CHAPTER 6

CONCLUSION

6.1 GENERAL

This chapter aims at reviewing the contributions made during the course of this work and proposing a few suggestions for future work. Before proceeding with the review of the work done, the objectives of this thesis stated earlier are recalled.

The main objective of the thesis has been to investigate the suitability of Fuzzy logic based Power System Stabilizer (FPSS) in enhancing the stability of multi-machine power systems. This thesis, specifically, aims at selection of a suitable configuration for FPSS which is robust for different operating conditions and gives the best damping of all the critical modes of the system. Further, the thesis also aims at evolving systematic methods for co-ordinated tuning of the parameters of PSS, both FPSS and Conventional PSS (CPSS).

6.2 REVIEW OF THE WORK DONE

A Single Machine Infinite Bus (SMIB) system was first chosen for carrying out detailed investigations on different configurations of FPSS as well as on CPSS with a view to choose a robust PSS and also to evolve a systematic tuning procedure for PSS parameters. Two different types of FPSS configurations were investigated for their damping performance and compared
with that of a typical CPSS. FPSS Type 1 is based on MacVicar-Whelan decision table with two fuzzy inputs (error and derivative of error) and one output, whereas FPSS Type 2 is based on Hiyama model with single fuzzy input and single output. A simple and effective method of tuning the parameters of PSS has been proposed. The problem was posed as an optimization formulation, minimizing a performance index which is 'Root Mean Squared Deviation' (RMSD) of the state variable which is closely related to the critical mode to be damped. The Crowding Genetic Algorithm (CGA) is used for optimal selection of PSS parameter values in which the RMSD index is evaluated at every iteration using a non-linear stability simulation of the power system at an operating condition and disturbance which excite most effectively the critical mode to be damped.

The results obtained from the SMIB system reveal that both the FPSS and the CPSS are effective in damping the system response. The results also demonstrate that FPSS Type 1 has lower RMSD index and the peak over shoot of rotor angle for all the cases studied, compared to FPSS Type 2 and CPSS. Further it is inferred that FPSS Type 1 is more robust compared to FPSS Type 2 and CPSS. Among the two types of FPSS, Type 1 is found to be more effective than Type 2.

Suitability of CPSS and FPSS for stability enhancement of multi-machine power systems has been investigated in Chapter 4. A step-wise procedure has been proposed for identifying the best PSS location for damping different critical rotor swing modes of a given power system using the concept of participation factors. A simultaneous tuning approach has been proposed to tune the parameters of PSS using Crowding Genetic Algorithm (CGA). In this approach, all the parameters of PSS's are tuned simultaneously for a chosen operating condition and disturbance which excite most effectively the first critical mode. The performance of all the PSS's is checked for another
operating condition and disturbance which excite most effectively the second critical mode. If the damping is found inadequate, retuning of the parameters of the respective PSS alone is carried out. This process is repeated for all other critical modes.

This approach was applied to a sample five machine eight bus system. The system response obtained with CPSS and FPSS are compared and discussed. From the results obtained, it is inferred that the RMSD index values of the FPSS Type 1 are less compared with those of the CPSS for different disturbances and loading patterns of the system. The results obtained for the sample system using simultaneous tuning method revealed that adequate damping could not be achieved for one of the critical modes.

To overcome this problem another method namely, sequential method of tuning of PSS parameters has also been proposed. This method comprises two stages. In the first stage, the damping of each one of the critical modes, taken one at-a-time, is maximized separately by tuning the parameters of the respective PSS through CGA. The second stage is carried out for checking the adequacy of damping of various critical modes by keeping the parameters of all the PSS at the optimal setting obtained in the first stage. If damping is found inadequate for any critical mode, the parameters of the corresponding PSS's alone are retuned.

The proposed sequential tuning algorithm was tested on the same five machine eight -bus system. From the results (both the system response and the RMSD index values) of all the cases studied, it is inferred that the performance of FPSS Type 1 is more robust than CPSS. It is also seen that the FPSS can damp both local and inter-area modes of oscillations effectively. These results are compared with the results obtained using simultaneous method.
Finally it is shown that the PSS parameters obtained using sequential tuning method give better PSS performance than the parameters obtained using simultaneous tuning method.

6.3 SCOPE FOR FUTURE WORK

It is observed that the following improvements may be made.

(a) In the design of Fuzzy logic based PSS linear triangular membership function is considered in this thesis. Non-linear membership functions can be used and its effectiveness in improving transient stability can be investigated.

(b) Static Var Compensators (SVC) are commonly used as voltage control devices to prevent transient voltage instability/collapse. The auxiliary control of SVC can be used to improve the stability of power system. In some cases, SVC’s are used to damp out inter-area oscillations of power systems than that of PSS’s. The Fuzzy logic control used in this thesis for PSS may be extended to SVC and its effectiveness may be investigated.

(c) Tuning of PSS’s parameters through CGA is taking a large amount of computational time for convergence. To overcome this problem, optimization methods such as state incremental dynamic programming or local variation method (Mohan et al., 1992) may be applied and effectiveness may be investigated.