

**Yadav Singh**

**Under the supervision of:**

**Prof. Ibraheem** (supervisor)

Department of Electrical Engineering, Faculty of Engineering & Technology  
Jamia Millia Islamia, New Delhi

**Prof. Prabhat Kumar** (Co-supervisor).

Department of electrical engineering, Z. H. College of Engineering & Technology  
Aligarh Muslim University, Aligarh

Title of thesis: **AGC STRATEGIES IN INTERCONNECTED POWER SYSTEMS UNDER DEREGULATED ENVIRONMENT**

### **ABSTRACT**

Power systems are typical interconnected large scale systems. They consist of many interconnected control areas. Therefore, their operation and control is not a simple task for power engineers. The AGC is a significant control process that operates constantly to balance the generation and load in power systems. The AGC is responsible for frequency control and power interchange, as well as economic dispatch. AGC provides an effective mechanism for adjusting the generation to minimize frequency deviation and regulate tie-line power flows. The last two decades have witnessed a transition of electric power industries throughout the world from regulated to deregulated structure adding a market based competition in the supply system of electricity.

In this thesis, study has been carried out for AGC of two-area interconnected power system operating under deregulated environment. The present research work provides an essence of AGC strategies in interconnected power systems, design of optimal AGC regulators, sampled-data AGC schemes, discrete mode optimal AGC of interconnected power systems with parallel AC/DC links, design and implementation of PID control strategy based AGC regulators using ZN, RS and GA tuning techniques. A due attention has also been paid to carry out the investigations considering parallel AC/DC links as an area interconnection and system non-linearities like; GDB, GRC and BD in deregulated power systems.

Different case studies are identified based on the types of power transaction contracts. The investigations carried out reveal that optimal AGC regulators based on PI control strategy are capable to eliminate the steady state error completely which was present in the dynamic responses obtained with proportional control strategy. However, responses are associated with more number of oscillations coupled with larger settling time resulted in degraded system dynamic performance in case of PI control strategy based optimal AGC regulators.

The digital mode control is more accurate and reliable, compact in size, less sensitive to noise and drift, and more flexible. Now the trend is completely towards the use of digital computers for the implementation of AGC schemes in modern power systems. Therefore, to design and

implementation of sampled data based AGC regulators for interconnected power system in deregulated environment is the need of hour. The discrete-mode optimal AGC regulators are designed considering different sampling periods. It is also shown that variation in sampling period influences the pattern of eigenvalues and hence the stability margins of the system. The power system model is considered to be operating in a deregulated environment with various market transactions. From the investigations carried out for dynamic responses, it is revealed that there is no additional power flow between control areas for (i) inner contracts and (ii) inner contracts with contract violations. However, in case of bilateral contracts and bilateral contract violations, the scheduled power exchanges between control areas are there as per the contract agreement. Moreover, the frequency deviation is more in the area in which DISCO violates the contracts. Moreover, it is also revealed that introduction of parallel AC/DC links as an area interconnection has resulted in an appreciable improvement in the system dynamic performance.

The two area interconnected power systems in deregulated environment is also investigated with ZN, RS and GA optimization technique based AGC regulators. The performance index is formulated using ISE criterion. The dynamic performance of RS based AGC regulators have been found to give appreciably better dynamic response in comparison to that offered by ZN based AGC regulators. Moreover, dynamic performance of power system under deregulated environment offered by GA based AGC regulators is appreciably improved as compared to that obtained with RS based AGC regulators. AGC of two area interconnected power system is carried out in deregulated environment incorporating non-linearities and AC/DC links as area interconnection in system dynamic model. The bilateral contracts are considered for transactions. From the study it is seen that the presence of GDB, BD and GRC deteriorate the system dynamic performance in some or other way. The power system model in deregulated environment interconnected through parallel AC/DC links and having system non-linearities is also investigated. From the studies, it is established that the incorporation of parallel AC/DC links as an area interconnection has an ameliorated effect on dynamic performance of the system even in the presence of system non-linearities like; GDB, BD and GRC.