$$\frac{dp_0}{dx} = \frac{M^2\alpha}{R} \tag{3.8}$$

This shows that in the presence of magnitude field, there exists a constant pressure gradient in y direction, where as in absence of the magnitude field this pressure turns out to be a constant, *i.e.* p_∞ However, equations (3.3), (3.5), (3.6) are independent of pressure p_o and can be solved without involving it with the boundary conditions of the problem.

To solve equation (3.3), we assume that

$$u_o = u_{oo} + k_2 = u_{01} \tag{3.9}$$

since $k_2 << 1$

Substituting (3.9) into the equation (3.3) and equating the like powers of k_2, we obtain

$$\frac{1}{2}\alpha u'''_{oo} - u''_{01} - u'_{01} = 0 \tag{3.10}$$

$$\frac{1}{R}u_{oo} + \alpha\, u'_{oo} = -RGe^{-RP\alpha y} \tag{3.11}$$

The solutions of equations (3.3), (3.5), (3.6), (3.8), (3.10) and (3.11)

$u_{oo} = 1 - A_2 e^{-R\alpha y} + A_1 e^{-RP\alpha y}$

$u_{01} = 1 + A_7 e^{-Ry} + A_5 e^{-R\alpha y} - e^{-RP\alpha y}$

for $P \neq 1$

$$v_o = -\alpha,\ w_o = 0,\ T_0 = e^{-RP\alpha y} \tag{3.12}$$

When $\varepsilon \neq 0$, substituting (3.1) in equations (2.4) to (2.8) and comparing the coefficients of identical powers of ε, neglecting ε^2, and with the help of the solution of the above two dimensional problem, we get the following equations as the coefficients of ε.

$$\frac{\partial v_1}{\partial v} + \frac{\partial w_1}{\partial z} = 0 \tag{3.13}$$

$$-\alpha\frac{\partial u_1}{\partial y} + v_1\frac{\partial u_0}{\partial z} = RGT_0 + \frac{1}{R}\left(\frac{\partial^2 u_1}{dy^2} + \frac{\partial^2 u_1}{dz^2}\right)$$

$$+k_2\left\{\frac{1}{2}\alpha\frac{\partial}{\partial x}\left(\frac{\partial^2 u_1}{dy^2} + \frac{\partial^2 u_1}{dz^2}\right) - \frac{1}{2}v\frac{\partial}{\partial y}\frac{\partial^2 u_0}{dy^2}\right.$$

$$\left. + \frac{1}{2}\frac{\partial u_0}{dy}\left(\frac{\partial^2 v_1}{dy^2} + \frac{\partial^2 v_1}{dz^2}\right) + \frac{\partial v_1}{dy}\frac{\partial^2 u}{dy^2}\right\} \tag{3.14}$$

$$-\alpha\frac{\partial u}{\partial y} = -\frac{\partial p_1}{\partial y} + \frac{1}{R}\left(\frac{\partial^2 v_1}{dy^2} + \frac{\partial^2 v_1}{dz^2}\right) + \frac{1}{2}k_2\alpha$$

$$\left\{\frac{\partial^3 v_1}{\partial y^3} + \frac{\partial^3 v_1}{\partial y\partial z^2}\right\} - \frac{M^2}{R}v_1 \tag{3.15}$$

$$-\alpha\frac{\partial w_1}{\partial y} = -\frac{\partial p_1}{\partial y} + \frac{1}{R}\left(\frac{\partial^2 w_1}{\partial y^2} + \frac{\partial^2 w_1}{\partial z^2}\right) + \frac{1}{2}k_2\alpha$$

$$\left\{\frac{\partial^3 w_1}{\partial y^3} + \frac{\partial^3 w_1}{\partial y\partial z^2}\right\} - \frac{M^2}{R}w \tag{3.16}$$

$$-\alpha\frac{\partial T_1}{\partial y} + v_1\frac{\partial T_0}{\partial y} = \frac{1}{RP}\left(\frac{\partial^2 T_1}{\partial y^2} + \frac{\partial^2 T_1}{\partial z^2}\right) \tag{3.17}$$

The corresponding boundary conditions become

$u_1 = 0;\ v_1 = -\alpha\cos\pi z,\ w_0 = 0,\ T_1 = 0$ at $y = 0$

$u_1 = 1;\ v_1 = 0,\ \ w_0 = 0,\ p_1 = 0,\ T_1 = 0$ at $y \to \infty$ (3.18)

In order to solve the differential equations (3.13) to (3.17) subject to the boundary condition (3.18), we assume u_1, v_1, w_1, p_1 and T_1 as follows:

$u_1(y, z) = u_{11}\cos\pi z,\ v_1(y, z) =$

$u_{11}\cos\pi z,\ w_1(y, z) = -\dfrac{1}{\pi}v'_{11}\sin\pi z,$