

Contents

List of Figures	xi
Preface	xvii
Abstract	xix
1 Introduction	1
1.1 Physiological systems associated with peristalsis	2
1.1.1 Oesophagus	2
1.1.2 Intestine	4
1.1.3 Ureter	6
1.1.4 Vas deferens	7
1.2 Peristaltic pump	7
1.3 Oesophageal diseases	8
1.3.1 Hiatus hernia	8
1.3.1.1 Sliding hiatus hernia	8
1.3.1.2 Para-oesophageal hiatus hernia	9
1.3.1.3 Symptoms of hiatus hernia	9
1.3.1.4 Cause of hiatus hernia	10
1.3.2 Gastro-oesophageal reflux disease	10
1.3.3 Barrett's oesophagus	11
1.3.4 Achalasia	11
1.3.5 Nutcracker oesophagus	12
1.3.6 Oesophageal cancer	12
1.3.6.1 Signs and symptoms of oesophageal cancer	13
1.3.6.2 Treatment options of oesophageal cancer	13
1.4 Characteristic of physiological fluids	13
1.5 Hypothesis of the research	14

2 Review of the literature	17
2.1 Review of the literature	17
2.1.1 Short study for Newtonian fluids	18
2.1.2 Non-Newtonian flows	19
2.1.3 Flows with particulate suspensions: application to diseased ureter	21
2.1.4 Multi-layered flows: application to intestinal flows	23
2.2 Flows in vessels of finite length: application to swallowing in oesophagus	23
2.2.1 Flows with dilating wave amplitude: application to sliding hiatus hernia	24
2.2.2 Heat transfer in peristaltic transport: application to cryosurgery	26
2.2.3 Flows in asymmetric channels	28
2.2.4 Flows in non-uniform vessels: application to vas deferens and uterine cavity	29
2.2.5 Flows of nano-fluids	30
2.2.6 Flows in elastic tubes	32
2.2.7 Flows in porous media	33
2.2.8 Electro-osmosis/electric double layer/electro-kinetic flows	35
3 Transportation of micro-polar fluid by dilating peristaltic waves: Application to flows in normal oesophagus	37
3.1 Introduction	37
3.2 Formulation of the problem	40
3.3 Solution of the problem	44
3.4 Reflux limit	52
3.5 Results and Discussion	56
3.5.1 Effect of dilating wave amplitude on pressure	56
3.5.2 Effect of Coupling Number on pressure	57
3.5.3 Effect of micro-polar parameter on pressure	59
3.5.4 Effect of dilating wave amplitude on wall shear stress	62
3.6 Effect of dilating wave amplitude on reflux	62
3.7 Conclusion and Physical Interpretation	64
4 Transportation of particulate suspension in a Newtonian fluid by dilating peristaltic waves in a tube of uniform cross-section: Application to flows in normal oesophagus	67
4.1 Introduction	67
4.2 Mathematical Formulation	70
4.3 Perturbation Solution	74
4.3.1 Solution for the zeroth order system	79

4.3.2	Solution of the first-order system	81
4.3.3	Solution for the second-order system	83
4.3.4	Stream function	90
4.4	Discussions and Results	91
4.5	Conclusions	100
5	Transportation of micro-polar fluids by means of dilating peristaltic waves in a tube of non-uniform cross-sectional area: Application to sliding hiatus hernia	103
5.1	Introduction	104
5.2	Mathematical Formulation	108
5.3	Solution of the Problem	112
5.4	Result and discussions	118
5.4.1	Effect of dilating wave amplitude on pressure	119
5.4.2	Effect of the gradient parameter on pressure	120
5.4.3	Effect of coupling number on pressure	124
5.4.4	Effect of the micropolar parameter on pressure	125
5.5	Conclusion and physical interpretations	126
6	Transportation of micro-polar fluids by means of peristaltic waves of dilating amplitude in a tube of exponentially changing cross-sectional area: Application to sliding hiatus hernia	131
6.1	Introduction	132
6.2	Problem Formulation	135
6.3	Mathematical Analysis	140
6.3.1	Time averaged volume flow rate	146
6.3.2	Reflux limit	149
6.4	Numerical results and discussion	153
6.4.1	Divergence along the entire length of the tube	154
6.4.1.1	Effect of wave amplitude dilation	154
6.4.1.2	Effect of Coupling Number	154
6.4.1.3	Effect of micropolar parameter	157
6.4.1.4	Effect of gradient parameter	157
6.4.1.5	Effect on wall shear stress	160
6.4.2	Divergence limited to a small length near the other end	163
6.4.3	Effect of wave amplitude dilation on reflux	166
6.5	Conclusion and physical interpretations	169
7	Analysis of unsteady two-phase peristaltic flow in a tube of exponentially changing cross sectional area: Application to sliding hiatus hernia	177
7.1	Introduction	177

7.2	Mathematical Formulation	180
7.3	Method of Solution	185
7.3.1	Solution for the zeroth order system	190
7.3.2	Solution of the first-order system	192
7.3.3	Solution for the second-order system	194
7.4	Results and discussion	201
7.4.1	Analysis of flow in the relaxed and contracted regions	202
7.4.2	Impact of the gradient parameter on flow	202
7.4.3	Effect of the wave-amplitude dilation on flow	204
7.4.4	Effects of the gradient parameter on the radial profile of the axial velocity	216
7.4.5	Effect of the dilation parameter on the radial profile of the axial velocity	218
7.5	Conclusions	218
8	Conclusions and further scope of the work	221
8.1	Further scope of the study	225
	References	227
	List of Publications	257