DISCUSSION :-

We follow the convention that the fluid region in one half of the channel bounded by the plane wall denotes region I and the remaining half bounded by the wavy wall denotes region II. The profiles for zeroth order axial velocity (u_0) (Fig.1) are asymmetric bell shaped curves with the maximum attained in the mid plane. The magnitude of the velocity u_0 in general at any point in the region I is large in compared to its magnitudes in the region II. For an increase in the Hartmann number M, the velocity u_0 decays rapidly and the decay in the region II is less rapid compared to its decay in the region I. Also it can be observed that when the suction parameter reverses its sign from positive to negative, the velocity in the region I decreases while the velocity near the wavy wall increases. Keeping M fixed, for an increase in suction parameter S (>0), the axial velocity u_0 increase uniformly in the region I and decreases in the region II. This shows that an increase in the suction parameter S (>0), causes an increase in the flux in the region I along the channel while an increase in S through negative values causes an increase in flux in the region II.

The zeroth order temperature profiles are drawn in (Figs.2 and 3) for different values of S, α and P.

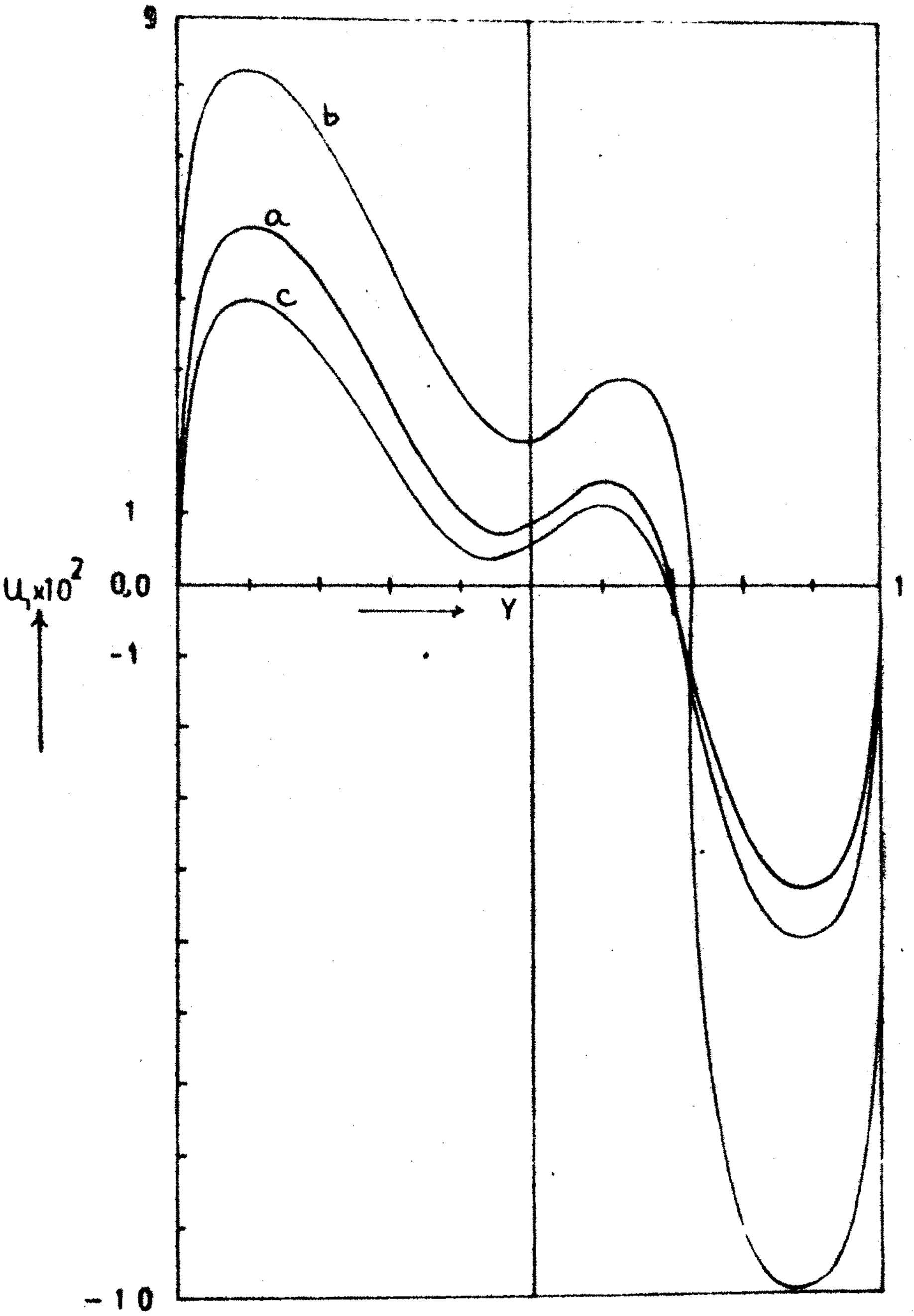

Fig. 4

First order axial velocity (u_1) with β = 0.2, α = 5

	a	b	c
M	1	1	3
λ	0.01	0.02	0.01

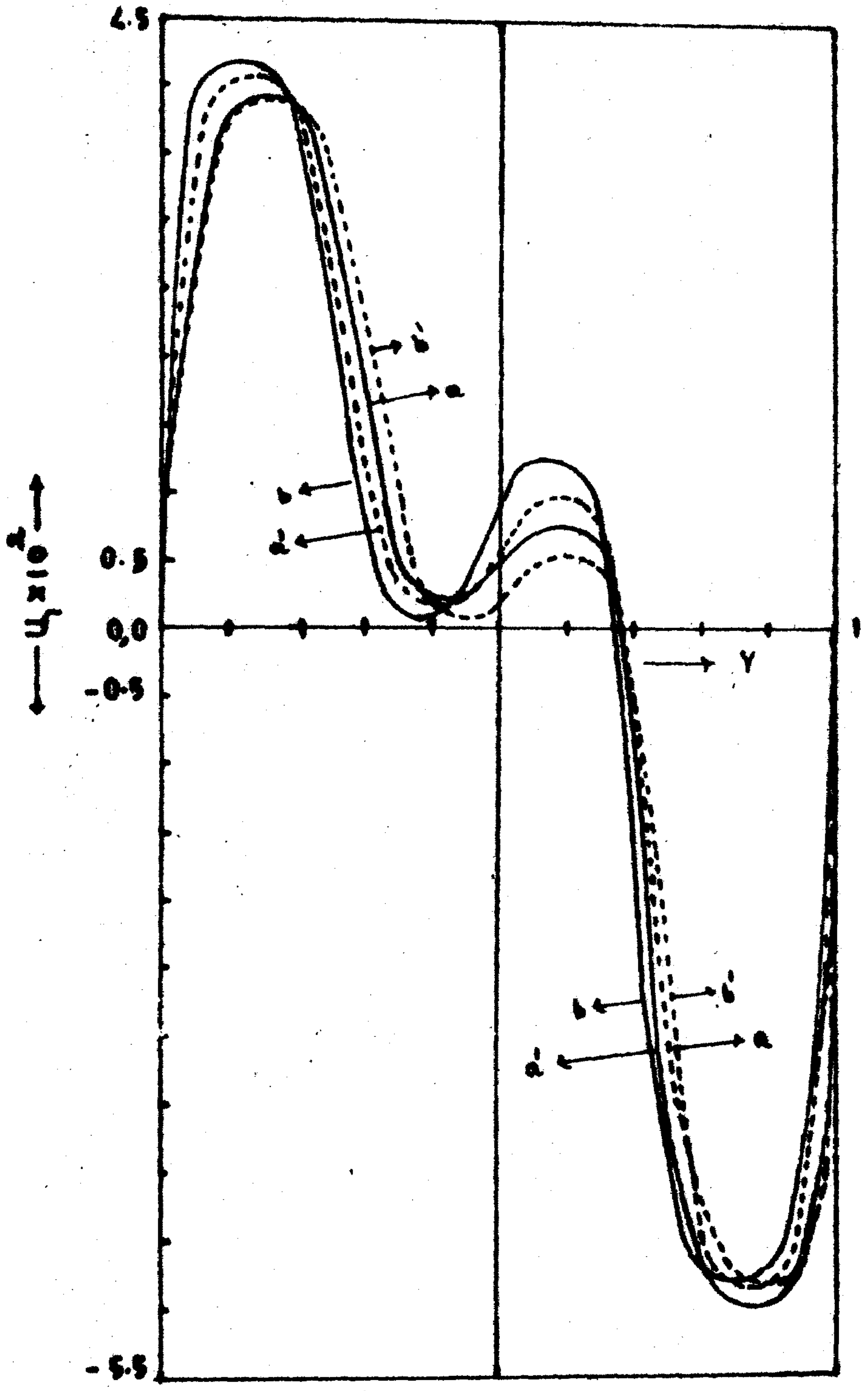

Fig.5.

Variation of u_1 for different S with M = 1, = 0.01

	a	a'	b	b'
S	0.2	-0.2	0.4	-0.4

In either case, the temperature grows rapidly in the region I till it attains its maximum in the other half of the channel near the mid plane and then rapidly falls towards the wavy boundary to attain its prescribed value. In case of water (P = 0.71) for positive values of suction parameter the growth of the temperature near the plane wall is rapid in compared to its growth when S is negative. This difference in the growth rates is much pronounced in case of air (P = 7). For an increase in S (>0) the temperature increases uniformly althrough the region while for an increase in S (<0) the temperature decreases throughout the channel. Where as for fixed S (positive or negative) an increase in the heat parameter α increases the temperature w.r.t. an increase in α is much large in compared to its growth w.r.t. an increase in S (>0).

The perturbation in the axial velocity (u_1) (Figs.4,5) contributes to the growth of the total axial velocity in region I and retards the same in the region II. This perturbation has a steep rise near the plane wall and a similar fall near the wavy boundary. The maximum in either region is attained very near the boundary. In the region I, it rapidly falls from its maximum value to the lowest value near the mid plane and once again rises in a narrow strip adjacent to the mid plane before getting reversed in the region II. This u_1 contributes to the fluid

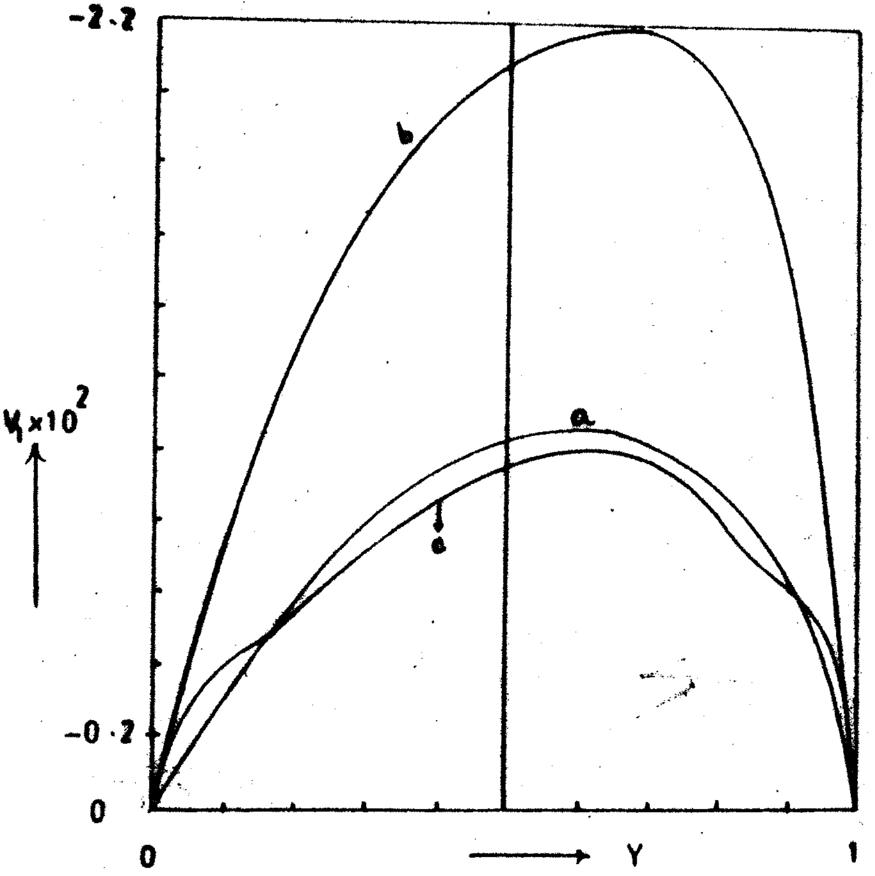

Fig. 6

Variation of v_1 with $\beta = 0.2$ and $\alpha = 5$

Curves as in Fig. 4

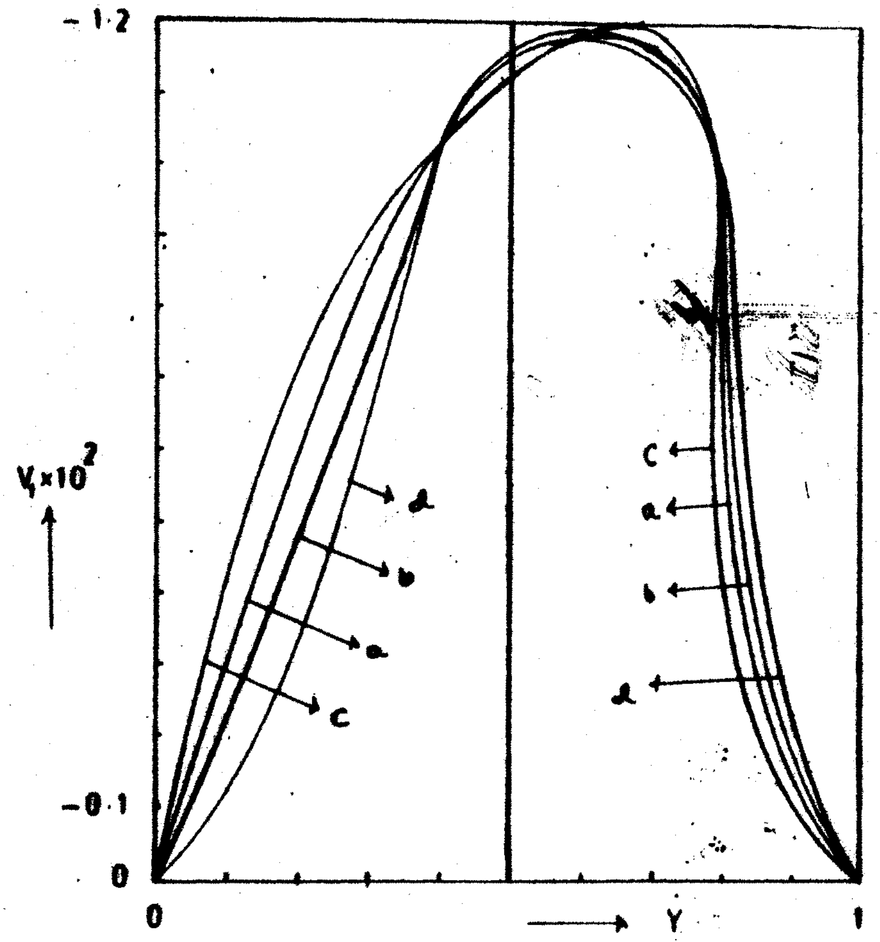

Fig. 7

Variation of (v_1) with ϕ for $M = 1$, $\lambda = 0.01$

Curves as in Fig. 5

accelaration along the channel in the region I and retards the motion in the region II. For all the values of the governing parameters, the extrema of the total axial velocity occur very near the boundaries the minimum value being near the wavy wall. For an increase in the wave length (λ) the growth in the magnitude of u_1 is almost proportional to variation in λ. When the suction (or injection) rate is maintained, an increase in the Hartmann number decreases the positive perturbations in region I and increases the reversed flow magnitudes in region II. Thus the axial motion is retarded in general due to an increase in M. For a fixed M, an increase in S (>0), decreases the magnitude of the perturbations in region I and increases their magnitude in region II away from the boundaries. Thus the total axial velocity retards in general, except in narrow layers abetting the boundary, due to increase in the suction parameter. When S increases through negative values the reversal is true and hence the axial velocity grows everywhere except near the boundary layers.

The profiles for the induced transverse velocity v_1 (Figs. 6, 7) are asymmetric bell shaped curves with peaks attaining in the region II and v_1 is negative, for all values of the governing parameters. For fixed S and λ,

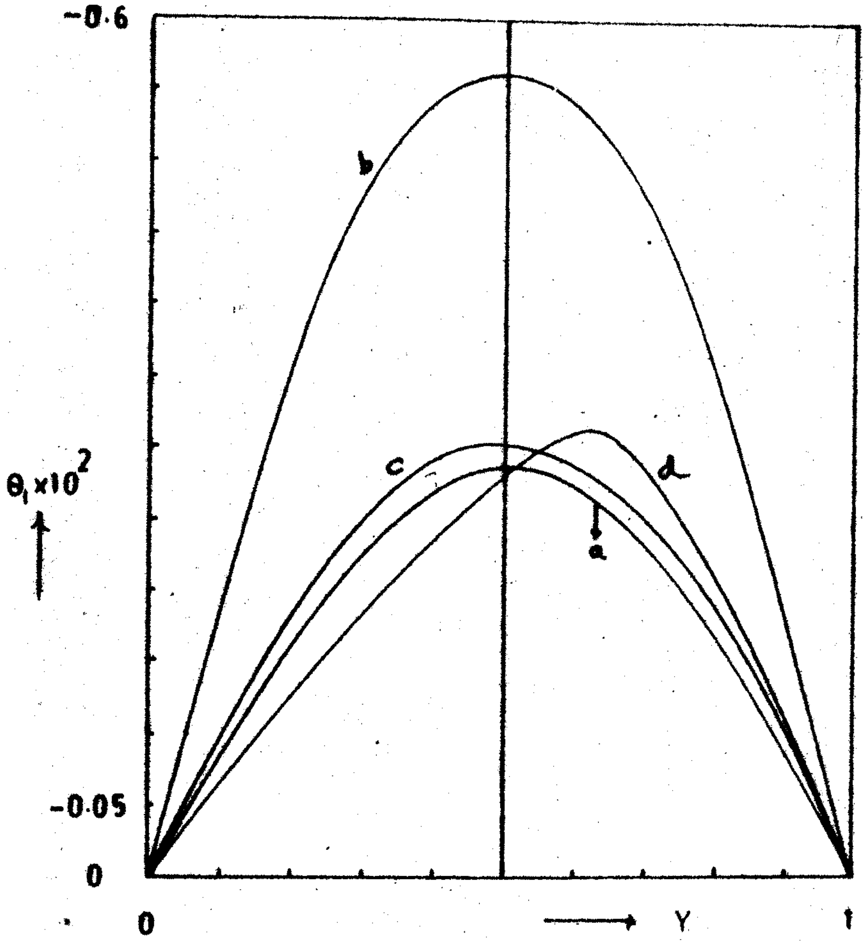

Fig. 8

Profiles for the first order

Temperature distribution (θ_1) with P = 0.71

	a	b	c	d
M	1	1	3	1
λ	0.01	0.02	0.01	0.01
α	5	5	5	10

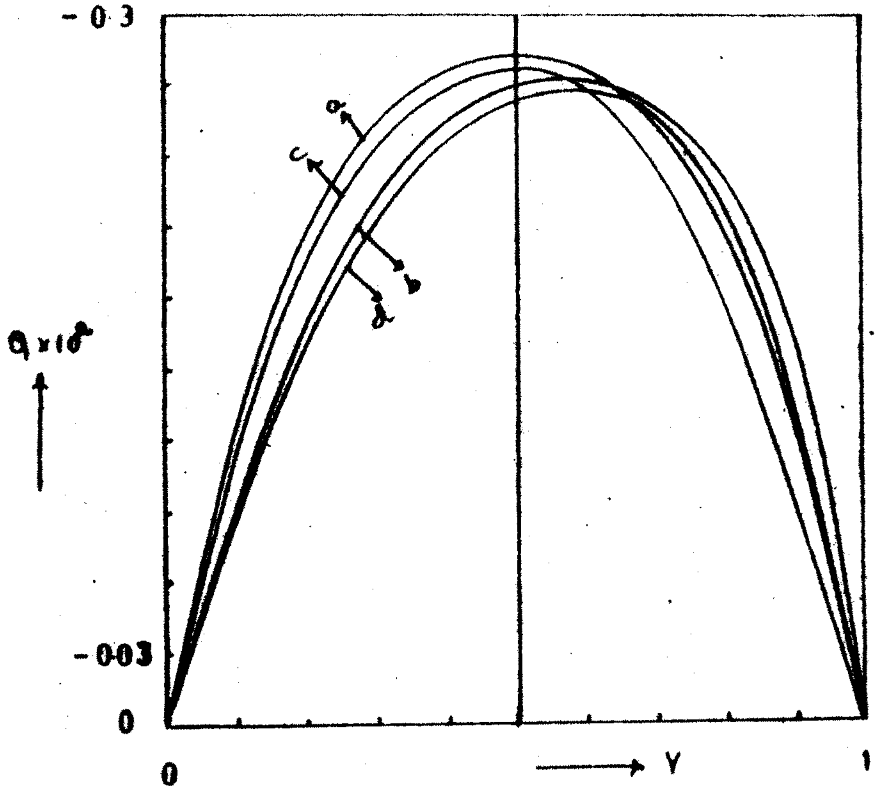

Fig. 9

Variation of θ_1 for different s for $M = 1, \lambda = 0.01$, $\alpha = 5$

	a	b	c	d
β	0.2	-0.2	0.4	-0.4

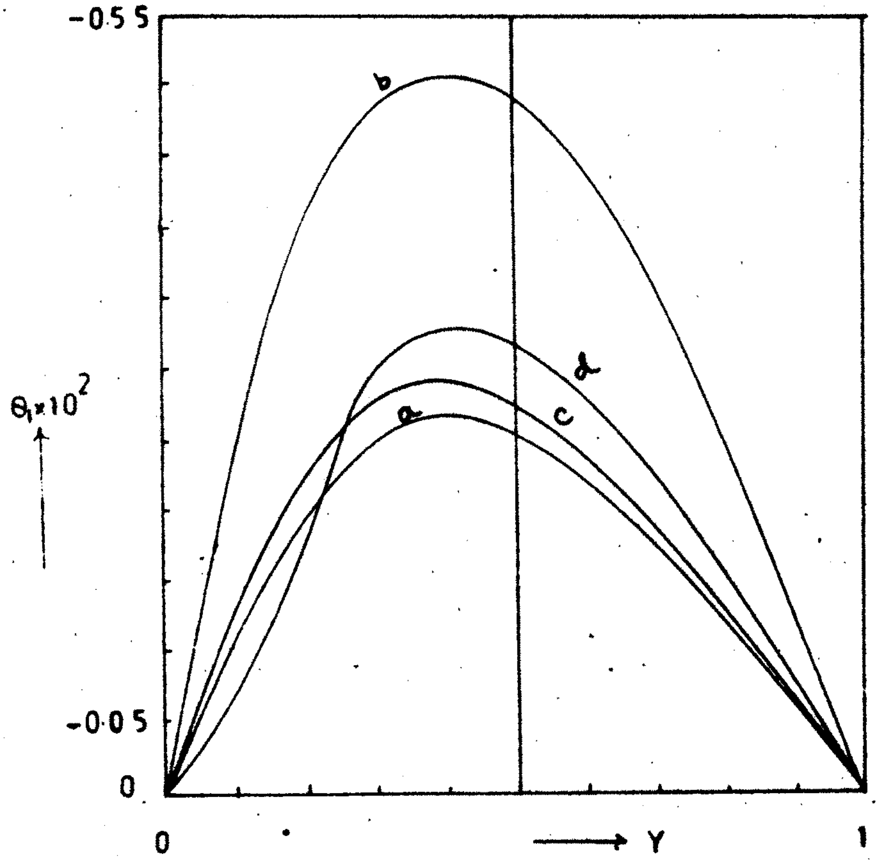

Fig. 10

Variation of θ_1 when $\beta = 0.2$ and $P = 7$

Curves as in Fig. 8

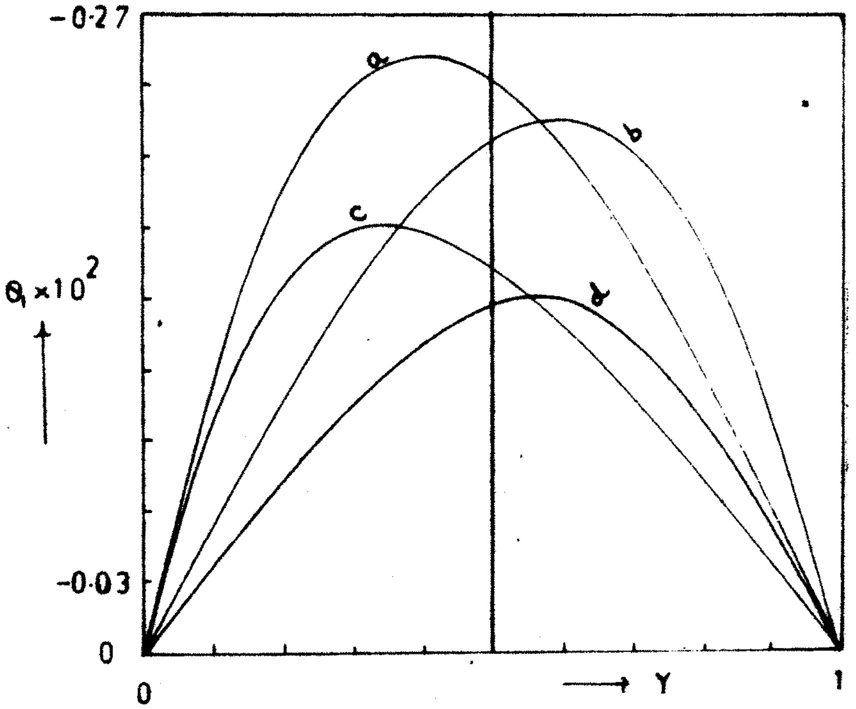

Fig. 11

Variation of θ_1 with ϕ for $M = 1, \lambda = 0.01$, $\alpha = 5$

Curves as in Fig. 9

an increase in M reduces the transverse velocity everywhere in the fluid region except in a narrow layers near the boundaries. Thus the effect of wavyness is to induce reversed transverse velocity whose peak values are attained near the mid plane in the region II. v_1 rises in proportion to rise in the wave length λ. Also w.r.t. an increase in S (>0) and for a fixed M, v_1 is found to experience a depression near the mid plane with rise and fall towards the boundaries. In fact it rises near the plane wall to a certain extent and decreases towards the mid plane and later rises in region II before decaying towards the wavy wall. When S is negative, the reversal is true with an elevation in the mid plane.

The perturbed temperature θ_1 depends on M, λ, P, S and α and the profiles are drawn for variations in these governing parameters (Figs. 8, 9, 10, 11). It is to be noted that θ_1 is negative for all variations in the parameters. The profiles for the perturbed temperature θ_1 are also asymmetric bell shaped curves with their peaks on the mid plane except in the case of large values of heat source parameter α. Keeping λ, P, S (>0) and α fixed for an increase in M, θ_1 increases althrough the region almost uniformly. For fixed M, S and λ, in case of water ($P = 0.71$) (Figs. 8, 9) θ_1 decreases in the region I

TABLE - 1

Skin friction at the plane wall (τ_o)

$S \mid \tau_o$	M = 1	M = 3
0.2	-0.8475	-0.6879
-0.2	-0.8114	-0.6659
0.4	-0.8655	-0.6990
-0.4	-0.7936	-0.6552

TABLE - 2

Skin friction at the wavy wall (τ_1)

$S \backslash \tau_1$	M = 1	M = 3
0.2	0.09979	-0.07464
-0.2	0.1281	-0.05062
0.4	0.08578	-0.06884
-0.4	0.1423	-0.05676

TABLE - 3

Nusselt Number (N_o) at the plane wall

N_o / α	a		a'		b		b'		c		c'		d		d'	
	P=0.71	P=7	P=0.71	P=7	P=0.71	P=7	P=0.71	P=7	P=0.71	P=7	P=0.71	P=7	P=0.71	P=7	P=0.71	P=7
0	1.018	1.863	0.936	0.462	1.078	1.863	0.93	0.462	1.154	2.984	0.87	0.184	1.154	2.97	0.854	0.17
5	3.623	4.908	3.364	2.39	3.623	4.908	3.364	2.39	3.757	6.499	3.24	1.643	4.131	2.96	3.543	1.93
10	6.168	7.954	5.792	4.317	6.168	7.954	5.792	4.319	6.361	10.01	5.609	3.101	6.917	11.24	6.25	4.05

	a	a'	b	b'	c	c'	d	d'
M	1	1	3	3	1	1	1	1
S	0.2	-0.2	0.2	-0.2	0.4	-0.4	0.4	-0.4
λ	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02

TABLE - 4

Nusselt Number (N_1) at the wavy wall

α \ N_1	a		a'		b		b'		c		c'		d		d'	
	P=0.71	P=7	P=0.71	P=7	P=0.71	P=7	P=0.71	P=7	P=0.71	P=7	P=0.71	P=7	P=0.71	P=7	P=0.71	P=7
0	0.93	0.454	1.074	1.872	0.93	0.4548	1.074	1.872	0.863	0.178	1.151	3.036	0.885	5.76	1.127	2.83
5	-1.563	-1.52	-1.542	-1.27	-1.563	-1.15	-1.497	-1.12	-1.569	-1.32	-1.526	-0.62	-1.389	-1.93	-1.056	-2.5
10	-4.056	-3.49	-4.157	-4.41	-4.056	-3.49	-4.157	-4.41	-4.001	-2.81	-4.202	-4.27	-3.651	-4.05	-3.243	-11.1

and increases in the region II, for an increase in the heat source parameter α. In case of air ($P = 7$) (Figs. 10, 11) θ_1 decreases in a narrow layer near the plane wall and later increases althrough the region. This perturbed temperature θ_1 is found to decrease althrough the region for an increase in S either through positive or negative values for $P = 7$. However, in case of water it increases in region I to a certain extent and later decreases with an increase in S (>0). This behaviour gets reverse for an increase in S (<0). In general the effect of wavyness is to reduce the total temperature in the entire flow field. This reduction is more pronounced in the middle region of the channel compared to the boundary regions. A marginal increase in the magnetic parameter increases the decay of the total temperature to a little extent. Also this decay in the total temperature is found to vary for different variations in S, in both the cases of water and air.

The skin friction and the Nusselt number at plane and wavy walls are tabulated for variations in the governing parameters in tables 1 - 4. On either of the boundaries the skin friction is found to decrease for an increase in M, keeping S fixed. But when M is fixed, an increase in S (>0) increases the skin friction at the plane wall while it is found to decrease for an increase in S (<0). At the wavy wall, the skin friction is found to decrease for an increase in S (>0) and increase for an increase in S (<0). Also it can be observed that the magnitude of the skin friction at the plane wall is very much large compared to its magnitude of the wavy wall. This shows that the effect of the wavyness is reduced to the skin friction on the boundaries to a very large extent. The Nusselt numbers at the boundaries almost do not vary for small variations in the magnitic parameters. The Nusselt numbers is found to decrease for an increase in S (>0) for all M, α and P. However, its behaviour w.r.t. an increase in S (<0) depends on α. A similar behaviour is found w.r.t. variations in λ. At the plane wall the Nusselt number (in case of water or air) increases with an increase in M or S (>0). But it decreases with an increase in S (<0) for all M and P.