International Journal of Engineering and Information Systems (IJEAIS)
ISSN: 2643-640X
Vol. 4 Issue 11, November - 2020, Pages: 27-33

Damping of Transient Oscillations due to Symmetrical Faults by Insertion of PSS Using GA for Tuning

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***Abstract**: the large disturbances happened in transmission lines due to three phase fault is very dangerous; because this problem may lead to loss of generation units and them synchronism. To solve such problem or reduce it there are various ways to did that, the famous way is to insert the compensation devices such as; TCSC, STATCOM, UPFC, PID, TSSS, AVR and PSS. Here in this paper we used the Power System Stabilizer (PSS) because of high response for damping oscillations and reduce the overall time response for machines to return back to its new position after the three phase fault occurs in transmission lines. Finally after seeing the plots and make comparisons we found that the PSS reduce the overall time response between 20-50%. The difficult that arises from how to get the optimum values of PSS parameters and optimum location of PSS; was solved by using Genetic Algorithm (GA) technique.*

Keywords— Transient Stability, Three phase fault, power system stabilizer (PSS), IEEE 9 bus system, Genetic Algorithm (GA).

1. INTRODUCTION

Power system stability is the ability of system to return to its equilibrium point when the disturbances happen in the network [1]. In the transient stability we study the capability of machine to stabilize when there is large disturbances occur with regard to the state of other machines [2]. Due to the complexity and vastness of this problem, it has been divided into smaller areas including rotor angle, frequency, and voltage stabilities. Rotor angle stability is the ability of system to return to its equilibrium state when there is a disturbance happen [3]. Rotor angle stability is separated into 2 types: small signal and transient stabilities [4].

There are many cases of transient one of them is three phase short circuit and due to this case the large disturbances happened and make system unbalance and the overall time response will extend and that might lead to loss of generation units.

2. METHODOLOGY

In this paper we did some steps to figure out the results ,and we used IEEE 9 bus as a case study , Digsilent for simulation, and PSS as a supplementary device for excitation system.

And we followed these steps:

A. IEEE 9 BUS SYSTEM

The IEEE 9 bus system consist of three generators, three loads and 9 busbars the machine number one connected to slack bus while machines 2, 3 connected to PV busbar. The total load is 321MW and 567MVA.

This network consist of three machines and nine buses the machine number one connected to swing busbar while machines two and three connected to PV busbar. Moreover this network included three loads A, B and C are connected in bus bars 5,6 and 8 respectively. The total generation is 567MVA and total load is 321MW. [5]

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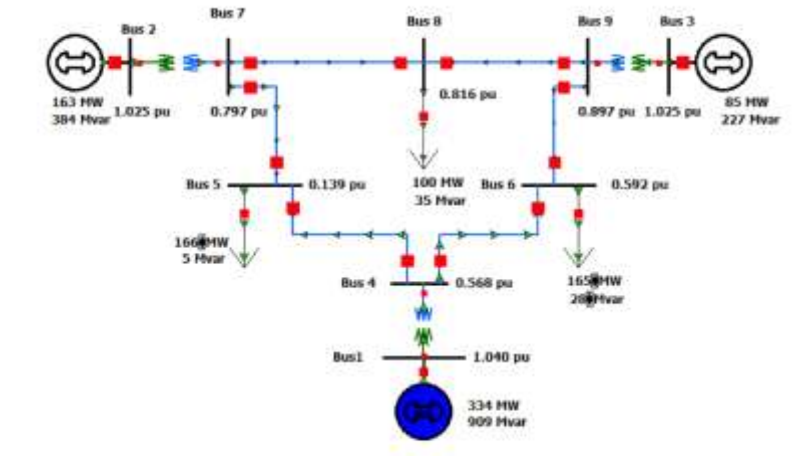

Fig.1. single line diagram of IEEE 9 bus system

B. POWER SYSTEM STABILIZER (PSS)

The essential work of a power system stabilizer (PSS) is to damp the generator rotor oscillations by controlling its excitation. To make a damping, the stabilizer should generate an electrical torque in phase with the rotor speed deviations. The PSS must function properly when the network is subjected to large disturbances such as the occurrence of a three-phase fault, the sudden outage of a line or the sudden application or removal of loads. The block diagram of the PSS design used in the power network is shown in Figure1.

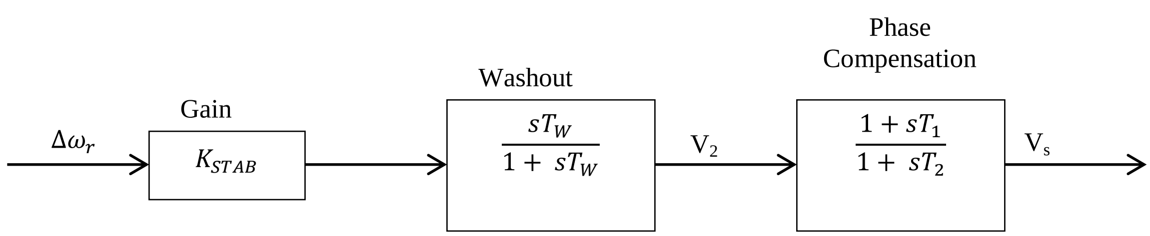

Fig.2. Block diagram of power system stabilizer

The power system stabilizer representation in Figure 1 consists of three blocks: a phase compensation block, a signal washout block and a gain block.

i. The phase compensation generate the appropriate phase-lead value to compensate for the phase lag between exciter input and the electrical torque of generator unit.

ii. The signal washout block work as a high-pass filter, with the Tw high enough to make signals related with oscillations in wr to pass unchanged. The washout circuit is provided to eliminate steady-state bias within the output of PSS which can modify the generator terminal voltage. It allows the PSS to reply only to changes in speed.

iii. The stabilizer gain, KSTAB determines the amount of damping introduced by the PSS. The gain is set at a value corresponding to maximum damping.[6]

C. Genetic Algorithm (GA)

GA is also a heuristic solution-search or optimization technique, originally motivated by the Darwinian principle of evolution through (genetic) selection. A GA uses intelligent evolutionary operations to develop solutions to given problems. The operation of GA relying on the artificial of chromosomes. These are strings during a finite alphabet (usually binary). Each chromosome represents an answer to a controversy and has fitness, a true number which could be a measure of how good an answer it's to the actual problem.

The genetic algorithm is based on selecting a random sample depending on fitness and recombination to determine the subsequent sample. The production of child chromosome depends on selecting random sample of fitness and recombination. These then pass into the successor population. As this process is iterated, a sequence of successive generations evolves and so the common fitness of the chromosomes tends to increase until some stopping criterion is reached. during this way, a GA “evolves” a best solution to a given problem. [7]

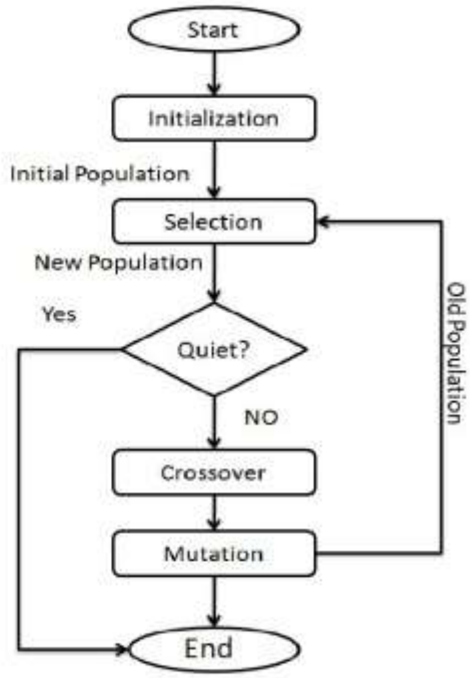

Fig.3. Flowchart of Genetic Algorithm

3. RESULTS AND OBSERVATIONS

We used the GA Algorithm to find the optimum parameters of PSS and the parameters were:

Table.1. Optimum parameters of PSS:

Names of Parameters	Values
Kpss Stabilizer Gain (pu)	9
Tw Washout Integrate Time Constant (s)	10
T1 First Lead/Lag Derivative Time Constant (s)	0.090261
T2 First Lead/Lag Delay Time Constant (s)	0.052884
T3 Second Lead/Lag Derivative Time Constant (s)	0.181181
T4 Second Lead/Lag Delay Time Constant (s)	0.178998
Vmin Signal pss Minimum(pu)	-0.03
Vmax Signal pss Maximum(pu)	0.03

- GENERATOR ONE:-
- Rotor angle

Fig.4. Rotor Angle Normal Case

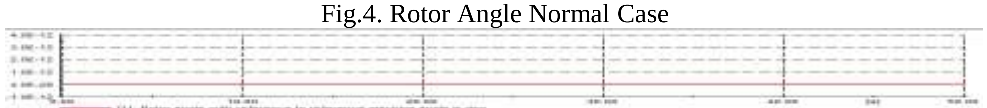

Fig.5. Rotor Angle without PSS (Fault in Line 2b)

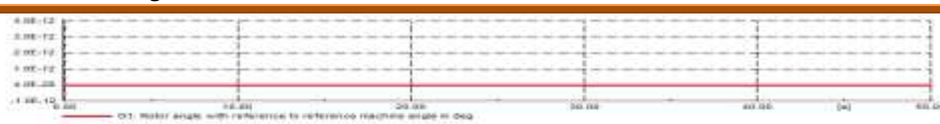

Fig.6. Rotor Angle with PSS (Fault in Line 2b)

- ❖ Excitation voltage

Fig.7. Excitation Voltage Normal

Fig.8. Excitation Voltage without PSS

Fig.9. Excitation Voltage with PSS

- ❖ OBSERVATIONS:-
- ➢ From figure 4, 5, 6 we noticed that the power angle is zero because the machine one is connected to slack bus bar.

- ➢ From figure 7 we noticed that the excitation voltage is stable in normal condition.
- ➢ From figure 8 we noticed that after three phase fault occurs on line 2b, Excitation voltage is oscillate and system return back after 30 sec.
- ➢ From figure 9 we noticed that after adding PSS and three phase fault occurs on line 2b, the Excitation voltage is oscillate and system return back after 20 sec.

- ❖ GENERATOR TWO:-
- ❖ Rotor angle

Fig.10. Rotor Angle Normal

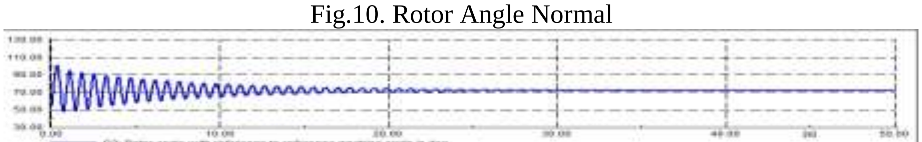

Fig.11. Rotor Angle without PSS

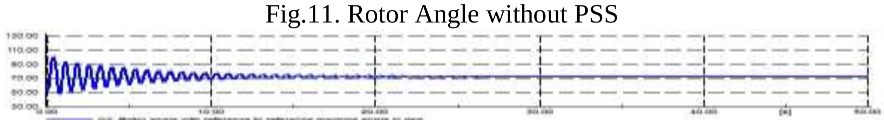

Fig.12. Rotor Angle with PSS

- ❖ Excitation voltage

Fig.13. Excitation Voltage Normal

Fig.14. Excitation Voltage without PSS

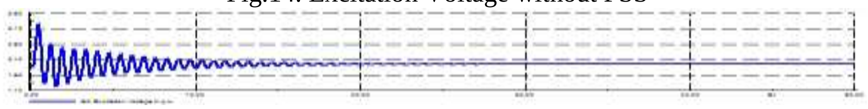

Fig.15. Excitation Voltage with PSS

- ❖ OBSERVATIONS:-
- ➢ From figure 10 we noticed that in the normal condition the power angle is stable.
- ➢ From figure 11 we noticed that after three phase fault occurs on line 2b, the power angle oscillate and system return back after 31 sec.
- ➢ From figure 12 we noticed that when PSS is adding by optimum location and tuning to machine 2 the power angle oscillate and system return back after 25 sec.

- ➢ From figure 13 we noticed that the Excitation voltage is stable in normal condition .
- ➢ From figure 14 we noticed that after three phase fault occurs on line 2b, Excitation voltage is oscillate and system return back after 35 sec.
- ➢ From figure 15 we noticed that after adding PSS and three phase fault occurs on line 2b, the Excitation voltage is oscillate and system return back after 27 sec.

- ❖ GENERATOR THREE :-
- ❖ Rotor angle

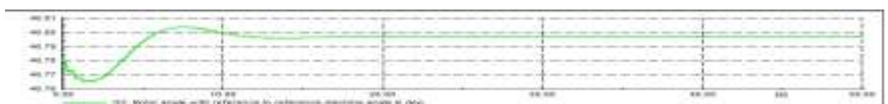

Fig.16. Rotor Angle Normal

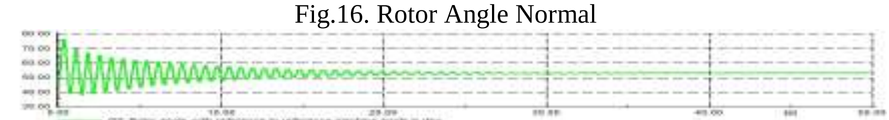

Fig.17. Rotor Angle without PSS

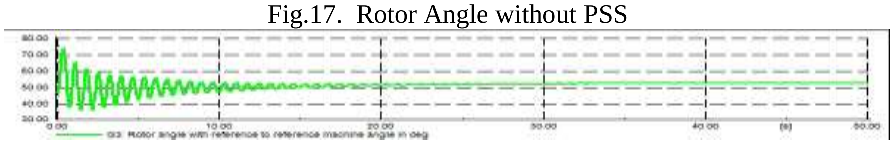

Fig.18. Rotor Angle with PSS

- ❖ Excitation voltage

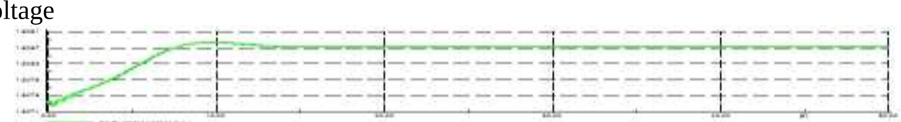

Fig.19. Excitation Voltage Normal

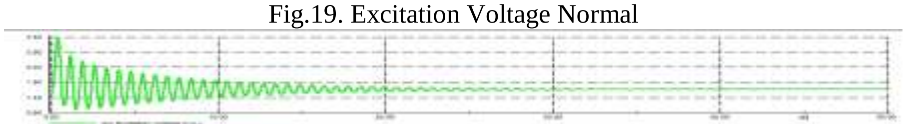

Fig.20. Excitation Voltage without PSS

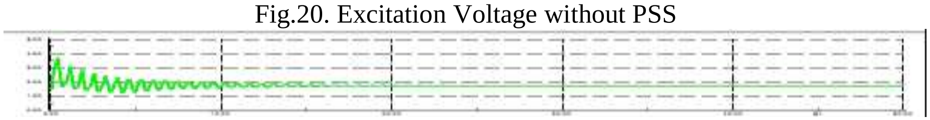

Fig.21. Excitation Voltage with PSS

- ❖ OBSERVATIONS:-

- ➢ From figure 16 we noticed that in the normal condition the power angle is stable.

- From figure 17 we noticed that after three phase fault occurs on line 2b, the power angle oscillate and system return back after 38 sec.
- From figure 18 we noticed that when PSS is adding by optimum location and tuning to machine 2 the power angle oscillate and system return back after 23 sec.
- From figure 19 we noticed that the Excitation voltage is stable in normal condition .
- From figure 20 we noticed that after three phase fault occurs on line 2b, Excitation voltage is oscillate and system return back after 34 sec.
- From figure 21 we noticed that after adding PSS and three phase fault occurs on line 2b, the Excitation voltage is oscillate and system return back after 18 sec.

4. CONCLUSION

In this paper, power system stability enhanced by using PSS was presented. For the proposed controller design problem GA was used to optimize PSS controller parameters .the effectiveness of this technology was appeared clearly in power system response by adding damping torque for mechanical power input to the rotor of synchronous machine. However, power system stabilizer (PSS) work side by side with (AVR) system by adding moderated voltage signal by power system stabilizer to the (AVR) system to help of damping electromechanical modes and reducing overall time response. And that appeared in curves for overall time response when we represented it without PSS and with PSS and we noticed that the time reduced between **20-50%.** Enhancing power system stability became an important issue in last year's due to complexity of power system. As the system become more complex by interconnected systems maximize the need of using (PSS) and other controllers to help in adding of damping torque for the rotor of synchronous machine.

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