Chapter 6
CONCLUSIONS AND FUTURE SCOPE

In the present work, the well-known evolutionary methods such as GA and PSO are applied to three cases of mechanical engineering. Also, the various MADM methods are applied to the two cases such as optimum material selection for journal bearing and optimum selection of mechanical drive.

6.1 Conclusions

Following conclusions are drawn:

1. For an optimal design of column, GA (Binary coded and Real coded) and PSO are applied. It is seen from the results (Table 4.11) that the PSO gives better results in comparison to other methods. i.e. the optimum weight is 56.42 kg. Also, the dimensional ratio of a/b achieved is 3.05 which is close as per recommendation of 3. However, GA results into 56.47 kg (by Binary coded) and 59.44 kg (by Real coded) and corresponding a/b ratios are 2.89 and 2.4 respectively which are away from recommended value. Hence, in this case, PSO proves to be a better option.

2. For optimal design of short journal bearing, an attempt of treating the objective functions as single objectives yields fruitful and satisfactory results using GA and PSO in comparison with earlier published work. The values of static variables are obtained little higher but the approach helps the designer for simplicity and easiness to employ for primary design. The robustness of evolutionary methods is realized in the present case. The results are compared with the existing in the literature. It is seen that the lubricant supply quantity and the temperature rise values obtained by GA and PSO are comparable and satisfactory.

3. The helical gear pair for heavy duty application is optimized for volume considering dimensional and strength requirements. The various factors associated with strength are calculated manually using DIN standards. This sets up a base for further using them for optimal design. The minimum volume as achieved by GA is 1.4037x10^8 mm³ with b=50 mm, Z₁=33, Z₂=130 and β=6.4° in 40 iterations. The application of PSO yields volume as 1.8046x10^8 mm³ with b=53 mm, Z₁=30, Z₂=142 and β=11.9° in 100 iterations. This illustrates that here GA gives better results in
comparison with the PSO. Also, as can be seen from Table 4.16, the optimum volume is obtained by PSO in 100 iterations, while the higher number of iterations do not help in improving the result. The optimum values of volume saves material and space which yields in overall economy of the gear pair.

Following conclusions are drawn based on GA and PSO application:

1. The advantage of using GA is realized for all the applications in the present work. Since GA is applicable to various types of objective functions with several types of constraints, in the present work, this method offers considerably good near optimal solutions.

2. The binary coded and real coded GA results show that the binary coded GA in the column design gives better results.

3. The PSO is also another algorithm to find near optimal solutions. In case of column optimization, this is realized and it offers better results than GA.

From the application of MADM to (i) optimum selection of material for journal bearing and (ii) optimum selection of mechanical drive, following observations are drawn:

1. The data matrix for optimum selection of journal bearing material is developed and MADM methods are applied to rank the various material alternatives for conflicting requirements. It is seen that the ranking is almost same for all the methods. The optimum selection of material helps the designer at the preliminary stage and also for replacement of existing design. The present work could be a part of an expert system for design of bearings.

2. All the methods viz. SAW, AHP, TOPSIS, Modified TOPSIS, VIKOR result into almost similar ranking of the alternatives. The SAW, AHP and TOPSIS agree for the first two rankings as 7th (i.e. aluminium alloy) as first rank and 6th (i.e. Tin bronze) as the second rank while the Modified TOPSIS ranks 6th alternative as first rank and 8th alternative (i.e. silver over-plated) as second rank. The VIKOR ranks 8th alternative as the first rank.

3. The data matrix for optimum selection of mechanical drive is developed and MADM methods are applied to rank the various drives. This helps the decision maker to arrive at a better decision and avoiding the bias. Also, at times, the database can be prepared based on the expertise of many experts according to the application.
addition, more attributes could be considered also.

4. For the drive selection, the first two ranks are same by AHP, Modified TOPSIS and VIKOR. i.e. 10th (Gear drive) while SAW ranks 8th alternative (i.e. Rope drive) as the first and 10th as the second rank.

A scientific approach is presented for optimization of mechanical elements. However, the users are required to modify the same based on brainstorming, applications and the need of the hour. The approaches presented could well become the part of an expert system and would be useful to the designers for primary design of mechanical elements.

6.2 Future Scope

1. The application of other evolutionary methods such as Artificial Bee Colony (ABC), Artificial Immune Algorithm, Biogeography Based Optimization (BBO), Cuckoo Search Algorithm (CS) and other hybrid algorithms such as PSO based ABC, Biogeography based ABC etc. can be explored for nonlinear multivariable constrained optimization problems as carried out in the present work for column, bearing and gear design. Other applications can also be sought.

2. In place of single objective being attempted here, multi-objective problems can be formulated.

3. The alternative MADM methods such as ELECTRE (Elimination and Choice Expressing the Reality), EVAMIX (Evaluation of Mixed Data), COPRAS (Complex Proportional Assessment) methods can be applied to the bearing material and drive selection.

4. In the present work, a 9 x 9 matrix for bearing material selection and a 10 x 10 matrix for mechanical drive is considered. The number of attributes could be more and hence the corresponding matrix size may be larger in future work.

Looking at the problem with theoretical perspective, the development of a novel method as well as a novel application could always be encouraged. The extension of the work could be by using other advanced evolutionary methods as well as formulating the optimization problem as per the need.