An Investigation of Non-Newtonian Blood Flow in Microvessels

Abstract of the Thesis

Biological fluid mechanics plays an important role in understanding of clinical and pathological observations and also in developing new methods for diagnosis in connection with both physiological and computational models. Magnetic drug targeting is an emerging area of research in this direction and is found to have vast applications in the human circulatory system. An attempt is made to understand the magnetic drug targeting of a carrier particle in the stream of blood using Herschel-Bulkley and Casson models in microvessels. The presence of the inertia and buoyant force is considered in the equations of motion of carrier particle along with the dominant effects of magnetic and fluidic forces in the movement of carrier particle. The trajectories of the carrier particle are obtained from the system of coupled nonlinear equations which are solved using classical fourth order Runge-Kutta method. The admissible parameters, which influence the flow field, are the radius of carrier particle, volume fraction of magnetic nanoparticles, radius of core region, density of therapeutic drugs, distance from the magnet to body surface, and the effect of inertia and buoyant force. Furthermore, magnetic drug targeting using a porous carrier particle has been analyzed considering a two-phase Casson model for blood incorporating the major influences of magnetic force, fluidic force and Saffman force. A stress-jump condition is employed at the interface between the porous surface of the carrier particle and blood. Also, peristaltic motion of blood is studied in a permeable microvessel assuming blood as Casson fluid and the principles of magnetohydrodynamics are used for the electrically conducting nature of blood. In another investigation, peristaltic blood flow is analyzed through a permeable microchannel considering blood as Herschel-Bulkley fluid and viscous dissipation is assumed as the heat source. In both of these studies, reabsorption process at the permeable wall of microvessel/microchannel is governed by Starling's hypothesis. The influence of the reabsorption parameter, yield stress parameter, slip parameter, amplitude ratio, Hercshel-Bulkley flow index, Joule heating parameter, Eckert number, and Prandtl number are discussed.

Keywords: Magnetic drug targeting; Multifunctional carrier particle; Blood rheology; Casson fluid; Herschel-Bulkley fluid; Two-phase flow model; Peristaltic flow; Starling's hypothesis; Magnetohydrodynamics; Lorentz force; Joule heating; Viscous dissipation; Permeable and impermeable microvessel.