

Heat and Mass Transfer in Fluid and Porous Medium

ABSTRACT of THESIS

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ABSTRACT

The thesis entitled "**Heat and Mass Transfer in Fluid and Porous Medium**" comprising of analytical/numerical solutions of some problems related with the topic, is an outcome of the research work carried out by me during the course of investigations under the supervision of Prof. B.S. Bhadauria, Professor, Department of Applied Mathematics, School for Physical Sciences, Babasaheb Bhimrao Ambedkar University, Lucknow.

Flow through porous media occurs in many science and engineering systems. The important topics investigated in this thesis are that of flow, heat and mass transfer in porous media. It is a subject of engineering interest, and an important field of study in itself. Several contributions have been made in modelling fluid flow, heat, and mass transfer through a porous medium. These contributions include the introduction of non-Darcy effects on momentum, energy, and mass transport in porous media for various geometrical configurations and boundary conditions ([Nield and Bejan, 1999](#)). A medium which is a solid body containing pores is called a porous medium. Flow through porous media is also of interest in chemical engineering (adsorption, filtration, and flow in packed columns), petroleum engineering, hydrology, soil physics, biophysics and geophysics. Two macroscopic properties of porous media which may be used to describe fluid flow are porosity and permeability. Therefore, the relevant studies on regulation of heat and mass transfer in the following chapters is performed. For more detailed analysis on thermal instability, refer some excellent books: [Ingham and Pop\(2005\)](#), [Nield and Bejan\(2012\)](#) and [Vafai\(2000\)](#).

The **first problem** deals with linear and nonlinear analyses has been done and the combine effect of internal heating and Soret effect on Darcy - Brinkman convection in a binary viscoelastic fluid saturated porous layer, heated and salted from below, has been studied, analytically. Linear stability analysis has been performed by using normal mode technique and nonlinear analysis is done using truncated Fourier series. The modified Darcy-Brinkman-Oldroyd model, including the time derivative term, is employed for the momentum equation. The effects of Darcy number, Soret parameter, relaxation and retardation parameters, solute Rayleigh number, internal heat source, Lewis number and Darcy-

Prandtl number on stationary and oscillatory convection are shown graphically. Also heat and mass transports are calculated in terms of the Nusselt number and Sherwood number and presented graphically.

In the **second problem**, the effect of internal heat source and Soret effect has been investigated on double diffusive convection in a rotating anisotropic porous medium saturated with a couple stress fluids, heated and salted from below. Linear stability analysis has been performed by using Normal mode technique and for nonlinear analysis, minimal representation of Fourier series up to two terms has been considered. The modified Darcy model, which includes the time derivative term and Coriolis term, has been employed in the momentum equation. The effect of Taylor number, couple stress parameter, solute Rayleigh number, internal heat source parameter, Lewis number, Darcy-Prandtl number, thermal and mechanical anisotropy parameter on the stationary and oscillatory modes of convection has been obtained and shown graphically, Also the heat and mass transports are obtained in terms of the Nusselt number and Sherwood number respectively, and shown graphically.

The **third study** deals with the effect of internal heating on double diffusive convection in a rotating anisotropic porous medium saturated with a viscoelastic fluid, which is heated and salted from below. Linear stability analysis has been performed by using normal mode technique and nonlinear theory is based on minimal representation of Fourier series up to two terms. The modified Darcy model, which includes the time derivative and Coriolis terms has been employed in the momentum equation. The effects of Taylor number, solute Rayleigh number, internal heat source parameter, diffusivity ratio, relaxation and retardation parameters, thermal and mechanical anisotropy parameters on the stationary and oscillatory convection are obtained and shown graphically. Also, heat and mass transports have been obtained in terms of the Nusselt number and Sherwood number respectively and presented through Figs.

The **fourth study** deals with the investigation of the effect of internal heating and Soret effect on linear and nonlinear double diffusive convection in a couple stress fluid satu-

rated anisotropic porous layer, heated and salted from below, analytically. Linear stability analysis has been performed by using normal mode technique and nonlinear analysis is done using truncated Fourier series. The modified Darcy model, which includes the time derivative term, has been employed in the momentum equation. The effects of Vadasz number, anisotropic parameter, Soret parameter, couple stress parameter, solute Rayleigh number, internal heat source parameter, Lewis number, Darcy-Prandtl number and normalized porosity on the stationary and oscillatory are shown graphically. Also heat and mass transports are calculated in terms of the Nusselt number and Sherwood number and shown graphically.

In the **last problem**, the double diffusive convection in a Maxwell fluid saturated rotating anisotropic porous layer in the presence of the Soret and Dufour effects has been investigated. Linear stability analysis has been performed by using normal mode technique, while nonlinear analysis is done using truncated Fourier series. The flow is also affected by temperature and concentration gradients in their medium. The modified Darcy model has been employed in the momentum equation. Effects of mechanical anisotropy parameter, relaxation parameter, retardation parameter, Darcy-Prandtl number, Dufour parameter, Soret parameter, solute Rayleigh number and Lewis number on the stationary and oscillatory modes of convection have been obtained and are shown graphically. Further, heat and mass transports across the porous medium are also presented in the figures.