ABSTRACT

Study of flow in porous media with applications

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This dissertation examines flow in porous media with applications specific to human physiology. In the problems that follow the porous media is modeled as a transition Brinkman layer overlying a Darcy region and blood modeled as a micropolar fluid. Each problem is developed and solved analytically. Analytical expressions for pressure, stream-functions, volumetric flow and where applicable, drag, are given. Plots are presented for different porous media parameters as well as Newtonian and non-Newtonian fluid parameters.
The motion, under the influence of gravity, of a single large micropolar bubble, immersed in an immiscible Newtonian fluid, contained within a porous tube is studied. The micropolar bubble is covered in a thin Newtonian wetting film that partially enters the porous tube. The model is suitable for a theoretical study of a two fluid model for blood flow within capillaries.
Peristaltic transport of an incompressible Newtonian fluid in an axisymmetric porous corrugated tube is investigated. The analysis is performed in a wave frame of reference. Lubrication theory as well as perturbation analysis are used to solve for the velocity field and pressure. The phenomenon of reflux or recirculation is observed and its dependency on the fluid flow parameters of hydraulic resistivity, tangential stress jump and the Darcy slip parameter is studied from streamline and velocity field plots. The model serves as a theoretical study into peristaltic transport in the gastrointestinal tract.
The creeping flow of an incompressible, bounded micropolar fluid, past a porous shell is investigated. The streamlines were found to vary significantly with changes in hydraulic resistivity, stress jump condition and micropolar parameters. An expression for the dimensionless drag for the unbounded case of the model is given and its variation with hydraulic resistivity presented. The model represents a theoretical study into drug delivery using porous micro spheres.

Keywords: micropolar fluid; drug delivery; peristaltic pumping.