

Fig. 3. The Velocity Distribution for the Elastic Parameter ( $R_c$ ), the Heat Source Parameter ( $S$ ) and Soret Number ( $S_0$ ) in Figures (a), (b) with  $t=0.1$ .

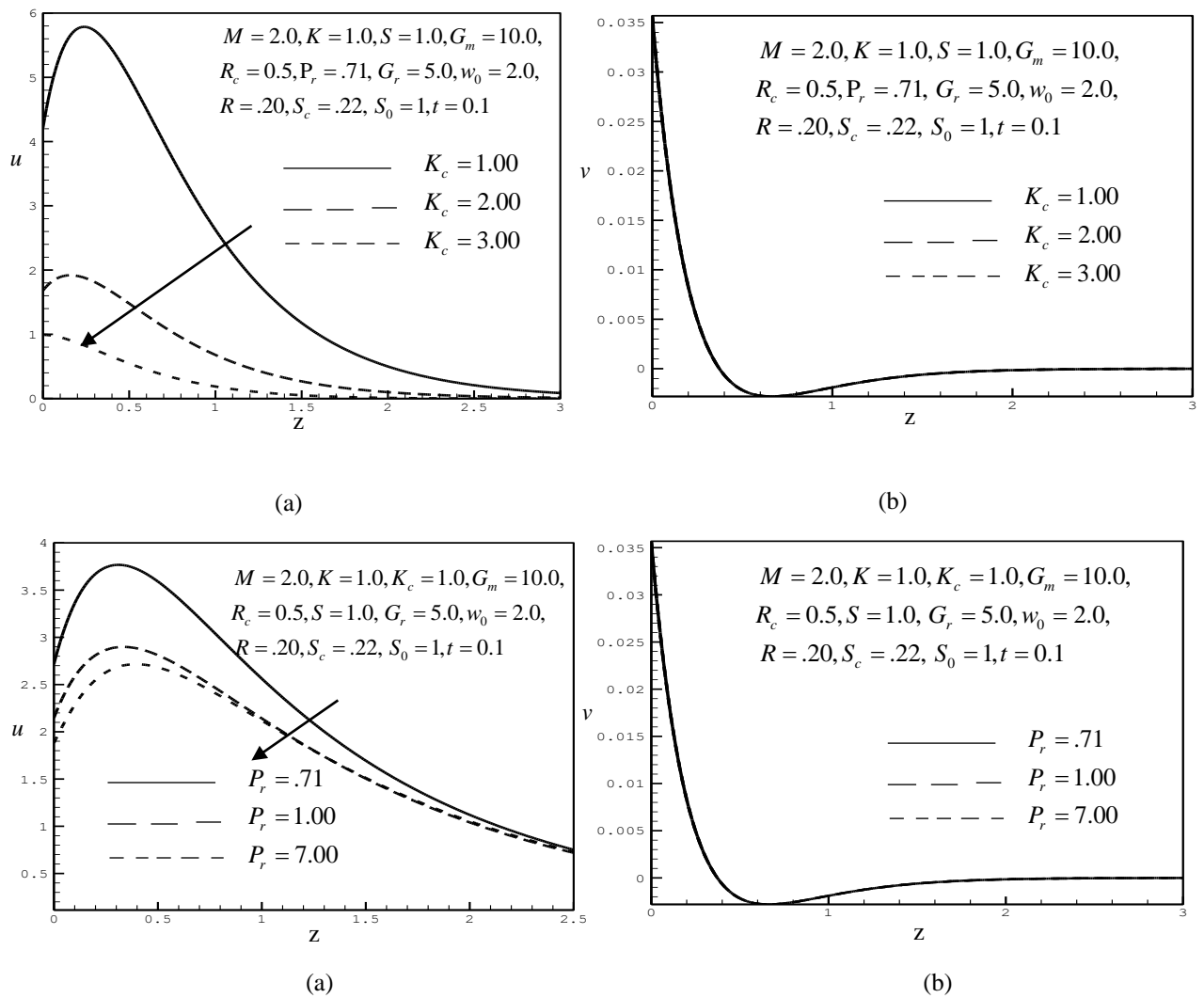


Fig. 4. The Velocity Distribution for the Chemical Reaction Parameter ( $K_c$ ) and Prandtl Number ( $p_r$ ) in Figures (a), (b) with  $t=0.1$

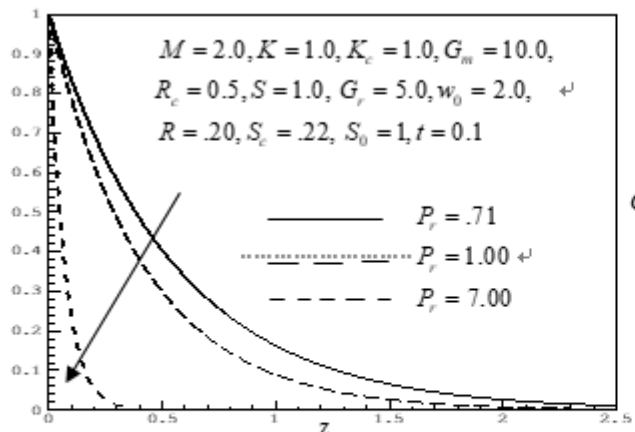


Fig. 5. Temperature Distribution for Different Values of Prandtl Number ( $P_r$ )

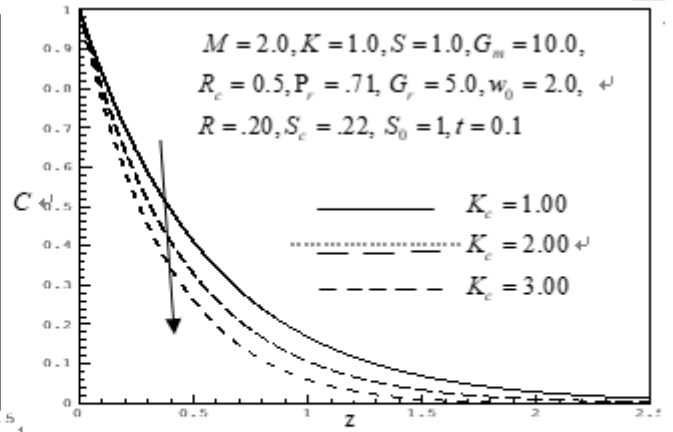


Fig. 8. Concentration Distribution for Different Values of the Chemical Reaction Parameter ( $K_c$ )

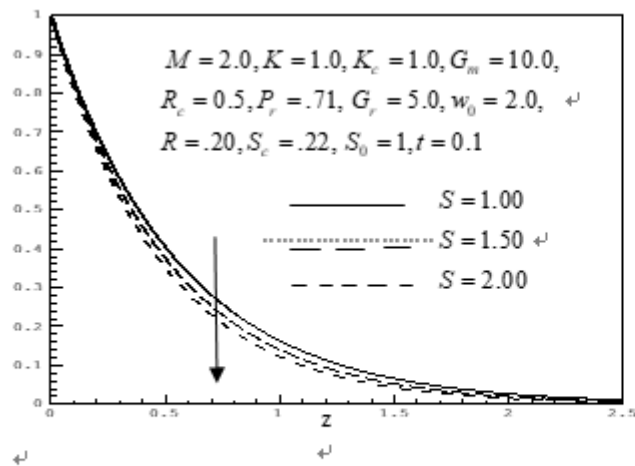


Fig. 6. Temperature Distribution for Different Values of Heat Source Parameter ( $S$ )

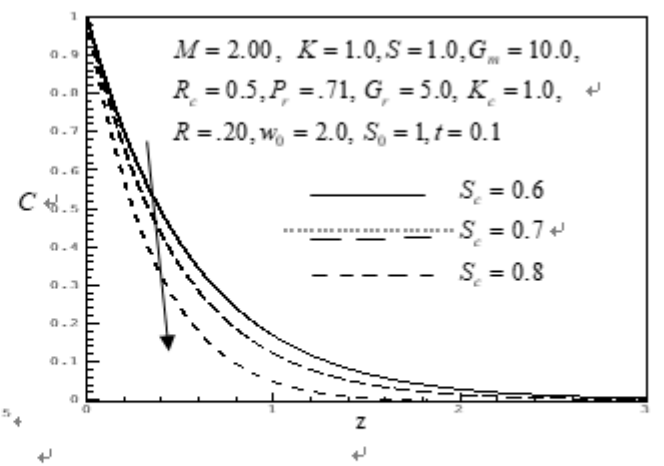


Fig. 9. Concentration Distribution for Different Values of the Schmidt Number ( $S_c$ )

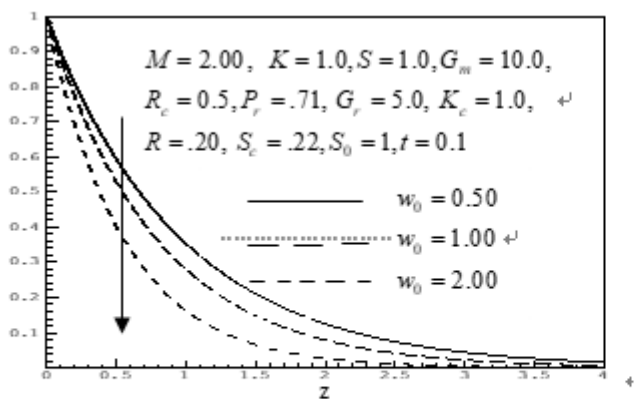


Fig. 7. Temperature Distribution for Different Values of Suction Velocity ( $w_0$ )

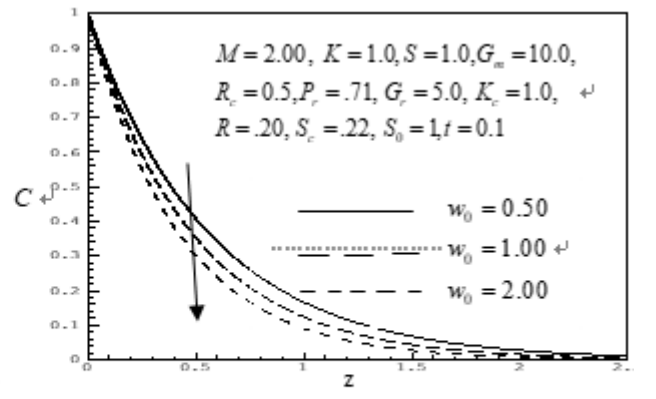


Fig. 10. Concentration Distribution for Different Values of the Suction Parameter ( $w_0$ )

## Case ii: Comparison

The unsteady flow of an incompressible visco-elastic fluid flow with heat and mass transfer along an oscillating porous plate under the influence of uniform transvers magnetic field has been discussed. The effect of non-dimensional parameters on the governing flow such as Prandlt number ( $P_r$ ), Hartmann number ( $M$ ), Elastic parameter ( $R_c$ ), Chemical reaction parameter ( $K_c$ ), Heat source parameter ( $S$ ), the Schmidt number ( $S_c$ ), Suction parameter ( $w_0$ ) on the velocity, temperature and concentration distributions have been studied analytically and presented with the help of Figures (11-16). Qualitative comparisons have been shown in Figures (11-16). The effect of Heat source parameter ( $S$ ) on the velocity distributions  $u$  and  $v$  of Raghunath et al. (2016) are represented in Figures (a, b) of (11) and present work are represented in Figures (c, d) of (11). In Figure 11(c), it is noticed that the velocity distribution  $u$  decreases with the increase of the value of ( $S$ ) and in Figure 11(d), there is no effect on velocity distribution  $v$  with the increase of ( $S$ ). In Figures (a, b) of (12-13), the effect of Hartmann number ( $M$ ) and the suction parameter ( $w_0$ ) on the velocity distributions  $u$  and  $v$  of Raghunath et al. (2016) are represented and the effect of the Hartmann number ( $M$ ) and the suction parameter ( $w_0$ ) on the distributions  $u$  and  $v$  of present work are represented in Figures (c, d) of (12-13). In Figure(c) of (12-13), the velocity distribution  $u$  decreases with the increase of ( $M$ ) and ( $w_0$ ). And in Figure (d) of (12-13), the velocity distribution  $v$  increases with the increase of ( $M$ ) and ( $w_0$ ). The velocity distributions  $u$  and  $v$  of Raghunath et al. (2016) for the elastic parameter ( $R_c$ ) are showed in Figures (a, b) of (14) and the effect of present work are represented in Figures (c, d) of (14). In Figures 14(c), it is found that the velocity distribution  $u$  increases with the increase of ( $R_c$ ) and in Figures 14(d), there is no effect on velocity distribution  $v$  with the increase of ( $R_c$ ). Figures (a, b, c) of (15) depict the effect of Prandlt number ( $P_r$ ), Heat source parameter ( $S$ ) and the suction parameter ( $w_0$ ) on the temperature distribution of Raghunath et al. (2016) and Figures (d, e, f) of (15) depict the effect of the Prandlt number ( $P_r$ ), the Heat source parameter ( $S$ ) and the suction parameter ( $w_0$ ) on the temperature distribution of present work. It is observed that the temperature distribution decreases with the increase of ( $P_r$ ), ( $S$ ) and ( $w_0$ ). Figures (a, b, c) of (16) depict the effect of the chemical reaction parameter ( $K_c$ ), the Schmidt number ( $S_c$ ) and the suction parameter ( $w_0$ ) on the

concentration distribution of Raghunath et al. (2016) and Figures (d, e, f) of (16) depict the effect of the chemical reaction parameter ( $K_c$ ), the Schmidt number ( $S_c$ ) and the suction parameter ( $w_0$ ) on the temperature distribution of present work. It is observed that the concentration distribution decreases with the increase of ( $K_c$ ), ( $S_c$ ) and ( $w_0$ ).

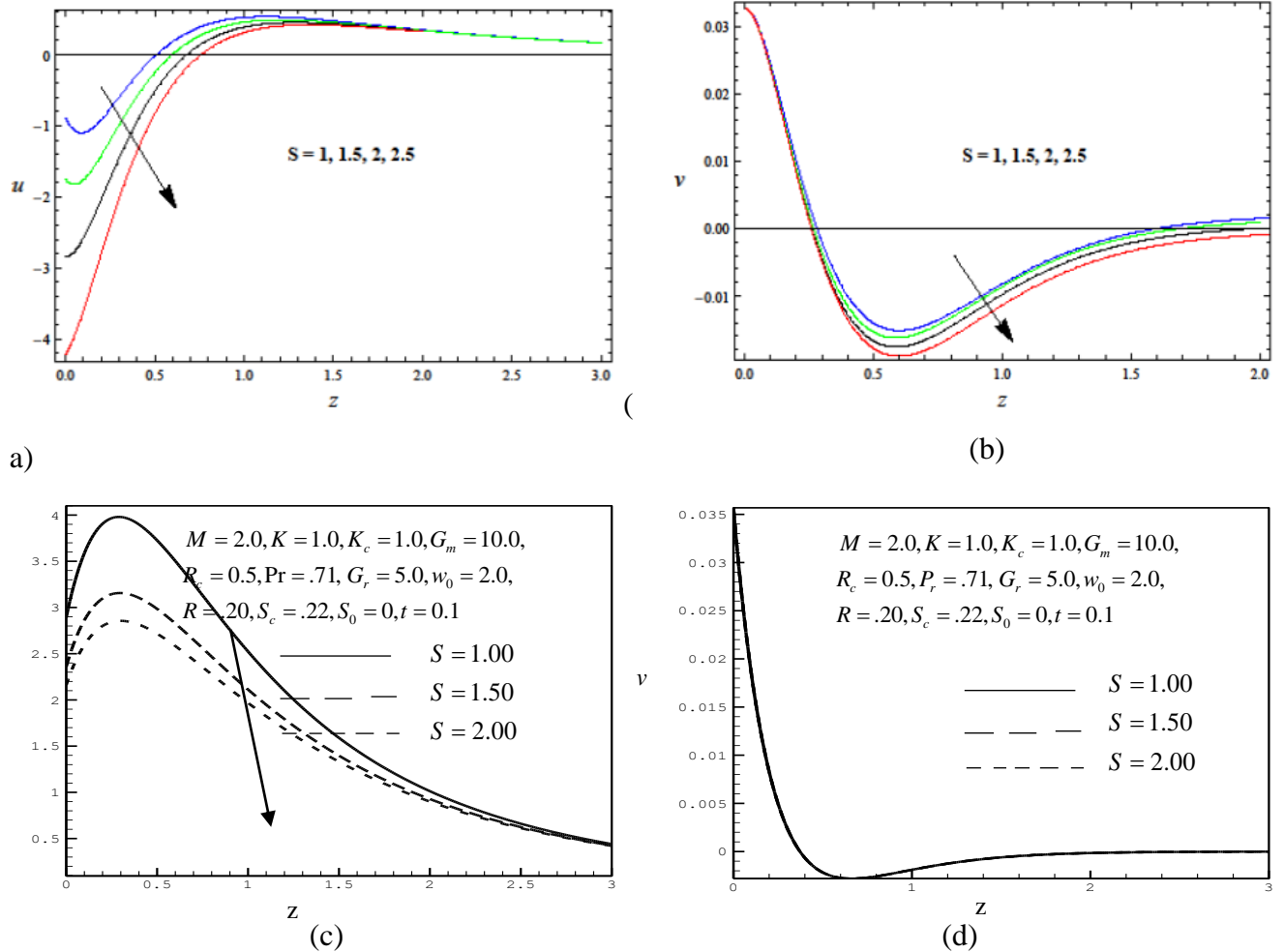
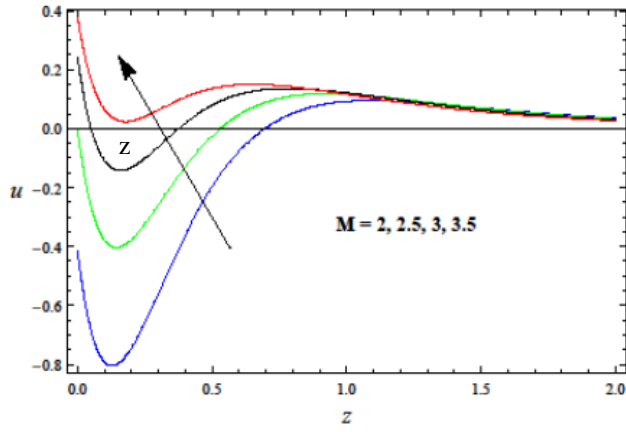
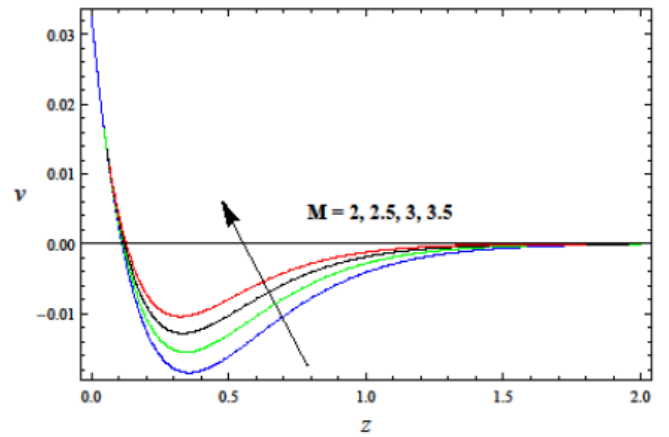


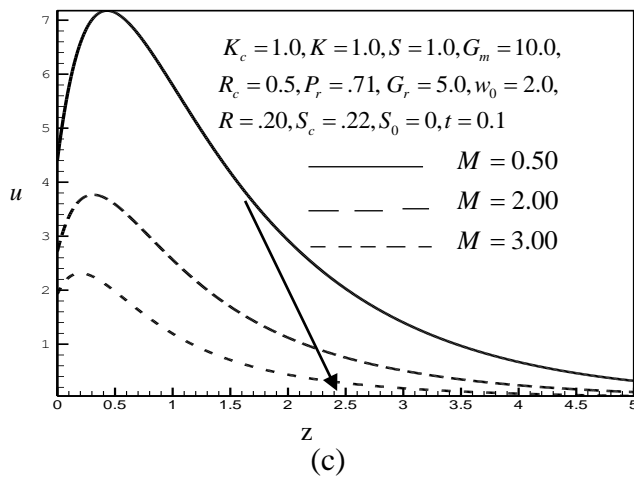
Fig. 11. The velocity distribution for the Heat source parameter ( $S$ ) of Raghunath et al. (2016) in figures (a), (b) and the velocity distribution for the Heat source parameter ( $S$ ) of present work in figures (c), (d) with  $t=0.1$  and  $S_0=0$



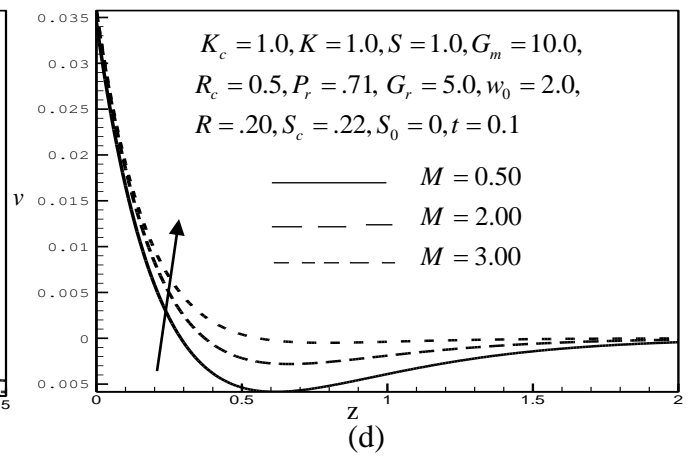
(a)



(b)

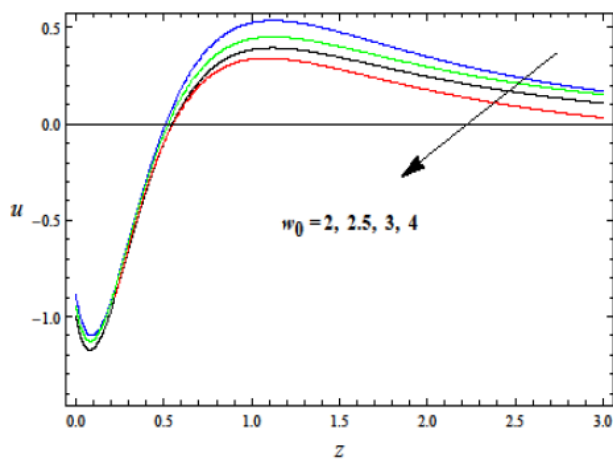


(c)

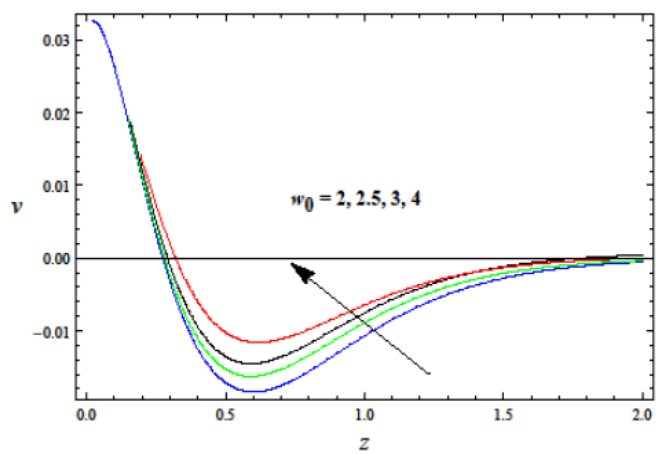


(d)

Fig. 12. The Velocity Distribution for Hartmann Number ( $M$ ) of Raghunath et al. (2016) in Figures (a), (b) and the Velocity Distribution for Hartmann Number ( $M$ ) of Present Work in Figures (c), (d) with  $t=0.1$  and  $S_0=0$



(a)



(b)

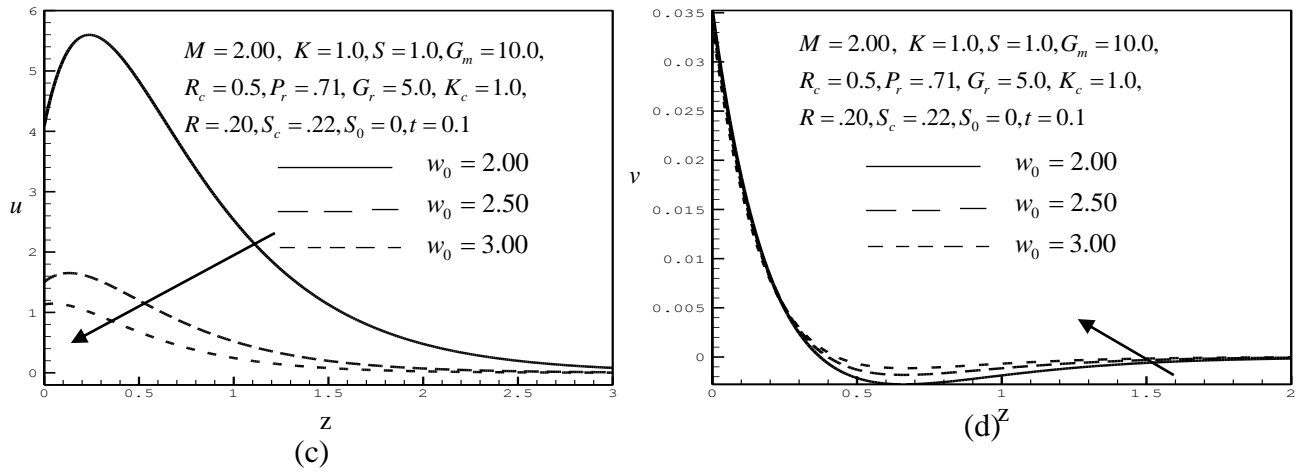


Fig. 13. The Velocity Distribution for Suction Parameter ( $w_0$ ) of Raghunath et al. (2016) in Figures (a), (b) and the Velocity Distribution for Suction Velocity ( $w_0$ ) of Present Work in Figures (c), (d) with  $t=0.1$  and  $S_0=0$

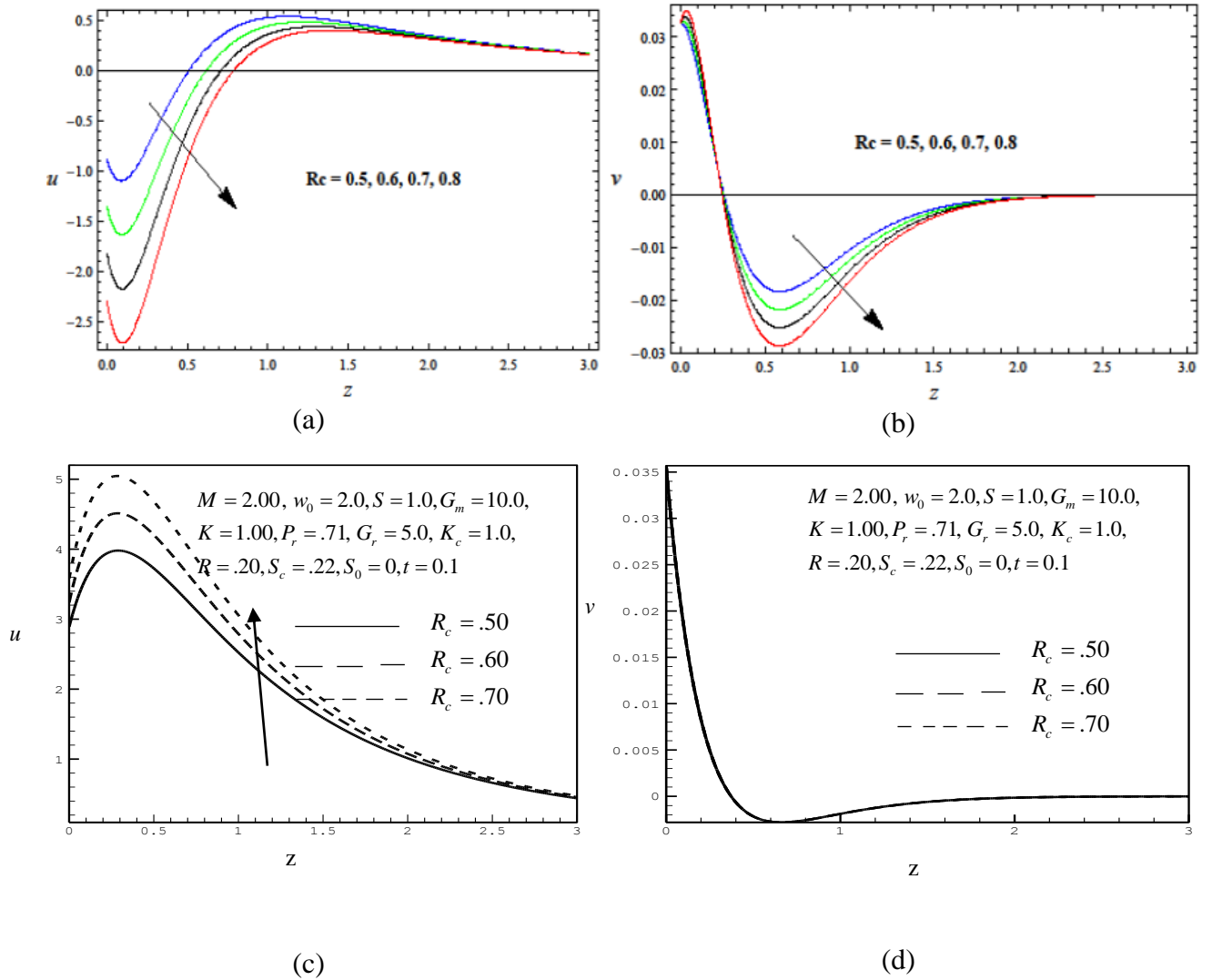




Fig. 14. The Velocity Distribution for Elastic Parameter ( $R_c$ ) of Raghunath et al. (2016) in Figures (a), (b) and the Velocity Distribution for Elastic Parameter ( $R_c$ ) of Present Work in Figures (c), (d) with  $t=0.1$  and  $S_0=0$

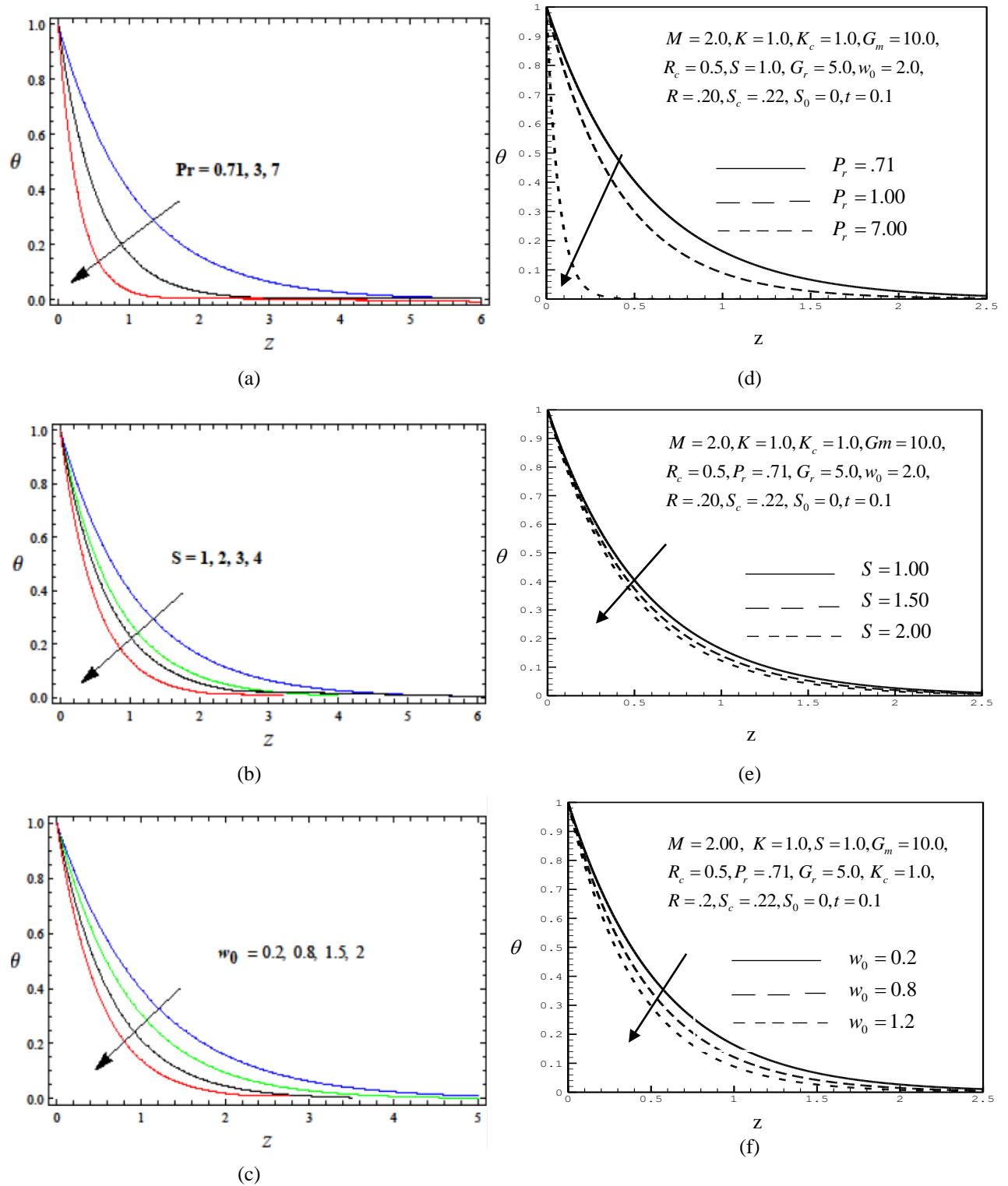


Fig. 15. Temperature Distributions for Prandtl

Number ( $P_r$ ), heat source parameter ( $S$ ) and suction velocity ( $w_0$ ) of Raghunath et al. (2016) in (a), (b), (c) and Present Work in (d), (e), (f) with  $t=0.1$  and  $S_0=0$

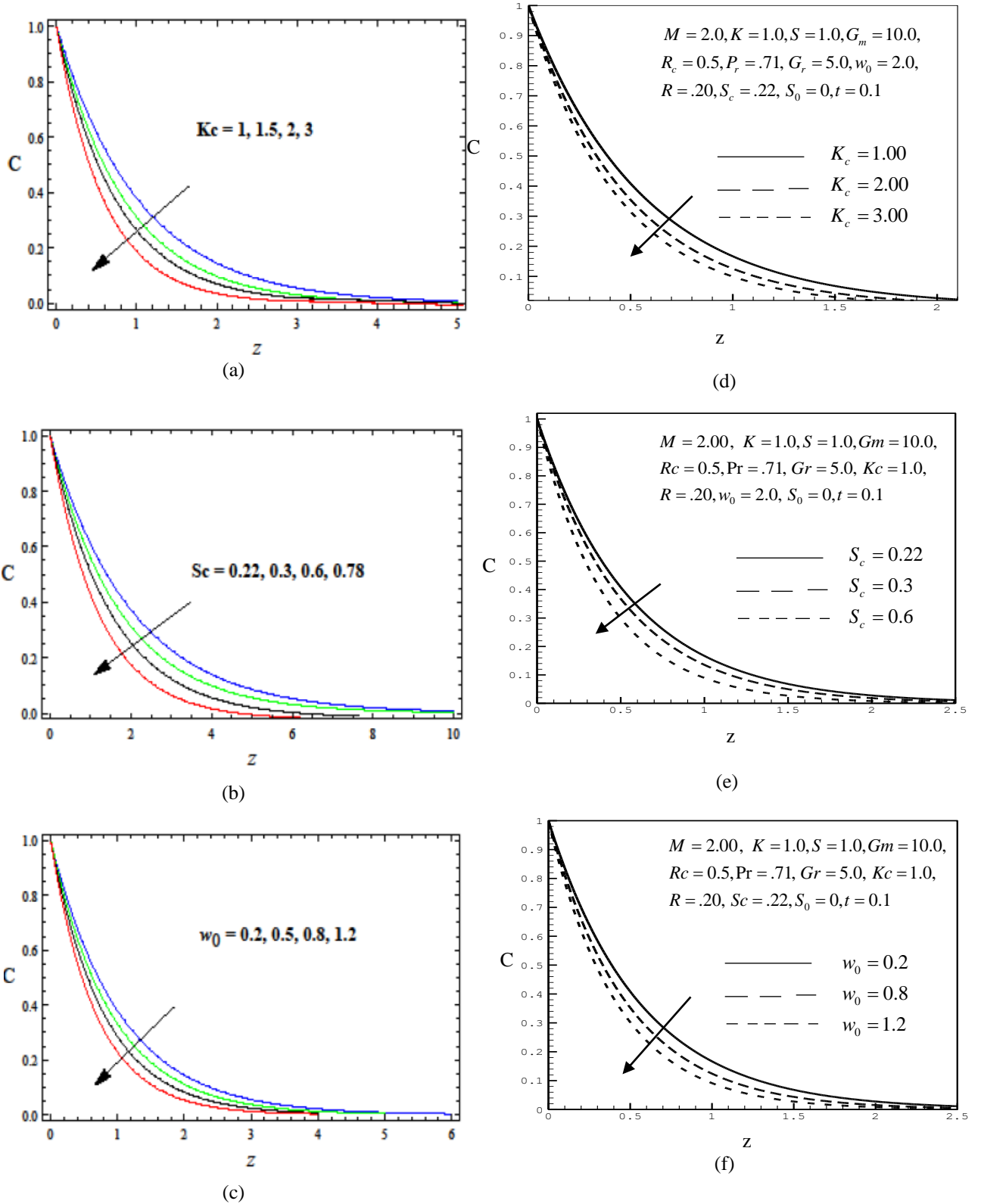


Fig. 16. Concentration Distributions for Chemical Reaction Parameter ( $K_c$ ), Schmidt Number ( $s_c$ ) and Suction Parameter ( $w_0$ ) of Raghunath et al. (2016) in (a), (b), (c) and Present Work in (d), (e), (f) with  $t=0.1$  and  $S_0=0$ .

## Conclusions

MHD visco-elastic fluid have been studied for the unsteady flow of an incompressible fluid through a porous medium with simultaneously infinite oscillating plate. The resulting system of dimensionless non-linear coupled partial differential equations are analytically solved by a perturbation method. The results have been discussed for different values of parameters as Prandlt number, Hartmann number, Porosity parameter, the elastic parameter, Chemical reaction parameter, Heat source parameter, Schmidt number, the suction parameter and Soret number. The effects of different parameters on velocity, temperature and concentration distribution have been discussed graphically. The comparison between Raghunath et al. (2016) and present solution have been presented graphically for velocity profile, temperature distribution and concentration distribution.

In present work the velocity component  $u$  decreases with the increase of  $w_0$ ,  $M$  and  $K$ . and the velocity component  $v$  increases with the increase of  $M$ ,  $w_0$  and the velocity component  $v$  decreases with the increase of  $K$ . In Raghunath et al. (2016) the velocity component  $u$  and  $v$  increase with the increase of  $M$ . Also the velocity component  $u$  decreases with the increase of  $w_0$  and the velocity component  $v$  increases with the increase of  $w_0$ .

In present work the velocity component  $u$  increase with the increase of  $R_c$  and  $S_0$  and there is no variation of velocity component  $v$  with the increase of  $R_c$  and  $S_0$ . In Raghunath et al. (2016) the velocity component  $u$  and  $v$  decrease with the increase of  $R_c$ .

In present work the velocity component  $u$  decreases with the increase of  $P_r$ ,  $S$  and  $K_c$  and there is no variation of velocity component  $v$  with the increase of  $P_r$ ,  $S$  and  $K_c$ . In Raghunath et al. (2016) the velocity component  $u$  and  $v$  decrease with the increase of  $S$ .

The temperature distributions decrease with the increase of the values of  $P_r$ ,  $S$  and  $w_0$  in both work.

The concentration distributions decrease with the increase of the values of  $K_c$ ,  $S_c$  and  $w_0$  in both work.

In this analysis, the effects of different parameters on the velocity, temperature distributions and concentration distributions have been discussed graphically. The analytic solution of Raghunath et al. (2016) have analysis error. The correct analysis has been shown in the field of comparison. The comparison has been drawn in graphically. From the comparison it has been found that the two solutions are qualitatively similar but not quantitatively similar and in maximum case it represents the same trend.

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## Nomenclature

$S_c$	Schmidt number	$M$	Hartmann number
$S_o$	Soret number	$K$	Permeability parameter
$G_r$	Grashof number	$\beta$	Volumetric coefficient of thermal expansion
$G_m$	Modified Grashof number	$w_0$	Suction Velocity
$D_T$	Thermal diffusivity	$\delta$	Boundary layer thickness
$K_c$	Chemical reaction parameter	$\mu$	Co-efficient of viscosity
$P_r$	Prandtl number	$\nu$	Co-efficient of kinematic viscosity
$C$	Concentration	$k_1$	Dimensionless permeability parameter
$R_c$	Elastic parameter	$\rho$	Boundary layer fluid density
$u$	Velocity components in $X$ -direction	$k_0$	Dimensionless elastic parameter
$v$	Velocity components in $Y$ -direction	$\theta$	Dimensionless temperature
$S$	Heat Source Parameter	$T$	Dimensional temperature

## Appendix

$$m_2 = \frac{\text{Pr} w_0 + \sqrt{\text{Pr}^2 w_0^2 + 4 \text{Pr} S}}{2}, m_6 = \frac{w_0 \text{Sc} + \sqrt{w_0^2 \text{Sc}^2 + 4 \text{KcSc}}}{2}$$

$$m_{10} = \frac{w_0 + \sqrt{w_0^2 + 4 \left( M^2 + \frac{1}{K} \right)}}{2}, m_{12} = \frac{w_0 + \sqrt{w_0^2 + 4 \left( M^2 + \frac{1}{K} + i\omega \right)}}{2}$$

$$a_1 = -\frac{\text{ScS}_0 m_2^2}{m_2^2 + \text{Sc} w_0 m_2 - \text{KcSc}}$$

$$a_2 = 1 - a_1, a_3 = \frac{-\text{Gr}}{m_2^2 + w_0 m_2 - \left( M^2 + \frac{1}{K} \right)}$$

$$a_4 = \frac{-\text{Gma}_1}{m_2^2 + w_0 m_2 - \left( M^2 + \frac{1}{K} \right)}, a_5 = \frac{-\text{Gma}_2}{m_6^2 + w_0 m_6 - \left( M^2 + \frac{1}{K} \right)}$$

$$a_6 = \frac{-1}{(1 + \text{Rm}_{10})} \{ (a_3(1 + \text{Rm}_2) + a_4(1 + \text{Rm}_2) + a_5(1 + \text{Rm}_6)) \}$$

$$a_7 = \frac{1}{1 + \text{Rm}_{12}}, a_8 = \frac{-w_0 a_3 m_2^3}{m_2^2 + w_0 m_2 - \left( M^2 + \frac{1}{K} \right)}$$

$$a_9 = \frac{-w_0 a_4 m_2^3}{m_2^2 + w_0 m_2 - \left( M^2 + \frac{1}{K} \right)}$$

$$a_{10} = \frac{-w_0 a_5 m_6^3}{m_6^2 + w_0 m_6 - \left( M^2 + \frac{1}{K} \right)}$$

$$a_{11} = \frac{-w_0 a_6 m_{10}^3}{m_{10}^2 + w_0 m_{10} - \left( M^2 + \frac{1}{K} \right)}$$

$$a_{12} = \frac{-1}{(1 + \text{Rm}_{10})} \{ (a_8(1 + \text{Rm}_2) + a_9(1 + \text{Rm}_2) + a_{10}(1 + \text{Rm}_6) + a_{11}(1 + \text{Rm}_{10})) \}$$

$$a_{13} = \frac{(-m_{12}^3 w_0 + i\omega m_{12}^2) a_7}{m_{12}^2 + w_0 m_{12} - \left( M^2 + \frac{1}{K} + i\omega \right)}$$

$$a_{14} = -a_{13}, a_{15} = a_{13} + a_{14}$$