ABSTRACT

In this thesis a comprehensive analysis on load frequency control (LFC) of isolated and interconnected power systems considering battery energy storage(BES) facility is studied. Investigations are also carried out for optimizing the gain parameters for various controllers using genetic algorithm(GA). A lower order model for interconnected two area reheat thermal power system is proposed and its parameters are estimated using genetic algorithm (GA). Dynamic performances of diesel and wind turbine generator system operating on an isolated power system considering simple proportional-integral (P-I) controller and variable structure controller (VSC) are studied. Effect of small battery energy storage (BES) facility on diesel and wind turbine generator system is also studied.

Chapter-1 introduces the various aspects of load frequency control (LFC) in general and presents a critical summary of the past work concerning load frequency control(LFC). It clearly lays down the objectives and motivation of the research work presented in the thesis.

Chapter-2 presents the effect of battery energy storage (BES) on load frequency control(LFC) of isolated and interconnected two area reheat thermal power system. Frequency deviation (ΔF) signal is used to control the BES system for isolated reheat thermal power system. For interconnected two area reheat thermal power system, both frequency deviation (ΔF) signal and conventional area control error (ACE) signal are used for controlling the BES system. New area control error (ACEN) signal is also used to control the BES system. Analysis reveals that frequency deviation (ΔF) signal is most suitable for controlling the BES system because it provides better dynamic performances in terms of peak deviation and settling time. Analysis also reveals that with BES system the integral controller gain setting is much higher than that of without BES system. Therefore, it is necessary to change the gain setting from higher to much lower value when BES is disconnected from the power system.

Chapter-3 presents the effect of battery energy storage (BES) system on isolated hydro power system, two area and three area interconnected hydro-thermal power system. Dynamic responses are compared with and without BES system. Effect of small size BES system on LFC is also studied. Analysis reveals that BES system improves the dynamic performances of isolated hydro power system, two area interconnected hydro-thermal power system and three area interconnected hydro-

thermal power system. Results also reveal that a ~~small size of~~ small size BES facility is capable of improving the dynamic performances significantly.

In **Chapter-4**, optimum gain settings of different types of controllers are obtained using genetic algorithm (GA) for isolated reheat thermal power system, two area reheat thermal power system, isolated hydro power system, two area hydro power system and two area hydro-thermal power system. Dynamic responses are compared for different type of controllers. Dynamic performances curves are also ~~carried out~~ obtained for variation of different system parameters. Analysis reveals that for isolated reheat thermal system, P-I controller gives slightly better dynamic performances in terms of peak deviation of frequency. Dynamic responses also remain more or less insensitive to large variation of reheat time constant (T_r), but highly sensitive to large variation of inertia constant (H). For two area interconnected reheat thermal power system only integral controller is suitable with very small gain. Analysis also reveals that for isolated hydro power system, two area hydro power system and two area hydro-thermal power system P-I-D controller gives better dynamic responses in terms of peak deviation and settling time as compared to that of other types of controllers.

In **Chapter-5**, dynamic responses are compared for different load frequency control (LFC) system equipped with electro-hydraulic and mechanical-hydraulic governors. Multi-turbine generator systems for isolated and interconnected power system are also studied. Optimum gain settings of the different types of controllers are obtained using genetic algorithm (GA). A lower order model is also proposed for two area interconnected reheat thermal power system and the unknown parameters of the lower order model are estimated using genetic algorithm (GA). In case of isolated and interconnected non-reheat and reheat thermal systems equipped with electro-hydraulic governor gives better dynamic performances in terms of peak deviation and settling time as compared to that of the same system equipped with mechanical-hydraulic governor. It is also found that P-I-D controller works very well for both isolated and interconnected thermal power system. Analysis also reveals that P-I-D controller performs very well for multi-turbine generating system of isolated and interconnected power system. For lower order model of two area reheat thermal system, the dynamic responses matches very closely with the dynamic responses of the original system both in the uncontrolled and controlled modes.

Chapter-6 deals with dynamics of diesel and wind turbine generators operating on an isolated power system. A simple variable structure controller (VSC) logic based on

simple proportional (P) and proportional-integral (P-I) controller is proposed. Effect of a small battery energy storage (BES) system on the dynamics of diesel and wind turbine generator system operating on an isolated power system is also studied. Analysis reveals that the variable structure controller gives better dynamic performance in terms of peak deviations and settling time as compared to that of the conventional fixed structure P-I controller. Analysis also reveals that the use of wind frequency deviation for the control of BES substantially reduces the peak deviations of frequencies, wind and diesel power and settling time is very less. It is also found that the BES system is capable of improving the system dynamic performances even under the random load disturbance.