

LIST OF FIGURES AND TABLES

Fig. 1.1 Human digestive system (Courtesy: https://www.canstockphoto.com/anatomical-diagram-digestive-tract-34292934.html).....	4
Fig. 1.2 Blood pump used in heart lung machines (Courtesy: https://www.dynetics.eu/media/1660/japan-servo-blood-pump-2.jpg).....	6
Fig. 1.3 Normal oesophagus and hiatus hernia (Courtesy: https://www.indiamart.com/proddetail/hiatus-hernia-treatment-8038127162.html).....	8
Fig. 1.4 Pictorial demonstration of Power law fluid and Herschel-Bulkley fluid.....	14
Fig. 3.1 Pictorial demonstration of Herschel-Bulkley fluid.....	32
Fig. 3.2 Geometry of the flow under peristaltic waves of progressively dilating amplitude. The continuous solid wave indicates position of single bolus; similar boluses lagging behind or leading simply symbolize that the previous position and the future position of the bolus.....	34
Fig. 3.3(a-f) Pressure distribution along axial distance at different time instants ($t = 0.0, 0.25, 0.50, 0.75, 1.0, 2.0$) showing the effect of radius of the plug flow region H_{pl} . Other parameters are taken as $\phi = 0.7, n = 1.1, k = 0.01$	41
Fig. 3.4(a-f) Pressure distribution along axial distance at different time instants ($t = 0.0, 0.25, 0.50, 0.75, 1.0, 2.0$) showing the effect of flow behavior index n . Other parameters are taken as $\phi = 0.7, k = 0.01, H_{pl} = 0.01$	43
Fig. 3.5(a-f) Pressure distribution along axial distance at different time instants ($t = 0.0, 0.25, 0.50, 0.75, 1.0, 2.0$) showing the effect of dilation parameter k . Other parameters are taken as $\phi = 0.7, H_{pl} = 0.01, n = 1.1$	45
Fig. 4.1 Schematic diagrams for (a) Normal oesophagus and (b) Sliding hiatus hernia affected oesophagus.....	48
Fig. 4.2 Schematic diagram of the flow under peristaltic waves of progressively dilating amplitude. Converging dashed dotted lines touching contracted wall positions indicate that the wave-amplitude dilates. Diverging dashed lines touching relaxed wall indicate stationary wall. The continuous solid wave indicates that at a time only single bolus will be transported; similar boluses lagging behind or leading simply symbolize that the previous position and the future position of the bolus.....	41
Fig. 4.3(a-f) Pressure variation along the length of oesophagus at different time instants showing the effect of tube wall slop b when tube diverges at distal end. Other parameters are taken as $\phi = 0.6, H_{pl} = 0.01, k = 0.01, n = 1.1$	59

Fig. 4.4 Pressure rise over one wavelength vs. time-averaged flow rate showing the effect of tube wall slop b when tube diverges at distal end. Other parameters are taken as $\phi = 0.6$, $H_{pl} = 0.01$, $k = 0.01$, $t = 0$, $n = 1.1$**60**

Fig. 4.5(a-f) Pressure variation along the length of oesophagus at different time instants showing the effect of dilation parameter k when tube diverges at distal end. Other parameters are taken as $\phi = 0.6$, $H_{pl} = 0.01$, $n = 1.1$, $b = 0.3$**62**

Fig. 4.6 Pressure rise over one wavelength vs. averaged flow rate showing the effect of dilation parameter, k , when tube diverges at distal end. Other parameters are taken as $\phi = 0.6$, $H_{pl} = 0.01$, $b = 0.2$, $t = 0$, $n = 1.1$**62**

Fig. 4.7(a-f) Pressure variation along the length of oesophagus at different time instants showing the effect of flow behavior index n when tube diverges at distal end. Other parameters are taken as $\phi = 0.6$, $H_{pl} = 0.01$, $k = 0.01$, $b = 0.3$**64**

Fig. 4.8(a-f) Pressure variation along the length of oesophagus at different time instants showing the effect of tube wall slop b when tube diverges and then converges at distal end. Other parameters are taken as $\phi = 0.6$, $H_{pl} = 0.01$, $k = 0.01$, $n = 1.1$**65**

Fig. 5.1 The schematic diagram of wall positions of oesophagus when a peristaltic wave of slightly dilating amplitude propagates along it with velocity c**71**

Fig. 5.2(a-b) Axial velocity profile of the fluid and solid particles versus the tube length at the fixed radial distance $r = 0.3$ and (a) $t = 0.0$ (b) $t = 0.4$. Other parameters are taken as $\delta = 0.06$, $k = 0.02$, $C = 0.12$, $\phi = 0.7$, $Re_0 = 5$, $\bar{Q} = 1.0$, $\bar{Q}^{(1)} = 15$, $M = 1139$**81**

Fig. 5.3 The radial profiles of the axial velocity respectively of the fluid and solid particles versus the tube radius at the fixed axial position $x = 0.6$ and $t = 0.4$. Other parameters are taken as $\delta = 0.06$, $k = 0.02$, $C = 0.12$, $\phi = 0.7$, $Re_0 = 5$, $\bar{Q} = 1.5$, $\bar{Q}^{(1)} = 20$, $M = 1139$**82**

Fig. 5.4(a-b) Radial profiles the axial velocity respectively of (a) the fluid and (b) solid particles versus the radial distance at the fixed axial position $x = 0.3$ and time $t = 0.9$ showing the impact of amplitude dilation parameter k . Other parameters are taken as $\delta = 0.06$, $C = 0.12$, $\phi = 0.7$, $Re_0 = 5$, $\bar{Q} = 1.5$, $\bar{Q}^{(1)} = 20$, $M = 1139$. Solid, dashed and dashed dotted line correspond respectively to $k = 0.0$, $k = 0.05$ and $k = 0.1$**83**

Fig. 5.5(a-b) The impact of δ on the relation between the axial velocity of the fluid and the radial distance for different volume fractions at the fixed axial position $x = 0.3$ for $k = 0.02$, $\phi = 0.8$, $Re_0 = 5$, $\bar{Q} = 1.5$, $\bar{Q}^{(1)} = 20$, $t = 0.9$, $M = 1139$, (a) $\delta = 0.06$, (b) $\delta = 0.0$. Solid line, dashed line and dashed dotted line respectively correspond to $C = 0.0$, $C = 0.12$ and $C = 0.24$**84**

Fig. 5.6 Radial velocity profile of the fluid along the radial distance for different volume fraction of particles at $x = 0.2$ for $t = 0.3$, $k = 0.02$, $\phi = 0.6$, $Re_0 = 5$, $\delta = 0.06$, $\bar{Q} =$

1.5, $\bar{Q}^{(1)} = 20, M = 1139$. Solid line, dashed line and dashed dotted line correspond respectively to $C = 0.0, C = 0.12$ and $C = 0.24$**85**

Fig. 5.7 The effect of δ on the relation between the pressure gradient and the time-averaged volume flow rate for different volume fraction of particles with $k = 0.02, \phi = 0.6, Re_0 = 5, \bar{Q}^{(1)} = 15, M = 1139, x = 0.8, t = 0.4$, (a) $\delta = 0.06$, (b) $\delta = 0.0$ Solid line, dashed line and dashed dotted line correspond to $C = 0.0, C = 0.12$ and $C = 0.24$ respectively.....**86**

Fig. 5.8(a-d) Streamlines in the fixed frame with $k = 0.02, C = 0.12, \phi = 0.6, Re_0 = 5, \delta = 0.06, \bar{Q}^{(1)} = 20, M = 1139, t = 1.0$ at different time-averaged volume flow rates (a) $\bar{Q} = 1.2$, (b) $\bar{Q} = 3.2$, (c) $\bar{Q} = 5.0$ and (d) $\bar{Q} = 5.1$**88**

Fig. 6.1 Schematic diagram of wall position showing inward radial force with dilating forcing amplitude.....**94**

Fig. 6.2(a-b) Pressure versus axis of the tube for different forcing amplitude $\epsilon = 6, 7, 8$ ($D = 1, k = 0.02$). Light dotted lines represent wall position of tube. (a) $t = 0.0$ and (b) $t = \pi$**100**

Fig. 6.3(a-b) Axial velocity of fluid versus radius of the tube at different forcing amplitude $\epsilon = 6, 7, 8$ ($D = 1, k = 0.02, x = 4$). (a) $t = 1.5$ and (b) $t = 2.5$**100**

Fig. 6.4(a-b) Radial velocity along tube radius showing the impact of forcing amplitude $\epsilon = 6, 7, 8$ ($D = 1, k = 0.02, x = 4$). (a) $t = 0.0$ and (b) $t = 2.5$**101**

Fig. 6.5 Wall position versus time at fixed axial position $x = 4$ ($\epsilon = 6, D = 1, k = 0.02$).**102**

Fig. 6.6 Time-averaged volume flow rate versus axis of oesophageal tube showing the impact of forcing amplitude $\epsilon = 4, 6, 8$ ($q = 0.8, D = 1, k = 0.02$). Light dotted lines represent wall position of oesophageal tube.....**102**

Fig. 6.7(a-d) Stream function showing the impact of forcing amplitude (a) $\epsilon = 3$, (b) $\epsilon = 3.5$, (c) $\epsilon = 4.0$ (d) $\epsilon = 5.0$ and others parameters are $D = 1$ and $k = 0.02$**103**

Fig. 7.1 Schematic diagram of the flow under peristaltic waves of progressively dilating amplitude. Long dashed lines touching relaxed wall indicate stationary wall. The continuous solid wave indicates position of single bolus; similar boluses lagging behind or leading simply symbolize that the previous position and the future position of the bolus.....**108**

Fig. 7.2(a-d) Pressure variation versus axial distance for $Gr = 0.0, 3.5, 7.0, l = 4, \phi = 0.7, k = 0.01, \Omega = 3.0$ and at various instants (a) $t = 0.26$, (b) $t = 0.93$, (c) $t = 1.69$, (d) $t = 2.78$**114**

Fig. 7.3(a-d) Pressure variation versus axial distance for $\Omega = 0.0, 4.0, 8.0, l = 4, \phi = 0.7, k = 0.01, Gr = 2.0$ and at various instants (a) $t = 0.26$, (b) $t = 0.93$, (c) $t = 1.69$, (d) $t = 2.78$**115**

Fig. 7.4(a-b) Pressure rise per wavelength versus time averaged volume flow rate for $l = 4$, $\phi = 0.6$, $k = 0.01$, $t = 1.5$ (a) $Gr = 0.0, 3.0, 6.0$ and $\Omega = 4.0$ (b) $\Omega = 0.0, 8.0, 16.0$ and $Gr = 5.0$**116**

Fig. 7.5(a-b) Local wall shear stress versus time averaged volume flow rate for $l = 4$, $\phi = 0.7$, $k = 0.01$, $x = 0.93$, $t = 0.93$ (a) $Gr = 0.0, 5.0, 10.0$ and $\Omega = 5.0$ (b) $\Omega = 0.0, 5.0, 10.0$ and $Gr = 5.0$**117**

Table 7.1 Local wall shear stress versus time averaged volume flow rate for $l = 4$, $\phi = 0.7$, $k = 0.01$, $x = 0.93$ and $t = 0.93$**117**