Scientific Journal Impact Factor (SJIF): 1.711

e-ISSN: 2349-9745
p-ISSN: 2393-8161

International Journal of Modern Trends in Engineering and Research
www.ijmter.com

DESIGN OF MPSS AND TCSC DAMPING CONTROLLERS IN MULTI- MACHINE POWER SYSTEM USING BFO.

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Abstract - The main approach of this paper is to do the small signal analysis in a two area four machine power system which has coordinated design of both MPSS and TCSC. TCSC controller is design based on power oscillation damping controller which is used for voltage series compensation at the voltage sag, voltage swell .Small signal stability analysis is nothing but analysis in power system for low frequency components in the range of 0.1hz to 2hz.Linear modeling of the power system is carried out to find out the frequency analysis at the different system components like transformer, other devices. BFO algorithm is used to minimize an Eigen value based multi-objective in which it tunes the parameter of the POD controller ,it will be improve the system stability and it saves the computational cost and in less iterations we can achieve the good optimized POD parameter values. The time domain simulation in MATLAB/SIMULINK environment carried out on two area four machine power system over various perturbations shows that superior enhancement in damping of power system oscillations has been obtained by utilizing proposed PSS-POD coordinated controllers in comparison with the CPSS-POD.

Keywords- Small signal stability, Multi-input power system stabilizer (MPSS), TCSC POD controller.

I. INTRODUCTION

Over the years the power system stability has posed a problem to the power system engineers. The problem is posed in two respects; the one is the modeling of the system. To get the correct assessment of power system stability a detail model of the power system need to be developed. Once the mathematical model is correctly developed, one has to obtain the solution through numerical techniques. Because of the large size of the power system, the numbers of differential equations are large in number and therefore solution through numerical techniques takes enormous time.

Stability of power system has been very important concern in system operation .The arising problems in power system may be small or large can be cause the synchronous operation .The severe nature of disturbance may be sudden increase load or loss of generation. Any other disturbance may be short circuit on transmission line, loss of a large generator or load or loss of a tie between two subsystems. A short circuit on a critical element followed by its isolation by protective relay will cause variations in power transfer, machine rotor speed and bus voltages. The voltage variations will actuate prime mover governor and the change in tie loadings may actuate generation controls and then change in tie line loading may actuate generation controls .Then the change in voltage and frequency will affect loads on the system.

Electromechanical oscillations are a major problem in power system. These oscillation may be occur in very weak damped case. TCSC power oscillation damping controller (POD) to provide better damping for these oscillation .Local problems may also be associated with oscillations between the rotors of a few generators close to each other. Such oscillations are called inter-machine or inter-plant mode oscillations. The local plant mode and interplant mode oscillations have frequencies in the range of 0.7 to 2.0 Hz. Global small-signal stability problems are caused by interactions among large groups of generators and have widespread effects.A very low frequency mode involving all the generators in the system. The frequency of this mode of oscillation is on the order of 0.1 to 0.3 Hz. Higher frequency modes involving subgroups of generators swinging against each other. The frequency of these oscillations is typically in the range of 0.4 to 0.7 Hz.

Small-signal stability is the ability of the system to be in synchronism when subjected to small disturbances. The disturbances can be switching of small loads, generators or transmission line tripping etc. The small-signal instability can lead to oscillations in the system.

Thyristor controlled series capacitor (TCSC) is a series flexible ac transmission system (FACTS) device that can be utilized for mitigating sub-synchronous resonance, damping power oscillation, line flow control, Secure loading of transmission lines nearer to their thermal limit and FACTS gadgets furnishes secure tie line connection with neighboring utilities by diminishing generally, For low frequency oscillation damping, Stability improvement, and for low- frequency oscillation mitigation and To improve transmission performance & the reliability of over head line.

II. SYSTEM DESCRIPTION

2.1. Basic details of PSS

A power system stabilizer (PSS) is a device which provides additional supplementary control loops to the automatic voltage regulator (AVR) system and/or the turbine-governing system of a generating unit. A PSS is also one of the most cost-effective methods of enhancing power system stability.

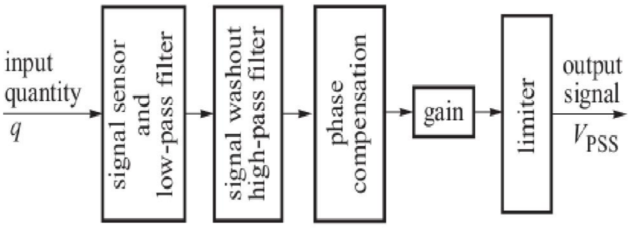

Fig.1 The major elements of a PSS

The general structure of the PSS is shown in Fig.1where the PSS signal V PSS can be provided from a number of different input signals measured at the generator terminals. The measured quantity (or quantities) is passed through low- and high-pass filters. The filtered signal is then passed through a lead and/or lag element in order to obtain the required phase shift and, finally, the signal is amplified and passed to a limiter. When designing the phase compensation it is necessary to take into account the phase shift of the input signal itself and that introduced by the low- and high- pass filters. Sometimes the filters are designed in such a way that they give a net zero phase shifts for the frequency of rotor oscillations. Typically the measured quantities used as input signals to the PSS are the rotor speed deviation, the generator active power or the frequency of the generator terminal voltage.

2.2. Operating principle of PSS

The basic function of power system stabilizer (PSS) is to add damping to the generator rotor oscillations by controlling its excitation by using auxiliary stabilizing signal(s). Based on the automatic voltage regulator (AVR) and using speed deviation, power deviation or frequency deviation as additional control signals, PSS is designed to introduce an additional torque coaxial with the rotational speed deviation, so that it can increase low-frequency oscillation damping and enhance the dynamic stability of power system. Fig.2 shows the torque analysis between AVR and PSS.

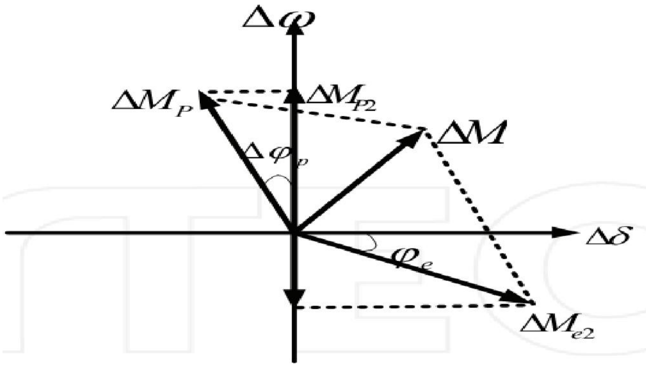

Fig. 2 Torque analysis between AVR and PSS

As shown in Fig.2, under some conditions, such as much impedance, heavy load , the additional torque ΔMe2 provided by the AVR lags the negative feedback voltage (-R̈Vt) by one angle φx ,which can generate the positive synchronizing torque and the negative damping torque component to reduce the low frequency oscillations damping. On the other hand, the power system stabilizer, using the speed signal(Δω) as input signal, will have a positive damping torque component ΔMp2. So, the synthesis torque with positive synchronous torque and the damping torque can enhance the capacity of the damping oscillation.

2.2.1. Structure of power system stabilizer(PSS)

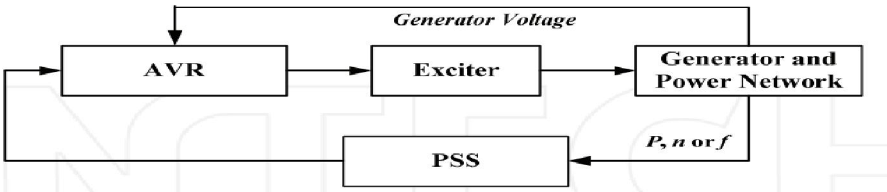

Fig.3 Structure diagram of power system stabilizer (PSS)

Fig.3 shows the structure diagram of power system stabilizer (PSS). Power system stabilizers (PSS) are added to excitation systems to enhance the damping of power system during low frequency oscillation. For the potential power oscillation problem in the interconnected power networks, the power system stabilizers solution is usually selected as the relative practical method, which can provide the additional oscillations damping enhancement through excitation control of the synchronous machines.

2.2.2. TCSC POD controller

The fig.4 shows the simple TCSC POD controller. The TCSC can be made to vary the series-compensation level dynamically in response to the controller-input signal so that the resulting changes in the power flow enhance the system damping. The traditional type of controller for Power Oscillations Damping (POD) purposes uses cascade-connected washout filters and linear lead-lag compensators to generate the desired reactance modulation signal. The purpose of the wash-out filters is to eliminate the average and extract the oscillating part of the input signal. The lead-lag compensators provide the desired phase shift at the oscillations frequency. In some situations, a simple controller consists of only the washout filters can have a better performance than that of the lead-lag controller.

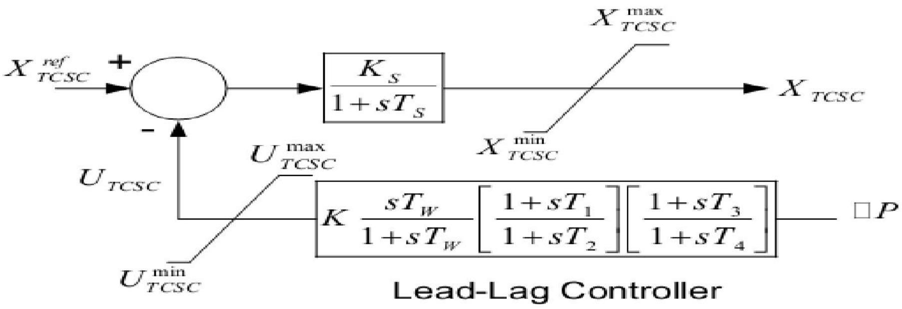

Fig .4 Structure of a simple TCSC POD controller.

III. PROPOSED MODULES

In the proposed techniques is bacterial foraging optimization.The Bacterial Foraging Optimization Algorithm belongs to the field of Bacteria Optimization Algorithms and Swarm Optimization, and more broadly to the fields of Computational Intelligence and Metaheuristics. It is related to other Bacteria Optimization Algorithms such as the Bacteria Chemotaxis Algorithm, and other Swarm Intelligence algorithms such as Ant Colony Optimization and Particle Swarm Optimization.

The TCSC POD controller has been implemented for damping power oscillation. The TCSC based POD controller has been used to improve the performance of power system stability. BFO algorithm is used to minimizing eigen value based objective function and tunes the parameter to get the better optimal solution.

3.1 Proposed Model Techniques

This dissertation deals with two aspects of small signal analysis of the power system placement of power system stabilizers (PSSs) and line outage screening based on estimation of the eigenvalues using sensitivities. A PSS is an instrument installed in a generator to stabilize the power system. From a system wide point of view, PSSs are used to stabilize the power system as the demand for power increases and more power is delivered over longer distances. From a design point of view, a PSS is a device used to increase the damping torque component of a machine. Although a PSS can be installed at every machine, only a few PSSs are needed to stabilize a power system. The determination of PSS placement is analogous to finding which PSS has the most effect on a particular mode in a system. This information can also be used to determine which PSS should be turned on or be looked at for tuning adjustments.

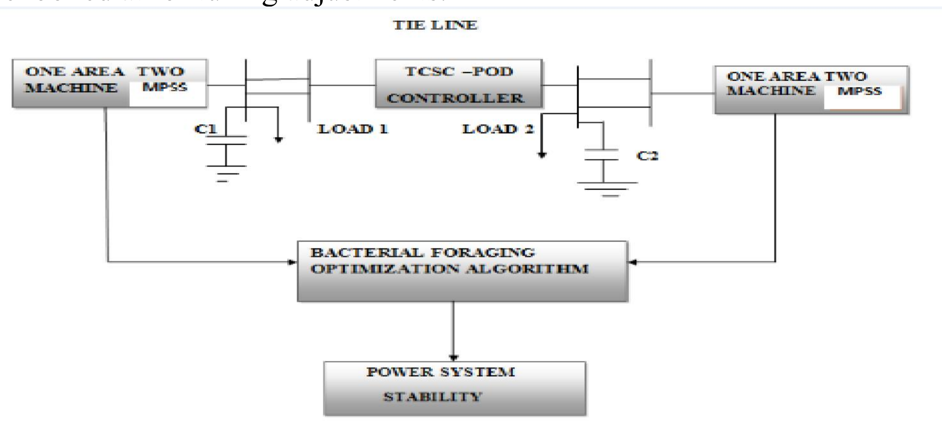

Figure 5. Block diagram of proposed module.

3.1.1. Flow chart of BFO

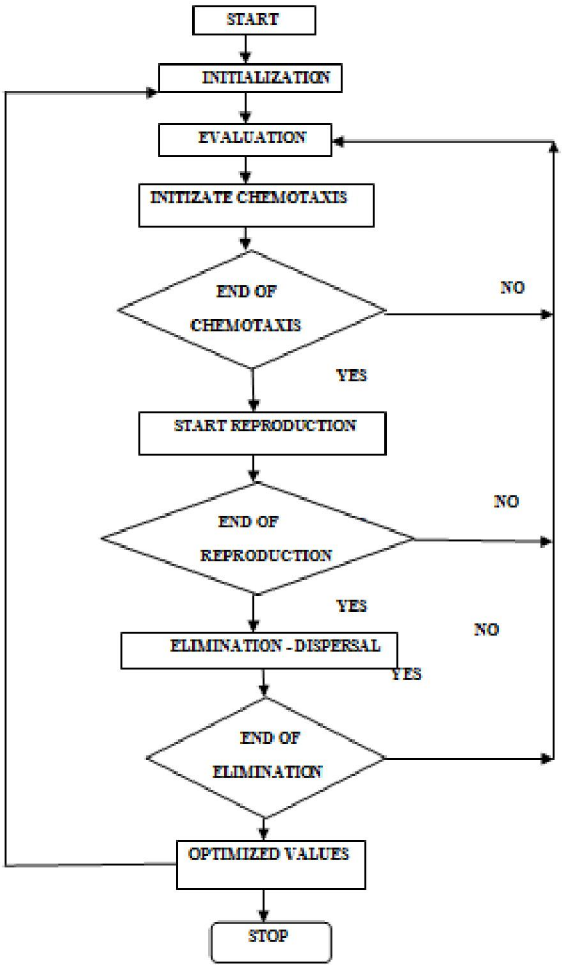

Fig .6 Flow chart of BFO

Bacteria Foraging Optimization (BFO) algorithm is a new class of biologically encouraged stochastic global search technique based on mimicking the foraging behavior of E. coli bacteria. This method is used for locating, handling, and ingesting the food. During foraging, a bacterium can exhibit two different actions: tumbling or swimming [4]. The tumble action modifies the orientation of the bacterium. During swimming means the chemotaxis step, the bacterium will move in its current direction. Chemotaxis movement is continued until a bacterium goes in the direction of positive-nutrient gradient. After a certain number of complete swims, the best half of the population undergoes the reproduction and eliminating the rest of the population. In order to escape local optima, an elimination-dispersion event is carried out where some bacteria are liquidated at random with a very small probability and the new replacements are initialized at random locations of the search space. Fig.6 Above shows the flow chart of the BFO algorithm.

3.1.2. Simulation model design of two area multi -machine system with TCSC

The MATLAB based model of Design of MPSS and TCSC in multi machine power system, using MATLAB SIMULINK in proposed system was shown in fig (3).,

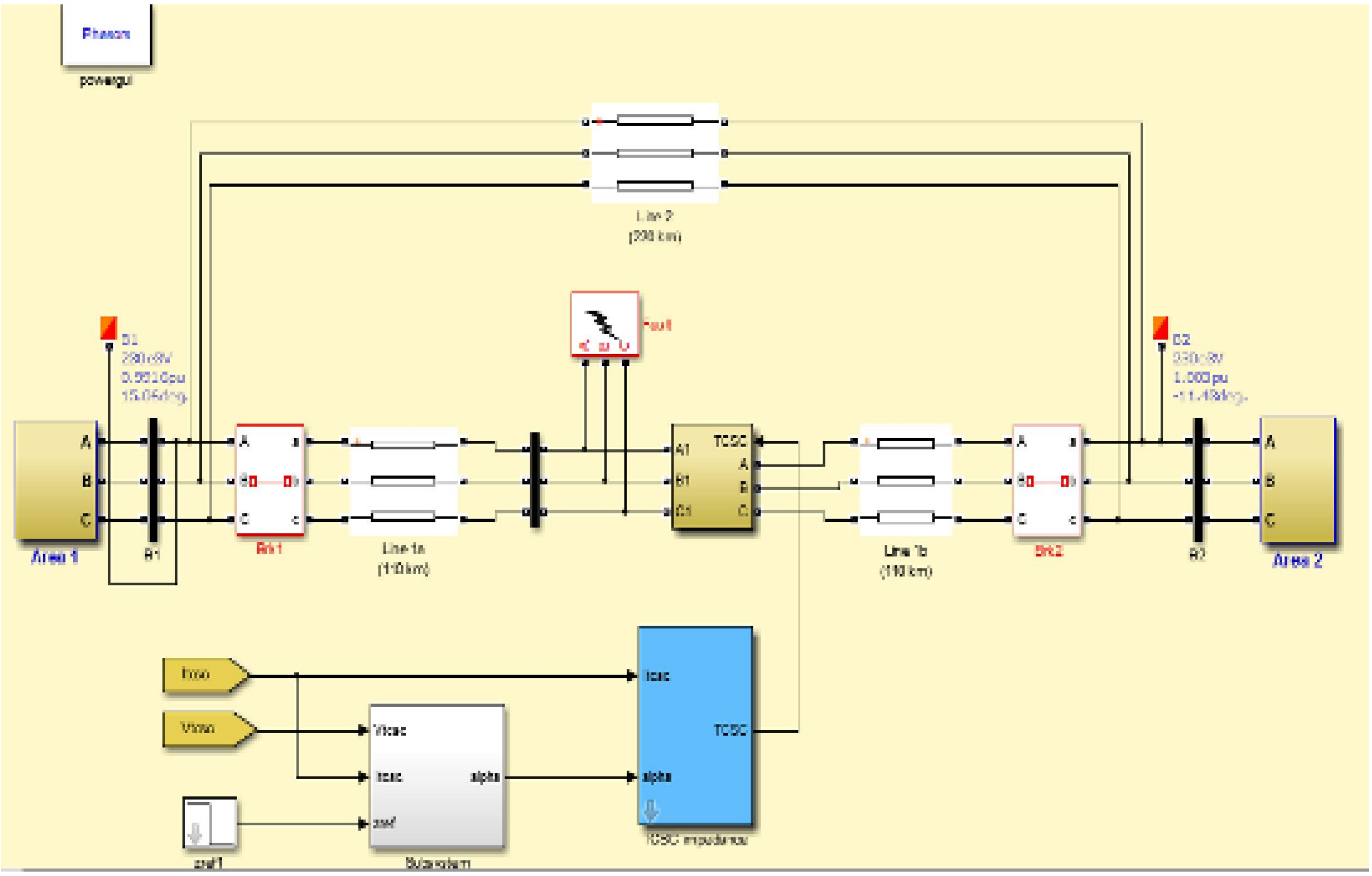

Fig. 7 Design of two area multi machine power system with TCSC.

IV. CONTROL TECHNIQUES

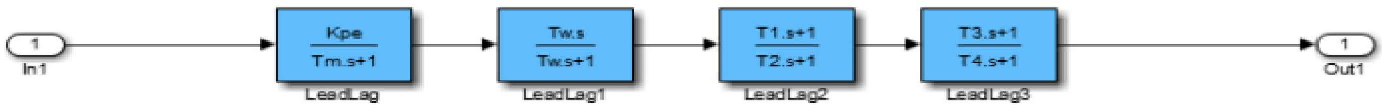

Fig.8 The schematic diagram for POD controller.

4.1. Model of TCSC.

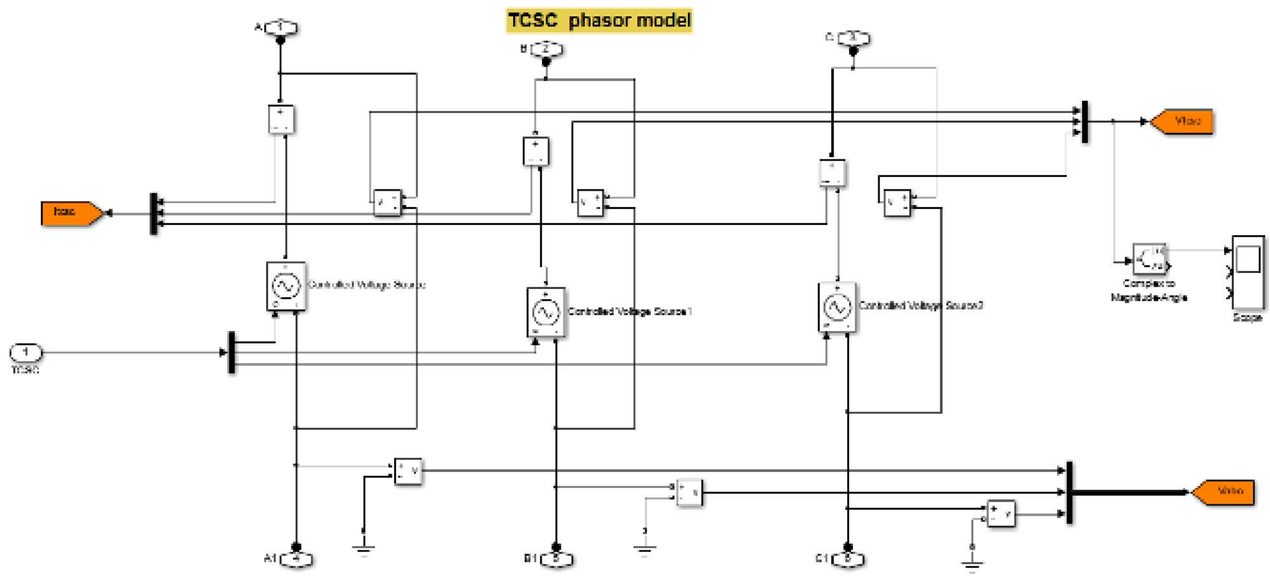

Fig.9 The TCSC phasor model

V. OUTPUT VERIFICATION

PSO Iterations are going on to find the best Solution......

EM Oscillation frequency	EM Damping Ratio	EM Real Value
1.921097	0.409223	- 5.413619
1.885041	0.401997	-5.199937
1.242489	0.673383	-7.110791
1.319485	0.620606	-6.561702
0.473550	0.305395	-0.954262
0.442951	0.542416	-1.796935
0.438245	0.547174	-1.800059
0.293029	0.572758	-1.286451

BFO Iterations are going on to find the best Solution…………..

EM Oscillation frequency	EM Damping Ratio	EM Real Value
1.882675	0.368301	-5.954981
1.847340	0.361797	-5.719931
1.217639	0.606045	-7.821870
1.293095	0.558546	-7.217872
0.464079	0.274855	-1.049688
0.434092	0.488175	-1.976629
0.429480	0.492456	-1.980065
0.287168	0.515482	-1.415096

The showing output BFO is better than PSO algorithm .If the electromechanical real value reaches most negative and damping ratio reaches minimum value then the system reaches stability condition.

5.1 SIMULATION OUTPUT

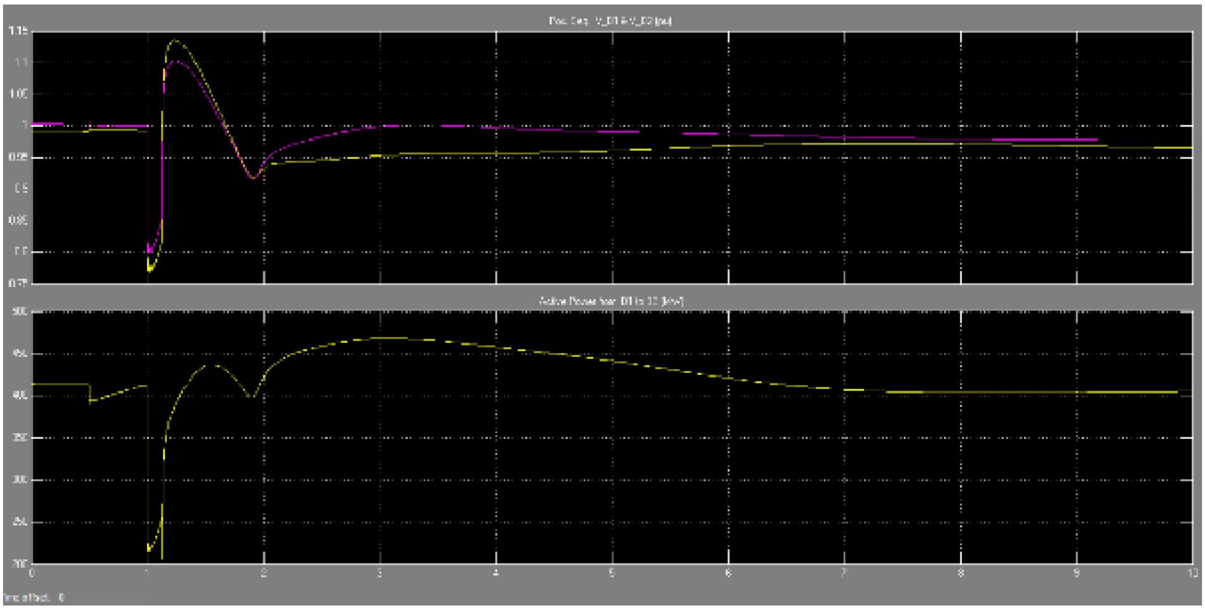

Fig.10 Voltage and power Vs time

VI. CONCLUSION

An optimized coordinated control of a power system stabilizer (PSS) with TCSC based damping controller is discussed. An objective function is minimized using BFO for finding the optimal control parameters of coordinated controller. . The time domain simulation of a non-linear system is carried out in MATLAB software package. The robustness of the proposed coordinated controller is investigated by testing its performance under different loading conditions. The simulation results show that the test system dynamic performance and overall damping effect are enhanced by simultaneous tuning of PSS and TCSC damping controllers. Therefore, coordinated control of PSS and TCSC based damping controller provides better damping of power oscillations.

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