and changes the speed set point. Te integral controller increases the system type by 1which makes the final frequency deviation to zero. The integral controller gain must be adjusted for a satisfactory transient response.

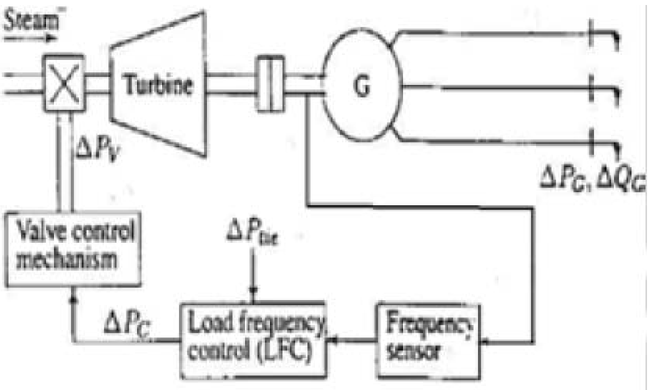

Figure 2: Schematic diagram of an LEC of a synchronous generator [10]

The schematic diagram of AGC is shown below. It consists of valve control mechanism, turbine, generator and governor. The change in frequency is compared with a reference speed. A valve controller is used to regulate the steam valve thereby increasing the power output from the generators which results in matching of generation and demand. As a result the frequency is restored to the original value [9]. Based on this, this network can be classified as single area or two area system as discussed below.

The combined block diagram of single area with, governor prime mover – rotating mass/load model is shown in figure 2.

4. Single Area System

The restoration of the frequency to the nominal value requires an additional control loop called the supplementary loop. This loop consists of an integral controller which makes the frequency deviation to zero. The ALFC with the supplementary loop is generally called the AGC as shown in Figure4. In order to make $\Delta\omega = 0$, the speed changer setting is changed in response to $\Delta\omega(S)$ through an integrator. Thus the integral action results in automatic adjustment of ΔP_{ref} so as to make $\Delta\omega = 0$.

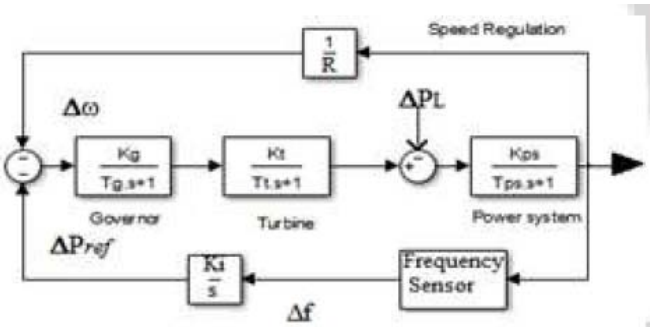

Figure 3: Block diagram of single area (PI controller)

5. Two Area System

The block diagram of a simple AGC for a two-area system is shown in figure4.

ACEs are used as actuating signals to active changes in the reference power set points, and when steady state is reached, ΔP_{12} and $\Delta\omega$ will be zero. Conventional LFC is based up on the tie-line bias control, where each area tends to reduce the area control error (ACE) to zero. The control error for each area tends to consists of linear combination of frequency and tie-line error.

$$ACE_i = \sum n_j = \Delta P_{ij} + K_i\, \Delta\omega \quad (7)$$

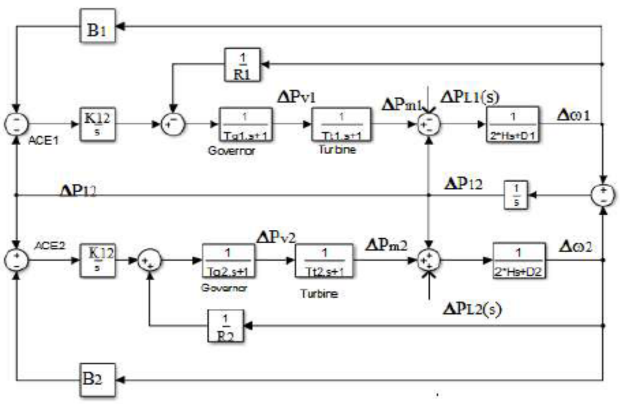

Figure 4: Block diagram of Two area system (PI Controller)

6. Simulation Results

The models of single area and two area system are simulated in SIMULINK.

6.1 Single Area system with PI controller

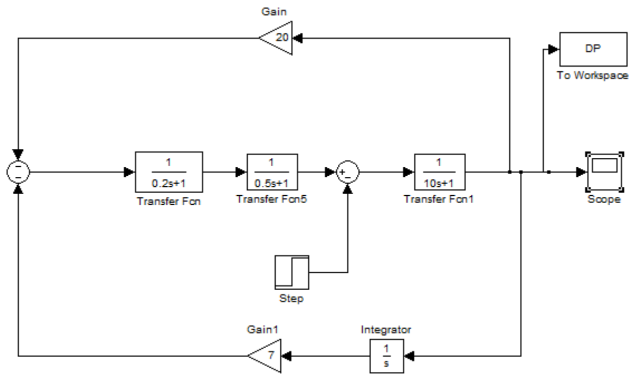

Figure 5: Single area system with PI Controller

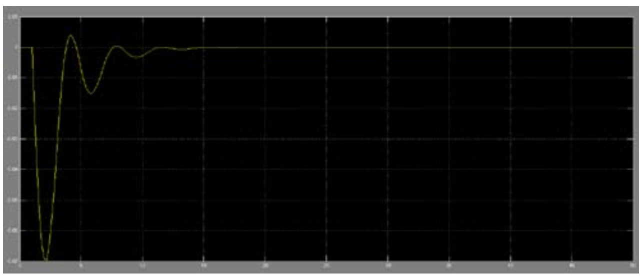

Figure 6: Simulation result for Single area system with PI controller

6.2 Two Area System with PI Controller

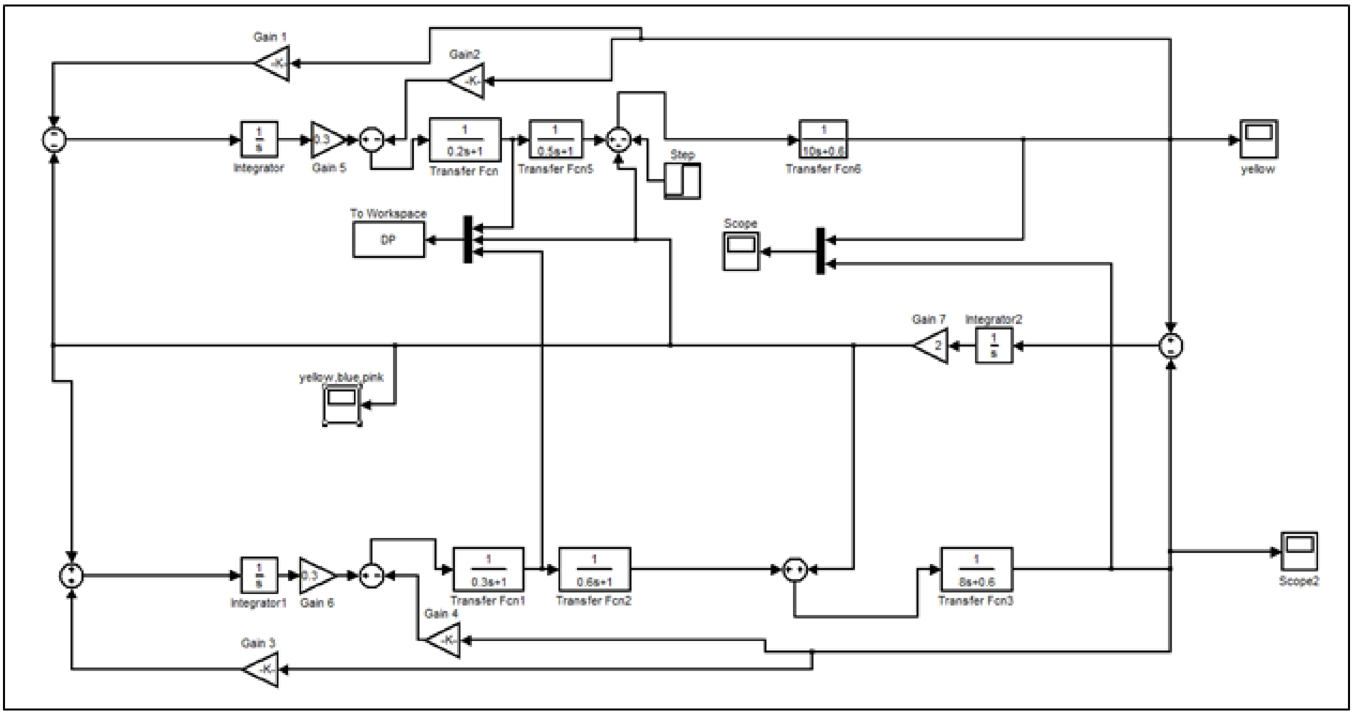

Figure 7: Two area system with PI Controller

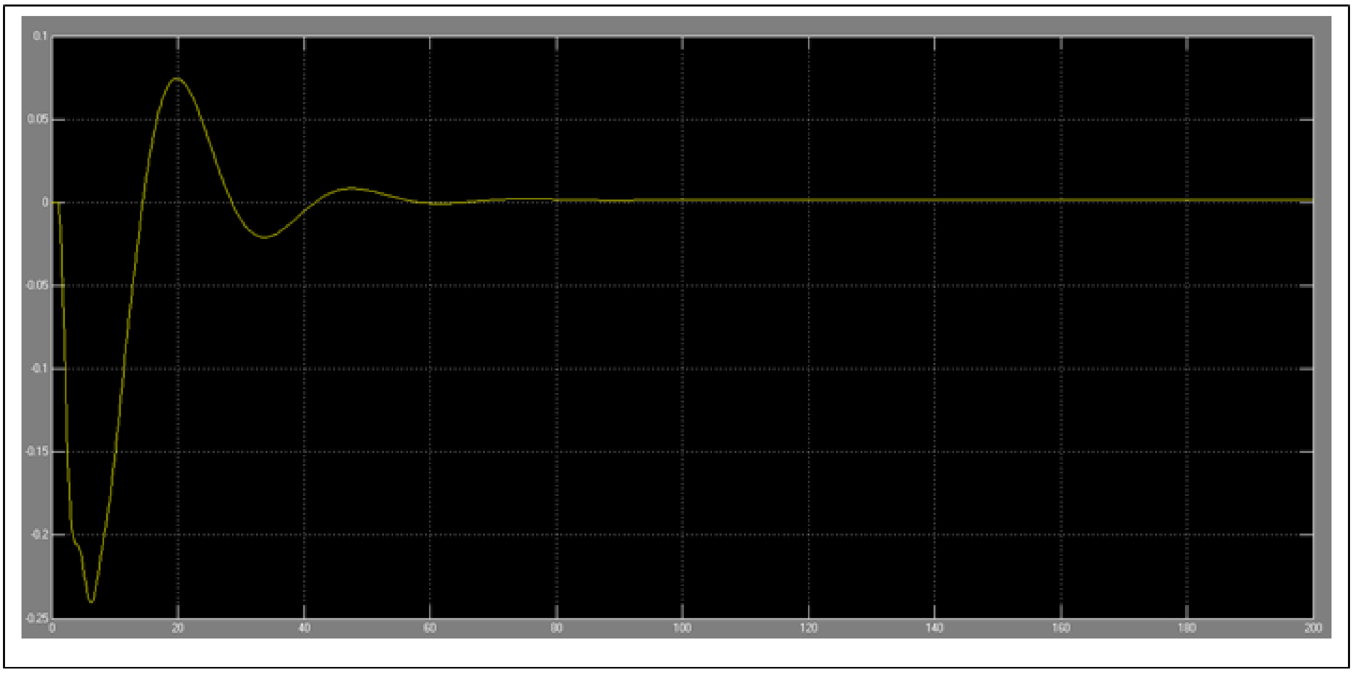

Figure 8: Simulation result for Two area system with PI controller

7. Conclusion

A Simulation study of single area and two area system with automatic generation and control is carried out with models developed in SIMULINK and results are shown in this paper. The advantage of interconnection can be understood by comparing the results of single and two area systems. It can be seen that the oscillations due to change in the load in any area is damped down quickly because of tie line power flow. It can also be observed that the dynamic response is mainly governed by the secondary loop and hence its design criteria are extremely vital for efficient implementation. Also, the dynamic performance of conventional PI controller is compared in single area and two area systems.

Appendix

Data for interconnected systems are:

$K_{p1}=1$ $K_{p2}=1$
$R_1=20.6$ $R_2=16.9$
$B_1=0.05$ $B_2=0.0625$
$T_{g1}=0.2$ $T_{g2}=0.3$
$T_{t1}=0.5$ $T_{t2}=0.6$

T_{p1}=10 T_{p2}=8

References

[1] "Recent philosophies of AGC of a Hydro-Thermal system in deregulated environment" by L.Shanmukharao, N.venkata ramana. IJAET, jan 2012.ISSN: 22311963.
[2] "Load frequency control adaption using artificial intelligent techniques for one and two different areas power system" by Mohamed Ismail, M.A.Mustafa Hassan. IJCAS vol.1.no.1, jan2012.
[3] "Frequency regulation by free governor mode of operation in power stations" by P.Vinoth kumar, S.Muthu kumar. IEEE 2010.ICCICR.
[4] "automatic generation control for inter connected hydro-thermo system with the help of conventional controllers" by Vikram kumar,Krishna arora, Preeti kuran. IJECE vol.2, no.4.Aug 2012.ISSN:2088-8708.
[5] "The state space modeling of single, Two and Three ALFC of power system using integral control and optimal LQR control method" by Nilay kumar, Shah, Chetan. IOSR journal of engg. Mar2012. Vol.2.
[6] "Load frequency control using fuzzy logic" by Amit,Azit,Ashwini,Umesh. IJSR.vol.2.Issue7.Jul2012. ISSN: 2250 3153
[7] "Two area load frequency control with fuzzy gain scheduling of PI controller", IEEE 2008.ICETET.
[8] "An adaptive fuzzy logic controller for a two area load frequency control problem" by K.A. El-Metwally, IEEE 2008, Power system conferences.
[9] "Simulation study of load frequency control of single and two area systems" by Adil usman, BP.Divakar. IEEE 2012.Global humanitarian technology conference.
[10] "Power system analysis" by Saadat, McGraw-Hill 1999.

Author Profile

Vijaya Kumar. K. has received B. Tech in the stream of Electrical and Electronics Engineering from JNTU, Anantapur, India. At Present he is pursing M. Tech in the stream of Electrical Power Systems under JNTU, Anantapur, India.