Chapter 7
Conclusions and Scope for Future work

7.1 Conclusions

In view of the practical significance of machine condition monitoring and fault diagnosis systems, one of the most critical and complex machine element, gearbox has been selected. Two frequently occurring faults in gears such as wear and broken tooth have been considered in this investigation. In order to develop a condition monitoring and fault diagnosis system, the present investigation has successfully fabricated an experimental set-up. On a selected gear tooth, different faults pertaining to different degrees of wear (20% wear, 40% wear, 80% wear) and broken tooth have been induced, one fault at a time. For no fault case and for each of the induced fault cases, experimental vibration data has been systematically collected and recorded and the following conclusions have been drawn:

- It is found that the fault diagnosis based on maximum vibration amplitude data pertaining to different cases not possible, as data is linearly inseparable.
- It is also not possible to diagnose faults based on extracted statistical features from maximum amplitude of vibration data, as the data is overlapping.
- As the vibration data pertaining to gear faults is more complex, it requires advanced computational methods such as artificial neural networks for fault diagnosis.
• Two ANN models: (i) 5I-2O fault classification system for wear and broken tooth, (ii) 5I-5O fault detection model for finding different degrees of wear, broken tooth and no fault are designed.

• For the 5I-2O ANN fault classification model, the optimum values of learning rate, number of hidden layer neurons is found to be 0.15 and 9 respectively.

• For the 5I-2O ANN fault classification system the classification accuracy of 100% is achieved.

• For 5I-5O system the optimum number of hidden layers is found to be three and maximum fault detection accuracy of 94% is achieved.

7.2 Scope for Future work

The present investigation was limited to develop condition monitoring and fault diagnosis system for two specific prominent faults at constant speed and no load conditions. Efforts can be made to develop condition monitoring and fault diagnosis system for these faults at different loads and speeds. Further similar system can be developed for all other faults at different loads and speeds.

The present investigation used time domain technique for vibration measurement, whereas other techniques such as frequency domain, time-frequency domain can be tried to develop a robust condition monitoring system.
In the present investigation analysis was carried out with prominent five statistical features; however, the effectiveness of each of the feature is not evaluated. Future research can be carried out to evaluate the effectiveness of these features. Further, more number of other statistical features can be tried in developing an effective ANN based fault diagnosis models.

Future work can also focus on developing an excellent ANN model which is capable of switching automatically to different diagnosis techniques, depending on the nature of data of the fault.