



## Multi Area Power System Frequency Stabilization

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### ABSTRACT

*Modern Power Systems Present an Energy Mix that comes with an Increasing Number of Powers Electronics-Based Devices like Energy Storage Systems, solar energy Systems, High Voltage DC Links, Etc. These Devices don't Have Inherent Inertia Like Traditional Systems to Counteract Frequency Deviations During Disturbances like Load Imbalance. A Virtual Inertia Controller in An Energy Storage System Is Presented during this Paper to Mitigate the Frequency Instability During System Disturbances. symbolic logic Control Is Proposed as An Intelligent Control Technique to supply Adequate Inertia Response to Drive the System Back to Steady State During Load Disturbance. The Concept of Support Vector Control is additionally wont to Drive the Steady State During Load Disturbance. The system was modelled and analyzed using MATLAB/ Simulink software.*

**Keyword**—fuzzy logic control, Neural network, power systems stability, renewable energy and virtual inertia.

### 01. Introduction

#### Preamble:

To meet the growing demand of electricity, it's necessary to harness various sources of power generation. Renewable energy, which appears to be a promising solution has gained prominent attention over the previous couple of decades. However, the mixing of renewable energy systems can significantly reduce the general inertia of the facility system thereby making the system susceptible to frequency and voltage fluctuations. this suggests that tackling the difficulty of power penetration from renewable sources don't solely believe ride through capabilities but frequency response and power regulation during system disturbances.

#### Aim:

This paper proposes the addition of HVDC links for inter-area power transmission and use of adaptive neuro fuzzy interface system and support vector machine approach as an impact scheme adopted in an energy storage system to supply virtual inertia during load perturbations and wind generation variation

#### Objectives:

1. to review the prevailing multi area power grid.
2. to review the Fourier, transform analysis-based techniques.
3. to review the prevailing FFT, adaptive neuro fuzzy interface system and support vector machine approach analysis-based techniques for multi area power grid analysis and detection.

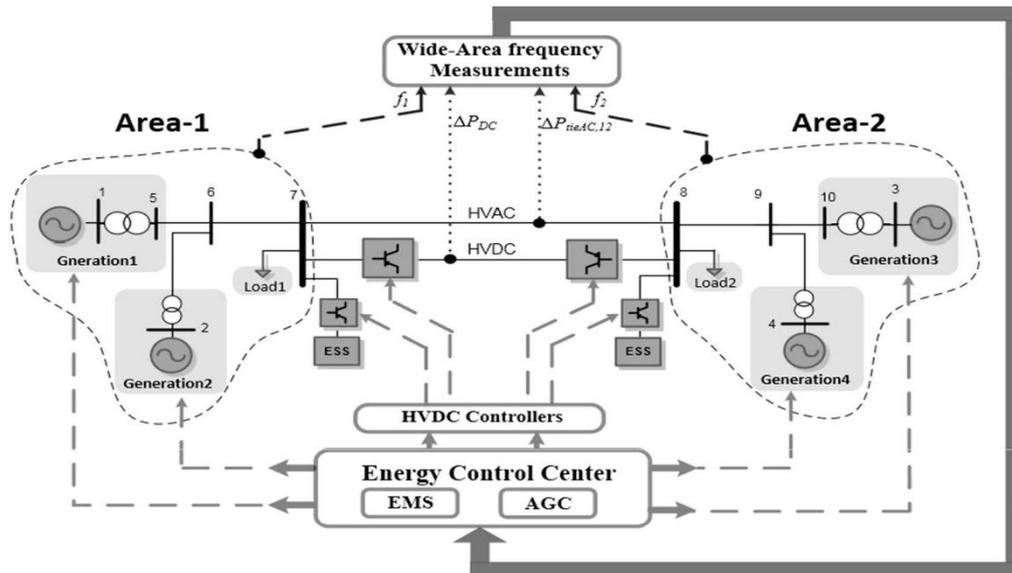


Figure. 1. Pictorial diagram of a two-area interconnected system with parallel ac/ac lines.

**System modelling:**

In conventional power systems that involve rotating masses, the kinetic energy is a function of the inertia. The overall kinetic energy present in a system is given as

$$E = \frac{1}{2} mJ^2$$

where  $J$  is the moment of inertia in the system in  $\text{kgm}^2$  and  $m$  is the angular frequency in  $\text{rad/s}$ .

For a rotating mass, the rate of change of angular frequency of the rotor depends on the difference in mechanical and electrical torque ( $T_m$  and  $T_e$ ). The torque equation commonly referred to as “swing equation”.

**FUZZY LOGIC CONTROL**

A fuzzy logic control (FLC) system is an intelligent control system that has found application in various fields of science and engineering [21]. A basic structure of a FLC system is shown in Figure. 3. It consists of a fuzzification process where the crisp input is converted to a fuzzy input, an inference engine that uses the rule base system to determine the fuzzy output and a defuzzification process that converts the fuzzy output into the crisp output is needed by the system. The rules in a FLC are determined by the IF-THEN statements [22].

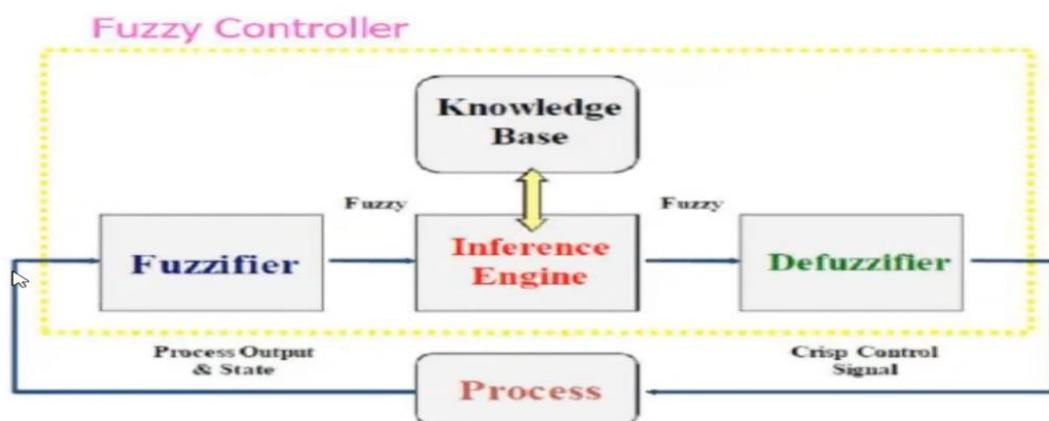


Figure. 2 Basic structure of a FLC system.

In this work, the FLC system consist of two inputs (frequency deviation and derivation of frequency deviation) and one output (inertia gain) as shown in Figure. 4. The output of the controller tunes the gain for the ESS to efficiently provide the necessary power to mitigate the frequency deviation.

I. The performance of the designed fuzzy controller is evaluated with a conventional derivative controller.

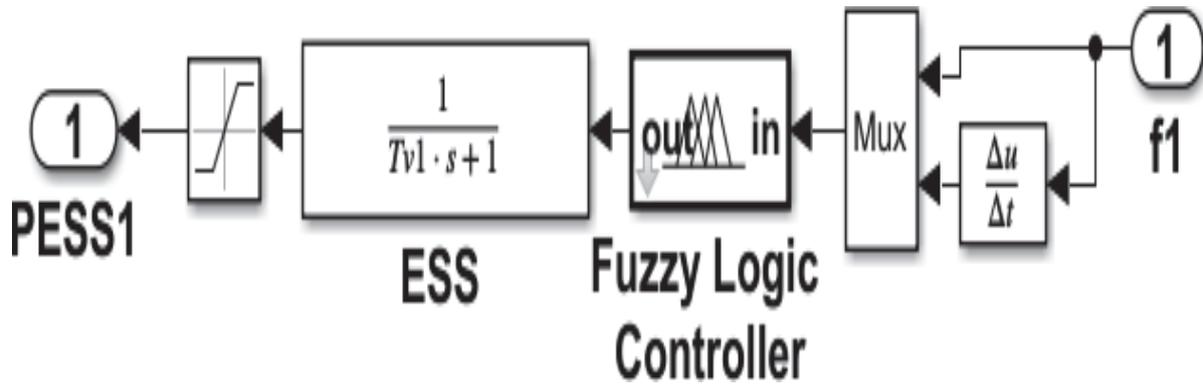


Figure. 3. Energy storage system with fuzzy logic controller

### RESULTS DISCUSSIONS

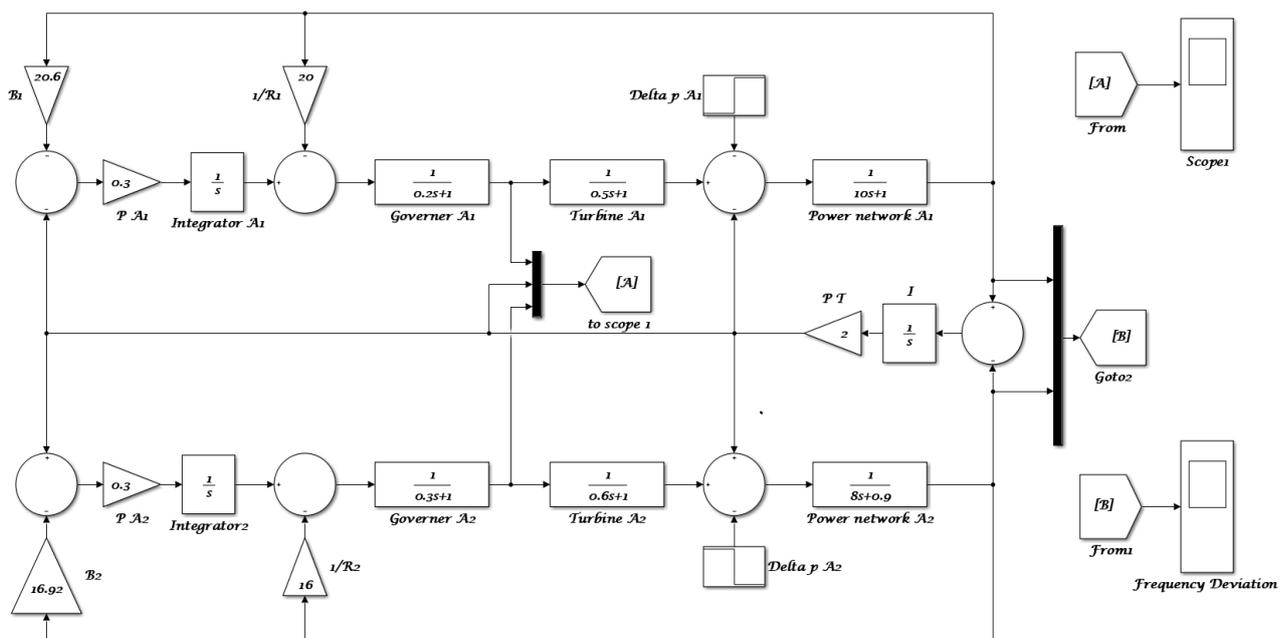


Figure. 4 multi area system with frequency and speed deviation

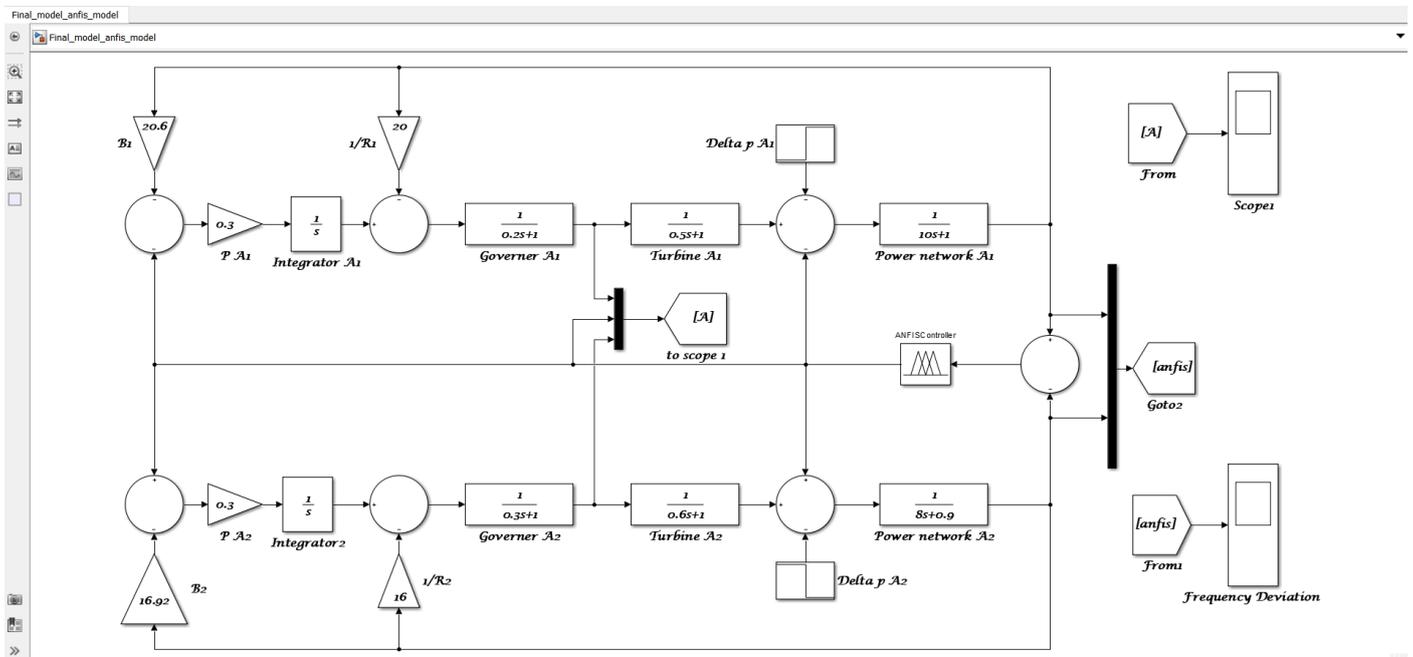


Figure.5 ANFIS MATLAB model of two area system

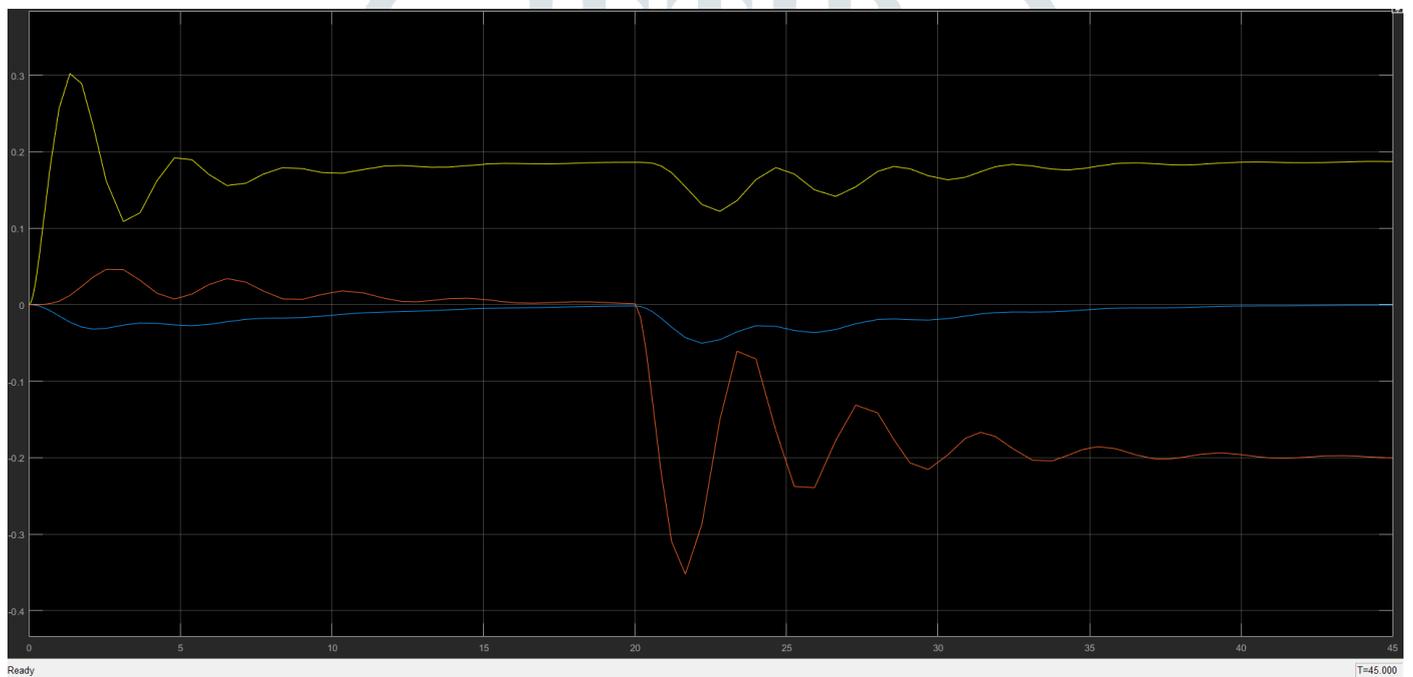


Figure. 6 speed deviation of multi area

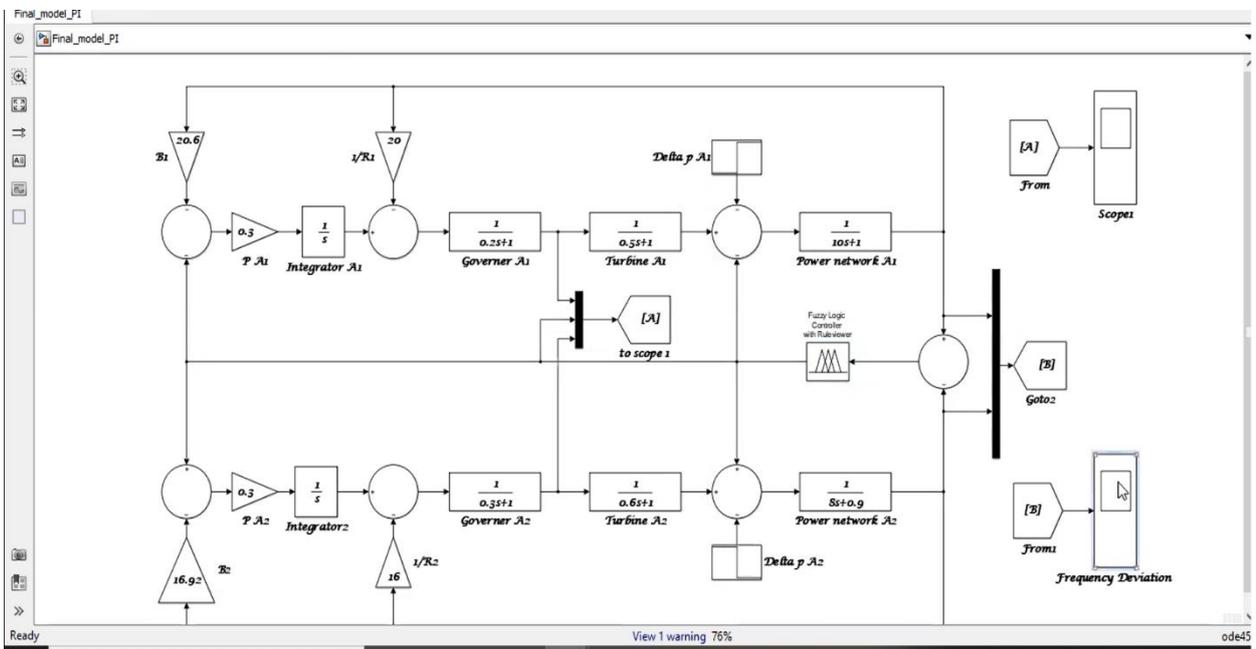


Figure.6 fuzzy MATLAB model of two area system

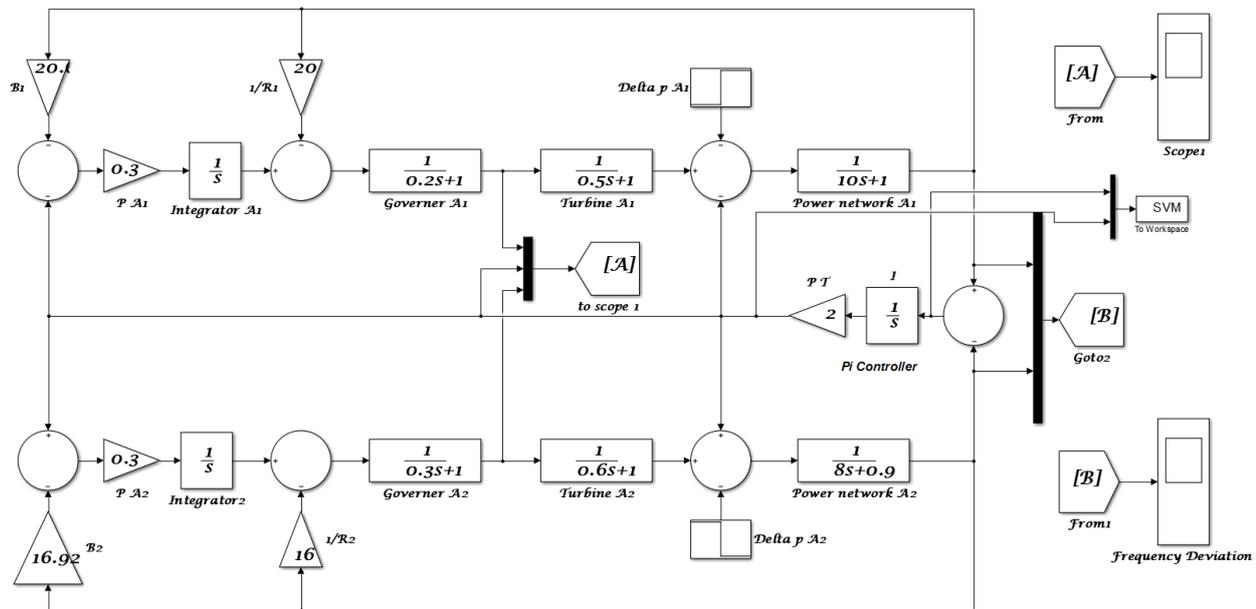


Figure 7 SVM MATLAB model of two area system

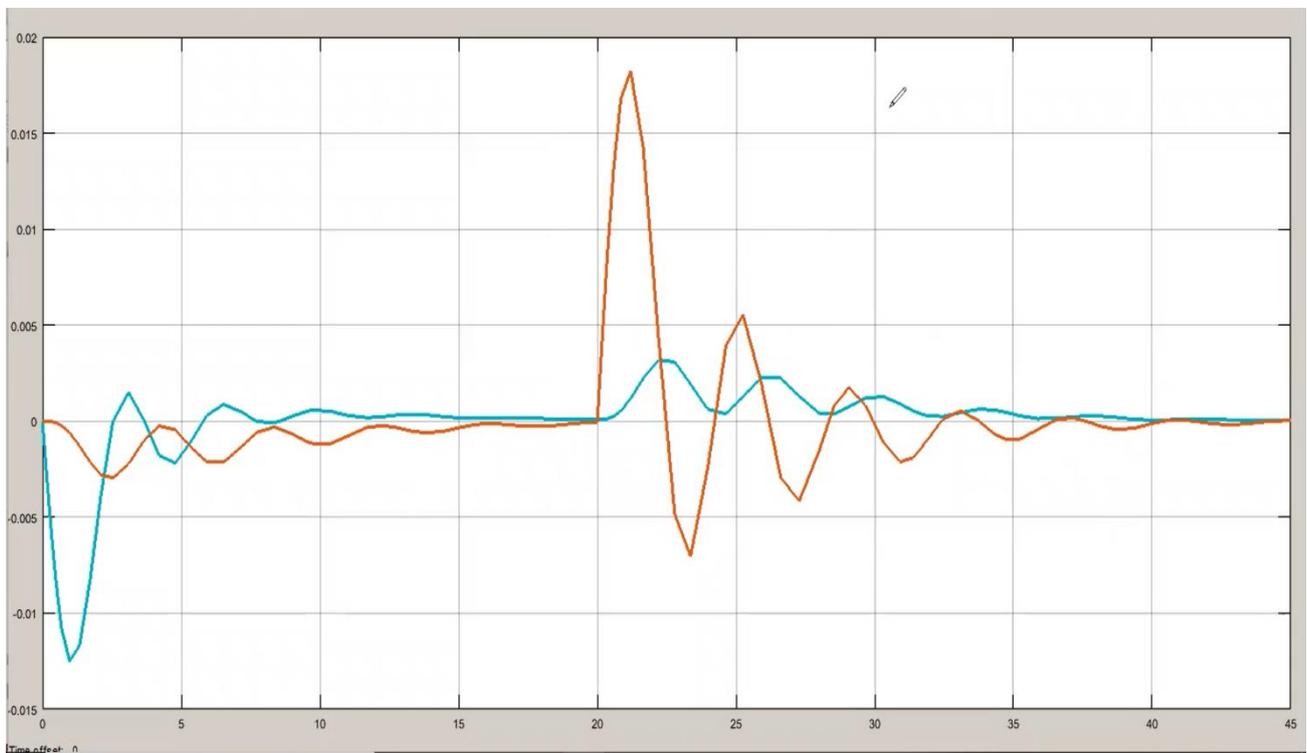


Figure 8 FREQUENCY DEVIATION OF PI MODEL

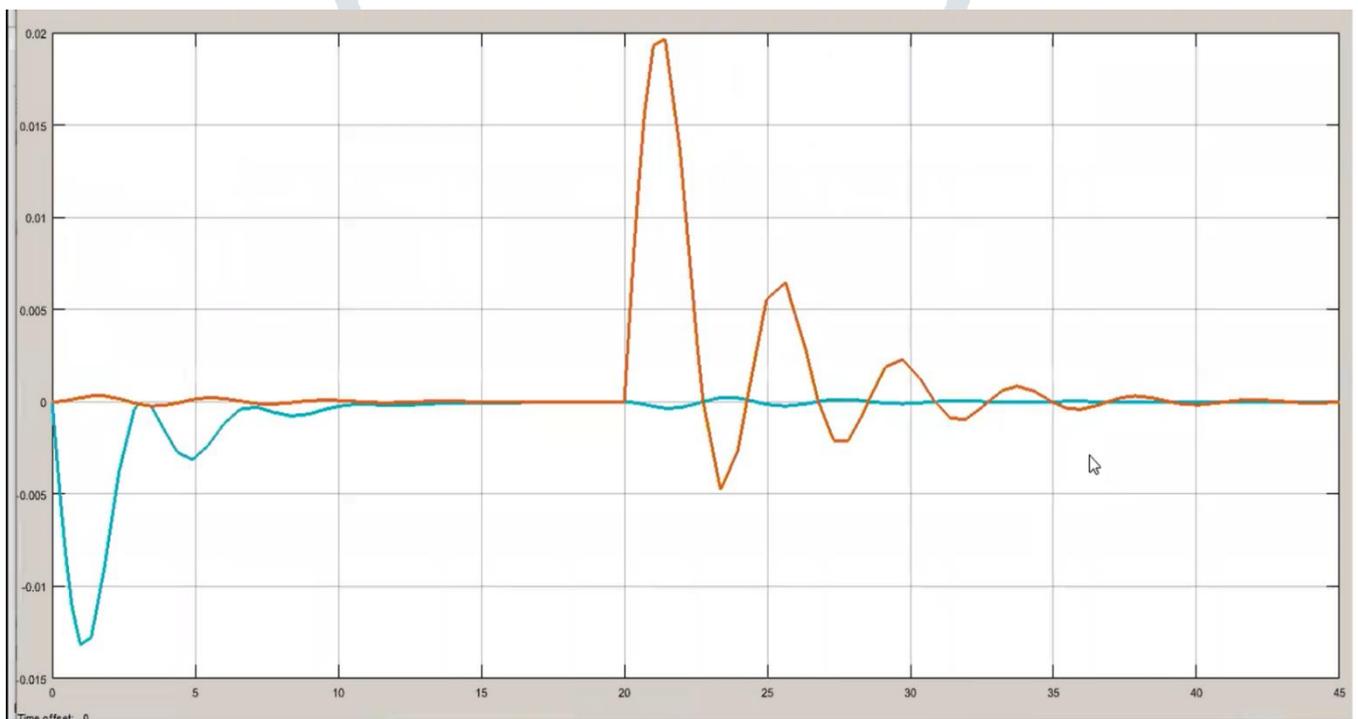


Figure 9 FREQUENCY DEVIATION OF FUZZY MODEL

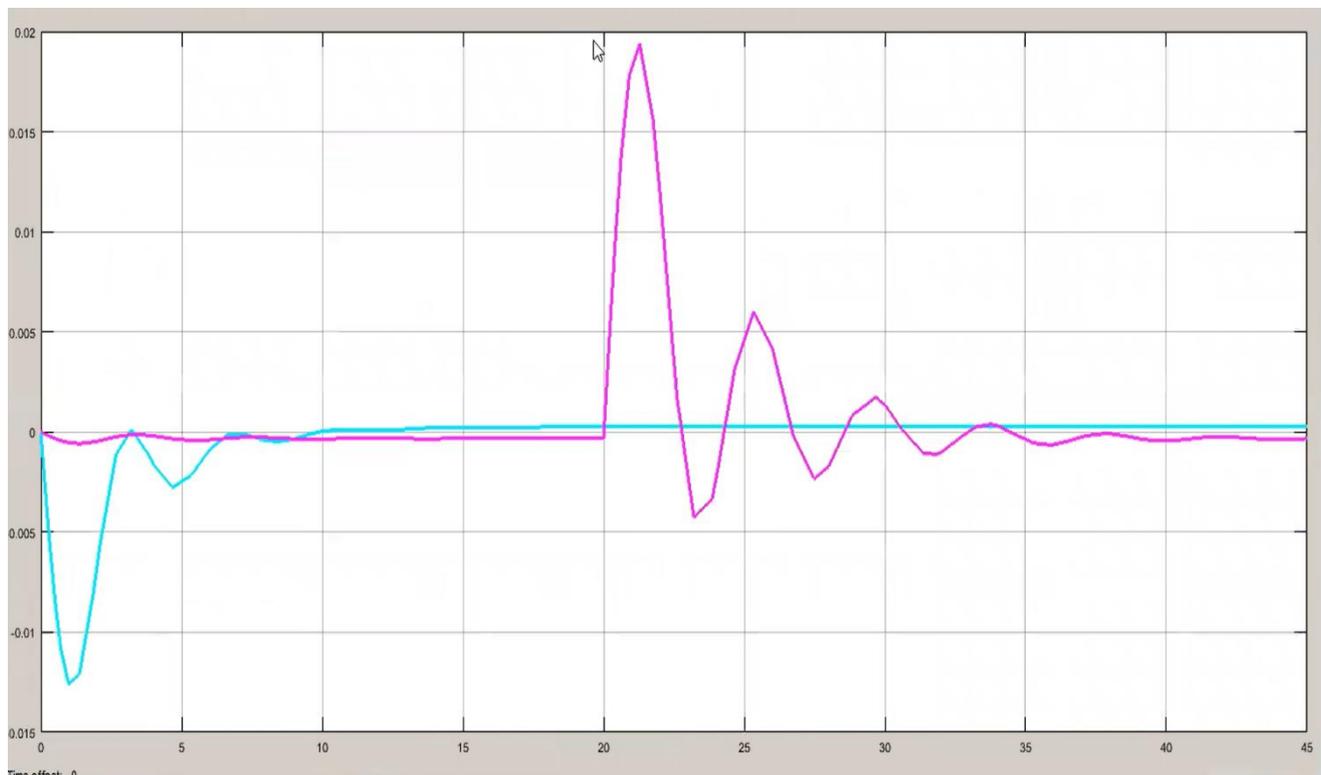


Figure 10: - FREQUENCY DEVIATION OF ANFIS MODEL

To analyse the effect of intermittency associated with renewable energy systems, a variation in wind power as shown in Figure.8 is simulated in Area 1. To analyse the effect of intermittency associated with renewable energy systems, a variation in solar power as shown in Figure. is simulated in Area 2. This intermittency is simulated in parallel with the step load increase described previously. It is that the continuous variation in wind power affects the frequency of the system continuously. Once again, the fuzzy logic virtual inertia controller provides the best performance under this intermittent condition with reduced frequency deviation and effective zero-reference tracking of frequency in both areas.

## CONCLUSION

In modern power systems with increased integration of renewable energy sources and dynamic system disturbance, it is necessary to maintain the system stability. In this paper, a fuzzy logic controller, ANFIS, is integrated to an energy storage system. The designed controller responds faster than the conventional derivative controller.

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