Effect of Jeffrey Fluid Flow and First Order Chemical Reaction on Magneto Convection of Immiscible Fluids in a Perpendicular Passage

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Abstract
In this article describes the effects of transfer heat and mass on free convective flow of developed fully electrically conducting with electrically Non-conducting immiscible fluids towards a perpendicular parallel passage. The resulting nonlinear governing coupled equations describes the fluid behaviour for velocity and temperature distributions are analysed and by applying method regular perturbation the differential equations are analytically solved with appropriate boundary and interface conditions for each fluid. Furthermore, the jump conditions for velocity and temperature are implemented on the left and right walls in the magnetic field existence in a perpendicular passage. The solutions are revealed through graphs for major parameters like thermal Grashof number, mass Grashof number, ratio of viscosity, width and conductivity, pressure gradient, Jeffrey parameter and chemical reaction parameter.

Keywords: Natural Convective Flow, Perturbation Method, Jeffrey Fluid, Electrically Conducting Fluid, Reynolds Number, MHD, Regular Perturbation Method.

Introduction

MHD is one of the major branch of physics plays a very extremely prime role in which we will learnt in the study of solar physics, MHD plasma physics, sun and astrophysics and we observed that MHD physics includes with the magnetic, electric and dynamic fluid conducting. MHD had played very important applications in planetary science, astrophysics, metallurgy, geophysics and especially in magnetic confinement fusion.

MHD Heat-generating/absorbing fluid flow of mixed convection flow in vertical concentric annuli with steady periodic regime at time periodic boundary conditions in the presence of a magnetic field analysed by Basant and Babatunde Ania, using Buongiorno's model Sameh and Rashed has been worked on magnetohydrodynamic free convection in a heat generating medium filled with porous wavy enclosures and thermophoresis and Brownian motion effects By the Reference of T. Linga Raju and B. Neela Rao studied the MHD transfer of heat conducting aspects of layered two fluid flow under the actions of magnetic and electric fields through a channel bounded by two parallel porous plates insulating system in a rotating manner. Chandrasekar et.al. considerable implementation has been made in this study MHD flow conducting electrically viscous incompressible fluid with Injection at the bottom and top suction in transverse magnetic field appearance between two porous parallel plates. By the Hafeez and Chifu deals with the incompressible viscous fluid flow with bottom injection and top suction between two parallel porous plates has been analysed [1-5].

Basant et.al. this study towards the theoretical MHD steady developed fully natural convection fluid flow of micro channel in a vertical parallel plate has been analysed in this paper and Zaheer Abbas, et al. describes the study of MHD viscous fluid with thermal radiation embedded in a vertical channel towards analysis of entropy generation using numerical approaches Keller box and shooting method. Muhim Chutia investigated MHD porous medium with uniform suction and injection in the presence of an inclined magnetic field using the numerical method (finite difference method) for the cases: Poiseuille flow and Couette Poiseuille flow and the fluid flow depicted through the graphs. Muthuraj and Srinivas analytically studied MHD flow of micropolar and viscous fluids are fully developed in a vertical channel using porous space homotopy analysis in the presence of temperature dependent sources of heat.Tasawar Hayat et al. by this reference we studied the MHD stagnation-point steady flow of Jefrrey fluid by a radically stretching surface and effects of heating and viscous dissipation are analysed. Mahadev Biradar the flow behaviour and transfer of heat of micropolar and viscous fluid in a vertical channel has been analysed and the solutions are obtained in the closed form and its effects on velocity and microrotational velocity discussed. Santhosh et.al. investigates the analytical results for the model of two-fluid model for the

flow of jeffery fluid with Newtonian fluid through narrow tubes in the presence of magnetic field in the peripheral region, Naveen Kumar and Sandeep Gupta they explain analytically on MHD Newtonian fluid and micropolar fluid free convective flow to the porous medium in a vertical channel. Kalidas et al.numerically investigates thermal radiation and heat transfer on MHD radio-active flow with surface slip and melting point of Jeffrey fluid past a stretching sheet by using numerical Runge-Kutta-Fehlberg method. By the reference Atendra et.al. the flow behaviour of Jeffrey fluid with porous medium in narrow tubes placed in the influence of an inclined magnetic field and great impacts on it. Shreedevi Kalyan et.al. in this paper reference concluded that the effect of flow of natural convective electrically conducting and electrically non conducting immiscible fluid undergoing first order chemical reaction in a vertical channel was examined for velocity and temperature fields in detail [6-15].

The abstract of the present paper work is to investigate the effect of Jeffrey fluid flow and first order chemical reaction on magneto convection of two immiscible fluids flow in the presence of Jeffrey fluid with viscous fluid (electrically conducting fluid) and non-conducting fluids in a perpendicular erect and the non-linear coupled governing equations are solved using regular perturbation method. The effect of Thermal Grashof number, Mass Grashof number, Thermal expansion coefficient,concentration expansion coefficient, concentration expansion coefficient, Jeffrey parameter, viscosity ratio, width ratio, thermal conductivity ratio, pressure gradient, Hartmann number and chemical reaction parameter on the fields velocity and temperature are exhibited through graph.

Nomenclature

b_t : The ratio of Thermal expansion coefficient, β_{T2}/β_{T1}
b_c : The ratio of concentration expansion coefficient β_{c2}/β_{c1}
g : Acceleration due to gravity
E : Electric field load parameter($E_0/B_0\overline{u_1}$)
E_0 : Applied electric filed
σ_e : Electrical conductivity
Br : Brinkmann Number $\mu_1\overline{U_1}^2/k_1(T_{w1}-T_{w2})$
GR_T : Thermal Grashof number
GR_c : MassGrashof number
G_1 : The ratio of Grashof to Reynolds numbers, Gr/Re
G_2 : The ratio of Grashof to Reynolds numbers, Gc/Re
λ_1 : Jeffrey parameter
h : Width ratio h$_2$/h$_1$
h_1,h_2 : Height of Region-I, II
d : diffusion coefficient ratio (D_2/D_1)
D_1,D_2 : diffusion coefficient
K : Thermal conductivities ratios, K_1/K_2
K_1,K_2 : Thermal conductivity in Region-I, II
n : Micro-rotational velocity
m : Ratio of viscosities,
Re : Reynolds number
P : Pressure Gradient ($\dfrac{h_1^2}{\mu_1\overline{U_1}}\dfrac{dp}{dX}$)
T : Temperature
T_{W1} , T_{W2} : Temperature of the boundaries
C_1 , C_2 : Concentrations of the boundaries
$\overline{C_1},\overline{C_2}$: Reference concentrations

U : Velocity
X,Y : Space co-ordinates

Greek Symbols

β : thermal expansion Coefficient
μ : Viscosity
γ : Spin gradient viscosity
ε : Jeffrey parameter in Region-I
α_1,α_2 : Chemical reaction parameters
ρ_1,ρ_2 : Density of Region-I, II
ΔT : Temperature difference
ΔC : Difference in concentration
υ_1,υ_2 : Kinematic viscosities
ϕ_1,ϕ_2 : concentrations in Region-I,II
θ : Dimensionless temperature
Subscript:1, 2 reference quantities for Region-I, II respectively

Mathematical Formulation

Consider MHD laminar steady free convection developed fully flow of an incompressible electrically conducting Jeffrey fluid with viscous fluid in middle of two vertical parallel plates. The inner surface of the left plate (i.e, at y = $-h_1$)and right plate (i.e, at y = $-h_2$) is kept at a constant temperature T$_{w1}$ and right wall temperature is maintained at a constant T$_{w2}$ (T$_{w2}$ > T$_{w1}$). The temperature T$_{w1}$ at y = $-h_1$ and concentration C_1 at y = $-h_2$ of boundary T$_{w2}$ and C_2 respectively. The flow which is described as two fluid model consisting Region-I, II flow is developed fully, fluid flow depends on y transverse coordinate and transverse velocity is zero. The first Region engrossed by electrically conducting Jeffrey fluid filled with viscosity μ_1 ,density ρ_1 ,thermal expansion coefficient β_{T1} , thermal conductivity K$_1$, diffusion coefficient D_1 , pressure gradient(P) and concentration expansion coefficient β_{C1} and the second Region engrossed by viscous fluid filled with ,viscosity μ_2 ,thermal conductivity K$_2$, density ρ_2,concentration expansion coefficient β_{C2} ,diffusion coefficient D_2 and thermal expansion coefficient β_{T2}.
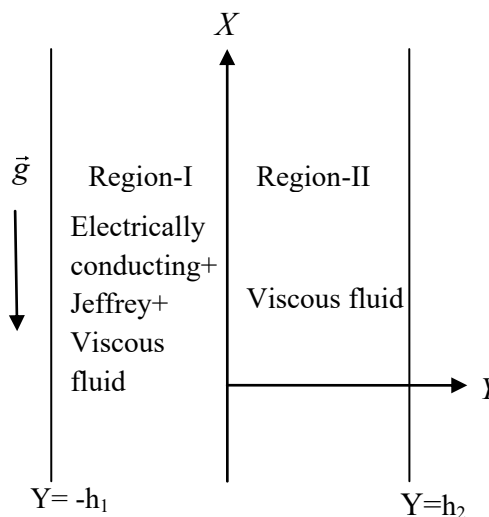

Figure 1: Physical Configuration

Region-I

$$\rho_1 \beta_{T1} g(T_1 - T_{w2}) + \rho_1 \beta_{C1} g(C_1 - \bar{C}_2) + \frac{\mu_1}{(1+\lambda_1)} \frac{d^2 U_1}{dY^2} - \frac{\mu_1 U_1}{\kappa} - \frac{dp}{dX} - \sigma_e (E_0 + B_0 U_1) B_0 = 0$$

$$\frac{d^2 T_1}{dY^2} + \frac{\mu_1}{\rho_1 \alpha_1 C_p} \left(\frac{dU_1}{dY} \right)^2 + \frac{\sigma_e}{\rho_1 \alpha_1 C_p} (E_0 + BU_1)^2 = 0$$

$$D_1 \frac{d^2 C_1}{dY^2} - K_1 C_1 = 0 \qquad\qquad (1)$$

Region-II

$$\rho_2 \beta_{T2} g(T_2 - T_{w2}) + \rho_2 \beta_{C2} g(C_2 - \bar{C}_2) + \mu_2 \frac{d^2 U_2}{dY^2} - \frac{dp}{dX} = 0$$

$$\frac{d^2 T_2}{dY^2} + \frac{\mu_2}{\rho_2 \alpha_2 C_p} \left(\frac{dU_2}{dY} \right)^2 = 0$$

$$D_2 \frac{d^2 C_2}{dy^2} - K_2 C_2 = 0 \qquad\qquad (2)$$

Now inserting conditions at the interface and boundary for the velocity, temperature and concentrations are

$$U_1(-h_1) = 0 \text{ at } Y = -1, \ U_2(h_2) = 0 \text{ at } Y = 1, U_1(0) = U_2(0), \quad \frac{\mu_1}{(1+\lambda_1)} \frac{dU_1}{dY}(0) = \mu_2 \frac{dU_2}{dY}(0),$$

$$T_1(-h_1) = Tw_1 \text{ at } Y = -1, T_2(h_2) = Tw_2 \text{ at } Y = 1, T_1(0) = T_2(0), K_1 \frac{dT_1}{dY}(0) = K_2 \frac{dT_2}{dY}(0)$$

$$C_1(-h_1) = \bar{C}_1 \text{ at } Y = -1, C_2(h_2) = \bar{C}_2 \text{ at } Y = 1, C_1(0) = C_2(0), \ D_1 \frac{dC_1}{dY}(0) = D_2 \frac{dC_2}{dY}(0) \quad (3)$$

We now introduce the following non-dimensional variables

$$u_i = \frac{U_i}{U_1}, \ y_i = \frac{Y_i}{h_i}, \ \theta_1 = \frac{T_1 - T_{w2}}{T_{w1} - T_{w2}}, \ \theta_2 = \frac{T_2 - T_{w2}}{T_{w1} - T_{w2}}, \ \phi_1 = \frac{C_1 - \bar{C}_2}{\bar{C}_1 - \bar{C}_2}, \ \phi_2 = \frac{C_2 - \bar{C}_2}{\bar{C}_1 - \bar{C}_2},$$

$$\Delta T = T_{w1} - T_{w2}, \ \Delta C = \bar{C}_1 - \bar{C}_2, \ \alpha_1^2 = \frac{K_1 h_1^2}{D_1}, \alpha_2^2 = \frac{K_2 h_2^2}{D_2}$$

$$Gr = \frac{g\beta_{T1}\Delta T h_1^3}{\upsilon_1^2}, \ Gc = \frac{g\beta_{c1}\Delta T h_1^3}{\upsilon_1^2}, \ \mathrm{Re} = \frac{\overline{U_1} h_1}{\upsilon_1}, \ Br = \frac{\overline{U_1}^2 \mu_1}{K_1 (T_{w1} - T_{w2})},$$

$$p = \frac{h_1^2}{\mu_1 \overline{U_1}} \frac{dp}{dX}, \ \mathrm{M}^2 = \frac{\sigma_0 \mathrm{B_0}^2 h_1^2}{\mu_1}, \mathrm{E} = \frac{\mathrm{E_0}}{\mathrm{B_0} \bar{u}_1} \qquad\qquad (4)$$

Substituting the non-dimensional variables (4) into Eqs. (1) to (2) we get

Region-I

$$\frac{d^2 u_1}{dy} + (1+\lambda_1) G_1 \theta_1 + (1+\lambda_1) G_2 \phi_1 - (1+\lambda_1) p - (1+\lambda_1) \mathrm{M}^2 [\mathrm{E} + u_1] = 0$$

$$\frac{d^2 \theta_1}{dy^2} + Br \left[\left(\frac{du_1}{dy} \right)^2 + \mathrm{M}^2 (u_1 + \mathrm{E})^2 \right] = 0$$

$$\frac{d^2 \phi_1}{dy} - \alpha_1^2 \phi_1 = 0 \qquad\qquad (5)$$

Region-II

$$\frac{d^2 u_2}{dy^2} + a_1 \theta_2 + a_2 \phi_2 - m h^2 p = 0$$

$$\frac{d^2 \theta_2}{dy^2} + Br \frac{k}{m} \left(\frac{du_2}{dy} \right)^2 = 0$$

$$\frac{d^2 \phi_2}{dy} - \alpha_2^2 \phi_2 = 0 \quad (6)$$

After the transformationof conditions at the interface and boundary equation (3)transforms into,

$$u_1(-1) = 0 \text{ at } y = -1, u_2(1) = 0 \text{ at } y = 1 \, u_1(0) = u_2(0), \quad \frac{1}{(1+\lambda_1)} \frac{du_1}{dy}(0) = \frac{1}{mh} \frac{du_2}{dy}(0) \text{ at } y = 0,$$

$$\theta_1(-1) = 1 \text{ at } y = -1, \theta_2(1) = 0 \text{ at } y = 1, \quad \theta_1(0) = \theta_2(0), \quad \frac{d\theta_1}{dy}(0) = \frac{1}{kh} \frac{d\theta_2}{dy}(0) \text{ at } y = 0,$$

$$\phi_1(-1) = 1 \text{ at } y = -1, \phi_2(1) = 0 \text{ at } y = 1, \quad \phi_1(0) = \phi_2(0), \quad \frac{d\phi_1}{dy}(0) = \frac{d}{h} \frac{d\phi_2}{dy}(0) \text{ at } y = 0 \qquad (7)$$

$$\text{Where } G_1 = \frac{Gr}{Re}, G_2 = \frac{Gc}{Re}, h = \frac{h_2}{h_1}, \quad m = \frac{\mu_1}{\mu_2}, \quad b_t = \frac{\beta_{T2}}{\beta_{T1}}, \quad b_c = \frac{\beta_{c2}}{\beta_{c1}}, n = \frac{\rho_2}{\rho_1}, d = \frac{D_2}{D_1}, \quad K = \frac{K_1}{K_2}$$

Method of Solutions
Perturbation Method
The solutions are obtained for the equations 5 and 6valid for small values of Brinkman number as follows:

$$u_i(y) = u_{i0}(y) + Br\, u_{i1}(y) + Br^2 u_{i2}(y) + \dots \qquad (8)$$

$$\theta_i(y) = \theta_{i0}(y) + Br\, \theta_{i1}(y) + Br^2 \theta_{i2}(y) + \dots \qquad (9)$$

Substituting Eqs. (8) and (9) into Eqs.(5) and (6) we get the solutions for Zeroth and first-order equationsand equating the coefficient of like powers of Br to zero and one.

Region-I

Zeroth-order Equations:

$$\frac{d^2 \theta_{10}}{dy^2} = 0 \qquad (10a)$$

$$\frac{d^2 u_{10}}{dy^2} + (1+\lambda_1)G_1\theta_1 + (1+\lambda_1)G_2\phi_1 - (1+\lambda_1)p - (1+\lambda_1)M^2(E + u_{10}) = 0 \quad (10b)$$

First-order equations:

$$\frac{d^2 \theta_{11}}{dy^2} + \left[\left(\frac{du_{10}}{dy} \right)^2 + M^2(u_{10} + E)^2 \right] = 0 \qquad (11a)$$

$$\frac{d^2 u_{11}}{dy^2} + (1+\lambda_1)a_1\theta_{11} - (1+\lambda_1)M^2 u_{11} = 0 \qquad (11b)$$

Region-II
Zeroth-order Equations:

$$\frac{d^2 \theta_{20}}{dy} = 0$$

$$\frac{d^2 u_{20}}{dy^2} + a_1 \theta_{20} + a_2 \phi_2 - m h^2 p = 0 \qquad (12)$$

First-order Equations:

$$\frac{d^2\theta_{21}}{dy^2} + a3\left(\frac{du_{20}}{dy}\right)^2 = 0$$

$$\frac{d^2u_{21}}{dy^2} = a_1\theta_{21} \tag{13}$$

Zeroth- Boundary and interface conditions:

$$u_{10}(-1)=0, \ u_{20}(1)=0, \ u_{10}(0)=u_{20}(0), \ \frac{1}{(1+\lambda_1)}\frac{du_{10}}{dy}(0) = \frac{1}{mh}\frac{du_{20}}{dy}(0)$$

$$\theta_{10}(-1)=1, \ \theta_{20}(1)=1, \ \theta_{10}(0)=\theta_{20}(0), \ \frac{d\theta_{10}}{dy}(0) = \frac{1}{kh}\frac{d\theta_{20}}{dy}(0) \tag{14}$$

First-Order Boundary and interface conditions:

$$u_{11}(-1)=0, \ u_{21}(1)=0, \ u_{11}(0)=u_{21}(0), \ \frac{1}{(1+\lambda_1)}\frac{du_{11}}{dy}(0) = \frac{1}{mh}\frac{du_{21}}{dy}(0)$$

$$\theta_{11}(-1)=1, \ \theta_{21}(1)=1, \ \theta_{11}(0)=\theta_{21}(0), \ \frac{d\theta_{11}}{dy}(0) = \frac{1}{kh}\frac{d\theta_{21}}{dy}(0) \tag{15}$$

The solutions Concentration Eqs. (5) and (6) can be obtained as

$$\phi_1 = B_1 Cosh(\alpha_1\, y) + B_2 Sinh(\alpha_1\, y)$$

$$\phi_2 = B_3 Cosh(\alpha_2\, y) + B_4 Sinh(\alpha_2\, y) \tag{16}$$

The solutions obtained for eqn. (10a) -(13) using boundary and interface conditions for temperature and velocityas given in Eqs. (14) and (15), respectively, as shown below.

$$\theta_{10} = c_1 y + c_2,$$

$$\theta_{20} = c_3 y + c_4,$$

$$u_{10} = A_1 Cosh[s\, y] + A_2 Sinh[s\, y] + r_1 + r_2 y + r_3 Cosh[\alpha_1\, y] + r_4 Sinh[\alpha_1\, y]$$

$$u_{20} = A_4 + A_3 y + r_5 y^2 + r_6 y^3 + r_7 Cosh[\alpha_2\, y] + r_8 Sinh[\alpha_2\, y]$$

Applying boundary conditions, the solutions of the first order perturbation equations (11a & b), (13) using interface and boundary conditions from equations (14) and (15).

$$\begin{aligned}
\theta_{11} = {} & A_6 + A_5 y + s_1 y^2 + s_2 y^3 + s_3 y^4 + s_4 Cosh[\alpha_1 y] + s_5 Sinh[\alpha_1 y] + s_6 Cosh[2\alpha_1 y] \\
& + s_7 Sinh[2\alpha_1 y] + s_8 Cosh[2sy] + s_9 Sinh[2sy] + s_{10} Cosh[sy] + s_{11} Sinh[sy] \\
& + s_{12} y Cosh[sy] + s_{13} y Sinh[sy] + S_{14} y Cosh[\alpha_1 y] + s_{15} y Sinh[\alpha_1 y] \\
& + s_{16} Cosh[(\alpha_1 + s)y] + s_{17} Cosh[(\alpha_1 - s)y] + s_{18} Sinh[(\alpha_1 + s)y] \\
& + s_{19} Sinh[(\alpha_1 - s)y]
\end{aligned}$$

$$\begin{aligned}
\theta_{21} = {} & A_8 + A_7 y + q_1 y^2 + q_2 y^3 + q_3 y^4 + q_4 y^5 + q_5 y^6 + q_6 Cosh(2\alpha_2\, y) + \\
& q_7 Sinh(2\alpha_2\, y) + q_8 y^2 Cosh(\alpha_2\, y) + q_9 y^2 Sinh(\alpha_2\, y) + q_{10} y Cosh(\alpha_2\, y) \\
& + q_{11} y Sinh(\alpha_2\, y) + q_{12} Cosh(\alpha_2\, y) + q_{13} Sinh(\alpha_2\, y)
\end{aligned}$$

$$u_{11} = A_9 Cosh(s\,y) + A_{10} Sinh(s\,y) + H_1 + H_2 y + H_3 y^2 + H_4 y^3 + H_5 y^4 + H_6 Cosh(\alpha_1\,y) +$$
$$H_7 Sinh(\alpha_1\,y) + H_8 Cosh(2\alpha_1\,y) + H_9 Sinh(2\alpha_1\,y) + H_{10} Cosh(2s\,y) + H_{11} Sinh(2s\,y)$$
$$+ H_{12} y Cosh(s\,y) + H_{13} y Sinh(s\,y) + H_{14} y Cosh(\alpha_1\,y) + H_{15} y Sinh(\alpha_1\,y) + H_{16} Cosh[(\alpha_1 + s)$$
$$+ H_{17} Cosh[(\alpha_1 - s)\,y] + H_{18} Sinh[(\alpha_1 + s)\,y] + H_{19} Sinh[(\alpha_1 - s)\,y] + H_{20} y^2 Sinh(s\,y)$$
$$+ H_{21} y^2 Cosh(S\,y)$$

$$u_{21} = A_{12} + A_{11} y + H_{22} y^2 + H_{23} y^3 + H_{24} y^4 + H_{25} y^5 + H_{26} y^6 + H_{27} y^7 + H_{28} y^8 + H_{29} Cosh(2\alpha_2\,y)$$
$$+ H_{30} Sinh(2\alpha_2\,y) + H_{31} y^2 Cosh(\alpha_2\,y) + H_{32} y^2 Sinh(\alpha_2\,y) + H_{33} y Cosh(\alpha_2\,y) + H_{34} y Sinh(\alpha_2\,y)$$
$$+ H_{35} Cosh(\alpha_2\,y) + H_{36} Sinh(\alpha_2\,y)$$

Results and Discussion

In this paper, we have concentrated on the effects of different parameters such as GR_T (thermal Grashof number), GR_C (mass Grashof number), b_t (thermal expansion coefficient ratio), b_c (concentration expansion coefficient ratio), λ_1 (Jeffrey parameter), m (viscosity ratio), h (width ratio), k (thermal conductivity), ε (perturbation parameter), P (pressure gradient), α (chemical reaction parameter)and M (Hartmann number)for the fluid flow in a vertical channel for V (velocity), θ (temperature) and ϕ (concentrations) are analysed by using the method regular perturbation, used ε is the perturbation parameter indicates the Brinkmann number and graphically portrayed. As we fixed the values 1,1,1,1,1,1,1,1, 0.1, pressure gradient is $P = -5$,1 and 1 respectively.

Fig 2(a) and 2(b) portrayed that velocity profiles enhances in both the regions for the different values of mixed convection parameter (GR_T) increases while fig 2(b)shows that the effect of temperature profiles enhances for different values of thermal Grashof number increases in both the regions because of the buoyancy force which supports the fluid motion.

Fig 3(a) and 3(b) depicted that the velocity and temperature field enhanced in both the regions with the higher values of mass Grashof number increases because of increases in buoyancy force, which extent the fluid motion.

From fig 4(a) and 5(b) shows that the effect of variation of thermal and concentration expansion coefficient ratio(b_t,b_c) , it is observed that increases in the(b_t,b_c), enhances the flow field for both velocity and temperatures which is illustrated graphically, for$(b_t=1,b_c=1)$ there is a symmetry in velocity profile.

From fig 6(a), we observed that for higher values of Jeffrey parameter λ_1 increases velocity profile increases in both the regions. It is seen that increase in the Jeffrey parameter λ_1 increases the flow because of presence electrically conducting viscous fluid, it is also observed that amplitude for Jeffrey fluid is more as compare with electrically non-conducting fluid while, temperature profile enhances with hgreater values of Jeffrey parameter λ_1 is shown in fig 6(b).

The above figures 7(a) and (b) the velocity profile goes on increases for different values of pressure P in the first region with the increases in pressure in the second region and the variations in pressure the temperature profiles also go on increases in both the regions which are portrayed.

The viscosity ratio m (μ_1 / μ_2) it effects on fields of velocity and temperature shows in the above two graphs fig 8 (a) and 8(b) respectively.viscosity ratio describes the ratio of electrically conducting fluid to the electrically non conducting fluid albeit viscosity ratio enhances the viscosity ratio m of the electrically conducting fluid is more as compared non conducting fluid in the second region.

From the fig 9(a)shows that the thermal conductivity ratio $K(K_1/ K_2)$ it effects the fields on velocity and temperature. We noticed that with greater values of thermal conductivity ratio in the presence of electrically conducting fluid enhances the velocity profiles goes on increases in the Region-I and region-II and we observed temperature profiles increases from fig 9(b) in the absence of electrically conducting fluid.

We observed that the effects of width ratio h from fig 10(a) and 10(b) we can see the flow distributions on velocity and temperatures fields. The higher values of width ratio the velocity and temperature profiles enhances in both the regions, due to width of the electrically conducting fluid is larger than the width of conducting fluid while the fluid flow is larger which is depicted. The first order chemical reaction parameter α , it effects on the flow fields on velocity, temperature including concentration as we observed in the above three figures such as fig 11(a),(b) and (c) accordingly. As we increase the values of chemical reaction parameter the field on velocity, temperature and concentration areas are decreases in both the regions i, e Region-I and region-II respectively, due to bombarding nature of solute molecules undergoing chemical reaction parameter.

Figure 12(a) and 12(b) exhibited that the effect of Hartmann number on the velocity and temperature fields. Larger the values of Hartmann number the velocity profiles go on decreases on the both the regions while temperature also suppress the fluid flow result.
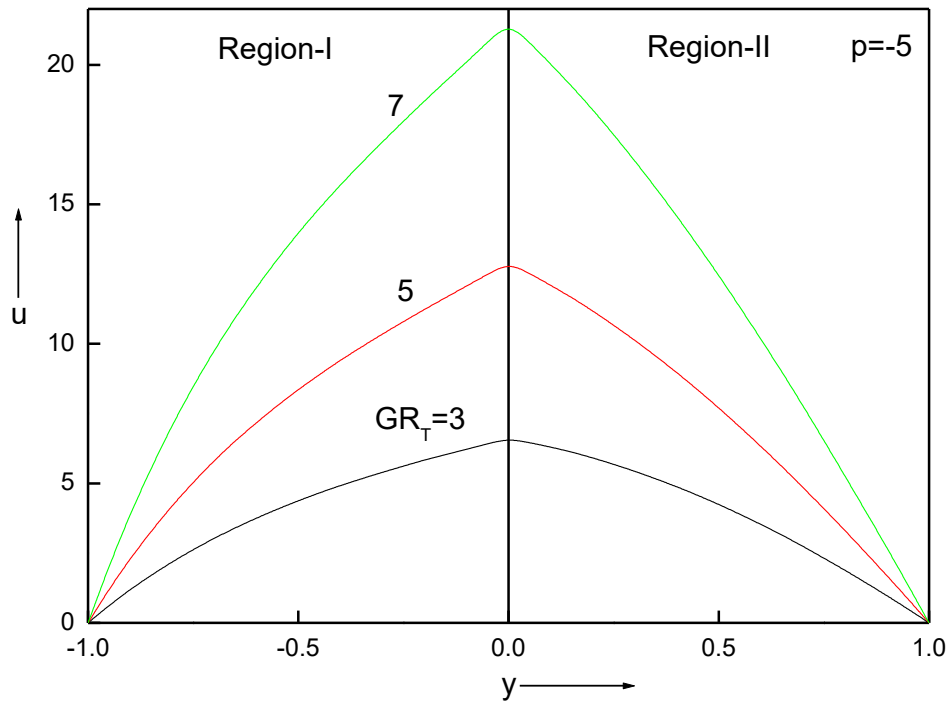
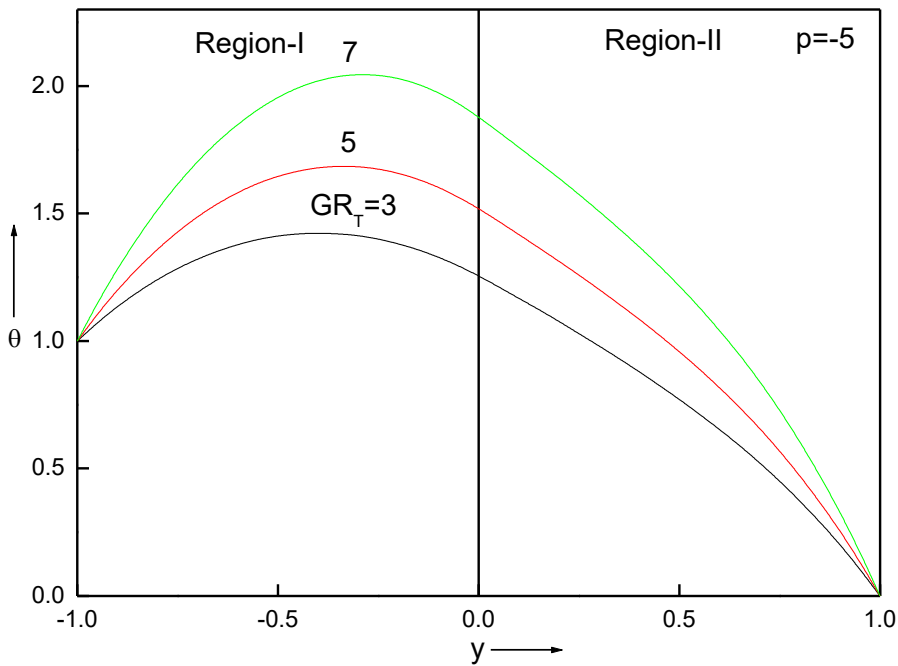fig2:(a)Thermal Grashof number GR_T effects on velocity profiles.

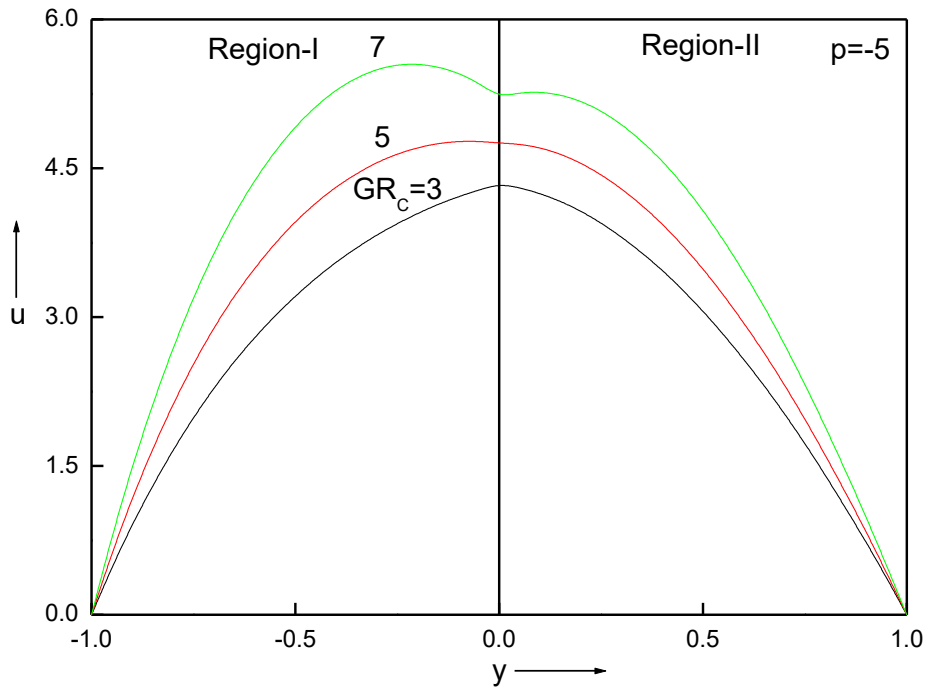fig2:(b) Thermal Grashof number GR_T effects on Temperature profiles.

fig3:(a) Mass Grashof number GR_C effects on Velocity profiles.
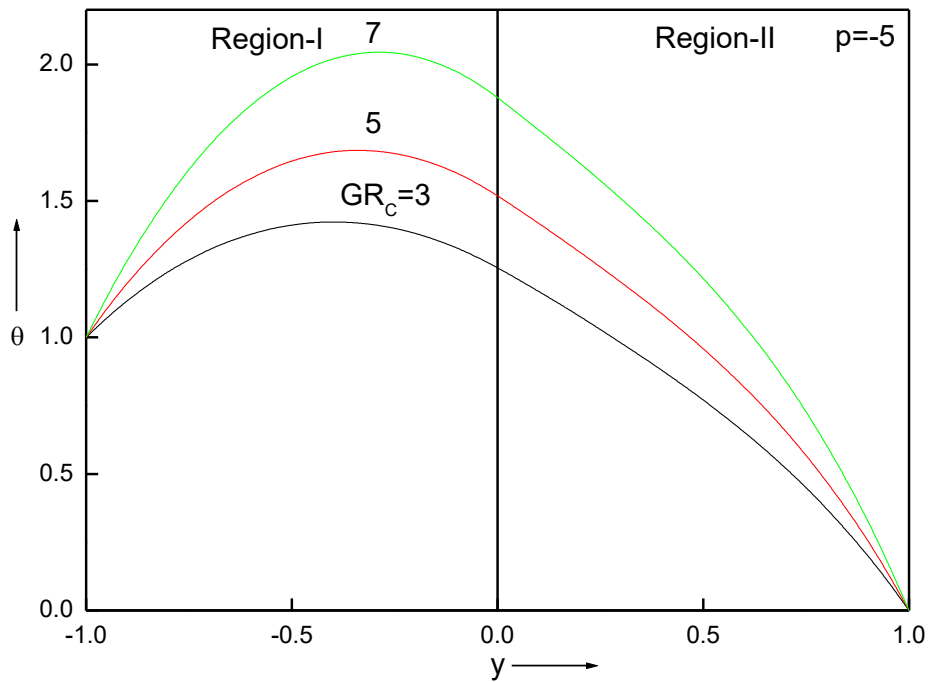

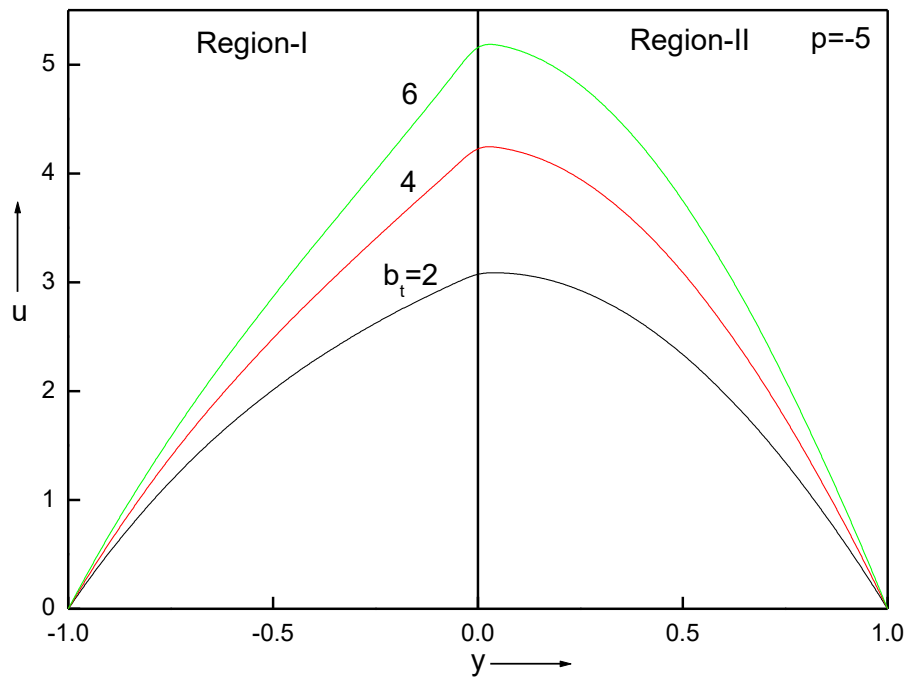fig3:(b) Mass Grashof number GR_C effects on temperature profiles.

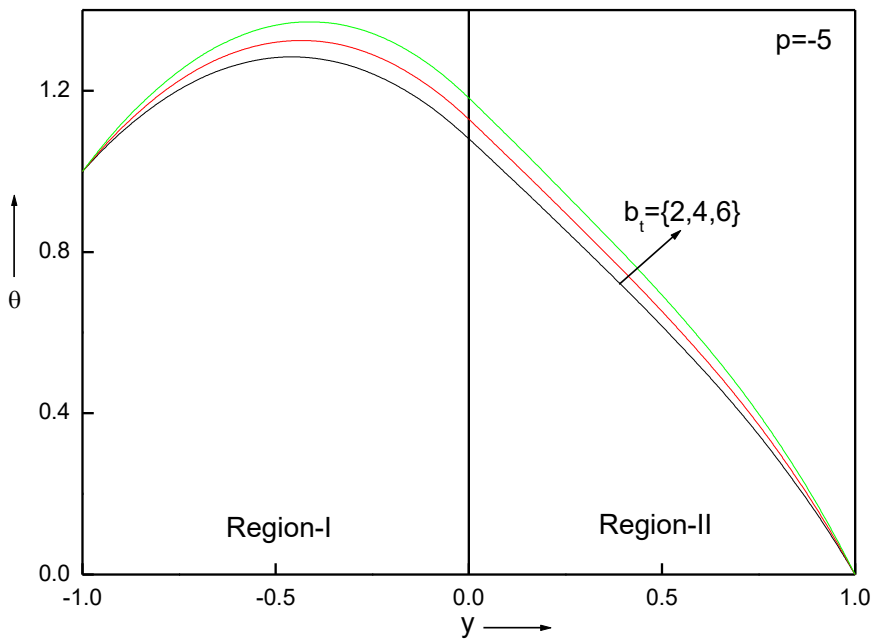fig4:(a) Thermal expansion ratio b_t effects on Velocity profiles.

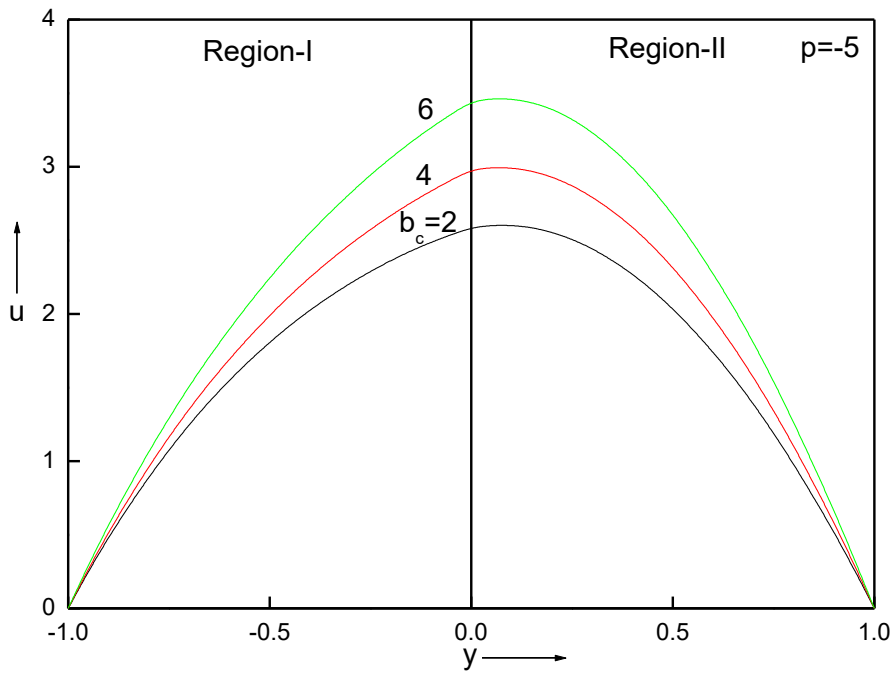fig4:(b) Thermal expansion ratio b_t effects on Temperature profiles.
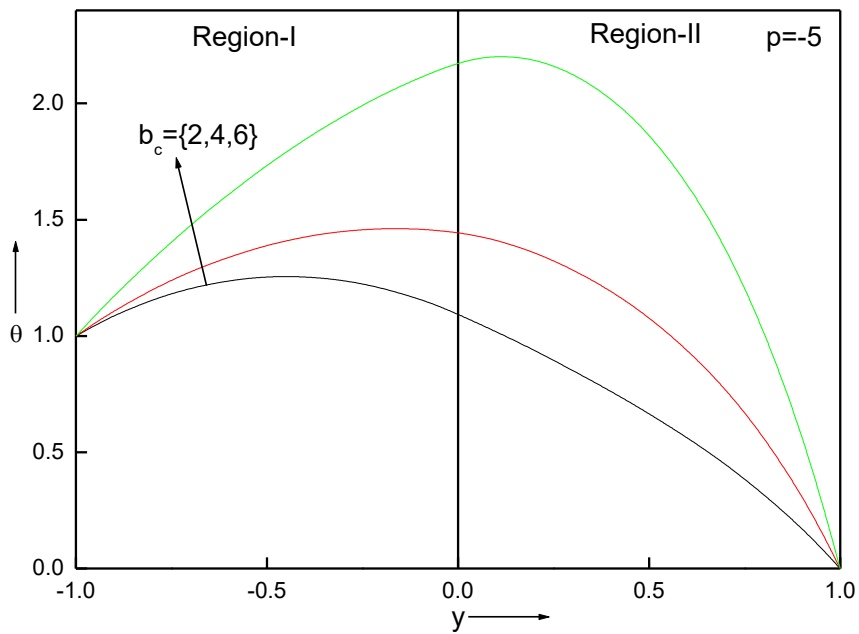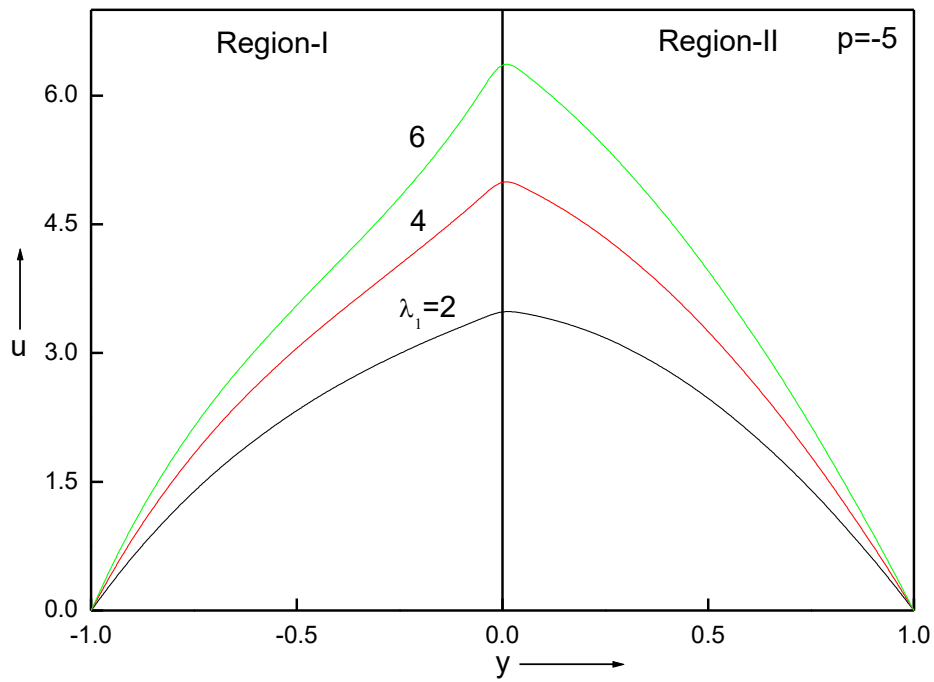
fig5:(a) Concentration expansion ratio b_c effects on Velocity profiles.

fig5:(b) Concentration expansion ratio b_c effects on Temperature profiles.

fig6:(a) Jeffrey parameter λ_1 effects on Velocity profiles .
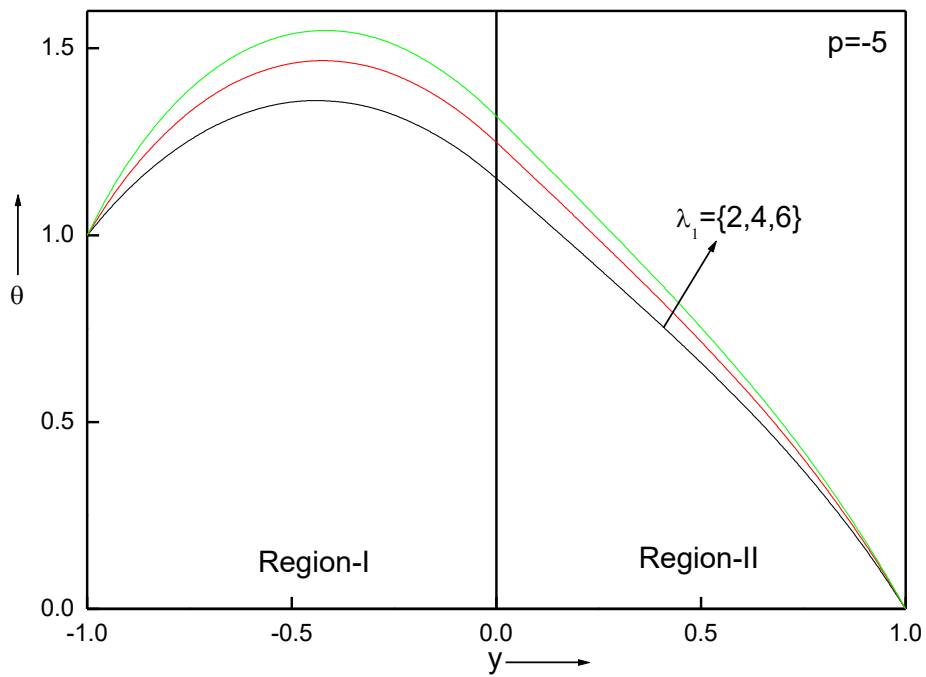
fig6:(b) Jeffrey parameter λ_1 effects on Temperature profiles.
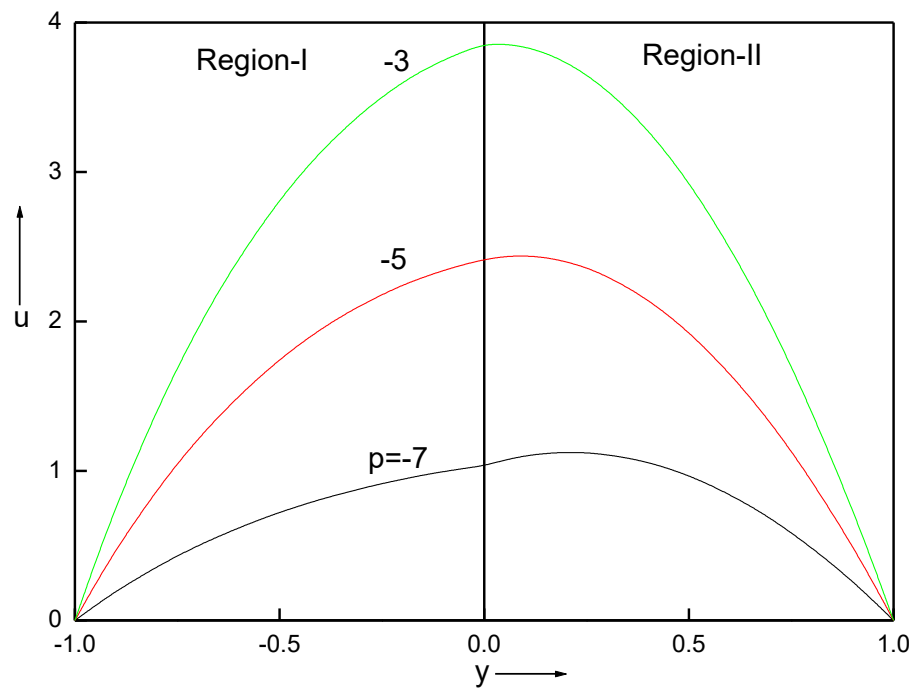
fig7:(a) Pressure gradient p effects on Velocity profiles.
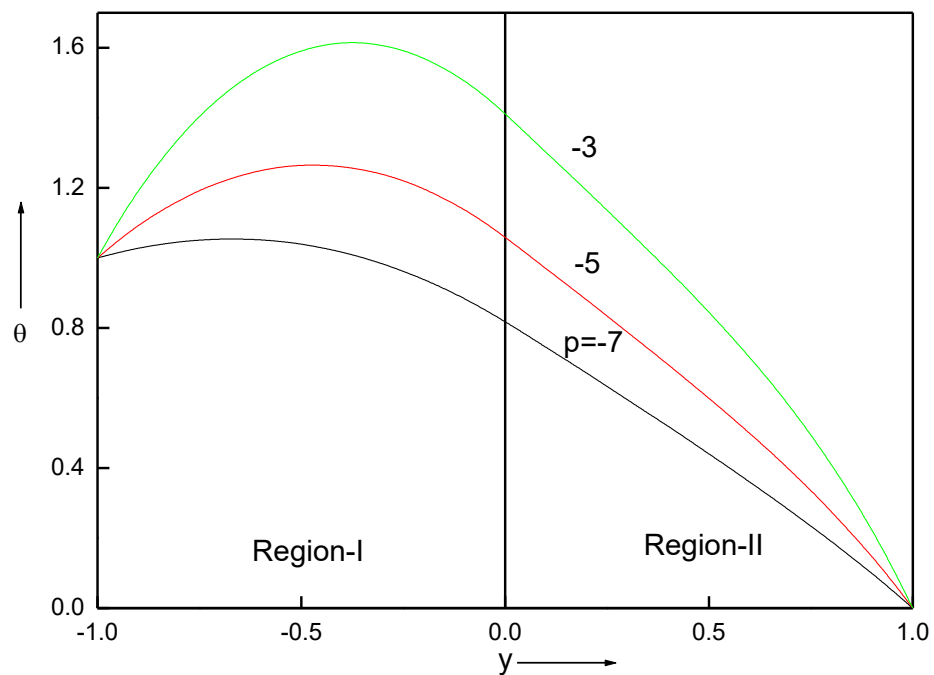
fig7:(b) Pressure gradient p effects on Temperature profiles.
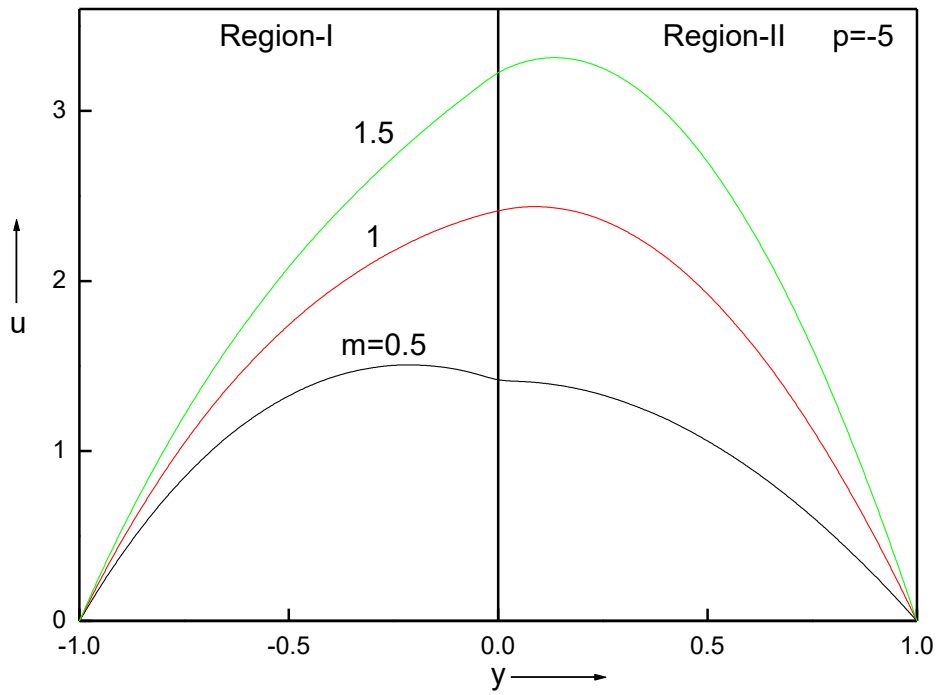
fig8:(a) Viscosity ratio m effects on Velocity profiles .
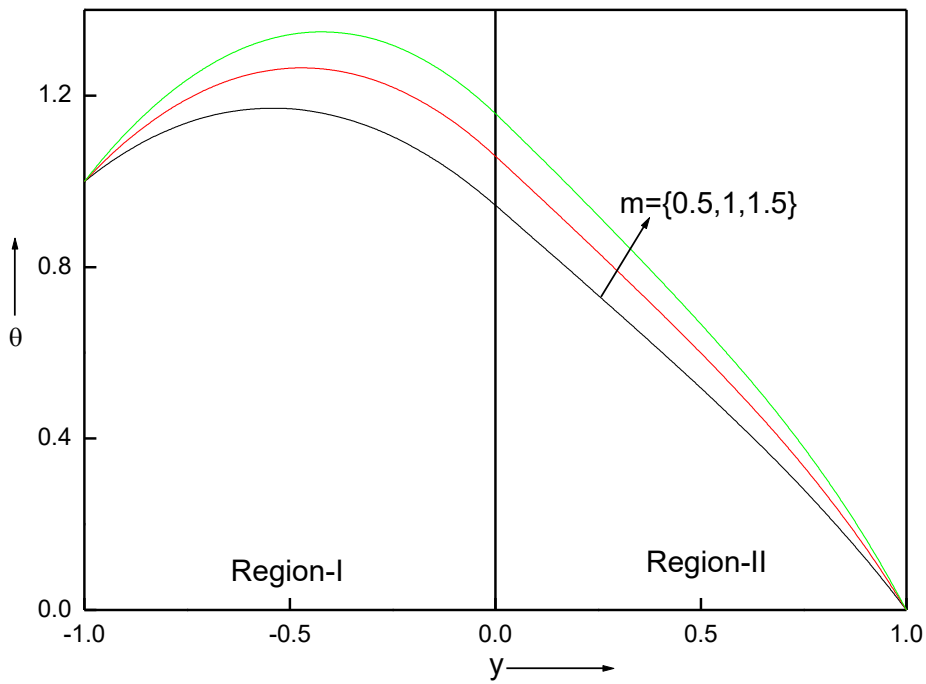
fig8:(b) Viscosity ratio m effects on Temperature profiles.
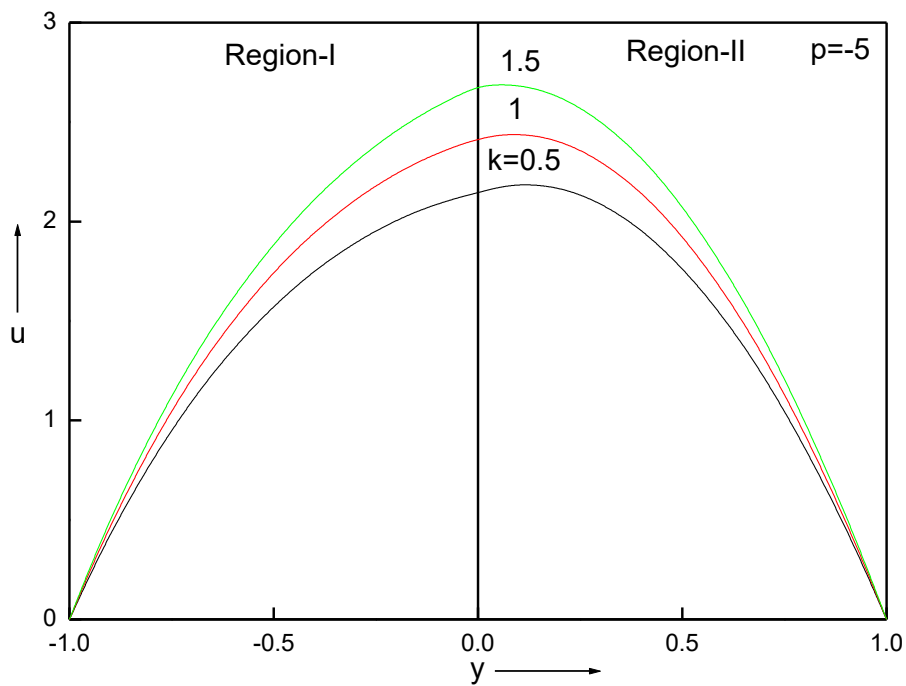
fig9:(a) Thermal conductivity ratio k effects on Velocity profiles.
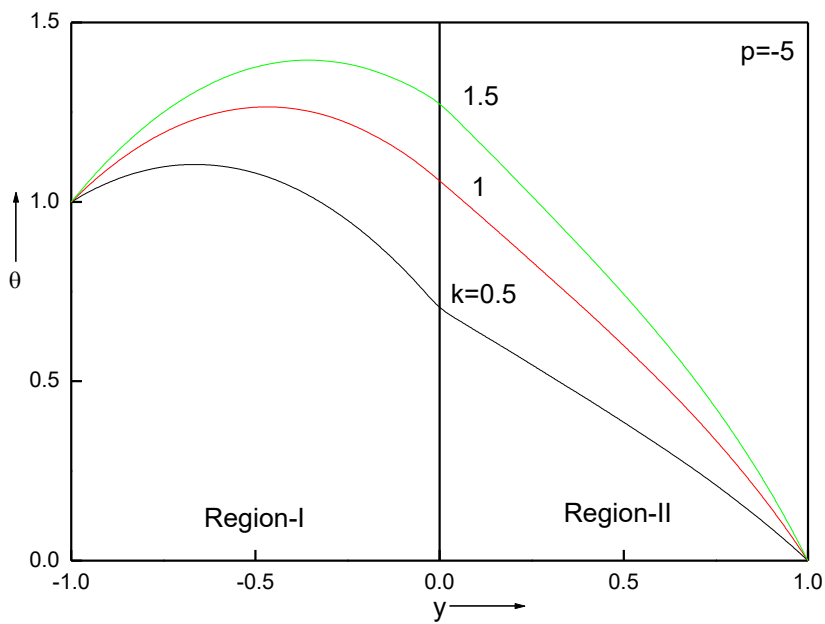
fig9:(b) Temperature profiles for different values of thermal conductivity ratio k.
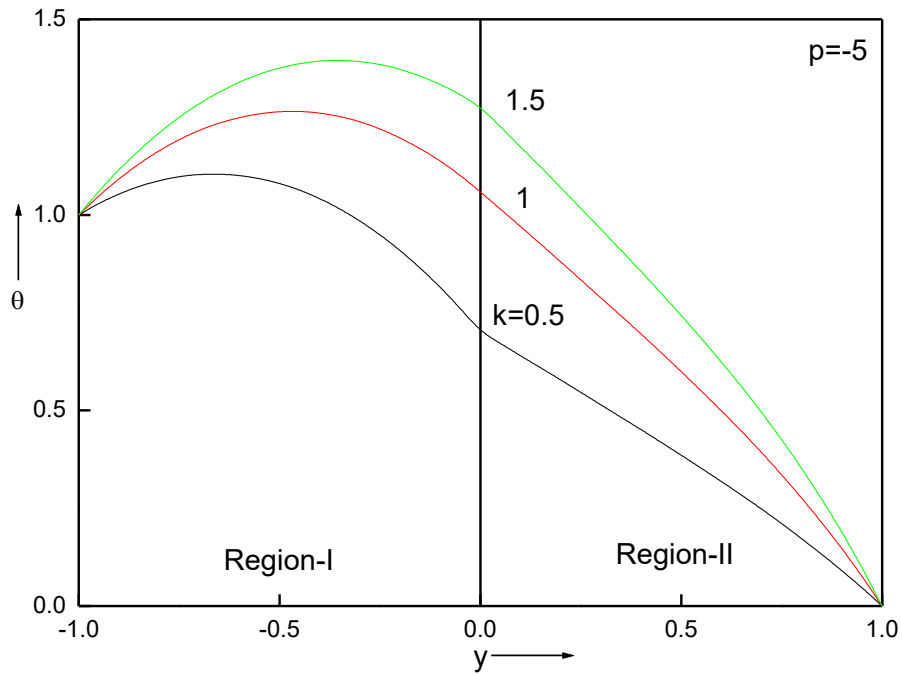
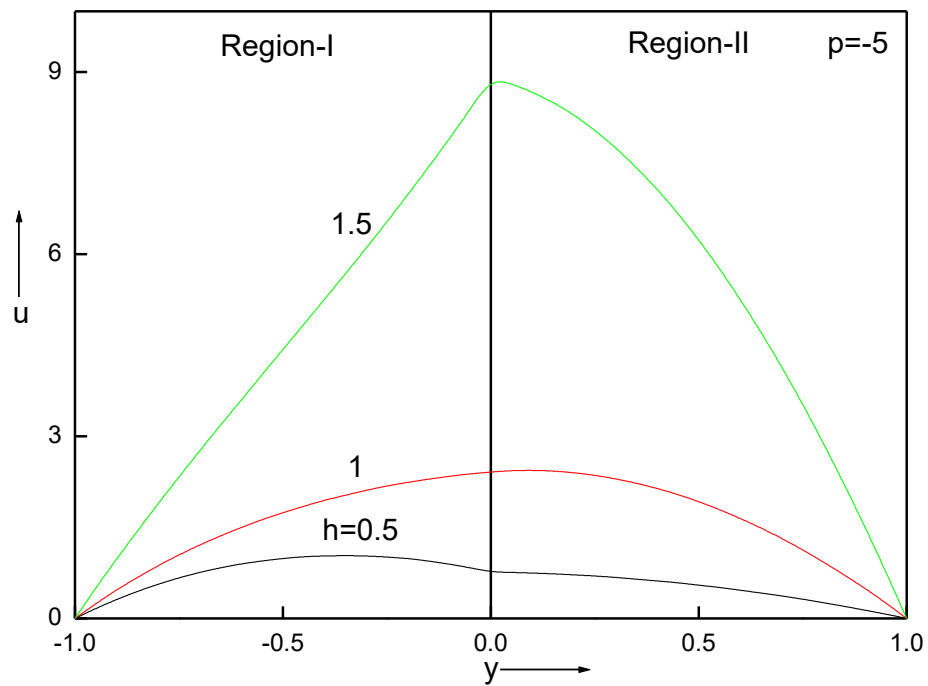fig9:(b) Thermal conductivity ratio k effects on Temperature profiles.
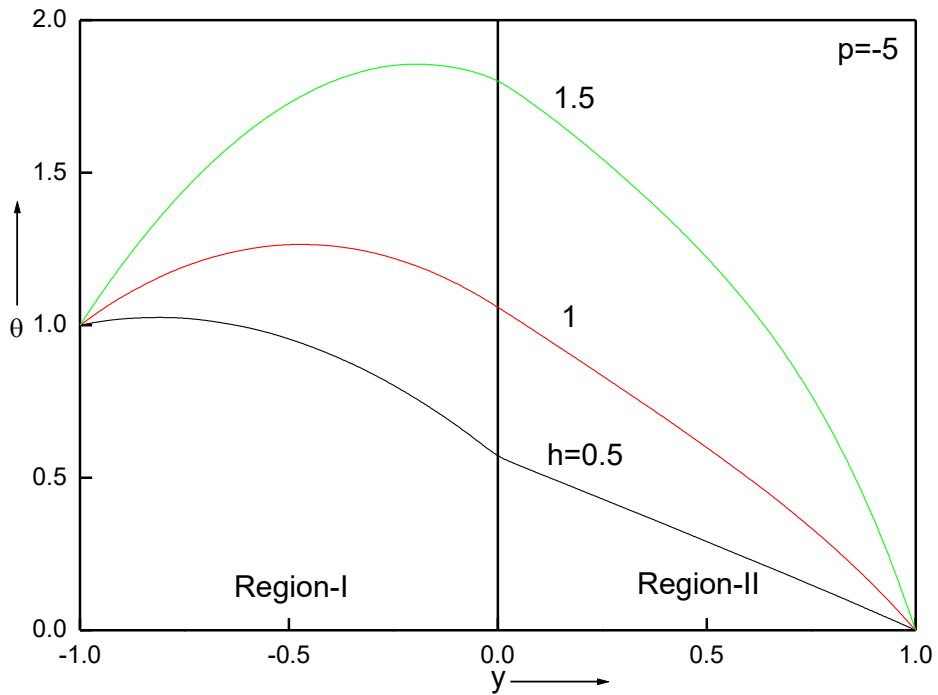

fig10:(a) Width ratio h effects on Velocity profiles.

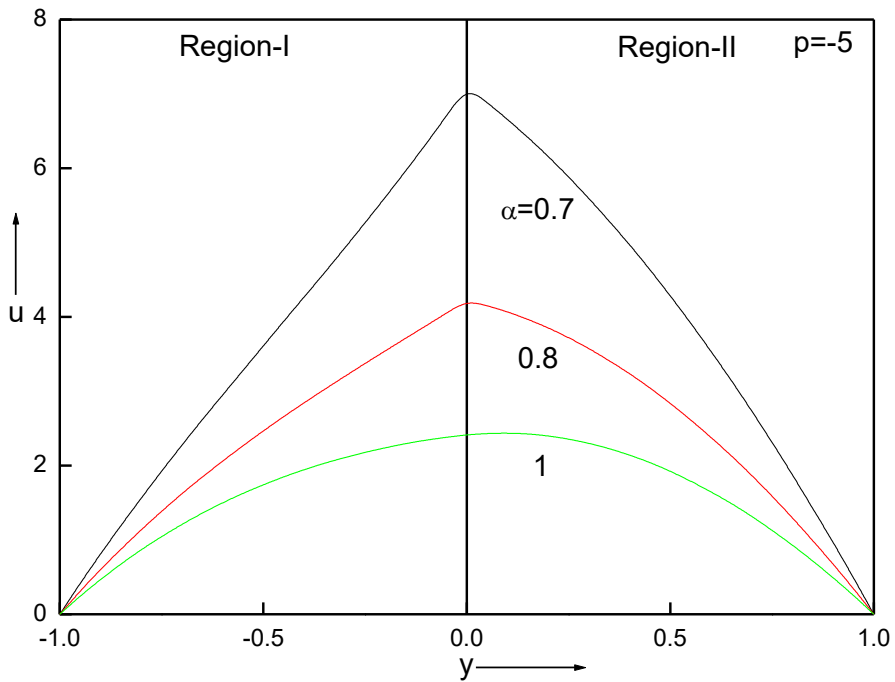fig10:(b) Width ratio h effects on Temperature profiles.

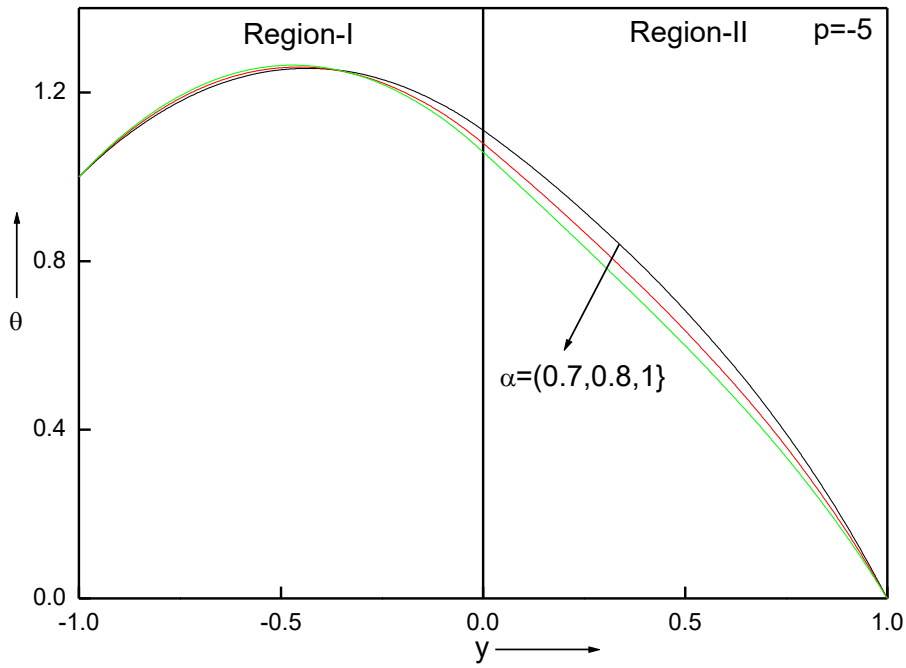fig11:(a) Chemical reaction parameter α effects on Velocity profiles.

fig11:(b) Chemical reaction parameter α effects on Temperature profiles.
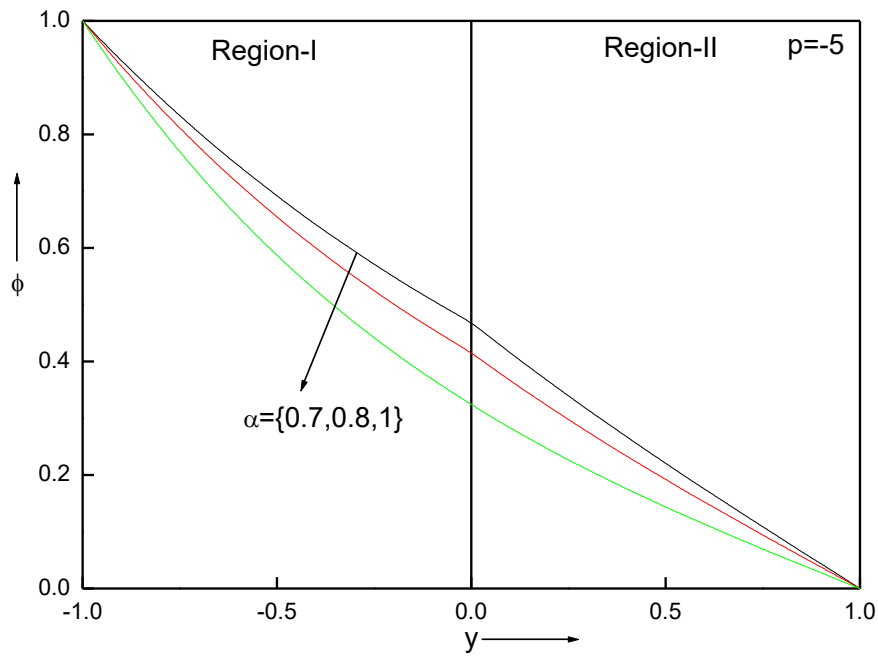

fig11:(c) Chemical reaction parameter α effects on Concentration profiles .
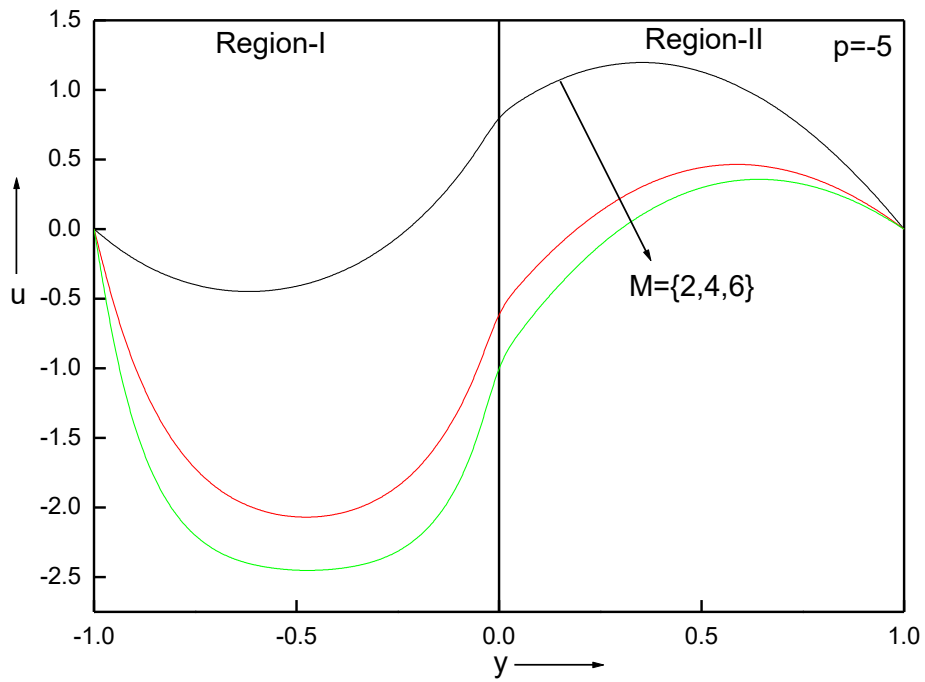
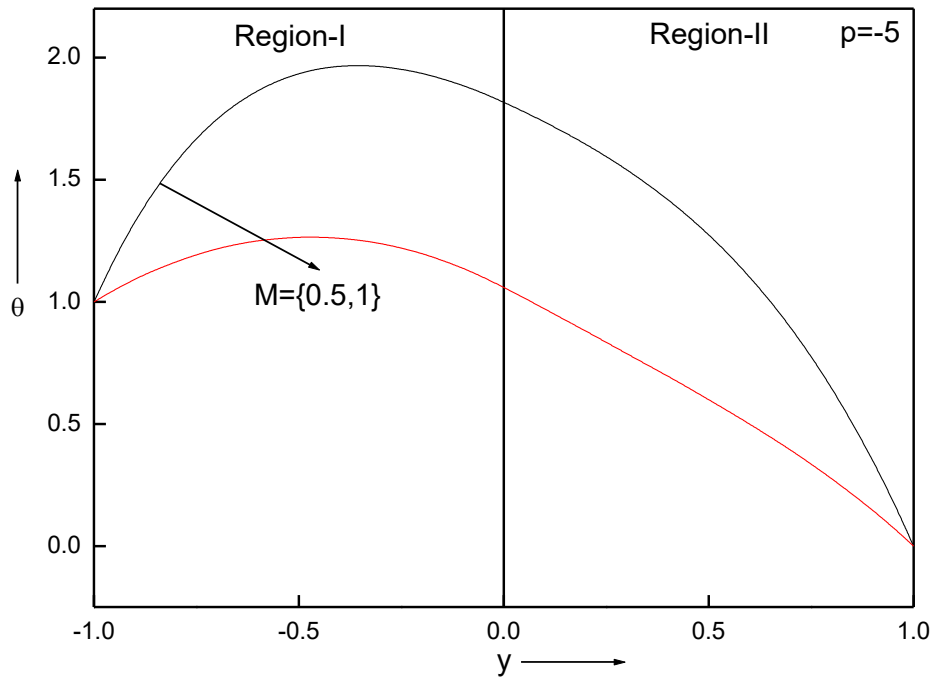fig12:(a) Hartmann number M effects on Velocity profiles.

fig12:(b) Hartmann number M effects on Temperature profiles.

Conclusion

The problem of effect of Jeffrey fluid flow and first order chemical reaction on magneto convection immiscible fluids in a perpendicular channel was analytically examined using regular perturbation method. Following conclusions are made

1. The effects of mixed convection parameters that is GR_T and GR_C fluid flow profiles on velocity domain and in temperature filed, as we increase the values of thermal Grashof number and mass Grashof number the flow fields enhance in the first region and second due to buoyancy force(force which helps the motion of the fluid).

2. we noticed that the effect of Jeffrey parameter on the velocity profile and temperature fields, greater values of Jeffrey parameter on velocity and temperature leads to increase in flow in both the regions because of its relaxation and retardation property.

3. The result was found for the effect of chemical reaction parameter on the field on velocity and temperature. Considering the higher values of chemical reaction parameter, the velocity, temperature and concentration suppress flow in both the regions.

4. The larger the values of Hartmann number, reduces the fluid flow on velocity and temperature profiles in both the regions, as a result it suppress the heat and mass transfer.

5.These above results are holds good with the results of Prathap Kumar et.al. [15].

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