SUMMARY

The results of the work described in this thesis can be summarised as follows:

It was possible to exploit the high sensitivity of the Mössbauer technique to the chemical environment, coupled with complimentary susceptibility and FMR measurements, to study the richness of the magnetic structure of $\text{Fe}_x \text{Mn}_x \text{Si}_{3-x}$ ternary alloys in detail. The competing exchange interactions together with the specific site substitution behaviour in this system were found to give rise to distinct hyperfine field variations at sites with different neighbour environments. The reentrant transition at low temperatures has been reasoned to be due to spin canting which can accommodate the competing exchange interactions. A better understanding of the magnetic behaviour of this complex system has therefore emerged from this study.

The addition of Cr to $\text{Fe}_3\text{Si}$ showed that the solubility of Cr is limited up to $x = 0.5$ in $\text{Fe}_{3-x} \text{Cr}_x \text{Si}$ alloys and the presence of $\text{Cr}_3\text{Si}$ phase is observed beyond $x = 0.5$ composition. This is in contrast to Mn and V additions to $\text{Fe}_3\text{Si}$ which show solubility over a wide concentration range. In the Cr substituted alloys, the presence of B32 and B2 ordered structures in addition to $\text{DO}_{19}$ order is also indicated.

In the $\text{Fe}_x \text{Mn}_x \text{Si}_{3-x}$ alloy system it is not possible to get the
chemically disordered state even by rapid quenching, whereas the situation in Fe$_3$Mn Al alloy system is favourable and it is easy to get chemically disordered alloys in this system by a moderate quenching rate. A study of the changes in magnetic behaviour due to chemical ordering was carried out and a very pronounced effect of near neighbour environments on the hyperfine field distributions was observed. The presence of Mn in Fe$_3$Al was found to stabilise the B2 phase which is only a metastable phase between 550$^\circ$ C and 800$^\circ$ C in Fe$_3$Al. The kinetics of ordering at the inequivalent sites were seen to be distinct and this is an interesting observation. Magnetic measurements on x = 1.2 composition alloy showed reentrant behaviour similar to the Mn substituted Fe$_3$Si system.

Addition of Si to the fcc Ni$_3$Fe system made it possible to see the effect of Si first neighbours on the hyperfine field at Fe in an fcc lattice and it was found that the field reduction at Fe site due to Si first neighbour is larger as compared to Si first neighbours in the bee lattice. On ordering, Si showed a preferential substitution for Fe sites in the L1$_2$ ordered structure and it is also suggested that a better degree of ordering may be achieved for the sluggishly ordering Ni$_3$Fe permalloy due to the presence of Si.

The quadrupole splittings were measured in the (Fe–Ni)$_{1-x}$Si$_x$ alloy system. A calculation of EFG for FeSi based on ionic character of the lattice gave a good agreement
with experimental value. This suggests that FeSi also has ionic character similar to other Rondo insulators. The transport properties of these systems have attracted considerable interest. Addition of Ni to FeSi decreases the quadrupole splitting at Fe due to charge transfer effects and it would also be of interest to study the transport properties of this ternary system.