Chapter 9
General Conclusions

In this thesis the convective instabilities in Newtonian and non-Newtonian fluid (Maxwell fluid, viscoelastic fluid and couple stress fluid) saturated porous layer under the influence of external rotation, anisotropy of porous layer, cross diffusion (Soret effect and Dufour effect) and internal heat source have been investigated.

In chapter - 3, the linear and nonlinear stability analysis of double diffusive convection in a rotating horizontal anisotropic porous layer with Soret effect is performed. The linear theory is based on the usual normal mode technique and the nonlinear theory on the truncated Fourier series analysis. The Darcy model extended to include time derivative and Coriolis terms with anisotropic permeability is used to describe the flow through porous media and the following conclusions are drawn:

➢ The effect of increasing the values of mechanical and thermal anisotropy parameters in the presence of rotation and Soret effect is to stabilize the onset of convection to be oscillatory rather than stationary. The effect of the mechanical anisotropy parameter is more pronounced compared to that of the thermal anisotropy.

➢ The effect of rotation is to stabilize the onset of both stationary and oscillatory convection. However, the oscillatory mode is most favorable for a system with moderate and high values of the Taylor number.

➢ The solute Rayleigh number stabilizes the system for both stationary and oscillatory mode. The Lewis number stabilizes the system for stationary mode and destabilizes the system for oscillatory mode.
➢ The positive Soret parameter destabilizes the system while negative Soret parameter stabilizes the system in both stationary and oscillatory convection.

➢ The effect of increasing the Darcy-Prandtl number is to advance the onset of oscillatory convection.

➢ The effect of increasing the normalized porosity parameter is to inhibit the onset of oscillatory convection.

➢ The thermal Nusselt number and the Sherwood number decrease with an increase of mechanical anisotropy parameter and Taylor number whereas the thermal Nusselt thermal and the Sherwood number increase with an increase of the thermal anisotropy parameter and the solute Rayleigh number.

➢ The Soret parameter suppresses the heat transport while the mass transport is reinforced by it.

In chapter - 4, the cross diffusion effects namely Soret and Dufour effects on the onset of double diffusive convection in a rotating anisotropic porous layer is studied using both linear and non-linear stability analyses. The normal mode technique is used in the linear analysis, while non-linear analysis is based on a minimal representation of the double Fourier series and the following conclusions are drawn:

➢ The effect of increasing the values of mechanical anisotropy parameter in the presence of rotation and cross-diffusion is to destabilize the onset of the oscillatory convection.

➢ The effect of Taylor number is to stabilize the onset of the oscillatory convection.

➢ The solute Rayleigh number stabilizes the system for the oscillatory mode.
The effect of increasing the Darcy-Prandtl number and normalized porosity parameter is to inhibit the onset of an oscillatory convection.

The positive as well as negative Soret parameter stabilizes oscillatory convection.

The Dufour parameter has stabilizing effect on the double diffusive convection in a rotating anisotropic porous medium.

The thermal Nusselt number and the Sherwood number decrease with an increase of mechanical anisotropic parameter and Taylor number while both increase with an increase of solute Rayleigh number.

The Soret parameter suppresses the heat transport while the mass transport is reinforced by it.

The effect of Dufour parameter is to enhance the heat and mass transport.

In chapter 5, the effect of rotation on the onset of double-diffusive convection in a sparsely packed anisotropic porous layer, in the presence of Soret effect is investigated analytically using the linear and nonlinear stability theories. The usual normal mode technique is used to solve the linear problem. The truncated Fourier series method is used to make the finite amplitude analysis. The following conclusions are drawn:

The mechanical anisotropy parameter has stabilizing effect on stationary and oscillatory modes. However, the convection sets in as oscillatory mode prior to the stationary mode.

The effect of thermal anisotropy parameter is to inhibit the onset of stationary and oscillatory convection.
The Taylor number has a stabilizing effect on the double diffusive convection in sparsely packed anisotropic porous medium.

The effect of Darcy number is to inhibit the onset of stationary convection while it has dual effect on oscillatory convection.

The effect of solute Rayleigh number is to delay both stationary and oscillatory convection. And the effect of Lewis number is to delay the onset of stationary convection while it advances the oscillatory convection.

The effect of normalized porosity is to advance the onset of oscillatory convection. And the Darcy Prandtl number has a dual effect on the oscillatory mode.

The Soret parameter has stabilizing effect on oscillatory convection and destabilizing effect on stationary convection.

The effect of mechanical anisotropy parameter and Taylor number is to reduce the heat and mass transport.

The heat and mass transport is reinforced by the thermal anisotropy parameter. The Darcy number and Soret parameter suppresses the heat transport while mass transport is reinforced by it.

In chapter 6, the onset of double diffusive convection in a Maxwell fluid saturated anisotropic porous layer in the presence of the Soret effect is investigated analytically using both linear and nonlinear theories. The normal mode technique is used to solve the linear problem. The truncated Fourier series method is used to carry out the finite amplitude analysis and the important conclusions are summarized as follows:
The effect of relaxation parameter is to destabilize the system for oscillatory mode.

The effect of increasing both the mechanical and thermal anisotropy parameters is to advance the oscillatory convection.

The negative Soret coefficient has destabilizing effect, whereas the positive Soret coefficient has a stabilizing effect.

The heat transfer decreases with an increase of the Soret parameter and thermal anisotropy parameter while mass transfer increases with an increase of the Soret parameter and thermal anisotropy parameter.

The effect of mechanical anisotropy parameter and Lewis number is to enhance the heat and mass transport.

The transient behavior of the Nusselt and Sherwood numbers approach the steady state values as time progresses.

In chapter 7 the onset of Darcy-Brinkman convection in a horizontal, sparsely packed porous layer saturated with a binary viscoelastic fluid with internal heat source is studied analytically using both linear and non-linear stability theories. The usual normal mode technique is used to solve the linear problem. The truncated Fourier series method is used to make the finite amplitude analysis. The following important conclusions are drawn:

The effect of increasing relaxation parameter is to advance the onset of oscillatory convection while increasing retardation parameter delays the onset of oscillatory convection.

The internal Rayleigh number has a destabilizing effect on the double diffusive convection in a porous medium.
The Darcy number and solute Rayleigh number have stabilizing effect on the system for stationary and oscillatory modes.

The Darcy-Prandtl number and normalized porosity have destabilizing effect on the system for oscillatory mode.

The effect of Lewis number is to advance the onset of oscillatory convection whereas its effect is to inhibit the stationary onset.

The effect of Darcy number is to suppress the heat and mass transport.

The heat transport is reinforced while the mass transport is suppressed by internal Rayleigh number.

The effect of solute Rayleigh number is to enhance the heat and mass transport.

The transient behavior of Nusselt and Sherwood numbers approach the steady state values (that of the Newtonian binary fluid) as time progresses.

In chapter 8, the onset of double diffusive convection in a couple stress fluid saturated horizontal porous layer with an internal heat source is studied analytically using linear and weak non-linear stability theories. The classical normal mode technique is used to solve the linear problem. The truncated Fourier series method is used to make the finite amplitude analysis. The effect of various parameters on neutral stability curves as well as heat and mass transfer are discussed. The following conclusions are drawn:

The internal Rayleigh number has a destabilizing effect on the double diffusive convection in a porous medium.

The couple stress parameter and solute Rayleigh number have a stabilizing effect on the stationary and oscillatory convection.
➢ The effect of the Lewis number is to inhibit the onset of stationary convection whereas its effect is to advance the oscillatory onset.

➢ The Darcy-Prandtl number has stabilizing effect while normalized porosity has destabilizing effect on the system for oscillatory mode.

➢ The effect of couple stress parameter is to suppress the heat and mass transport.

➢ The heat transport is reinforced while the mass transport is suppressed by the internal Rayleigh number.

➢ The effect of the solute Rayleigh number and the Lewis number is to enhance the heat and mass transport.

➢ The transient behavior of the Nusselt and Sherwood numbers approach the steady state values as time progresses.