Application of Advance Control Logic for Power System Automatic Generation Control

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Abstract:-The steady state analysis of voltage stability is vital thing for study of power system stability. The voltage collapse is occurred due to different reason of power system. The main reason is frequency unbalance, and changing of reactive power in transmission line due to change of load. If voltage and frequency is fluctuating a long period whole power system may be collapse. This creates ice landing of grid failure and black out of a major area. So the analysis of this problem is very much essential how to overcome from this problem. The reactive power is changing due to change of excitation, and frequency is changing due to changing of load demand. None of them can be tolerated to the power system. So here research about this small topic how to control the load frequency, when the load is continuously changing and maintain the power system voltage stability. This approach has been analyzed in different ways with using different software by different authors. Here we have analyzed the problem by using MATLAB simulink.

Key-words: *Load frequency control (LFC), Automatic generation control (AGC), Reactive power, Voltage control, PID controller, Mat lab/simulink.*

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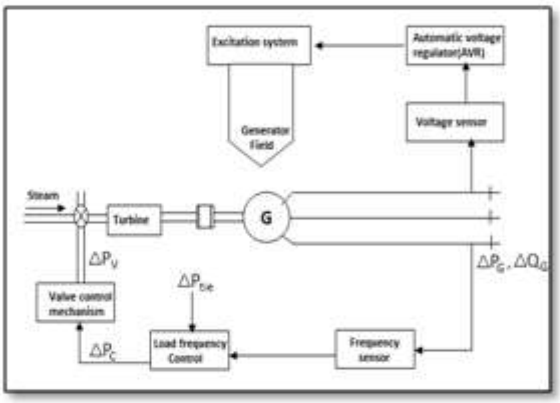
I. Introduction

Power systems consist of control areas representing a coherent group of generators i.e. generators which swing in unison characterized by equal frequency deviations. In addition to their own generations and to eliminate mismatch between generation and demand these control areas are interconnected through tie-lines for providing contractual exchange of power under normal operating conditions. One of the control problems in power system operation is to maintain the frequency and power interchange between the areas at their rated values. Automatic generation control is to provide control signals to regulate the real power output of various electric generators within a prescribed area
in response to changes in system frequency and tie-line loading so as to maintain the scheduled system frequency and established interchange with other areas .The performance of the automatic generation control depends upon how various power generating units respond to these signals. The speed of their response is limited by natural time lags of the various turbine dynamics and the power system itself. In other words the design of automatic generation controller depends upon various energy source dynamics involved in the AGC of the area.
The load over a day varies which is evident from a daily load curve. Therefore the contributions of generations from various sources in an area are adjusted to meet the load variations. The performance of the Automatic Generation Control may also vary in respect to the changes in the share of different type of power generations to the total generation of the area. In order to obtain the optimum realistic AGC performance, the automatic generation controller parameters have to be optimized for various nominal loading conditions. It has also A equipment are installed for each generator. Fig 1 represents the schematic diagram of the

Load frequency control loop and the automatic voltage regulator loop. The controls are set for a particular operating condition and take care of small changes in load demand to maintain the frequency and voltage magnitude within the specified limits. Small changes in real power are mainly dependent on changes in rotor angle D and thus the frequency. The reactive power is only dependent on voltage magnitude. The excitation system time is constant and its transient decay much faster and does not after the LFC dynamic. Thus the cross-coupling between LFC loop and AVR loop is negligible, and the load frequency and excitation voltage control are analyzed independently.



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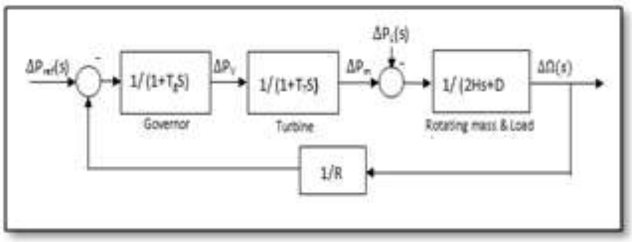
II. LOAD FREQUENCY CONTROL (LFC):

The operation objectives of the LFC are to maintain reasonably uniform frequency, to divide the load between the generators, and to control the tie line interchange schedules. The change in frequency and tie line real power are sensed, which is a measure of the change in rotor angle δ, i.e., the error $\Delta\delta$ to be corrected. The error signals ,i.e., Δf and ΔP_{tie}, amplified, mixed and transformed into a real power command signal ΔP_V, which is sent to the prime mover to call for an increment in the torque.

The prime mover, therefore, bring change in the generator output by an amount ΔP_g which will change the values of Δf and ΔP_{tie} within the specified tolerance. The first step in the analysis and design in the control system is mathematical modeling of the system. The two most common methods are the transfer function method and the state variable approach. The state variable approach can be applied to portray linear as well as nonlinear system. In order to use the function and linear state equation s, the system must first be liberalized the mathematical equation describing the system, and a transfer function model is obtained for the following components.

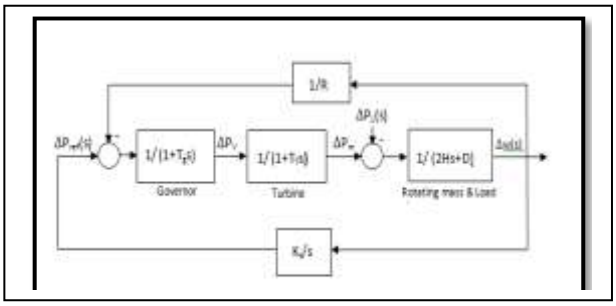


III. AUTOMATIC GENERATION CONTROL (AGC):

If 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 diminishes, the error signal becomes smaller and the position of the governor fly ball gets closer to the point required to mention a constant speed. However, the constant speed will not be the set point. And there will be offset. One way to restores the speed or frequency to its nominal value is to add and integrator. 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 points. Integral action is also known as the rest action. Thus, as the system load changes continuously, the generation is adjusted automatically to restore of the frequency to the nominal value. The scheme is known as the automatic generation control (AGC).

IV. AGC IN A SINGLE AREA SYSTEM:

With the primary LFC loop, a change in the system load will result in a steady state frequency deviation, the depending on the governor speed regulation. In order to reduce the frequency deviation to zero, we must provide a reset action. The rest action can achieve by introducing an integral controller to act on the load reference setting to change the speed set point. The integral controller increases the system type by 1 which forces the final frequency deviation to zero. The LFC system, with the addition of the secondary loop, if shown in figure. The integral controller gain KI must be adjusted for a satisfactory transient response, combining the parallel branches results in the equivalent block a diagram shown in below . Figure:



V. AGC IN MULTIAREA SYSTEM:

In many cases, a group of generators are closely coupled internally and swing in unison. Furthermore, the generator turbines tend to have the same response characteristics. Such groups of generator are said by coherent. Then it is possibly to let the LFC loop represent the whole system, which is referred to as a controlled area. The AGC of a multi area system can be realized by studying first the AGC for a two area system.

The generator excitation system maintains generator voltage and controls the reactive power flow. The generator excitation of older systems may be provided through slip rings and brushes by means of DC generator mounted on the same shaft as the rotor of the synchronous machine. However, modern excitation system usually use as generators with rotating rectifiers, and are known as brushless excitation. Automatic voltage regulator (AVR), the role of an (VAR) is to hold the terminal voltage magnitude of a synchronous generator at a specified level.

An increase in the reactive power load of the generator is accompanied by a drop in the terminal voltage magnitude is sensed through a potential transformer on one phase. The voltage is rectified and compared to a dc set point signal. The amplified error signal controls the exciter field and increases the exciter terminal voltage. Thus, the generator field current is increased, which results in an increase in the generated emf. The reactive power generation is increase to a new equilibrium, raising the terminal voltage to the desired value. We will look briefly at the simplified models of the component involved in the VAR system.

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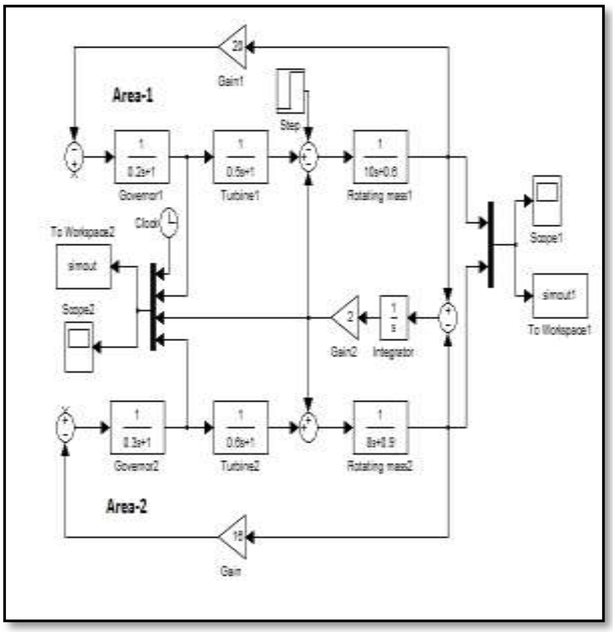
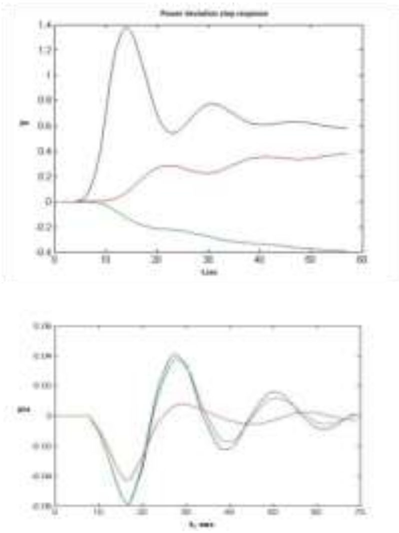
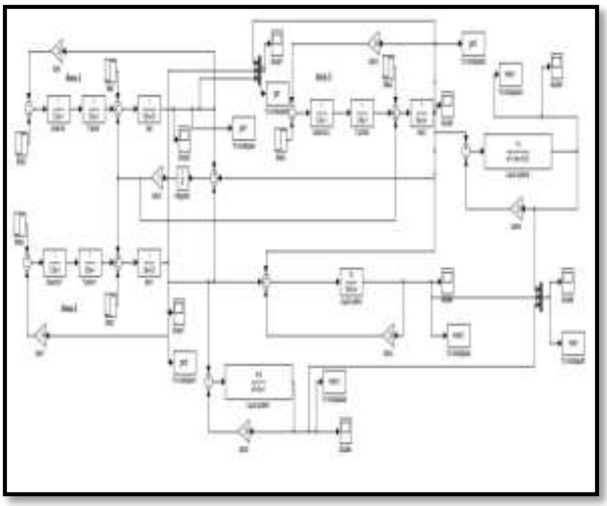
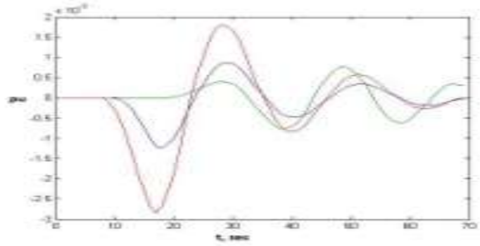




Ouput response of motor and generator graph

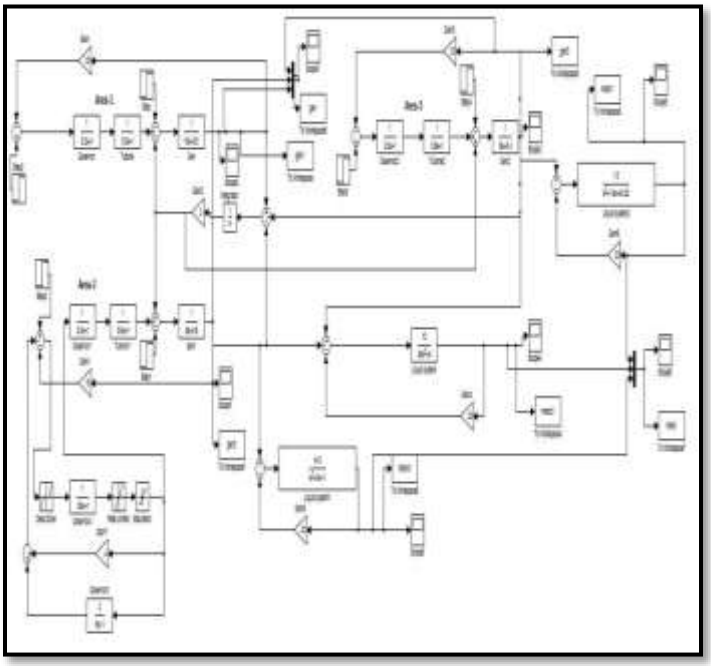
Case-III: AGC in Multi area system



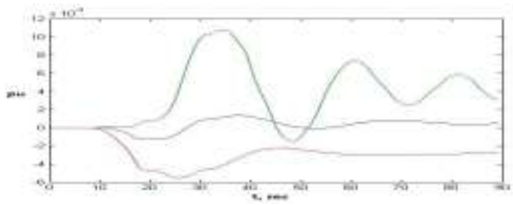


<u>Output response of Generator graph:</u>

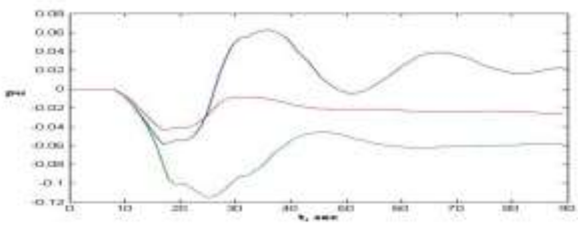
<u>Case-IV:</u> Add Rate limiter, Dead zone, Saturation curve for finding more stability.



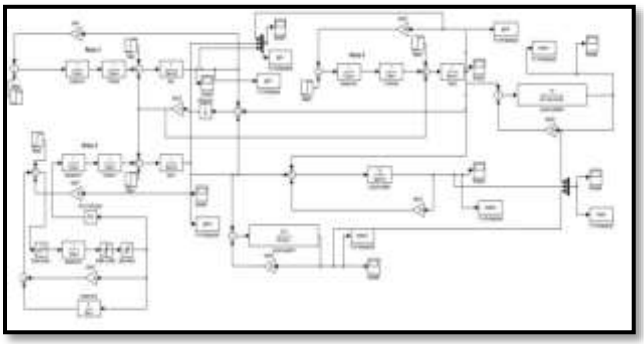
Generator graph: :



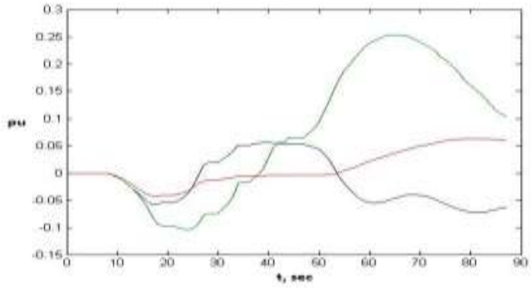
Motor graph



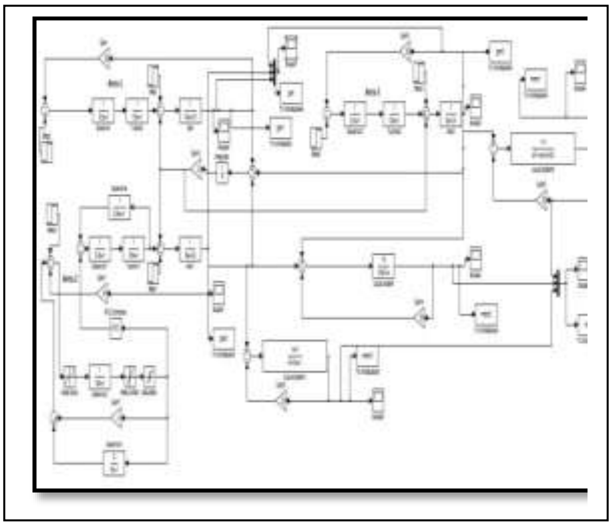
<u>Case-V:</u> Add PID controller for more stability.



Generator graph:



Case-VI: AGC in Multi area system



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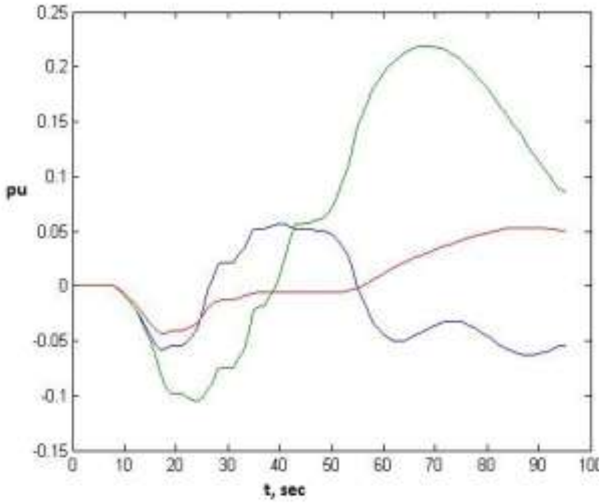
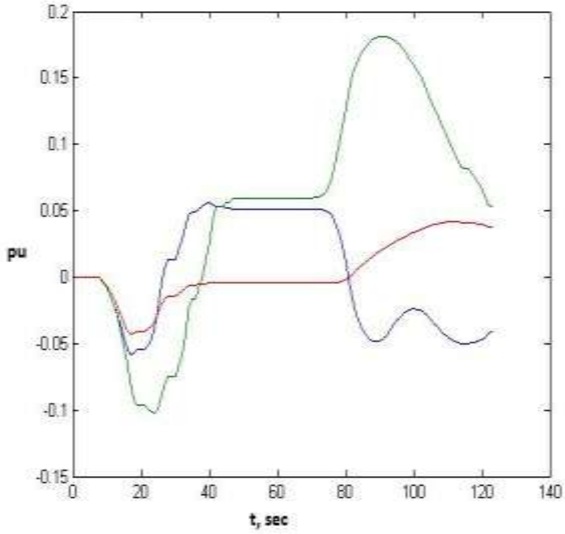
Generator graph:



Case-VII: AGC in Multi area system

Generator graph:



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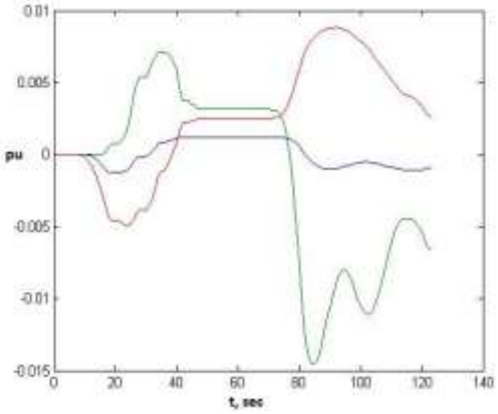
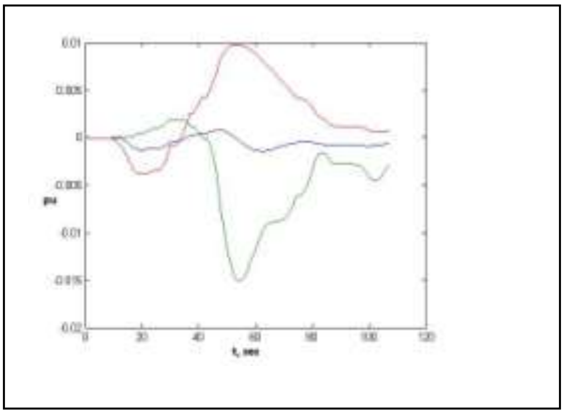
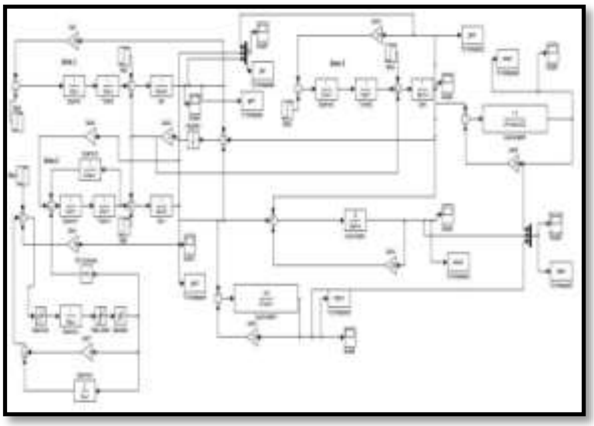
Motor graph:



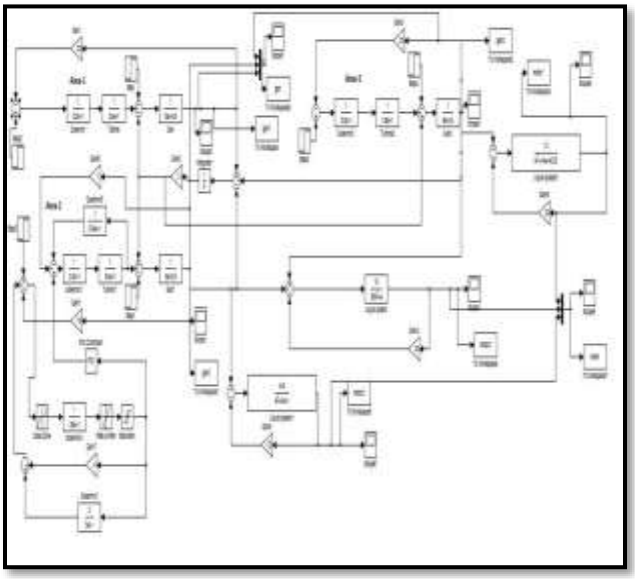
Motoring Graph



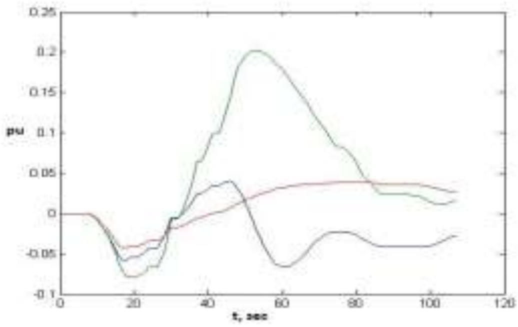
Case-VIII: AGC in Multi area system



Case-IX: AGC in Multi area system



Generator graph



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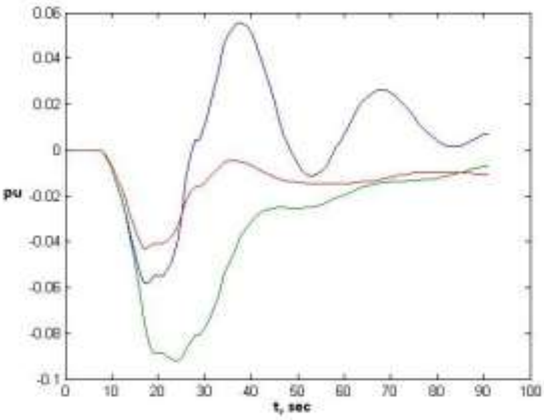
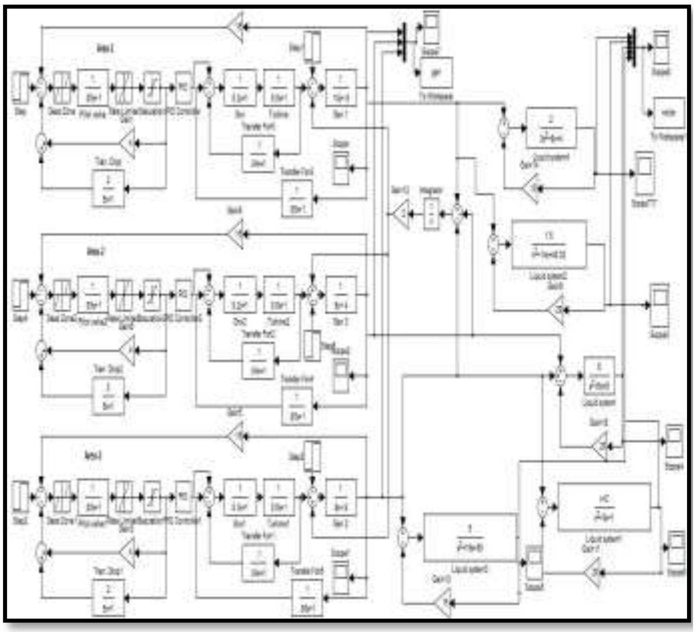
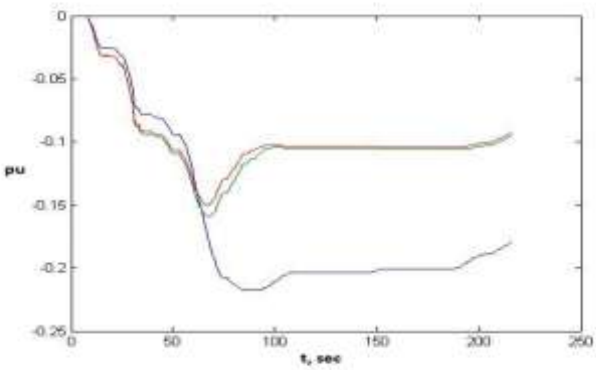
Generator graph:



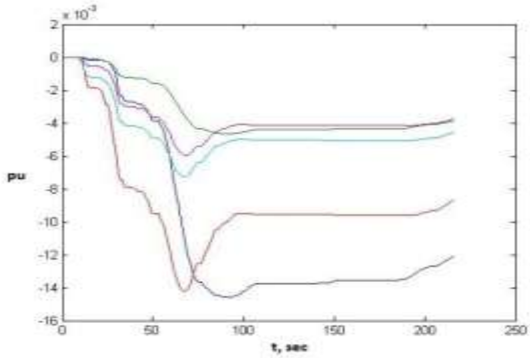
Case-IX: AGC in Multi area system



Generator graph:



Motor graph:



VI. AUTOMATIC GENERATION CONTROL: DESIGN AND IMPLEMENTATION ASPECTS

The objective of the AGC in an interconnected power system is to maintain the frequency of each area and to keep tie-line power close to the scheduled values by adjusting the MW outputs the AGC generators so as to accommodate fluctuating load demands. When frequency changes, under primary regulation, governors respond immediately. But as mentioned earlier, frequency does not get restored but will settle down at a different value. At this point of time LFC function comes in to the picture.LFC maintains the system frequency by performing the function of Secondary Regulation. It provides generation set points to the generators participating in the frequency regulation. But these set points may not be the optimum from cost point of view. Economic dispatch (ED) function readjusts the set points of the generations after the time scale of LFC. In a large interconnected power system there are a number of areas connected by tie lines with share agreements with neighbors. The LFC and ED functions have to take care of these agreements. This function is performed by Interchange Scheduling (IS).. Each of these areas is responsible for generating enough power to meet its own customers or "native load." By keeping the generated power equal to the power consumed by the load, utilities keep the overall system frequency at 50 Hz. Not only must areas adjust their generation to meet their own changing native load, but they must also maintain any scheduled tie-line transactions. It is possible, by monitoring both the tie-line flow and the system frequency to determine the proper generation action (raise or lower). Thus, electric utilities use an automatic generation control (AGC) system to balance their moment-to-moment electrical generation to load within a given control area.The current practice of the load frequency control (LFC) function of automatic generation control (AGC) is based on a strategy known as tie-line bias control. In this control strategy each area of an interconnected system tries to regulate its area control error (ACE) to zero, where: The term (T,-T,) is the difference between the actual and the schleduled net interchange on the tie lines. The term representing the area's natural response to frequency deviations is lOp(f,-f,). The coefficient, p, is known as the system natural response coefficient. It is difficult to obtain an accurate value of p since it depends on the governor reslponse capability of the generating units presently on-line

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and the frequency dependence of the constantly changing load. This characteristic is expressed as: where, (1/R) is the generator regulation or droop, D is the load damping Characteristic.

VII. CONCLUTION:

In an electric power system, **automatic generation control** is a system for adjusting the power output of multiple generators at different power plants, in response to changes in the load. Since a power grid requires that generation and load closely balance moment by moment, frequent adjustments to the output of generators are necessary. The balance can be judged by measuring the system frequency; if it is increasing, more power is being generated than used, and all the machines in the system are accelerating. If the system frequency is decreasing, more load is on the system than the instantaneous generation can provide, and all generators are slowing down. Before the use of automatic generation control, one generating unit in a system would be designated as the regulating unit and would be manually adjusted to control the balance between generation and load to maintain system frequency at the desired value. The remaining units would be controlled with speed droop to proportion their share of the load according to their ratings. With automatic systems, many units in a system can participate in regulation, reducing wear on a single unit's controls and improving overall system efficiency, stability, and economy. Where the grid has tie interconnections to adjacent control areas, automatic generation control helps maintain the power interchanges over the tie lines at the scheduled levels. With computer-based control systems and multiple inputs, an automatic generation control system can take into account such matters as the most economical units to adjust, the coordination of thermal, hydroelectric, and other generation types, and even constraints related to the stability of the system and capacity of interconnections to other power grids.

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