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AUTOMATIC GENERATION CONTROL OF MULTI AREA MULTI SOURCE POWER SYSTEM USING PSO OPTIMISED 2DFO PID CONTROLLER

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ABSTRACT

This study extensively represents a practical power system using thermal power plant in each control area. Practical swarm optimization algorithm (PSO) is applied for tuning purpose. Two degree of freedom controller is designed here based on Particle Swarm Optimization (PSO) for controlling the frequency deviation which is a major problem of a two area interconnected power system. In order to improve the performance of supplying power of a power system, error function is minimized. The objective function taken into consideration over here is Integral Time multiplied with Absolute Error (ITAE). Tuning of controllers are done in order to get the gain values or controller parameters such that the desired frequency and power interchange with neighboring systems is maintained within specific value. The dynamic performance of the system is inspected by considering various time response specifications like peak undershoots, peak overshoots and settling time. The analysis includes a comparative study between, PID controller and 2degree of freedom PID (2DOF-PID) controller.

1.1 INTRODUCTION

The objectives of the Load Frequency Control (LFC) are to divide the load between generators and to control the tie-line power to pre-specify values and to maintain sensibly uniform frequency. In order to supply reliable electric power with good quality, LFC in power system is very important. Constant frequency is identified as the mark of a normally operating system.

A power plant got to monitor the load conditions and serve consumers entire day. It is therefore irrelevant to consider that uniform power is generated throughout. So depending on load power generation varies. The objective of control strategy is to deliver and generate power in an interconnected system as reliably and economically as possible while maintaining the frequency and voltage within the limits. The system frequency is mainly affected due to change in load, while reactive power depends on changes in voltage magnitude and is less sensitive to frequency. To keep the frequency constant conventional controller is used which controls the turbines used for tuning the generators and also the steady state error of system frequency is reduced by tuning the controller gains. There are different algorithms to optimize the controller gains for load frequency control of an interconnected power system like Genetic Algorithm (GA) but this one is difficult to implement because of its complexity in coding and low speed of convergence. Here in this work Particle Swarm Optimization (PSO) is used because of its simplicity and is not affected size of problem and effectively solve large –scale non-linear optimization problems. Before these algorithms got attention there were methods like Conventional method, Ziegler-Nicholas and LQR method were used to tune the controller.

1.2 LITERATURE SURVEY

Dipayan Guha et al [1] proposed to solve load frequency control (LFC) problem in an inter-connected power system network equipped with classical PI/PID controller using grey wolf optimization (GWO) technique. The main aim of the present study is to design and implement a new evolutionary algorithm (EA) known as grey wolf optimization (GWO) for optimal design of PI/PID controller to solve LFC problem. Four different interconnected power system networks with steam turbine nonlinearity are considered to test the effectiveness of proposed GWO algorithm and simulation results are investigated. Tarkeshwar et al [2] In this paper, load frequency control of an isolated hybrid distributive generation (IHDG) following small step load perturbation is analyzed. A powerful quasi-opposition harmony search algorithm has been used for optimization of the controller Gains of the studied IHDG model. To study the IHDG system behavior and characteristics and to develop a small signal model of IHDG. To apply QOHS algorithm for optimization of the gains of different classical controllers such as integral(I), proportional-integral (PI), integral-derivative (ID) and proportional-integral-derivative (PID) considered individually in the studied IHDG model.

Shengchun Yang et al [3] this paper proposes a MAS-based two-level coordinated control frame to design the LFC for multi-area interconnected power System. The upper-level agent is used to deal with the contradiction between the ACE control and the system frequency recovery and the lower level agents are designed to cooperate with the neighboring agents to realize mutual power support.

D.Das et al [4] the paper presents a simple and efficient method for solving radial distribution network. This method is very efficient and requires less computer memory. The proposed method can easily handle different types of load characteristics. The proposed method involves only the evaluation of simple algebraic expressions of voltage magnitude and no trigonometric terms, as opposed to the standard load flow case. However the proposed method can easily include composite load modeling, if the breakup of the loads is known.

Sheetla Prasad et al [5] This paper addresses non-linear sliding mode controller (SMC) with matched & unmatched uncertainties for load frequency control (LFC) application in three-area interconnected power system. The proposed controller has ability to vary closed-loop system damping characteristics according to uncertainties and load disturbances present in the system. Manoj Kumar Debnath et al [6] here an unique controller termed as 3 degree of freedom proportional integral-derivative (3DOF-PID) controller is recommended for automatic generation control of a hybrid source power system. The scrutinized system includes a unified power system having two area where every area consists of three varieties of generating sources viz. a gas, hydro and a thermal unit.

Sanjoy Debbarma et al [7] in this paper, Two-Degree-of-Freedom-Fractional Order PID (2-DOF-FOPID) controller is proposed for automatic generation control (AGC) of power systems. Proposed controller is tested for the first time on a three unequal area thermal systems considering reheat turbines and appropriate generation rate Constraints (GRCs). Ibraheem a et al [8] this article presents the design of optimal automatic generation control regulators for an interconnected power system operating in a deregulated environment. An extra-high-voltage AC transmission line in parallel with a high-voltage DC link is considered as an area interconnection between the two areas. Haluk Gozde et al [9] In this study, a novel gain scheduling Proportional-plus-Integral (PI) control strategy is suggested for Automatic generation control (AGC) of the two area thermal power system with governor dead-band nonlinearity.. In this strategy, the control is evaluated as an optimization problem, and two different cost functions with tuned weight coefficients are derived in order to increase the performance of convergence to the global optima.

Banaja Mohanty et al [10] this paper presents the design and performance analysis of Differential Evolution (DE) algorithm based Proportional–Integral (PI) and Proportional–Integral–Derivative (PID) controllers for Automatic Generation Control (AGC) of an interconnected power system.

1.3 OBJECTIVE

As we know 50 Hz is normal operating frequency in India and if there is a variation of ± 2.5 Hz then it is going to seriously affect the entire system. For example turbine blades are prone to get damaged in such condition. Also there is a relation between frequency and motor speed which is also going to be affected by frequency variation. The objective of this work is to design a controller based on the optimized parameters obtained from PSO algorithm for restricting the value of frequency to a constant against any variation in load demand. The power flow through the tie line of each area must be maintained to its pre-specified value Minimize the error of the system.

2. System considered

The system considered is a two-area hydrothermal power system taken from the works of Sahu and Chandrakala et al [21] and shown in Figure 1. The parameters of the system are given in Appendix C. The 2DOFPID is designed for the system and PSO is employed to find out the optimal parameters of 2DOFPID considering objective function ITAE as considered.

2.1 PID CONTROLLER:

PID controller has all the necessary dynamics: fast reaction on change of the controller input (D mode), increase in control signal to lead error towards zero (I mode) and suitable action inside control error area to eliminate oscillations(P mode). Derivative mode improves stability of the system and enables increase in gain K and decrease in integral time constant Ti, which increases speed of the controller response.

PID controller is used when dealing with higher order capacitive processes (processes with more than one energy storage) when their dynamic is not similar to the dynamics of an integrator (like in many thermal processes). PID controller is often used in industry, but also in the control of mobile objects (course and trajectory following included) when stability and precise reference following are required. Conventional autopilot is for the most part PID type controllers.

2.2 2DOF PID CONTROLLER:

The degree of freedom of a control system is defined as the number of closed-loop transfer functions that can be adjusted independently. The design of control systems is a multi-objective problem, so a two-degree-of-freedom (abbreviated as 2DOF) control system naturally has advantages over a one degree-of-freedom (abbreviated as 1DOF) control system. This fact was already stated by Horowitz, but did not attract a general attention from engineers for a long time. It was only in 1984, two decades after Horowitz's work, that a research to exploit the advantages of the 2DOF structure for PID control systems was made.

2.3 Particle swarm optimization

Particle swarm optimization (PSO), originated by James Kennedy and R.C. Eberhart in 1995. It is a stochastic (connection of random variable) evolutionary computation method used to explore search space. This technique is based on swarm's intelligence and movement. As this is based on swarm behavior, is a population based technique. The bird generally follows the shortest path for food searching. Based on this behavior, this algorithm is developed. It uses a number of particles where every particle is considered as a point in N-dimensional space. Each particle keeps on accelerating in the search space depending on the knowledge it has about the appreciable solution comparing its own best value and the best value of swarm obtained so far. It is well described by the concept of social interaction because each particle search in a particular direction and by interaction the bird with best location so far and then tries to reach that location by adjusting their velocity this require intelligence.

3. SIMULATION BLOCK DIAGRAM

Fig 1 Two Area thermal and hybrid systems with 2DOF PID & PID controllers

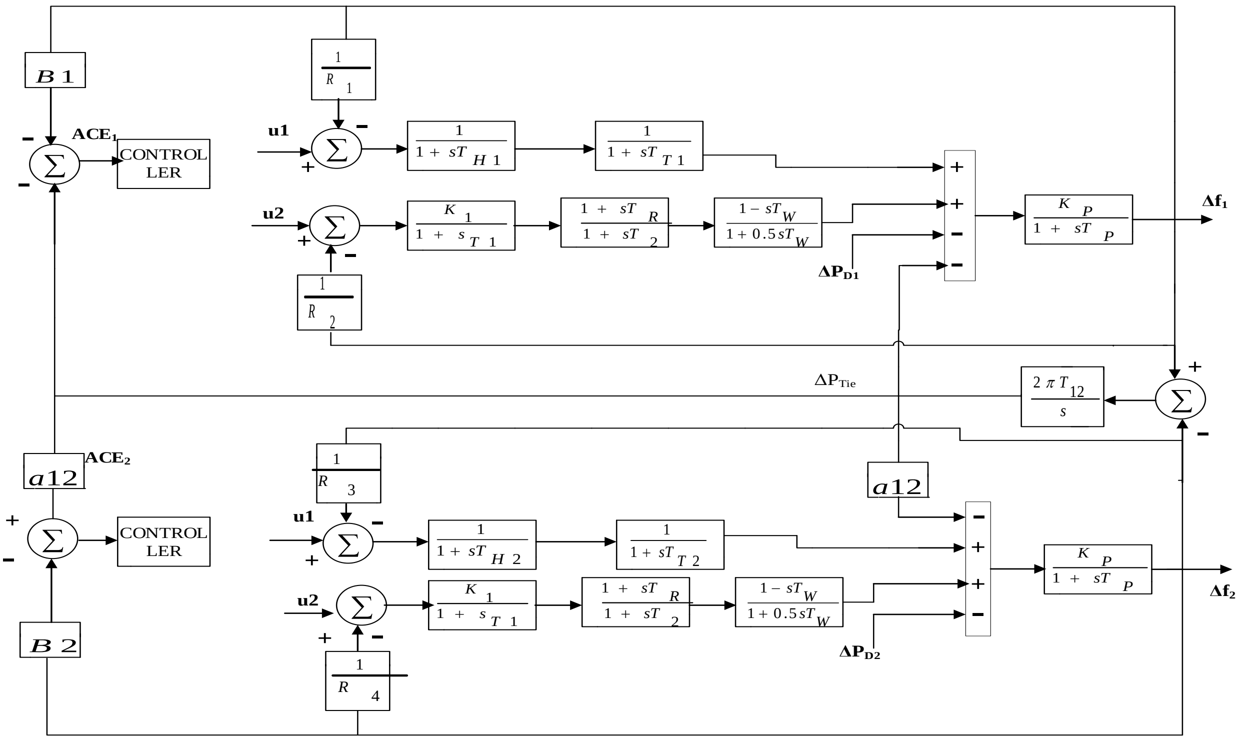

Table- 1 PSO optimized values of PI, PID and 2DOF PID controller for two area

CONTROLLER	Pw_1	dw_1	Pw_2	dw_2	Pw_3	dw_3	Pw_4	dw_4	K_{p1}	k_{p2}	k_{p3}	k_{p4}	k_{i1}	k_{i2}	k_{i3}	k_{i4}	k_{d1}	k_{d2}	k_{d3}	k_{d4}	n
2DOF PID	0.4	1.1	0.5	1	1	0.9	0.8	1.1	1.8	1.7	1.7	1.8	1.74	1.98	-1.3	1.63	0.2	0.1	0.3	0.2	112.82
PID	---	---	---	---	-	---	---	---	1.8	0.3	1.2	1.0	1.62	0.12	1.8	-0.35	0.6	0.3	0.4	0.4	100
ZN PI [21]	---	---	---	---	-	---	---	---	0.7	0.7	0.7	0.7	0.61	0.61	0.6	0.61	---	---	---	---	---
GA PI[21]	---	---	---	---	-	---	---	---	0.7	0.7	0.7	0.7	0.62	0.62	0.6	0.62	---	---	---	---	---

3.2 simulation Results:

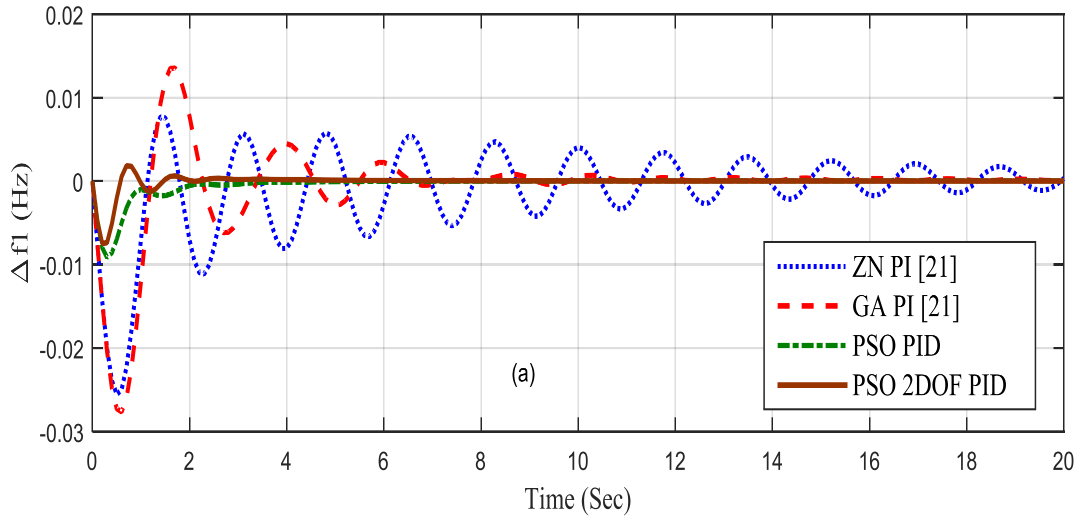

Fig 1.1 Frequency deviation two area thermal and hydral system at area-1 for load disturbance of 1%

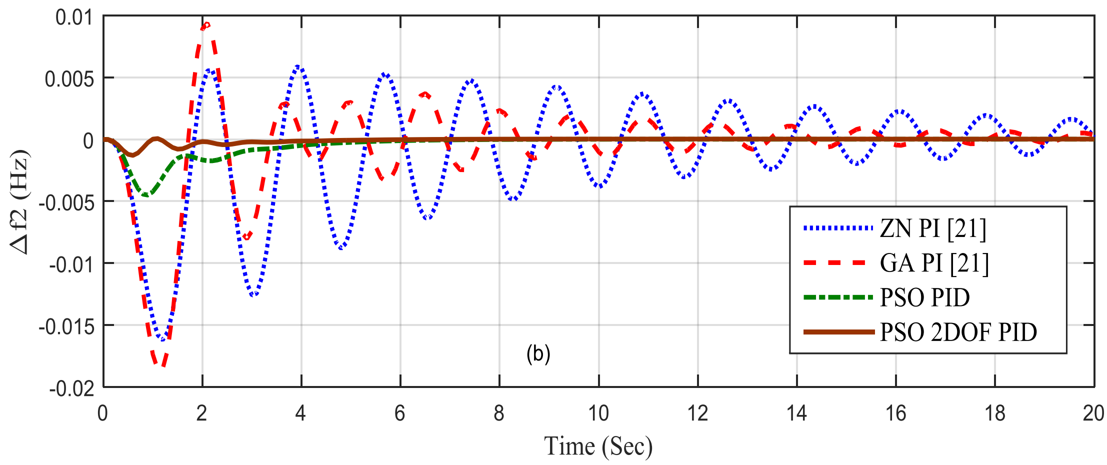

Fig1.2 Frequency deviation two area thermal and hydral system at area-2 for load disturbance of 1%

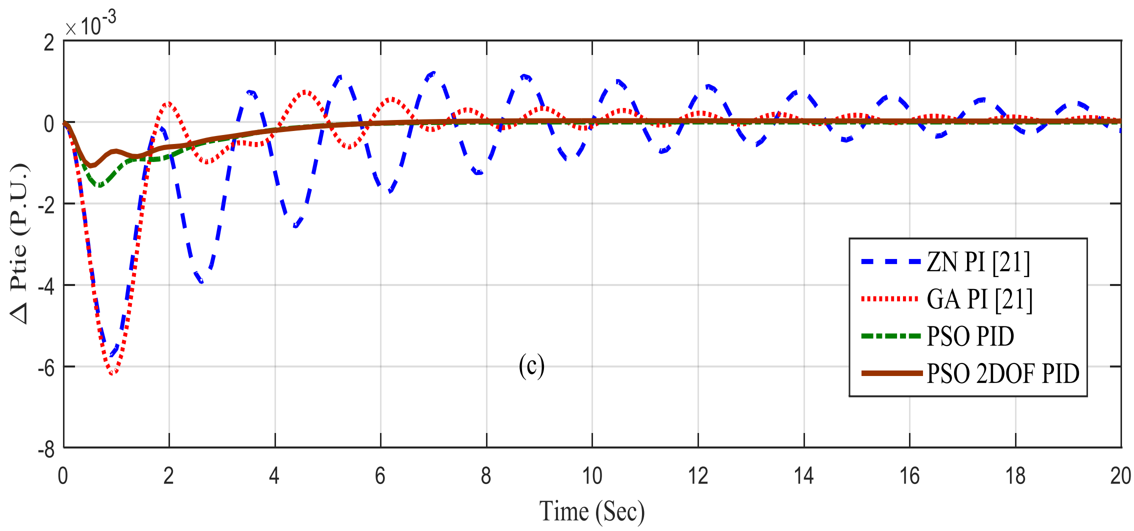

Fig 1.3 Tie line power deviation for two area thermal and hydral systems

Table- 2 Settling time, Overshoot, Under shoot values of two area thermal and hydral system with 2DOF PID controller

CONTROLLER	Δf_1 in HZ			Δf_2 in HZ			Δp_{tie} in P.U		
	U_{SH} in Hz (10^{-3})	O_{SH} in Hz (10^{-3})	T_S in sec	U_{SH} in Hz (10^{-3})	O_{SH} in Hz (10^{-3})	T_S in sec	U_{SH} in Hz (10^{-3})	O_{SH} in Hz (10^{-3})	T_S in sec
2DOF PID	-7.5	1.8	3.7	-1.3	0.0616	3.6	-1.1	0.034	4
PID	-9.1	0.0076	4.1	-4.5	0.0078	5.2	-1.6	0.0038	4.8
ZN PI	-27.7	13.6	10.5	-18.74	9.4	19.8	-6.19	0.74	29.9

4.1 RESULT ANALYSIS

The settling time of 2DOF PID controller is 3.7 which is 9.75% better improvement comparing to PID controller and 64.7% better than ZN PI controller and 88.02% better than GA PI controller, over shoot of 2DOF PID controller reduces to 86.76% compared to ZN PI controller and 76.92% compared to GA PI controller , under shoot of 2DOF PID controller reduces to 17.58% compare with PID controller and 72.92% compare with ZN PI controller and 70.70% better than GA PI controller at area-1. The settling time of 2DOF PID controller is 3.6 which is 30.76% better comparing to PID controller and 81.81% better than ZN PI controller and 88.66% better than GA PI controller,over shoot of 2DOF PID controller reduces to 99.34% compare with ZN PI controller and 98.9% compared to GA PI controller , under shoot of 2DOF PID controller reduces to 71.11% compare with PID controller and 93.06% compare with ZN PI controller and 91.97% compared with GA PI controller for frequency deviation of area-2. The settling time of 2DOF PID controller is 4 which is 16.6% better comparing to PID controller and 16.66% better than ZN PI controller and 91.76% better than GA PI controller , over shoot of 2DOF PID controller reduces to 95.40% compare with ZN PI controller and 97.16% compared to GA PI controller , under shoot of 2DOF PID controller reduces to 31.25% compare with PID controller and 82.22% compare with ZN PI controller and 80.70% compare with GA PI controller for power deviation in area-1&2

4.2 CONCLUSION

Controlling of power systems in order to meet the demands of consumers is a challenging task that motivates to design optimum controllers. They should have the capability of monitoring the power system like maintenance of frequency and voltage in 1ess time. In this thesis, PSO is used to tune parameters of Two degree of freedom controller. A two-area system is taken into consideration to show the better performance of the proposed controller. Different plots of frequency deviation were obtained by varying the load demand of areas. Its superiority over other methods used to tune the controller is justified by comparing the error values.

REFERENCES

1. *Dipayan Guha, Provas Kumar Roy , Subrata Banerjee, Load frequency control of interconnected power system using grey wolfoptimization.SwarmandEvolutionaryComputation27(2016)97–115.*
2. *Tarkeshwar, V.Mukherjee, Almoataz Y.Abdelaziz,Comparative study of classical controllers for LFC of an isolated hybrid distributive generation system. Int. Journal of Engineering, Science and Technology Vol. 7, No. 3, 2015, pp. 133-140.*
3. *Shengchun Yang, Chongxin Huang Yijun Yu, Dong Yue, and Jun Xie, Load Frequency Control of Interconnected Power System via Multi-Agent System Method , Electric power components and systems,00(00):1-13,2017.*
4. *D.Das, D.P.Kothari, A.Kalam, Simple and efficient method for load flow solution of radial distribution networks. Electrical power and energy systems, vol 17,no 5 pp,335-346,1995.*
5. *Sheetla Prasad, ShubhiPurwar, N.Kishor, Non-linear sliding mode load frequency control in multi-area power system. Control Engineering Practice 61 (2017) 81–92.*
6. *Manoj Kumar Debnath, Priyambada Satapathy, Ranjan Kumar Mallick, 3DOF-PID Controller Based Automatic Generation Control Using TLBO Algorithm, International general of pure and applied mathematics volume 114 No. 9 2017, 39-49.*
7. *Sanjoy Debbarma ,Lalit Chandra Saikia b, Nidul Sinha b, Automatic generation control using two degree of freedom fractional order PID controller. Electrical Power and Energy Systems 58 (2014) 120–129.*
8. *Ibraheem a , Prabhat Kumar b , Naimul Hasan a & Yadav Singh ,Optimal Automatic Generation Control of Interconnected Power System with Asynchronous Tie-lines under Deregulated Environment. Electric Power Components and Systems, 40:1208–1228, 2012.*
9. *Haluk Gozde, M. Cengiz Taplamacioglu, Automatic generation control application with craziness based particle swarm optimization in a thermal power system. Electrical Power and Energy Systems 33 (2011) 8–16.*
10. *Banaja Mohanty , Sidhartha Panda , P.K. Hota, Differential evolution algorithm based automatic*

generation control for interconnected power systems with non-linearity.Alexandria Engineering Journal (2014) 53, 537–552.
11. *Bjorn H. Bakken,Ove S. Grande, Automatic Generation Control in a Deregulated Power System. IEEE Transactions on Power Systems, Vol. 13, No. 4, November 1998.*
12. *SanjoyDebbarma, LalitChandraSaikia , Nidul Sinha , Solution to automatic generation control problem using firefly algorithm optimized IλDm controller. ISA Transactions53(2014)358–366.*
13. *H. Golpîraa, H. Bevrani , H. Golpîra, Application of GA optimization for automatic generation control design in an interconnected power system. Energy Conversion and Management 52 (2011) 2247–2255.*
14. *P.Subbaraj, K. Manickavasagam, Automatic generation control of multi-area power system using fuzzy logic controller. Euro. Trans. Electr. Power 2008; 18:266–280.*
15. *Sanjoy Debbarma1, Lalit Chandra Saikia, Nidul Sinha, Automatic Generation Control of Multi-Area System Using Two Degree of Freedom Fractional Order PID Controller. Int. Journal of Electrical Power &*
16. *Energy Systems, Vol. 49, pp. 19-33, 2013.*
17. *S.C.Tripathy, K.P.Juengest, Sampled Data Automatic Generation Control with Superconducting Magnetic Energy Storage in Power Systems. IEEE Transactions on Energy Conversion, Vol. 12, No. 2, 1997.*
18. *Deepak. M , Rajesh Joseph Abraham, Improving the AGC performance in a power system with Thyristor Controlled Series Compensator. IEEE Transactions on Power Systems, Vol.18,No.4,pp.1487-1496,2003.*
19. *Rabindra Kumar Sahu , Tulasi chandra Sekhar Gorripotu, Sidhartha Panda, Automatic generation control of multi-area power systems with diverse energy sources using Teaching Learning Based Optimization algorithm. Engineering Science and Technology, an International Journal 19 (2016) 113–134.*
20. *José Luis Rodríguez-Amenedo, Santiago Arnalte, Juan Carlos Burgos, Automatic Generation Control of a Wind Farm With Variable Speed Wind Turbines. IEEE Transactions on energy conversion ,Vol.17,no.2, june 2002.*
21. *Dipayan Guha , Provas Kumar Roy , Subrata Banerjee, Application of backtracking search algorithm in load frequency control of multi-area interconnected power system. Ain Shams Engineering Journal (2016).*
22. *K.R.M. Vijaya Chandrakala , S. Balamurugan , K. Sankaranarayanan , Variable structure fuzzy gain scheduling based load frequency controller for multi source multi area hydro thermal system. Electrical Power and Energy Systems 53 (2013) 375–381.*