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RELIABLE ANALYSIS FOR THE PERISTALTIC TRANSPORT OF AN INCOMPRESSIBLE VISCOUS FLUID IN AN ASYMMETRIC CHANNEL UNDER THE EFFECT OF TRANSVERSE MAGNETIC FIELD WITH SLIP BOUNDARY CONDITIONS

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Abstract. In this study, we studied the effects of both magnetic field and wall slip conditions on the peristaltic transport of a Newtonian fluid in an asymmetric channel using the homotopy perturbation method (HPM). The channel asymmetry is generated by propagation of waves on the channel walls traveling with different amplitudes, phases but with the same speed. We considered the long wavelength and low Reynolds number assumptions in obtaining solution for the flow. Also we investigated the flow in a wave frame of reference moving with velocity of the wave. Closed form expressions have been obtained for the stream function and the axial velocity component in fixed frame. Numerical example is presented to illustrate the efficiency, simplicity and reliability of the method.

Keywords. Homotopy perturbation method, Peristaltic transport, Asymmetric channel, Slip flow, Newtonian fluid.

1 Introduction

In this paper, the HPM is implemented to study the effects of both magnetic field and wall slip conditions on the peristaltic transport of a Newtonian fluid in an asymmetric channel. The HPM introduced by He [1-8]. In this method the solution is considered as the summation of an infinite series which usually converges rapidly to the exact solutions. Using homotopy technique in topology, a homotopy is constructed with an embedding parameter $p \in [0,1]$ which is considered as a "small parameter". Considerable research works have been conducted recently in applying this method to a class of linear and non-linear equations [9-22].

Peristalsis is a mechanism for pumping fluid in a tube by means of a moving contractile ring around the tube, which pushes the material onward. The peristaltic wave generated along the flexible walls of the tube provides an efficient means of transport of fluids in living organisms and in industrial pumping. It is an inherent property of many syncytial smooth muscle tubes, since stimulation at any point causes a contractile ring around the tube. Several theoretical and experimental studies have been conducted to understand peristaltic action. The first attempt to study the fluid mechanics of peristaltic transport is by Latham [23]. Based on this experimental work, Burns and Parkes [24] studied the peristaltic motion of a viscous fluid through a pipe and a channel by considering sinusoidal variation at the walls. The mathematical models obtained by a train of periodic sinusoidal waves in an infinitely long two-dimensional symmetric channel or axisymmetric tubs containing a Newtonian or non-Newtonian fluid have been investigated by some researchers [25,26].

The study of MHD flow problems has gained considerable interest because of its extensive engineering and medical applications. The magnetohydrodynamic flow of a conducting dusty fluid between two parallel plates is discussed by Mitra and Bhattacharyya [27]. The effect of moving magnetic field on blood flow was studied by Sud et al. [28]. They observed that the effect of suitable moving magnetic field accelerates the speed of blood. Agrawal and Anwaruddin [29] studied the effect of magnetic field on blood flow by taking a simple mathematical model for blood through an equally branched channel with flexible outer walls executing peristaltic waves. Srivastava and Agrawal [30] considered the blood as an electrically conducting fluid. Recently, physiologists observed that the intra-uterine fluid flow due to myometrial contractions is peristaltic-type motion and the myometrial contractions may occur in both symmetric and asymmetric directions, De Vries et al. [31]. Eytan et al. [32] have observed that the characterization of non-pregnant woman uterine contractions is very complicated as they are composed of variable amplitudes, a range of frequencies and different wavelengths.

In several applications the flow pattern corresponds to a slip flow, the fluid presents a loss of adhesion at the wetted wall making the fluid slide along the wall. When the molecular mean free path length of the fluid is comparable to the distance between the plates as in nanochan-

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