channel decreases in the velocity profile, the medium of permeability decreases the fluid velocity in the flow direction, lowering K to free flow velocity.Figure (3) The axial flow in the velocity profile decreases as the rotation rate decreases, and the strong rotation rate also decreases. The flow is perpendicular to the duct due to the pressure gradient and the tube rotating on its axis. Figure (4) As the magnetic field of the stress strain tensor decreases with the fluid components u and v, the second-grade fluid decreases. Figures (5) and (6) As the plate is cooling, the effects of thermal Grashof number Gr and mass Grashof number Gm in the velocity profiles increase, which has the potential to increase the buoyancy effect and induced flow transport, and a reverse effect causes the plate to increase when heating.Figure (7) Different values of Prandtl number Pr are seen in the velocity profiles; as the flow field decreases, the values of Prandtl number increase; hence, higher Prandtl number Pr contributes to a faster cooling plate.Figure (8) shows the effect of cooling and heating the plate in the presence of a chemical reaction parameter that affects both profiles; as the values rise, the chemical reaction parameter decreases.Figure (9) The effect of Schmidt number Sc shows that as the Schmidt number increases, the velocity of the fluid decreases, which is followed by a decrease in the momentum of the boundary layer thickness. Figure (10) As the dimensionless concentration falls, the values of increase.Figure (11) As the temperature decreases in Prandtl number and increases in frequency of oscillation and dimensionless concentration while increasing the fluid velocity, the temperature decreases in Prandtl number and increases in frequency of oscillation and dimensionless concentration.Figure (12) Which indicates the Schmidt number Sc concentration distribution has different values, which decreases the Schmidt number chemical reaction parameter (Kc) second grade parameter (N) and increases the frequency of oscillation, which causes theconcentration buoyancy effects to decrease, yielding a reduction in fluid velocity, which is followed by a parallel reduction in boundary layers.

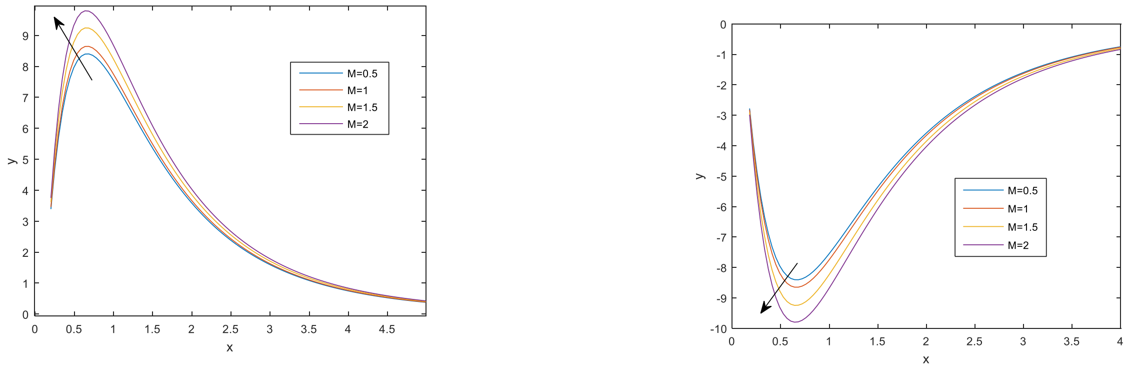


**FIGURE 1:** Velocities for u and v against M, K=0.5, E=0.1, S=1, Gr=5,$G_c$=5, Pr=0.71, Sc=0.22, Kc=1, ∅=1, ω=π/6, t=0.1

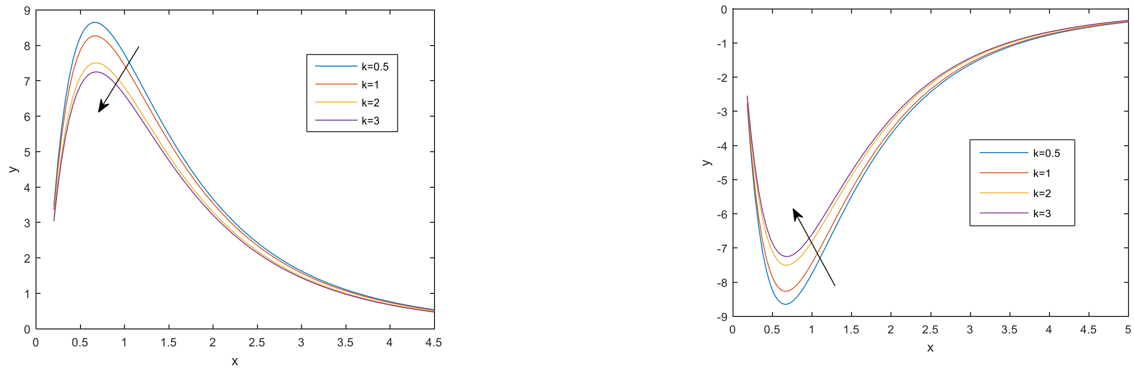


**FIGURE 2:** Velocities for u and v against K, M=0.5, E=0.1, S=1, Gr=5,$G_c$=5, Pr=0.71, Sc=0.22, Kc=1, ∅=1, ω=π/6, t=0.1

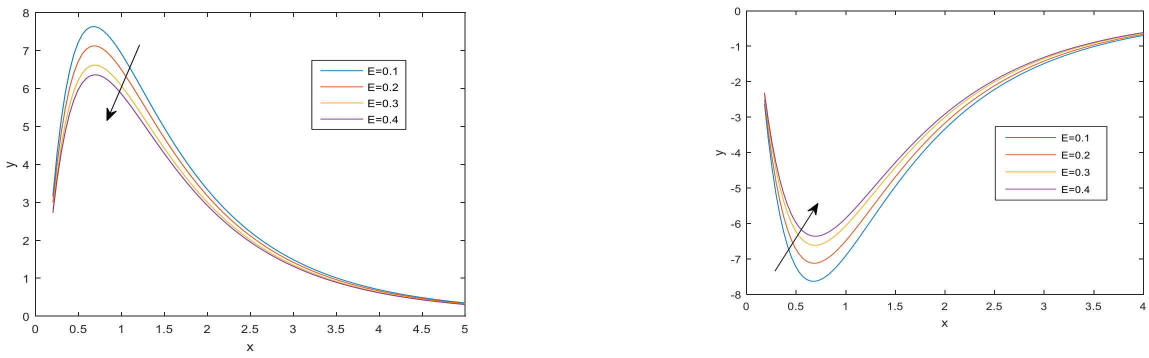


**FIGURE 3:** Velocities for u and v against E, M=0.5, K=0.5, S=1, Gr=5,$G_c$=5, Pr=0.71, Sc=0.22, Kc=1, ∅=1, ω=π/6, t=0.1

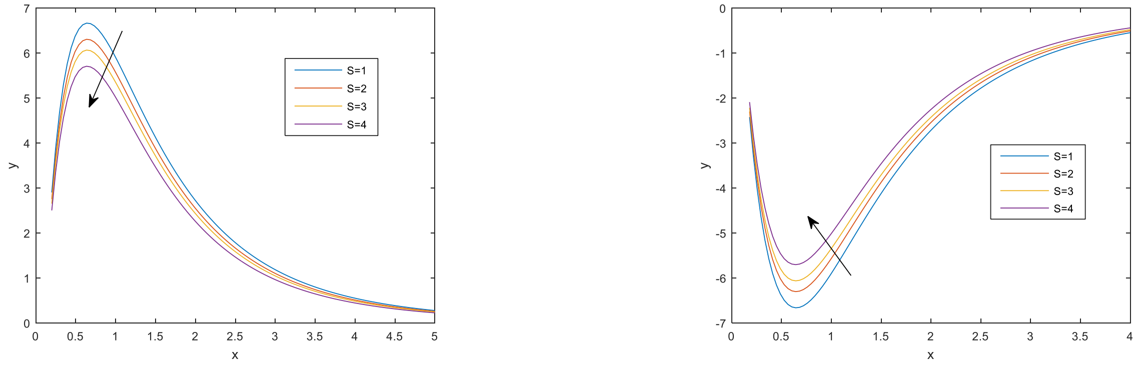


**FIGURE 4:** Velocities for u and v against S, M=0.5, K=0.5, E=0.1, Gr=5,$G_c$=5, Pr=0.71, Sc=0.22, Kc=1, ∅=1, ω=π/6, t=0.1

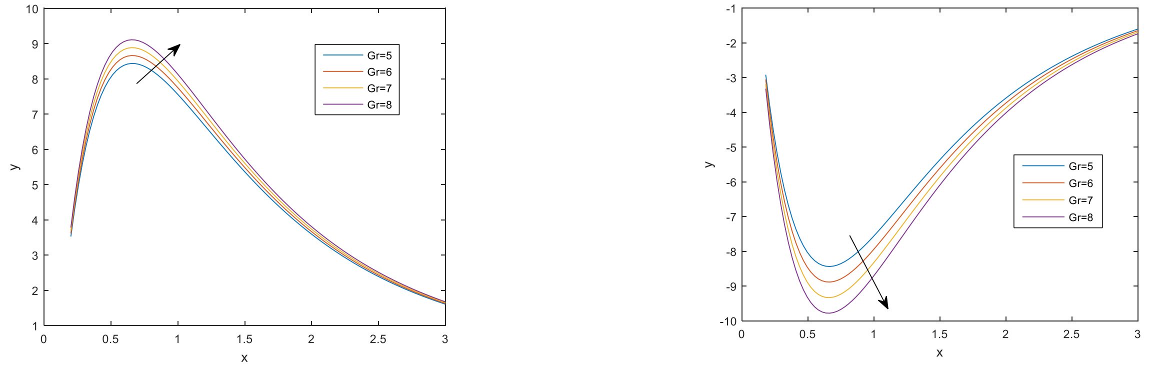


**FIGURE 5:** Velocities for u and v against $G_r$, M=0.5, K=0.5, E=0.1, S=1, $G_c$=5, Pr=0.71, Sc=0.22, Kc=1, ∅=1, ω=π/6, t=0.1

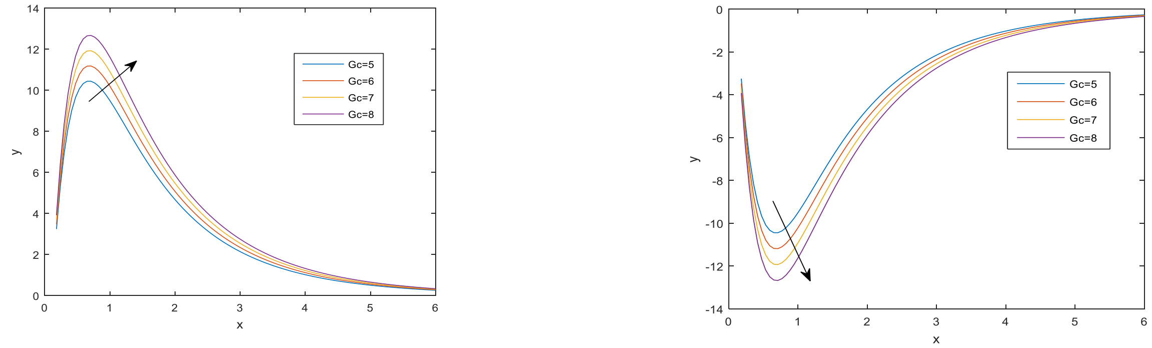


**FIGURE 6:** Velocities for u and v against $G_c$, M=0.5, K=0.5, E=0.1, S=1, Gr=5, Pr=0.71, Sc=0.22, Kc=1, ∅=1, ω=π/6, t=0.

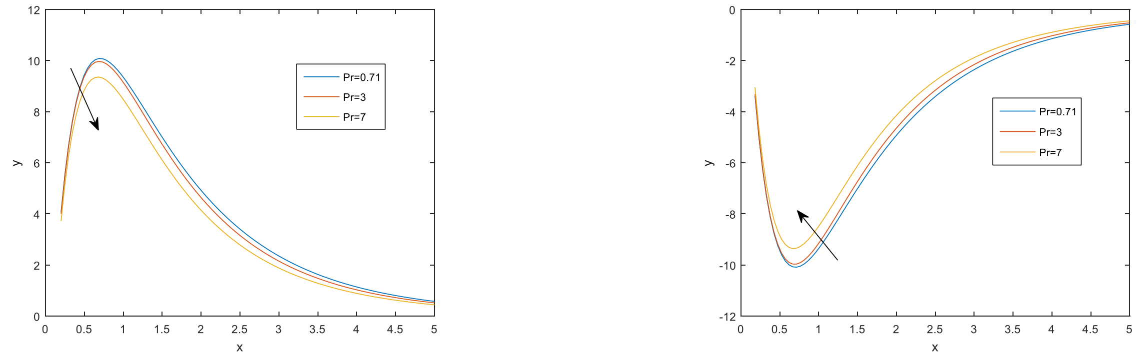


**FIGURE 7:** Velocities for u and v against $P_r$, M=0.5, K=0.5, E=0.1, S=1, Gr=5, $G_c$=5, Sc=0.22, Kc=1, ∅=1, ω=π/6, t=0.1

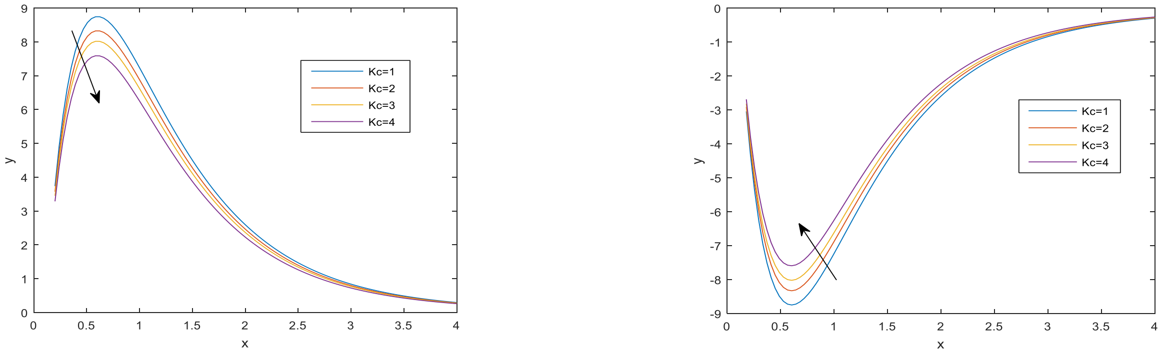


**FIGURE 8:** Velocities for u and v against $K_c$, M=0.5, K=0.5, E=0.1, S=1, Gr=5, $G_c$=5, Pr=0.71, Sc=0.22, ∅=1, ω=π/6, t=0.1

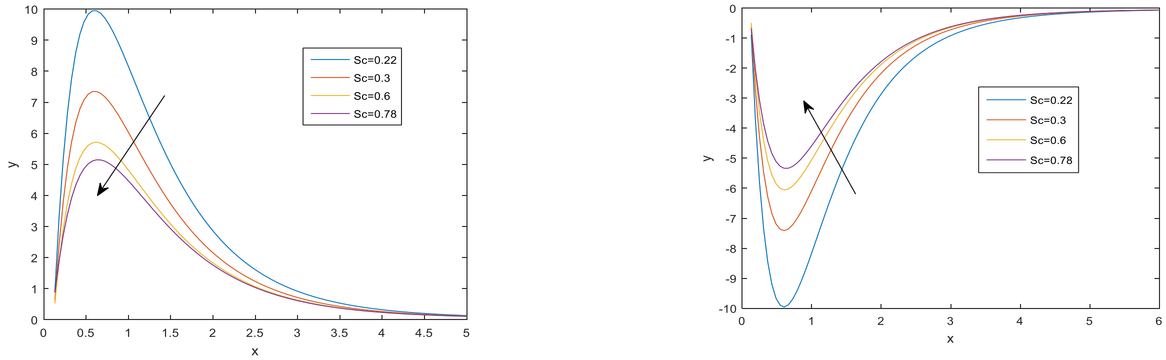


**FIGURE 9:** Velocities for u and v against $S_C$, M=0.5, K=0.5, E=0.1, S=1, Gr=5, $G_c$=5, Pr=0.71, Kc=1, ∅=1, ω=π/6, t=0.1

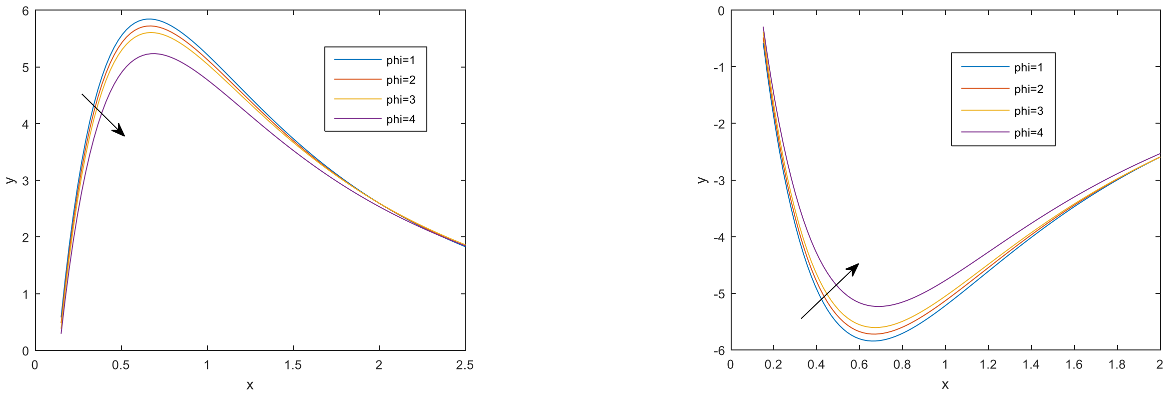


**FIGURE 10:** Velocities for u and v against ∅, M=0.5, K=0.5, E=0.1, S=1, Gr=5, $G_c$=5, Pr=0.71, Sc=0.22, Kc=1, ω=π/6, t=0

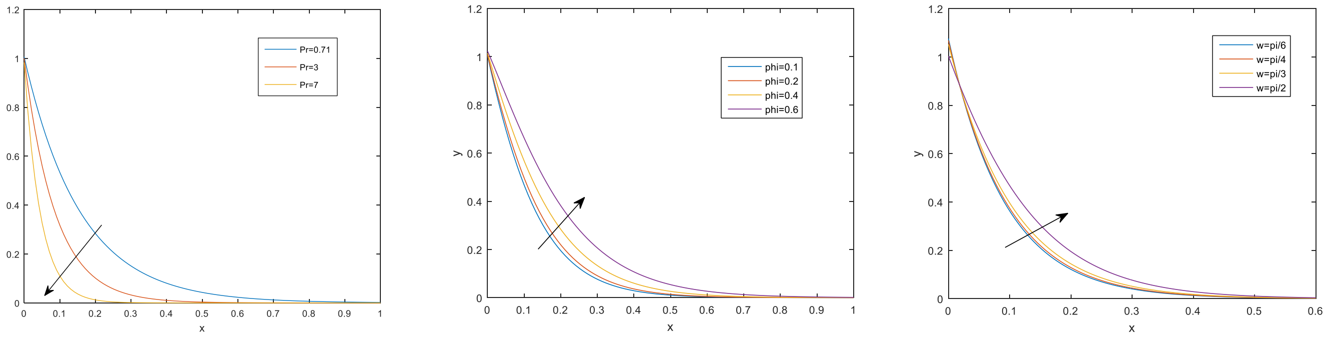


**FIGURE 11:** The temperature profiles for θagainst $P_r$, ∅and ω with ∅=1,Pr=0.71, ω=π/6

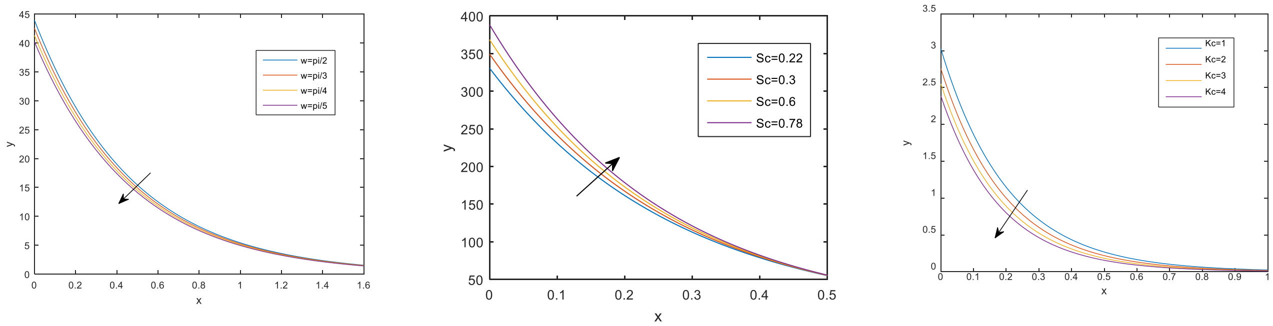


**FIGURE 12:** The concentration profiles for ∅ against ω, Sc and Kcwith Sc=0.22, ω=π/6, Kc=1.

**Table 1:** Skin Friction

| M | K | E | S | $G_r$ | $G_c$ | $P_r$ | $K_c$ | $S_c$ | ∅ | $\tau_{xz}$ | $\tau_{yz}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.5 | 0.5 | 0.1 | 1 | 5 | 5 | 0.71 | 1 | 0.22 | 0.1 | 0.324926 | -0.324926 |
| **1** | 0.5 | 0.1 | 1 | 5 | 5 | 0.71 | 1 | 0.22 | 0.1 | 0.341090 | -0.341090 |
| **1.5** | 0.5 | 0.1 | 1 | 5 | 5 | 0.71 | 1 | 0.22 | 0.1 | 0.343973 | -0.343973 |
| 0.5 | **1** | 0.1 | 1 | 5 | 5 | 0.71 | 1 | 0.22 | 0.1 | 0.288934 | -0.288934 |
| 0.5 | **1.5** | 0.1 | 1 | 5 | 5 | 0.71 | 1 | 0.22 | 0.1 | 0.273677 | -0.273677 |
| 0.5 | 0.5 | **0.2** | 1 | 5 | 5 | 0.71 | 1 | 0.22 | 0.1 | 0.288934 | -0.288934 |
| 0.5 | 0.5 | **0.3** | 1 | 5 | 5 | 0.71 | 1 | 0.22 | 0.1 | 1.273677 | -1.273677 |
| 0.5 | 0.5 | 0.1 | **2** | 5 | 5 | 0.71 | 1 | 0.22 | 0.1 | 0.259084 | -0.259084 |
| 0.5 | 0.5 | 0.1 | **3** | 5 | 5 | 0.71 | 1 | 0.22 | 0.1 | 0.193241 | -0.193241 |
| 0.5 | 0.5 | 0.1 | 1 | **6** | 5 | 0.71 | 1 | 0.22 | 0.1 | 0.332806 | -0.332806 |
| 0.5 | 0.5 | 0.1 | 1 | **7** | 5 | 0.71 | 1 | 0.22 | 0.1 | 0.342457 | -0.342457 |
| 0.5 | 0.5 | 0.1 | 1 | 5 | **6** | 0.71 | 1 | 0.22 | 0.1 | 0.359988 | -0.359988 |
| 0.5 | 0.5 | 0.1 | 1 | 5 | **7** | 0.71 | 1 | 0.22 | 0.1 | 0.099668 | -0.099668 |
| 0.5 | 0.5 | 0.1 | 1 | 5 | 5 | **3** | 1 | 0.22 | 0.1 | 0.198952 | -0.198952 |
| 0.5 | 0.5 | 0.1 | 1 | 5 | 5 | **7** | 1 | 0.22 | 0.1 | 0.257975 | -0.257975 |
| 0.5 | 0.5 | 0.1 | 1 | 5 | 5 | 0.71 | **2** | 0.22 | 0.1 | 0.215539 | -0.215539 |
| 0.5 | 0.5 | 0.1 | 1 | 5 | 5 | 0.71 | **3** | 0.22 | 0.1 | 0.246063 | -0.246063 |
| 0.5 | 0.5 | 0.1 | 1 | 5 | 5 | 0.71 | 1 | **0.3** | 0.1 | 0.173594 | -0.173594 |
| 0.5 | 0.5 | 0.1 | 1 | 5 | 5 | 0.71 | 1 | **0.4** | 0.1 | 0.317088 | -0.317088 |
| 0.5 | 0.5 | 0.1 | 1 | 5 | 5 | 0.71 | 1 | 0.22 | **0.2** | 0.310175 | -0.310175 |
| 0.5 | 0.5 | 0.1 | 1 | 5 | 5 | 0.71 | 1 | 0.22 | **0.3** | 0.322424 | -0.322424 |

| $P_r$ | ∅ | ω | $N_u$ |
|---|---|---|---|
| 0.71 | 1 | π/6 | 0.2172 |
| **3** | 1 | π/6 | 0.2698 |
| **7** | 1 | π/6 | 0.6113 |
| 0.71 | **2** | π/6 | 0.5056 |
| 0.71 | **3** | π/6 | -0.5136 |
| 0.71 | 1 | **π/4** | 0.2148 |
| 0.71 | 1 | **π/2** | 0.2113 |

**Table 2:** Nusselt Number

| ω | $K_c$ | $S_c$ | $S_H$ |
|---|---|---|---|
| π/6 | 1 | 0.22 | -0.1698 |
| **π/4** | 1 | 0.22 | -0.1737 |
| **π/2** | 1 | 0.22 | -0.1846 |
| π/6 | **2** | 0.22 | 9.9339 |
| π/6 | **3** | 0.22 | -5.6030 |
| π/6 | 1 | **0.3** | 2.7124 |
| π/6 | 1 | **0.6** | -14.0850 |

**Table 3:** Sherwood Number

## CONCLUSION

An unsteady two-dimensional MHD second-grade fluid in a porous medium under the influence of a magnetic field in a parallel plate. An empirical approach is used to solve the dimensionless equations as follows:

- The velocity profile increases in Hartmann number, thermal Grashof number, modified Grashof numberand decreases with permeability parameter, rotation parameter, second grade fluid, Prandtl number, chemical reaction parameter, Schmidt number, heat absorption parameter, radiation parameterthus the fluid increases velocity decreases.
- The temperature profile increasesheat absorption parameter, ω, radiation parameter and decreases due to Prandtl number.
- The concentration profile increases ω and decreases with second grade fluid, Prandtl number, chemical reaction parameter, Schmidt number, radiation parameter.

As the viscosity of a fluid increases due to conductivity, the rate of heat and mass transfer increases dramatically.

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