Chapter 7

Conclusion

The onset of thermal convection in a fluid saturated horizontal porous layer was investigated under periodically varying gravity field. The temperature gradient imposed across the layer may be either parallel or antiparallel to the gravity field. The flow through the porous medium was governed by Brinkman's law. Both continued fraction and Hill's infinite determinant methods, which can handle arbitrary values of vibration parameters were used to predict the linear instability criteria. The influence of non-Darcian effect, mechanical and thermal anisotropies, local thermal nonequilibrium phenomenon and viscoelastic nature of the fluid were investigated. The present study is consistent with the previously established results and its outcomes are summarized below chapter wise.

When \( Ra > 0 \), \( \eta \) can both favour and suppress setting up of convection depending on \( \omega \). Gravity modulations with small \( \eta \) leads to a convective pattern with frequency synchronizing with the forcing one whereas those of large \( \eta \) results in a convective pattern which could oscillate subharmonically against the forcing frequency. A significant increase in \( \omega \) always favours the S mode. The behaviour is different when \( Ra < 0 \). In this case \( \eta \) always destabilizes the system irrespective of the values of \( \omega \). The transitions between S and SH modes of instability occur only at lower range of \( \omega \) and beyond that the SH mode emerges as the deciding one for higher values of \( \omega \). An increase in \( Da \) makes the system sensitive to modulations for a wider range of \( \omega \) for \( Ra > 0 \). The Brinkman model always delays instability
when compared to the Darcy model, with a decrease in the corresponding $\alpha_c$. The parameter $c$ restricts the competition between the S and SH modes to a lower range of $\omega$. Its is found to produce opposite effects in the Brinkman and the Darcy regimes. In addition it can stabilize or destabilize the system depending on $\eta$ for $Ra > 0$, whereas it has a unique effect for $Ra < 0$. In general $Ra_c$ and $\alpha_c$ for rigid boundaries are always greater than its stress free counterparts irrespective of all other parameter values. The presence of rigid boundaries makes the nesting between the S and SH modes for a wider range of low frequencies when $Ra < 0$. For very low and very high $Pr$, $Ra_c$ approaches the unmodulated value. An increase in $Da$ can introduce SH response for intermediate values of $Pr$. For lower and intermediate values of $\omega$, the effect of gravity modulation with sufficiently large $\eta$ on the critical boundaries remains the same for both $Ra > 0$ and $Ra < 0$.

The two anisotropy parameters produce opposite effects on the onset condition - $K_r$ triggers it whereas $\chi_r$ suppresses it. Their effects become less significant for large and small values of $K_r$ and $\chi_r$ respectively. But a simultaneous increment in both $K_r$ and $\chi_r$ leaves a destabilizing effect until they reach a certain value, which depends on their ratio, beyond which a stabilizing behaviour is noticed. For lower values of $\omega$, both $K_r$ and $\chi_r$ significantly affect the system but the effect of $K_r$ is comparatively larger. A change in $\chi_r$ does not affect the transition frequency much whereas a decrease in $K_r$ shifts the transition frequencies to higher $\omega$ range. A simultaneous decrease in both $K_r$ and $\chi_r$ introduces a CDL in the marginal curve near the transition frequencies for both $Ra > 0$ and $Ra < 0$; however as the nesting between the S and SH modes is more for the latter case the CDL appears often. For $Ra < 0$, smaller values of $K_r$ makes the nesting between the S and SH modes for a wider range of frequencies. It was also found that an increase in $\omega$ starts introducing closed instability region of the marginal curve well below the traditional unbounded marginal curve as a CDL for smaller values of $K_r$.

The nonequilibrium effect is felt only for intermediate values of $H$ depending on $\gamma$, $Da$, $\omega$ and $\eta$; $H$ stabilizes the system. The effect of $\gamma$ is to advances the onset of motion. It constricts the convective cells ensuing at the threshold except when the layer heated from below is subjected to small amplitude vibrations. The
competition between the S and SH modes becomes significant when $\gamma$ assumes smaller values. It is found to occur over a wider range of $\omega$ when $Da$ takes higher values. However this coupling cannot be observed for small amplitude vibrations.

In the case of $Ra > 0$ the interaction between the two phases is suppressed for a wider range of $H$ when both $\omega$ and $\eta$ are large. But in the case of $Ra < 0$ the suppression is found when $\omega$ takes higher values irrespective of $\eta$. In contrast to the LTE situation the NLTE introduces the SH mode for intermediate values of $Pr$ irrespective of the value taken by $Da$.

The viscoelastic parameter $\Gamma$ can both stabilize and destabilize the system depending on $\eta$ and $\omega$. The effect of vibration is found to get shifted to lower frequencies for an increase in $\Gamma$, independent of other parameters. $Da$ stabilizes the system at low and high $\omega$ whereas destabilizes it at intermediate $\omega$ except when $\eta = 2$ for $Ra > 0$. $\alpha_c$ of the SH mode increases against $\omega$ and becomes constant for the Brinkman model whereas it continuously increases for the Darcy model. The effect of $\Gamma$ is insignificant at small $Pr$ for both $Ra > 0$ and $Ra < 0$. $\Gamma$ suppresses the SH mode to low $Pr$ for $Ra > 0$. 