AGC IN FOUR AREA POWER SYSTEM USING PID AND FUZZY LOGIC CONTROLLER

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Abstract: Automatic generation control is very important in the power system operation and control for supplying sufficient and reliable electrical power. The load demand should match the power generation so if there is any imbalance then load frequency problems arise. In modern power system multi area inter connected systems are used for more reliability and economic purpose. In this paper using four areas for inter connected systems the frequency problems can be effectively decreased by using PID controller and better performance can be obtained using fuzzy logic controller. Performance of the system is analysed by different control parameters like steady state error, settling time, overshoot are effectively reduced.

***Keywords* – Automatic generation control, PID, Fuzzy logic controller.**

I. Introduction

Interconnected power system consists of control areas which are connected to each other by tie lines. In a control area, all the generators speed up or slow down together to maintain the frequency and relative power angles to scheduled values in static as well as dynamic conditions. In an interconnected power system, any sudden small load perturbation in any of the interconnected areas causes the deviation of frequencies of all the areas and also of the tie line powers.[1]

To maintain scheduled value of frequency and power angles controllers are used. In this paper LFC problems are solved using PID and Fuzzy logic controller in four area power system which consist reheat thermal plant.

II. LOAD FREQUENCY CONTROL

Load frequency control regulates the power flow between different areas while holding the frequency constant. Load frequency control (LFC) has the following two objectives:

- Hold the frequency constant ($\Delta f = 0$) against any load change. Each area must contribute to absorb any load change such that frequency does not deviate.
- Each area must maintain the tie-line power flow to its pre-specified value. [2]

When the load on the system is increased, the turbine speed drops before the governor can adjust the input of the steam to the new load. As the change in the value of speed reduce, the error signal becomes smaller and position of the governor falls gets closer to the point required to maintain a constant speed. To restore the speed or frequency to its nominal value integrator is added. The integral unit monitors the average error over a period of time and will overcome the offset. Because of its ability to return a system to its set point, integral action is known as the rest action. Thus, as the system load change continuously, the generation is adjusted automatically to restore the frequency to the nominal value. This scheme is known as the load frequency control (LFC). During large transient disturbances and emergencies, LFC is bypassed and other emergency controls are applied. Modern power system network consists of a number of utilities interconnected together & power is exchanged between utilities over tie-lines by which they are connected. Load frequency control (LFC) plays a very important role in power system as its main role is to maintain the system frequency and tie line flow at their scheduled values during normal period and also when the system is subjected to small step load perturbations. A simplified four-area interconnected power system used in this study is shown in Figure.1.

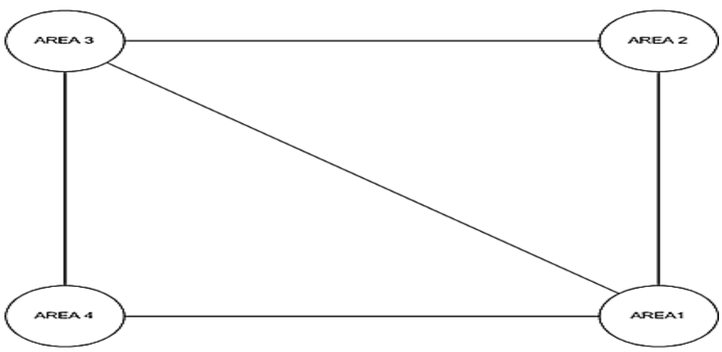

Figure 1 Proposed Four Area Systems

Figure.2 shows block diagram of reheat turbine model of LFC after modeling all the models like speed governor, turbine and generator-load models.

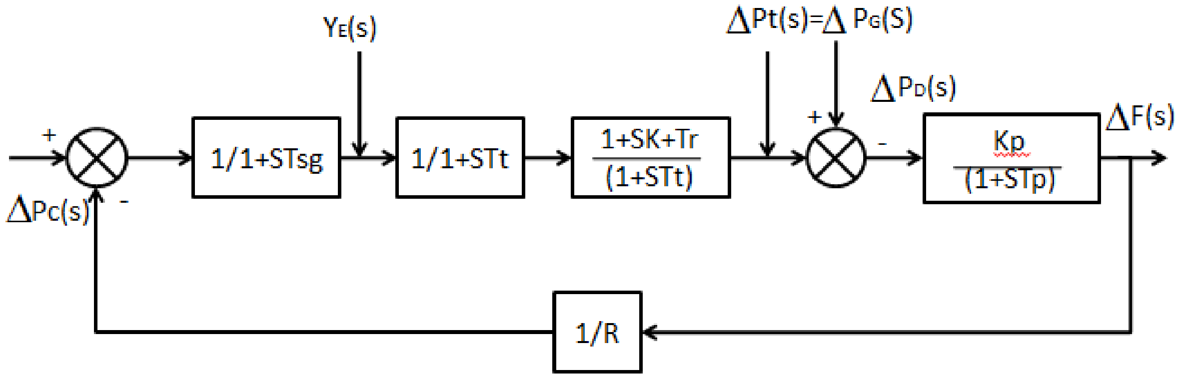

Figure 2 Block diagram of single area load frequency control

III. PID AND FUZZY LOGIC CONTROLLER

3.1Population and Sample

The tuning of PID controller is done to improve the performance of the load frequency control of power system. So, to tune the controller control law u = - K(s) Δf, where K(s) has the form

$$K(s) = K_P\left(1 + \frac{1}{T_I s} + T_D s\right) \quad (1)$$

In general, practically PID controller is implemented to reduce the noise effect. So, K(s) can be written for this case

$$K(s) = K_P\left(1 + \frac{1}{T_I s} + \frac{T_D s}{Ns+1}\right) \quad (2)$$

Where, N = filter constant

$$K(s) = K_P\left(1 + \frac{1}{T_I s} + T_D \frac{1-e^{-Ts}}{Ns+1}\right) \quad (3)$$

Where, T= very small sampling rate.

K_P, K_I and K_D are the proportional, integral and derivative controller gains respectively.

3.2 Fuzzy Logic Controller

The FLC involves fuzzification of input and output variables, formation of rule base, fuzzy interfacing and defuzzification. Figure 3 shows the Design of fuzzy logic controller.

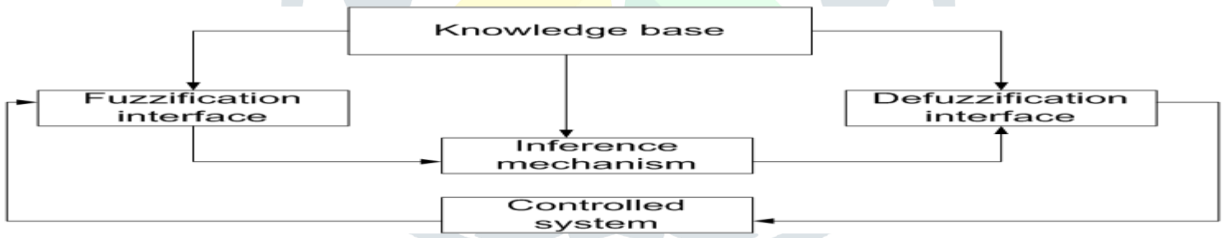

Figure 3 Design of fuzzy logic controller

For the reheat thermal plants, error in frequency dACE and ACE are the inputs. The output is change in reference setting (ref ΔP). For converting the crisp value into fuzzy values, all the input and output variables for all the four plants are classified into five linguistic variables with triangular membership function. Since the two inputs and single output are having five subsets, 25 rules are to be formed. The rules are formulated and given in Table 1. The center of gravity method is used for defuzzification.

Table 1 Fuzzy rules

		dACE				
		NB	NS	Z	PS	PB
ACE	NB	PS	PS	PB	PS	Z
	NS	PS	PS	PS	Z	PM
	Z	PB	PS	Z	NM	NB
	PS	PB	Z	NS	NM	NM
	PM	Z	NM	NS	NM	NM

IV. SIMULATION AND RESULTS

For LFC analysis in four area power system 1% step load perturbation applied in area 1 of the system. So steady state frequency deviation in area-1, area-2, area-3 and area-4 are -0.7892 Hz, -0.7896 Hz, -0.7896 Hz and -0.7894 Hz respectively. PID and Fuzzy Logic Controllers are used for zero steady state error, to reduce settling time and overshoot. Figure 4 shows the simulation model for four area system.

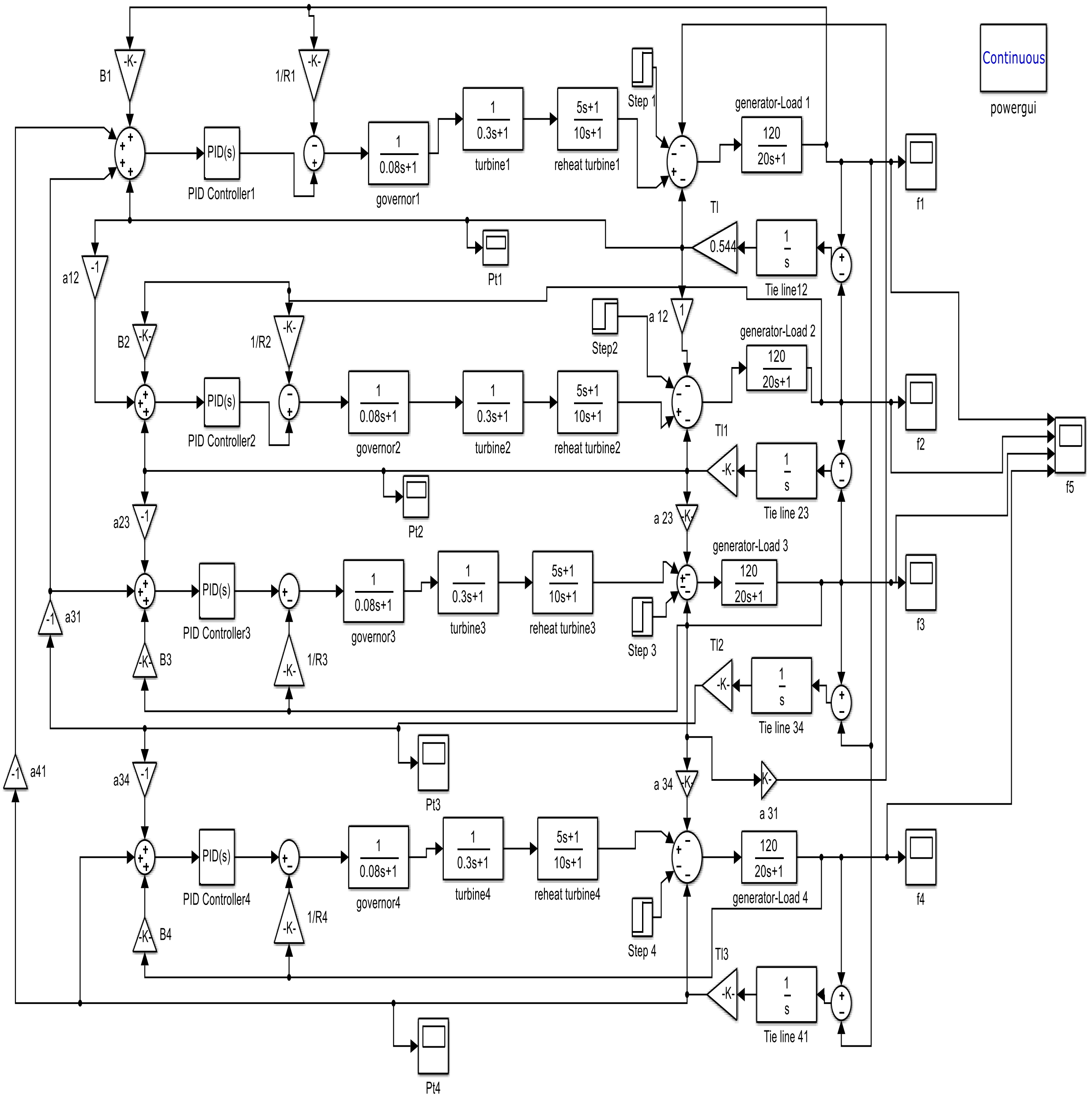

Figure 4 Simulation model for four areas thermal reheat power plant

Results of PID controller in this system for 1% load perturbation in four areas are shown in Figure 5, 6, 7 and 8 respectively.

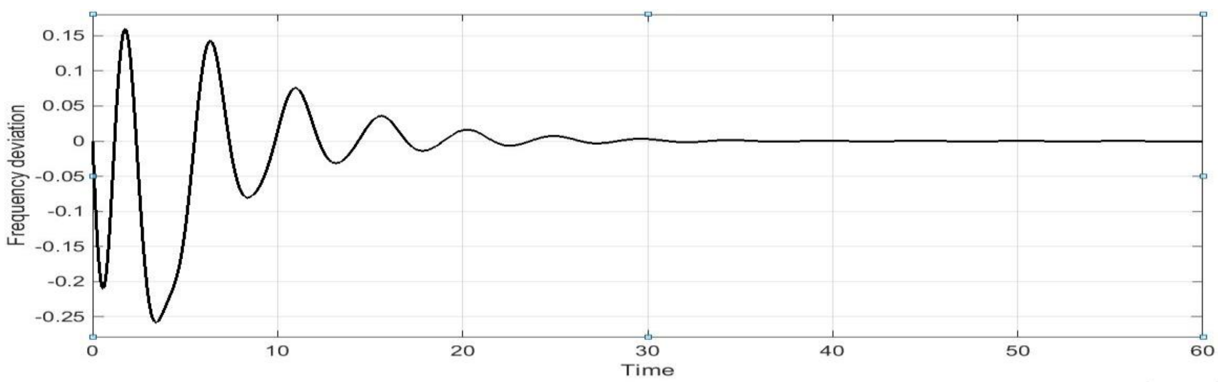

Figure 5 Frequency deviations in area-1 with PID controller

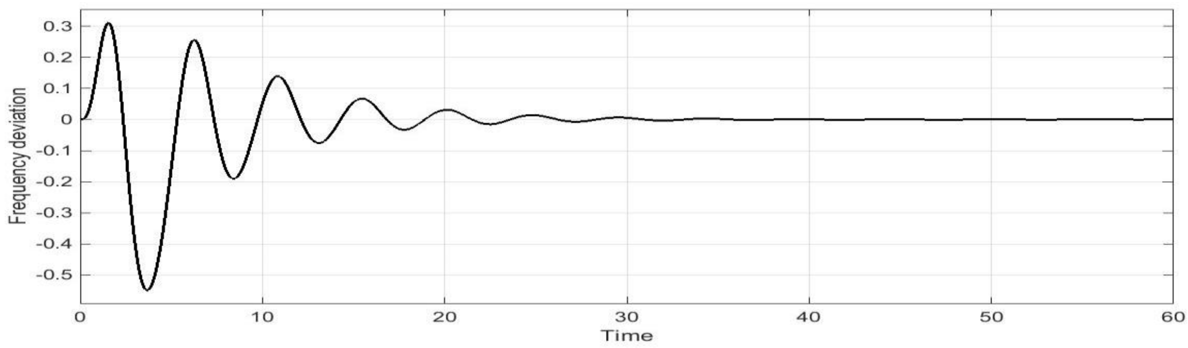

Figure 6 Frequency deviations in area-2 with PID controller

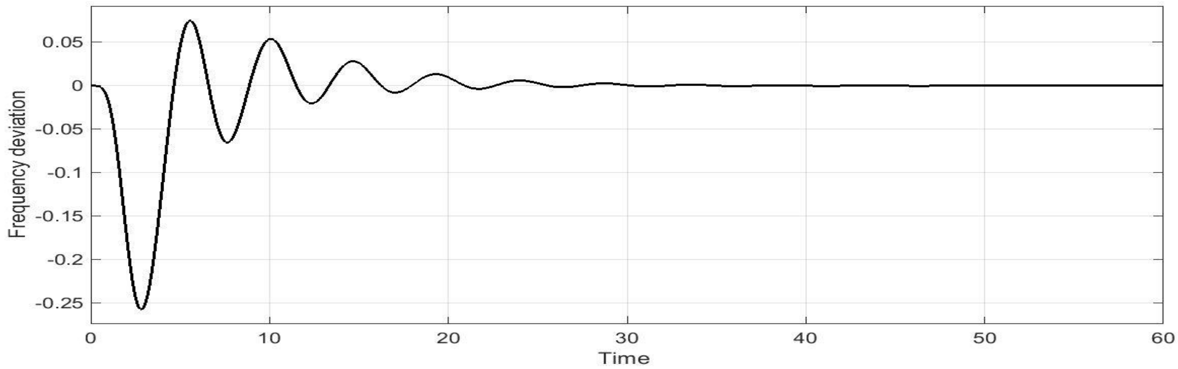

Figure 7 Frequency deviations in area-3 with PID controller

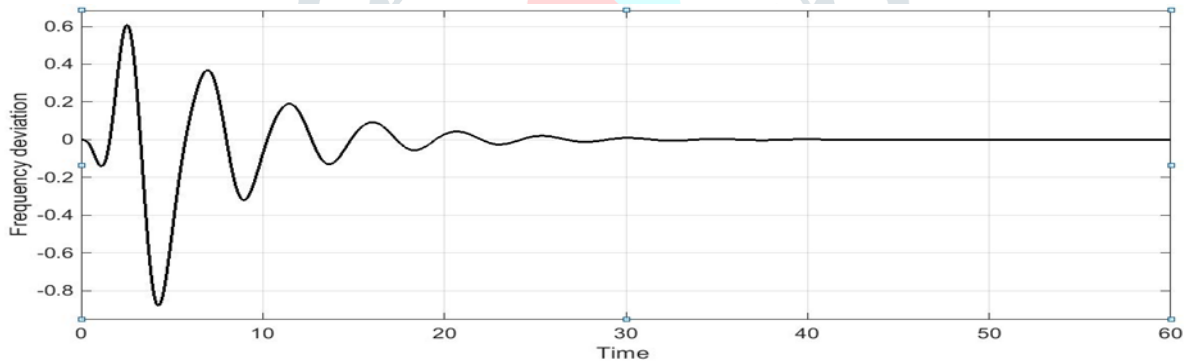

Figure 8 Frequency deviations in area-4 with PID controller

So from the above results final steady state errors in area 1, area 2, area 3 and area 4 are 0.00000277 Hz, 0.0000059 Hz, 0.00000166 Hz and 0.00000172 Hz respectively. The settling time of area 1, area 2, area 3 and area 4 are 33 sec, 34 sec, 33 sec and 33 sec respectively. For further improvement in the parameters fuzzy logic controller is used and its results are shown in Figure 9, 10, 11 and 12.

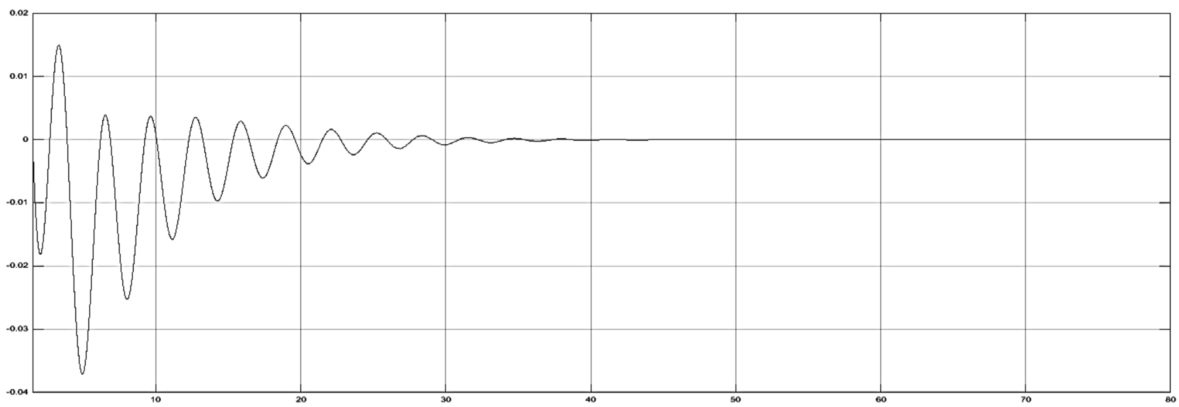

Figure 9 Frequency deviations in area-1 with Fuzzy Logic controller

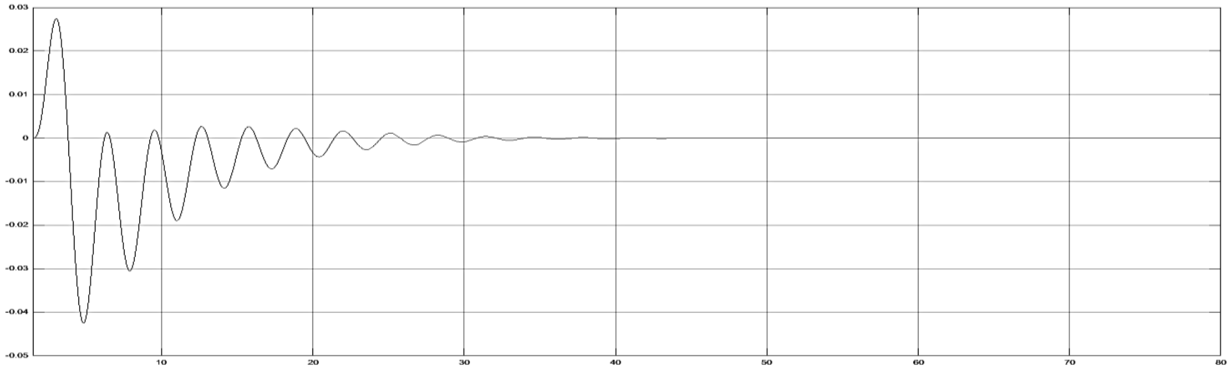

Figure 10 Frequency deviations in area-2 with Fuzzy Logic controller

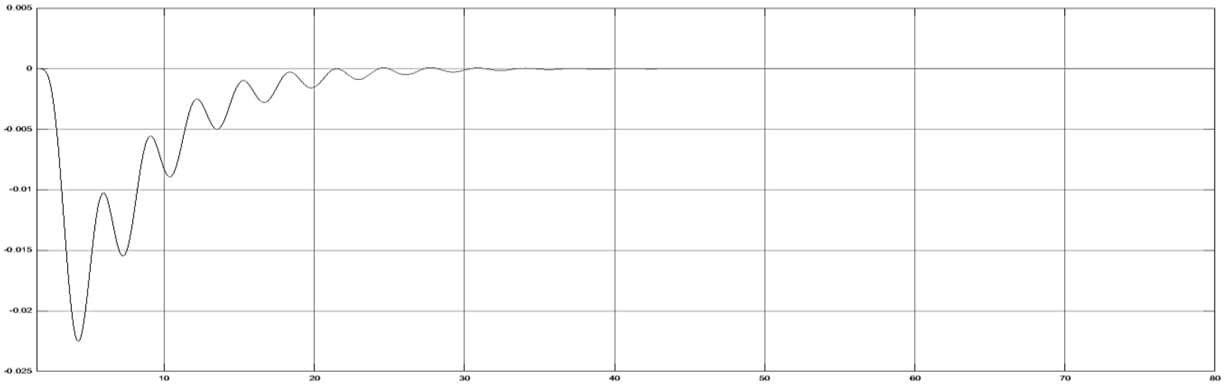

Figure 11 Frequency deviations in area-3 with Fuzzy Logic controller

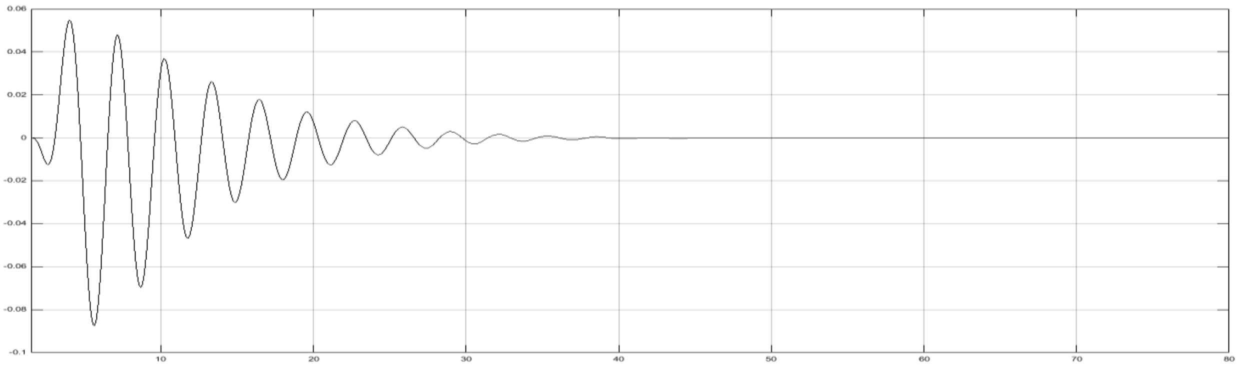

Figure 12 Frequency deviations in area-4 with Fuzzy Logic controller

So from the results it is shown that steady state error of the system is zero and also overshoot and settling time of the system is reduced.

V. Conclusion

From the above results conclusions are as follows:

- PID controller is very simple for implementation and gives better dynamic response.
- Fuzzy logic controller minimizes the peak overshoot; reduce the settling time and steady state error of frequency deviation compared to conventional controllers.

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