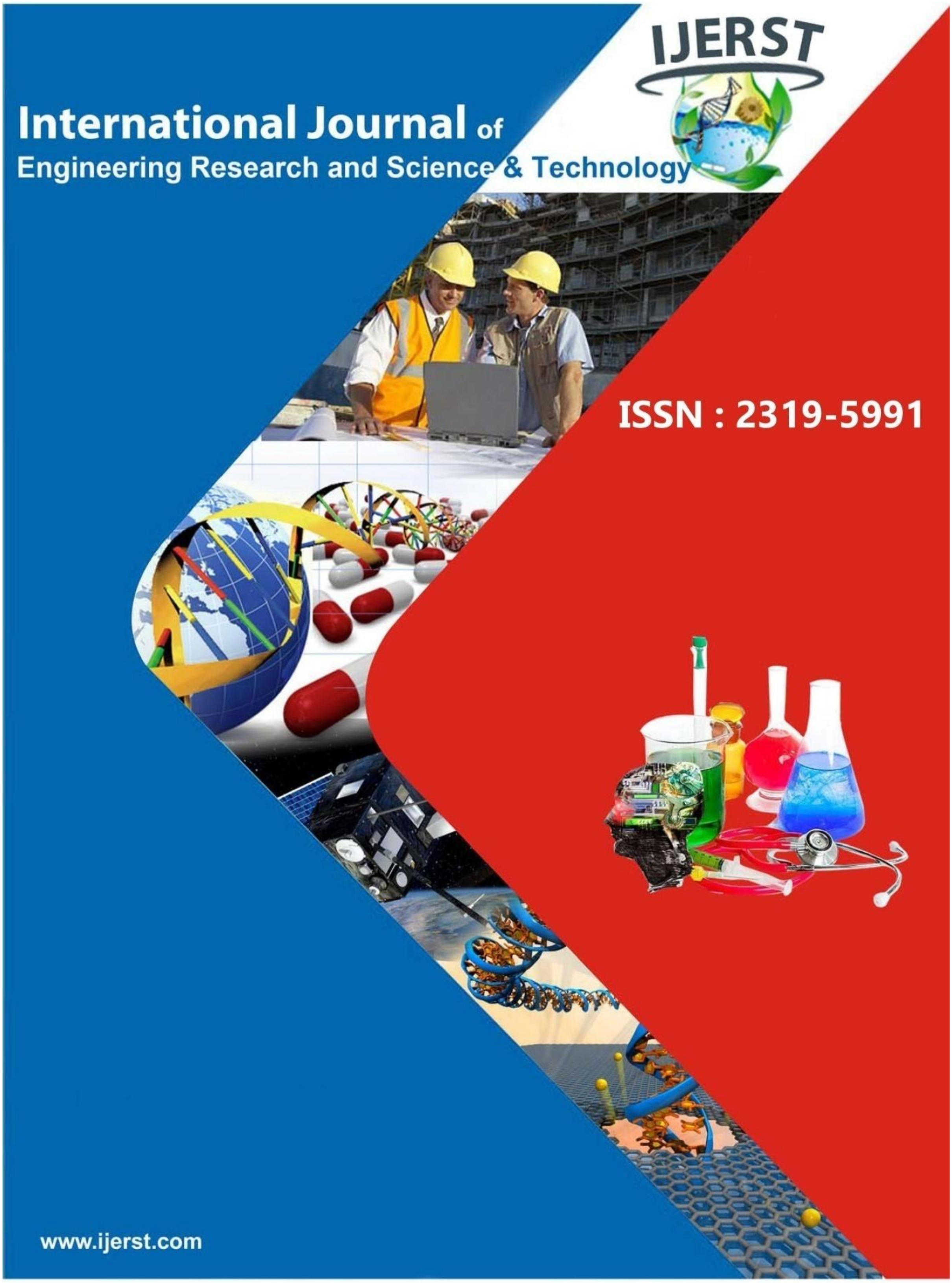

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LOAD FREQUENCY CONTROL IN A MULTI AREA SYSTEM:A COMPARATIVE ANALYSIS

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ABSTRACT

In the present paper the analysis of a four area interconnected power system is studied using the classical and modern controllers. Amongst the classical methods the integral and PID controllers are explored while the modern approach are carried out by used are MRAS, LQR and the LQG controllers. The Load Frequency Control (LFC) analysis and results have shown that the performance of the modern controller is better over their classical counterparts.

KEYWORDS: **Load Frequency Control (LFC), Proportional Integral Derivative (PID), Model Reference Adaptive System (MRAS), Linear Quadratic Regulator (LQR), Linear Quadratic Gaussian (LQG).**

1. INTRODUCTION

In a electrical power system load frequency control (LFC) is very important for stability of the system. The main aim of the load frequency control is to maintain the real frequency and the desired output power in the interconnected power system and to control the change in tie line power between control areas.[1]In a interconnected power system any small sudden load change in any of the areas causes the fluctuation of frequency in each and every area and also in the power tie line[2,3]. After each load change, the LFC for a interconnected power system which consist of a control system which is appropriate and capable of bringing effectively tie line power and the frequency of each area back to original set point values or very nearer to the set point. In different power systems researchers have used different control techniques for LFC design. The application of different advanced control strategies which can take quick decision is expected to improve the LFC results in a power system. Optimal control techniques which forms a part of the advance feedback controllers can be used to achieve better performances[4,5]. Optimal control pole placement, Linear quadratic regulator (LQR) ,Linear quadratic Gaussian regulator (LQG), PID controller, Fuzzy logic controller, internal mode control, robust control, sliding mode control[6,7] are some good example of advanced control. Another controller in the form of Fuzzy logic control of systems, which is based on fuzzy gain schedule of integral and proportional integral parameter[8], can also be used. In this paper, the results using both the classical PID and optimal control techniques are explored for use in for a four area interconnected power system. The controllers Dynamic performances in the form of settling time, peak overshoot of the controller has been shown in the simulation results.

2. FOUR AREA POWER SYSTEM

In a four area power system, 6 tie lines connect all the four areas, through which power can flow from one area to the other. The Power flow and frequency, which get affected by changes of load are required to be controlled. A simplified arrangement for such a scheme is shown below in Fig.

1.

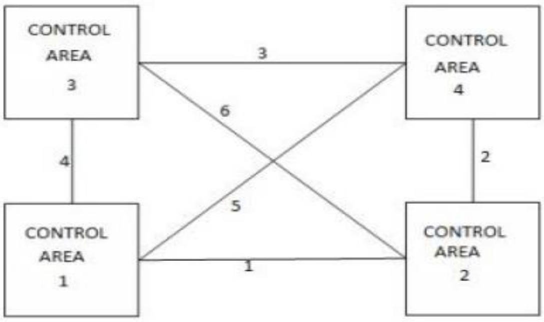

Figure1:A Four area power system

2. MATHEMATICALLY MODELING OF FOUR AREA CONTROL SYSTEM

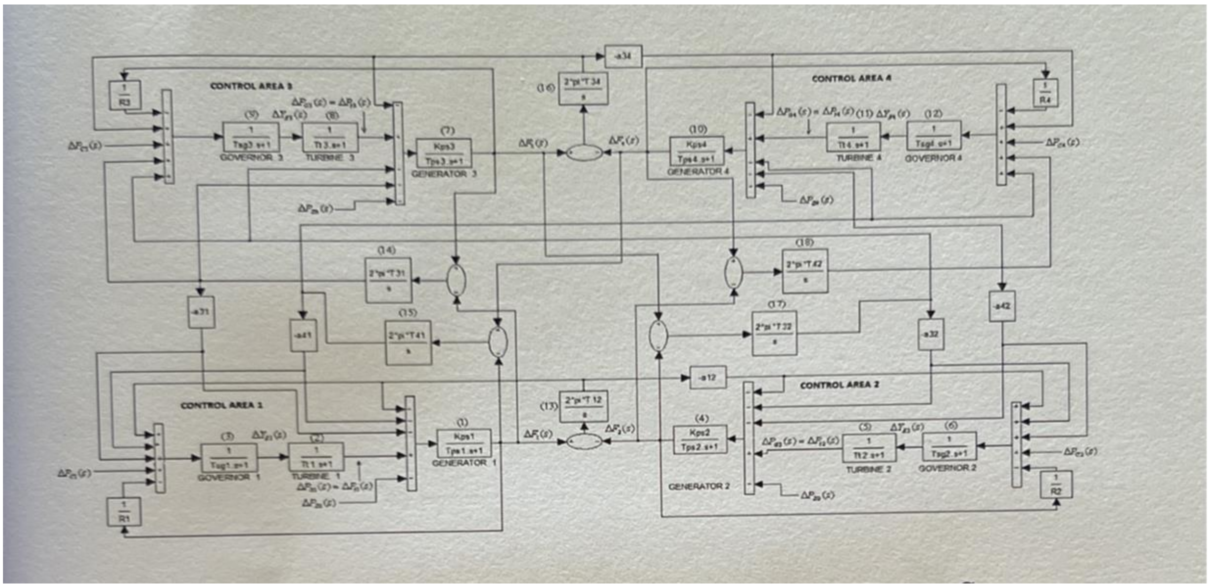

Fig.2.Model of a Four Area Interconnected Power System

In a four area interconnected power system which has been shown in Fig. 2 each area is connected to each other by six tie lines. In State Space modeling there will be total 22 state equations .The modeling of the state equations are carried out as follows:-

$x_1 = \Delta f_1$; $x_2 = \Delta P_{g1} = \Delta p_{t1}$; $x_3 = \Delta Y_{E1}$; $x_4 = \Delta f_2$; $x_5 = \Delta P_{g2} = \Delta p_{t1}$; $x_6 = \Delta Y_{E2}$;

$x_7 = \Delta f_3$; $x_8 = \Delta P_{g3} = \Delta P_{t3}$; $x_9 = \Delta Y_{E3}$; $x_{10} = \Delta f_4$; $x_{11} = \Delta P_{g3} = \Delta P_{t4}$; $x_{12} = \Delta Y_{E4}$;

$x_{13} = \Delta P_{tie,12} = \Delta P_{tie,21}$; $x_{14} = \Delta P_{tie,13} = \Delta P_{tie,31}$;$x_{15} = \Delta P_{tie,14} = \Delta P_{tie,41}$; $x_{16} = \Delta P_{tie,34}$;

$x_{17} = \Delta P_{tie,23} = \Delta P_{tie,32}$; $x_{18} = \Delta P_{tie,24} = \Delta P_{tie,42}$;

3. EXPERIMENTAL RESULTS AND DISCUSSION

After the experiments were carried out by using the classical and the modern controllers the observations are shown below in figures Fig.3. to Fig.5.

Optimal LQR and LQG controllers:-

$$\text{PI}=\frac{1}{2} = \int_0^\infty (X^T Q X + u^T R u) dt$$

Where, the positive semi-definite State weighing matrix Q and positive definite Control weighing matrix R are both real and symmetric.

On the other hand by solving the Algebraic Ricatti Equation (ARE) the Kalman gain of the LQG controller is calculated to use the this controller for load flow analysis. Basically a LQG controller can be assumed to be a LQR in tandem with a Kalman filter in the presence of white noise. So in LQG control at first the LQR gain has to be calculated before the using the Kalman filter with it.

Adaptive based MRAS controllers:-

In a model reference adaptive system (MRAS) a model system is assumed to mimic the actual

Power system to give the requisite output. This basically boils down to calculation of the

When a LQR controller is used in the interconnected network the feedback gain of the LQR controller is found by using a quadratic performance index equation.

It is of the form of:-

adaptation gain for the controller, using the error betweer the plant output and the actual model

outputs.

Integral and PID controllers:-

In these conventional controllers, the gains for the proportional, Integral and derivative components

are calculated after proper tuning. The tuned controller is used for load flow analysis.

The results which are found after applying all the different types of controllers in turns in the

interconnected power system can be seen in the following figures.

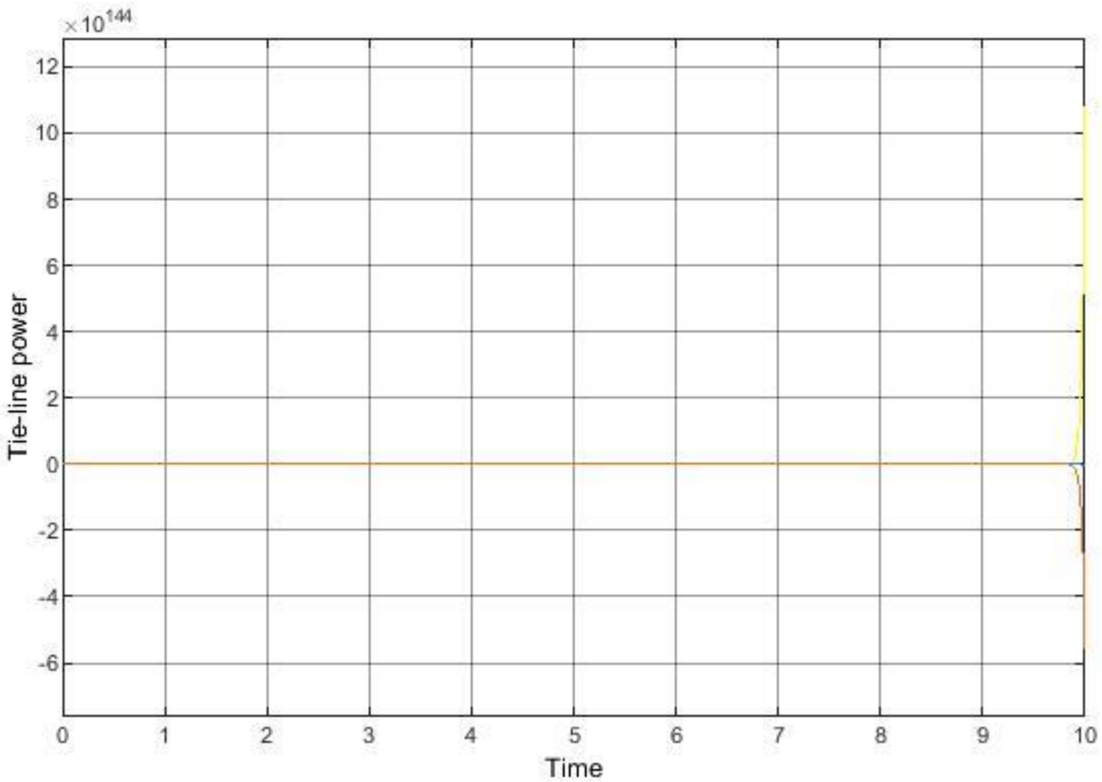

Fig.3. Results with LQG Controller

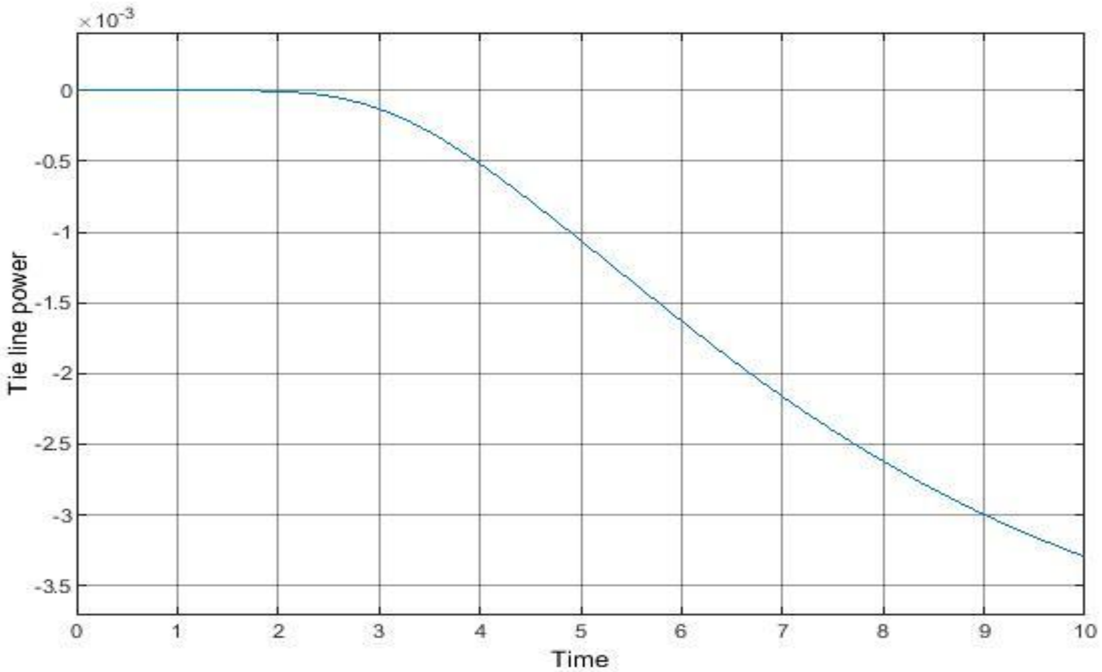

Fig.4. Results with MRAS Controller

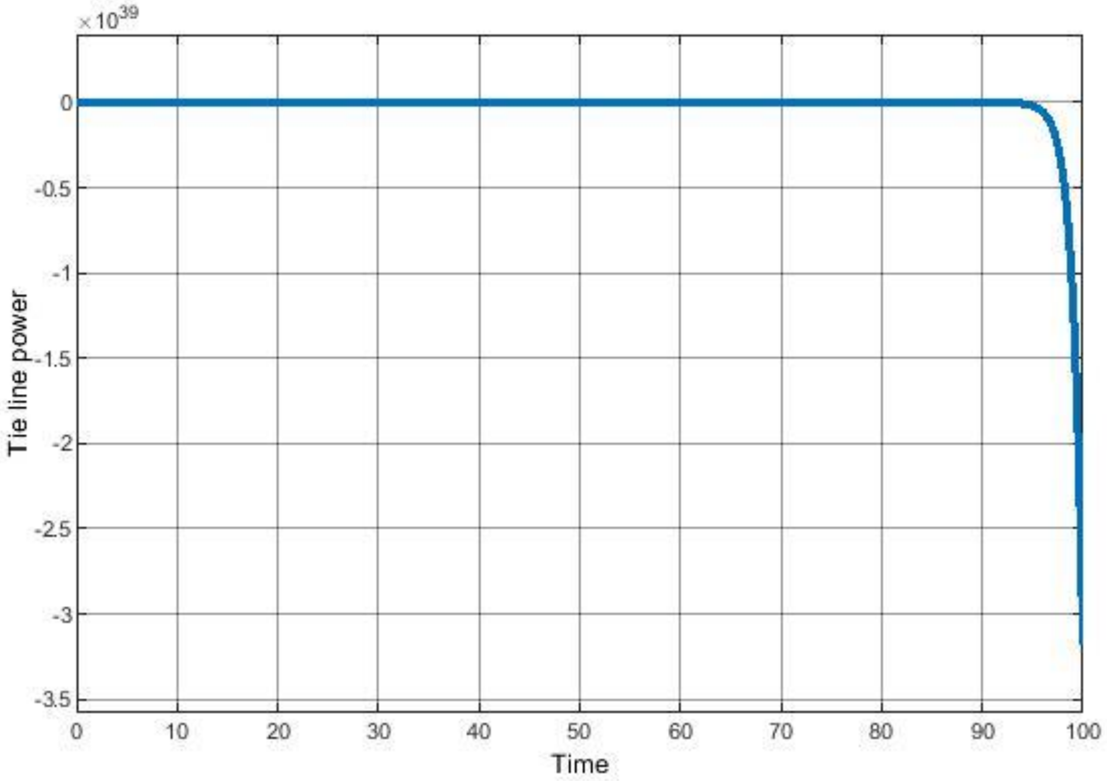

Fig.5. Results with PID Controller

4. CONCLUSION

From the simulation results it can be seen that the performance of the modern LQG and the adaptive MRAS controller are better than the classical PID controller, for this particular 4-area Power System. Amongst the better performed controls the MRAS is holding an edge over its LQG counterpart. But for a concrete and firm conclusion, the present work may be extended to a system with more number of inter connected areas and also applying the same for a Distributed power system.

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