Chapter 7

Conclusions and Future Scope

7.1 Conclusions

The objective of the present research is titled “Robust control of grid connected doubly fed induction generator (DFIG) based power systems.

- To construct a mathematical model of the DFIG wind turbine system (for steady state as well as transient analysis) connected to power grid.
- Exploration of various uncertain models for DFIG based wind farms/grids under various connectivity conditions.
- Analysis of uncertain wind power models for robustness.
- Selection of control objectives and development of robust control techniques.

The main aim of the thesis is to formulate and implement the robust control technique for DFIG based power systems. Dynamic models of 1.5MW and 5MW DFIG based wind turbines have been explored with the help of MATLAB Simulink model to analyze the impact of lumped force induced on the wind turbine structure i.e blade and tower accelerations induced due to the force developed by wind speed. The importance of pitch control to stabilize the electrical power output from wind turbine is also elaborated in Chapter 3. The steady state and dynamic mathematical models of DFIG have been explored for stationary and rotor reference frames by using parks transformations i.e. $dq_0$. A simulation study was carried out on 1.5MW DFIG based wind turbine connected to grid and operating under different connectivity conditions. The frequency support model of DFIG based wind turbine is also has been derived in Chapter 4. The design
equations for dynamics of power systems based on synchronous generators such as steam
and hydro and DFIG for frequency control are derived and implemented in
MATLAB/Simulink® environment. A five area Simulink test model was made by
interconnecting steam, hydro, diesel and DFIG based WT unit for analysis of frequency
response. Simulation study was carried out to obtain the system frequency control due to
sudden change in the load demand by implementing conventional PI controller, fuzzy
based PI and PSO based PI controller. From the simulation results it was observed that
PSO based optimized PI gains give optimal results as compared to conventional hit and
trail methods and fuzzy approach as described in chapter 5.

A hybrid BFOA-PSO technique to tune the PI parameters of multi area power
system for load frequency control has been proposed in chapter 6. The proposed
technique effectively tunes the PI parameters of the PI controllers of each area. The
effectiveness of the proposed technique has been studied via simulation based study of
three area power system network with and without DFIG generators in any one area. The
integral square AFCE minimization approach has been adopted. The proposed controller
effectively reduces the settling time of the response apart from minimized AFCE in all
considered cases as compared with other approaches. The robustness of the proposed
technique has been studied by considered ±30% variations in the system parameters and
it is observed that the controller effectively maintains the system performance despite
parameter variations.

The latter part of the chapter discusses the design of PID controller through multi
objective optimization techniques. Ant colony optimization based multi-objective
optimization has been carried out to design the PID controller and is compared with
genetic algorithm based and teacher learner based optimization based controllers. For the
considered scenario ant colony optimization based controller provides better results.
7.2 Future Scope

- The control design freedom via hybrid approach for other heuristic algorithms and for other complex systems remains a topic for further research.

- Hybrid algorithms can be applied for more accurate analysis of the dynamic models of DIFG for active and reactive power controls.

- The pitch angle controllers designed with heuristic approach have the wide scope for research findings.

- In this work all the research findings were simulation based, the practical implementation of the hybrid techniques become the scope for future research.

- The simulation analysis of the impact of wind gusts on the wind turbine structural models will helpful for efficient design of the turbine structures.