MINIMIZING FREQUENCY DEVIATION IN MULTI AREAPOWER SYSTEM USING PD, PI CONTROLLERS

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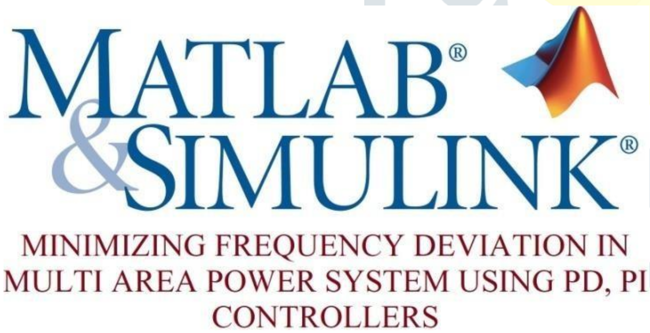
Abstract **— The aim of this paper is to demonstrate the effective control of frequency deviations in a system using different controllers, namely PD and PI controllers. These controllers are used to minimize the frequency errors and to ensure that the system settles quickly to the desired operating conditions. The two controllers are responsible for controlling the frequency deviations and ensuring that the system settles fast in response to load variations. The paper concludes by presenting a comparative chart of the two controllers with respect to their settling time, and determining which controller is most effective in eliminating errors quickly and ensuring that the system settles fast. The LFC models are simulated using MATLAB SIMULINK.**



I. INTRODUCTION

To run an electrical system efficiently, the system must have good power quality environment. Any system which is having poor power quality leads to failure or undesired performance of the system. Such power quality parameters mostly include voltage, current and frequency. There are compensating devices to regulate or to control voltage and current. In which frequency is also an important factor that has to be controlled.

Initially frequency variation occurs in the power system. When there occurs a dissimilarity of frequency across the generation and the load. This unbalanced frequency may leads to unusual operation of the equipment.

In case of an interconnected system, the actual load side frequency control is, to continue or to maintain the frequency within the specified limits and to maintain the exact tie-line power which must flow within the specified tolerance. In this work, thermal and hydro power plants are considered to be interconnected for the load frequency control with the assist of PD and PI controllers.

II. Function of controllers

Generally, the main function of controllers is to control the process. Here we have used PD and PI controllers to gain control over load frequency. In PD controller, which stands for Proportional plus Derivative controller, proportional controller is added with a derivative/differentiator section. This differentiator section generates a derivative signal which produces an output that is proportional to input change along with a constant which represents the differentiation function. This constant will define the output of the controller. When the rate of the input change is kept constant, then the output magnitude obtained is also constant. New input change will lead to new magnitude of output. Hence in PD controller, output is directly proportional to rate of change of error when the error is constant, the controller output becomes zero. In this way, a PD controller sets the input of controller depending on the error variation speed and there by stability of system is being improved remaining steady state error unaffected.

PI controller stands for proportional plus integral which makes the steady state error zero. The primary objective for adopting PI controller is to operate the reference point of load up to the difference in the frequency becomes zero. The constant in PI controller gives, advantages such as reliability, simplicity. The integration part of this controller reduces the disadvantages more over there will be some oscillatory offset. The conventional proportional plus integral have less performance characteristics. So in order to achieve improved performance, the proportional integral controller is being chosen in various systems. Proportional controller decreases the overpass whereas integral controller makes the difference of error in steady state to zero. In this context controller works on tie-line bias control whose responsibility is to decrease the area control error to zero. However along with this there are some effects associated with PI controller such as system order has been increased, system type is increased. Majority this controller enhance the steady state without making any disturbance to transient part.

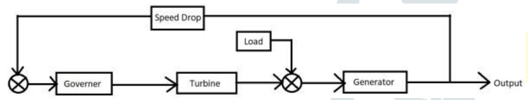
III. METHODOLOGY

For this project, the simulation tool MATLAB was utilized to create a Simulink model and analyze the load frequency control of a power system with multiple generators and controllers. The use of MATLAB allowed for the representation of system behavior through graphs, and images from the simulation and analysis have been included in the report. The PI and PD controllers were used to control the load frequency, and the methodology employed provided a systematic approach to building the Simulink model and conducting the simulation.

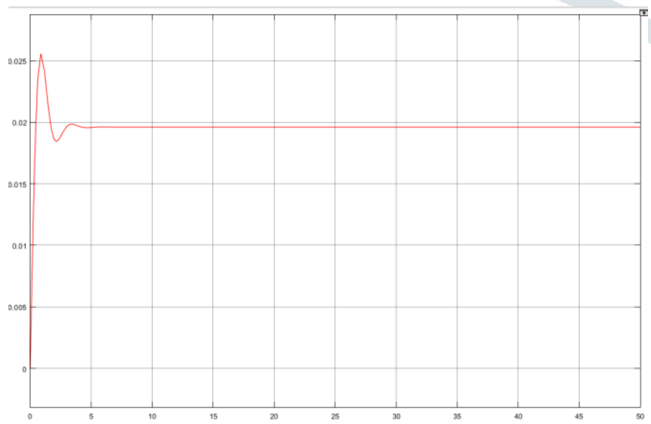
IV. Block Diagrams and Results

A. Single Thermal system without controller

The below block diagram shows us the Single Thermal area system without the use of a controller.



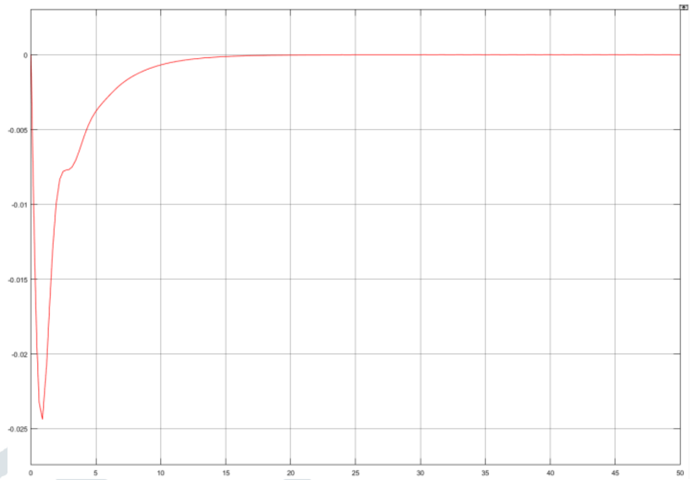
The response obtained for the the Single Thermal area system without the use of a controller is,



B. Single Thermal system with PI controller

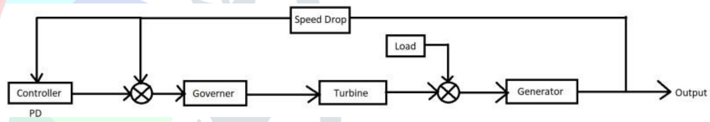
The Below block diagram shows us the Single Thermal area system that is controlled by a PI controller.

The response obtained for the Single Thermal area system that is controlled by a PI controller is,

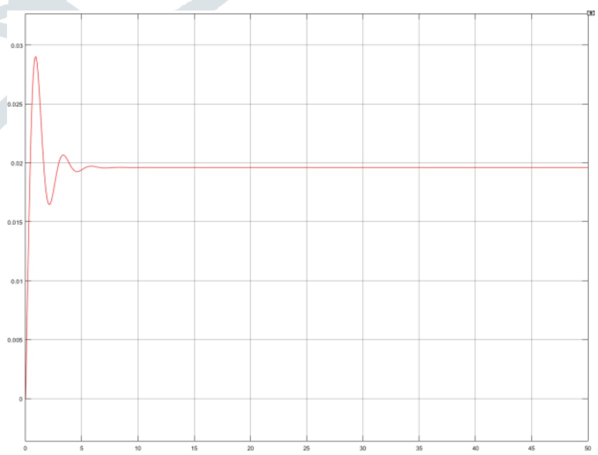


C. Single Thermal system with PD controller

The below block diagram shows us the Single Thermal area system that is controlled by a PD controller.

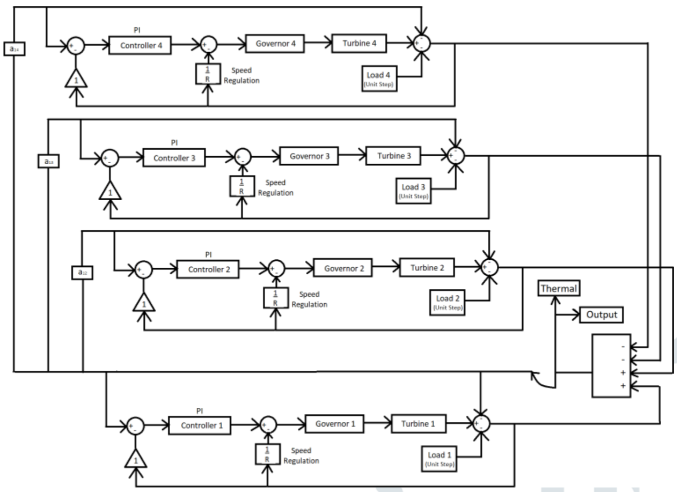


The response obtained for the Single Thermal area system that is controlled by a PD controller is,

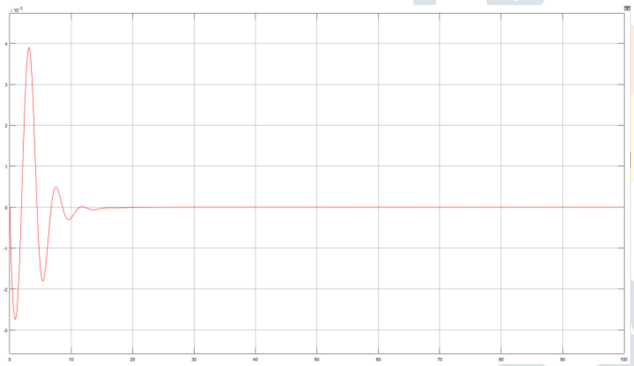


D. Multi Thermal system with PI controller

The below block diagram shows us the Four Thermal area system that is controlled by a PI controller.



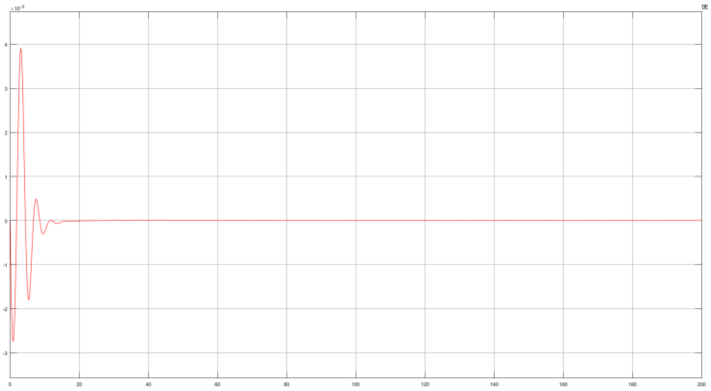
The response obtained for the Four Thermal area system that is controlled by a PI controller is,



E. Multi Thermal system with PD controller

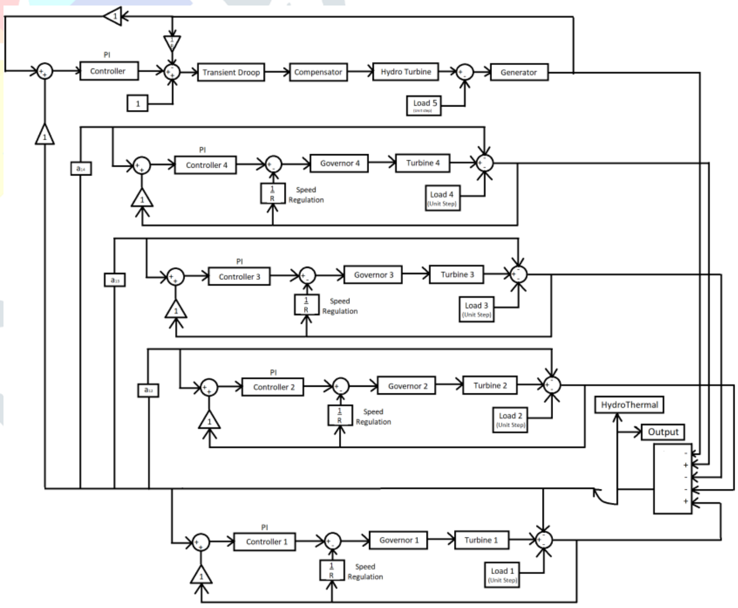
The below block diagram shows us the Four Thermal area system that is controlled by a PI controller.

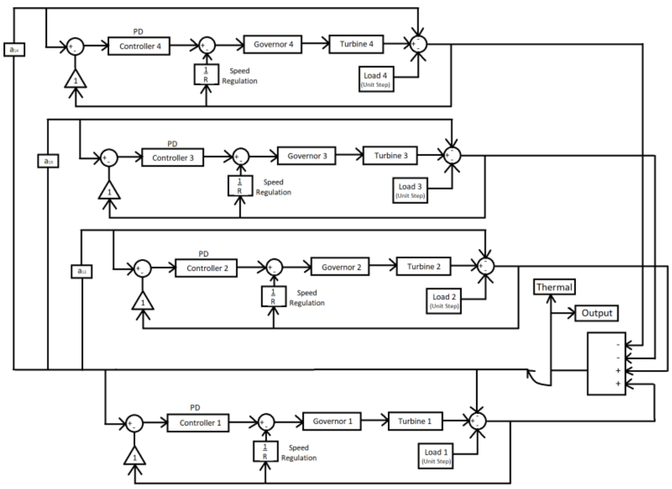
The response obtained for the Four Thermal area system that is controlled by a PD controller is,



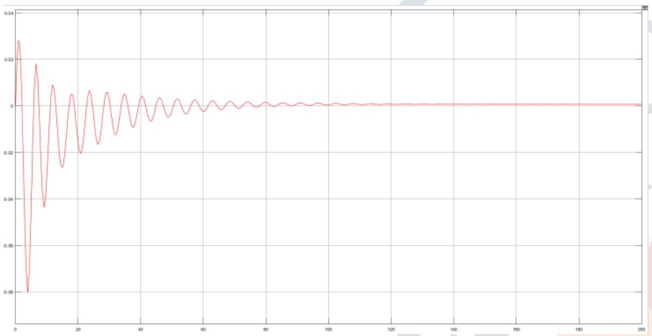
F. Multi Thermal and Hydro system with PI controller

The below block diagram shows us the Four Thermal area along with hydro area system that is controlled by a PI controller.



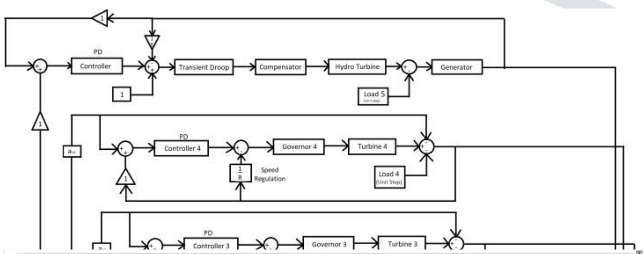


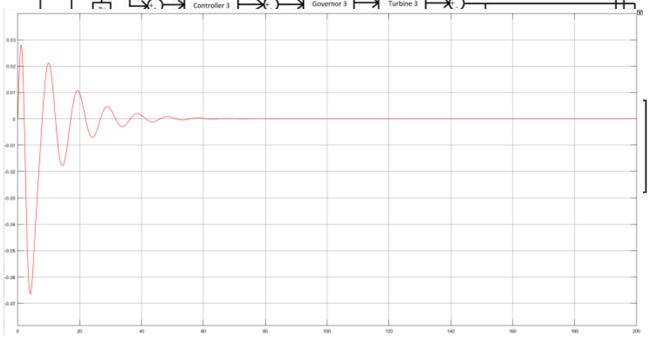
The response obtained for the Four Thermal area along with hydro area system that is controlled by a PI controller is,



G. Multi Thermal and Hydro system with PD controller

The below block diagram shows us the Four Thermal area along with hydro area system that is controlled by a PD controller.





The response obtained for the Four Thermal area along with hydro area system that is controlled by a PD controller is,

V. Literature Survey

Multi-area power systems are an interconnected network of power systems, consisting of several control areas, each with a local generating unit, and the overall objective of the control is to maintain the system frequency, which is a critical parameter in power systems. The frequency deviation in power systems may arise due to various reasons, including variations in load demand, sudden changes in generation, or transmission line failures. Therefore, it is crucial to minimize frequency deviation to ensure the stability and reliability of the power system.

One approach to minimizing frequency deviation is by using proportional-derivative (PD) and proportional-integral (PI) controllers. The PD controller is a feedback control system that uses both proportional and derivative terms to regulate the output of the system, while the PI controller uses both proportional and integral terms.

There has been significant research on the use of PD and PI controllers to minimize frequency deviation in multi-area power systems. One such study by Maheshwari et al. (2015) proposed a PD controller to minimize frequency deviation in a three-area power system. The study showed that the PD controller effectively reduced frequency deviation and improved the overall stability of the system.

Another study by Liu et al. (2017) proposed a PI controller to minimize frequency deviation in a multi-area power system. The study used a genetic algorithm to optimize the parameters of the PI controller, and the simulation results showed that the optimized PI controller effectively reduced frequency deviation and improved the transient stability of the system.

In a more recent study, Ahmad et al. (2021) proposed a hybrid PD-PI controller to minimize frequency deviation in a multi-area power system. The study used a particle swarm optimization algorithm to optimize the parameters of the hybrid controller, and the simulation results showed that the hybrid controller outperformed both the PD and PI controllers in terms of frequency deviation and settling time.

In summary, the use of PD and PI controllers has shown promising results in minimizing frequency deviation in multi-area power systems. Future research could focus on developing more sophisticated control strategies that can handle more complex scenarios, such as changes in the topology of the power system or cyber-attacks.

VI. CONCLUSION

The analysis conducted in this paper reveals that the significance of Load Frequency Control increases significantly with the introduction of a substantial amount of renewable power sources, such as hydro power generation. To effectively manage the frequency deviations in such scenarios, the Tie Line Bias Control method of LFC has been employed, which distributes the loads among various units and minimizes frequency deviations. The study also incorporates the use of pi and pd controllers in Thermal and Hydro Systems for Load Frequency Control.

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