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Study of Excitation System and Power System Stabilizer for Single Machine Infinite Bus System

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***Abstract* - A Power system is a dynamic system, and constantly being subjected to disturbances. This disturbance must create the unstable condition such as the small-signal instability also affect system stability. For this to add the sufficient damping torque for electromechanical modes of oscillation. The Heffron-Phillips model in the single bus infinite bus system considers for it. Power system stabilizer and automatic voltage regulator produce sufficient damping torque in the synchronous generator. The mathematical solution of the Heffron-Phillips model at different operating condition and analysis in MATLAB software with time domain. A comparison between different condition such as a constant field, excitation system and Power system stabilizer controller. To add the fuzzy logic in the single machine infinite bus system reduce the oscillation and gain the stable condition.**

Keyword; Small-signal stability, Generator excitation system, Automatic voltage regulator (AVR), Power system stabilizer (PSS).

I. INTRODUCTION

Nonlinear power systems continuously experience generation and load change conditions along with severe disturbance causing a change in the power system operating conditions [1]. It is constantly subjected to disturbance, according to which generator outage, load changes, voltage collapse. Due to this small-signal instability, it includes in the system and affects system performance, so the power system instability is a major concern for the modern power system operation. For each power system, the synchronous generator is the most important component. The most control of the synchronous generators is through the excitation system. An excitation system is mostly used to maintain the system's stability. The excitation system has a fast-acting AVR to eliminate the synchronous torque but affect the damping torque. The additional signals are mostly derived from excitation system deviation, speed deviation or accelerating power. This is accomplished by inserting a stabilizing signal into the excitation system voltage reference summing point junction. The device arrangement is to provide the signal is called "power system stabilizer" [2]. PSS provides the supplementary signal to the excitation system to improve the oscillatory instability, and the PSS is also faster to improve stability.

II. SYSTEM MODELLING

A. *Small signal stability*

Small signal stability of the power system to maintain the synchronism under small disturbance. Small disturbance occurs due to change in load and generation. The unstable condition caused by the increase in the rotor angle in the system. This condition caused insufficient synchronizing torque is called non-oscillatory instability. Another instability is oscillatory instability due to insufficient damping torque. Classification of the power system stability,

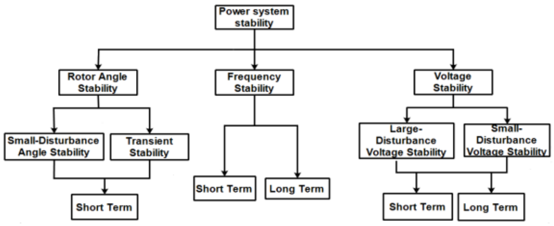

Fig. 1.1 Classification of power system stability

A. *Synchronous machine modelling*

The synchronous machine is extensive equipment in the power system. A synchronous machine connected with an infinite bus through the transmission line.

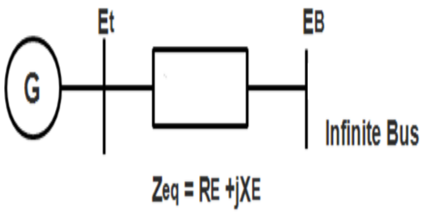

Fig.1.2 Single machine infinite bus

The machine response in two cases one is constant field voltage with no voltage regulator, the second one is excitation control. To present the equivalent circuit of the synchronous machine connected to an infinite bus system.

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B. classical system model

For small signal stability analysis, dynamic modelling is required for the major component of the power system. It is included a synchronous generator, excitation control, voltage regulator and also a different parameter. The different type of model used for the dynamic analysis and it depends on their parameter. The single machine infinite bus system model used the obtain the Heffron-Phillips model K constant.

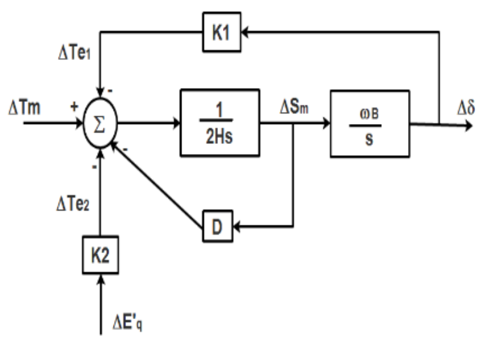

Fig. 3 Classic model of the single machine infinite bus

From the block diagram the mathematic equation,

Δδ=ωBsδSm=ωBsΔω

ΔE'q=0 and the characteristic equation,

2Hs2+Ds+K1ωB=0

For stability, both K and D should be positive, if D is negligible then the characteristic equation,

s1,s2=±K1ωB2H=±jωn

In this paper, the Heffron-Phillips model, shown in fig (1.4).in. This Ks is called synchronizing coefficient, Kd is damping coefficient, H is inertia constant, s is Laplace operator, wB is rated speed,T'd0 is direct axis transient open circuit time-constant, K1 to K6 is K constant. Synchronizing torque and damping torque introduce by the AVR and it depends on the K5 value.

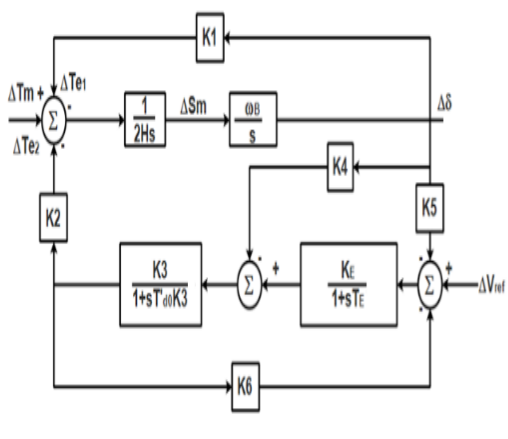

Fig.1.4 Block-diagram of Heffron-Phillips model

$$K_1 = \frac{E_b E_{q0}\cos\delta_0}{(x_e+x_q)} + \frac{(x_q - x'_d)}{(x_e+x'_d)} E_b i_{q0} \sin\delta_0$$

$$K_2 = \frac{(x_e+x_q)}{(x_e+x'_d)} i_{q0} = \frac{E_b \sin\delta_0}{(x_e+x'_d)}$$

$$K_3 = \frac{(x_e+x'_d)}{(x_d+x_e)}$$

$$K_4 = \frac{(x_d - x'_d)}{(x'_d+x_e)} E_b \sin\delta_0$$

$$K_5 = \frac{-x_q V_{d0} E_b \cos\delta_0}{(x_e+x_q)V_{to}} - \frac{x'_d V_{q0} E_b \sin\delta_0}{(x_e+x'_d)V_{to}}$$

$$K_6 = \frac{x_e}{(x_e+x'_d)} \cdot \left(\frac{V_{q0}}{V_{to}}\right)$$

C. Power system stabilizer

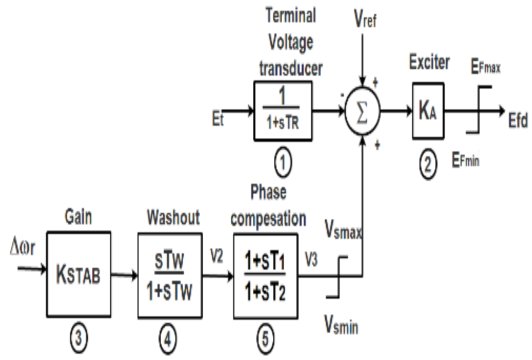

Fig. 1.5 Block-diagram of Excitation system

The basic function of a power system stabilizer is as known as an auxiliary device. It provides positive damping of electrical torque in phase with rotor speed deviation in the system. To add the Automatic voltage regulator block with the PSS block, it's called the 'Excitation controller' described in figure (1.5).

III. SIMULATION MODEL AND RESULT

TABLE -1

Parameters	Nominal values
P	0.8
Q	-0.2
Xd	1.6
Xq	1.55
0.5X'd	0.32
T'd0	6
H	5
D	0
F	50 HZ
Eb	1 P.u
Et	1 P.u
Ke	200
Te	0.05 sec
Efd max	6 P.u
Efd min	-6 P.u

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T1	0.078
T2	0.026
Kpss	16
Tw	2
Re	0
Xe	0.04

A. Performance with constant field voltage

This represents the dynamic characteristic of constant k. the values of the k constant calculate using the above parameter values.

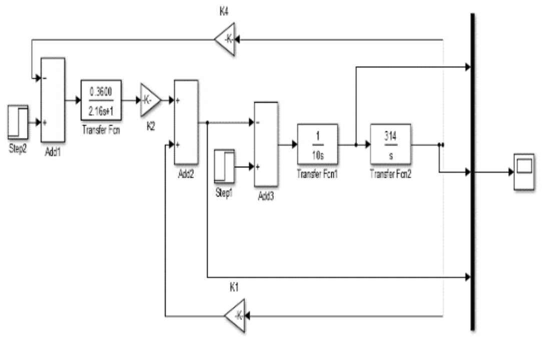

Fig. 1.6 Simulink model of Constant field voltage

K1= 1.0789, K2= 1.3659, K3= 0.3600, K4=1.7484

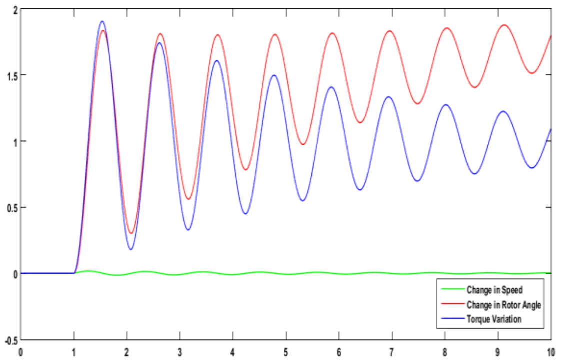

Fig.1.7 The waveform of 5% change in system value

B. Performance with Excitation system

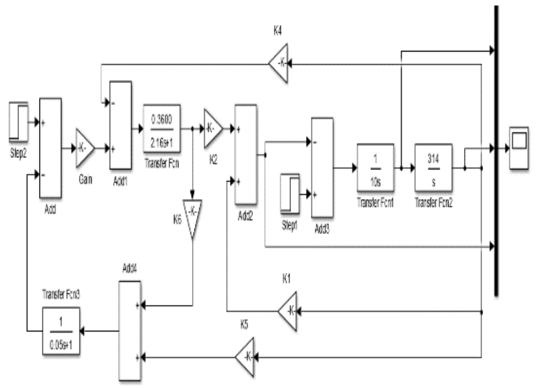

Fig. 1.8 Simulink model of Excitation system

The standard IEEE type ST1A excitation system model has been considering for analysis with a single machine infinite bus. The excitation parameter is K= 200, Te= 0.05.

The value of K constant calculated using above parameter, K1= 1.0789, K2= 1.3659, K3= 0.3600, K4=1.7484 K5=-0.0868, K6= 02701.

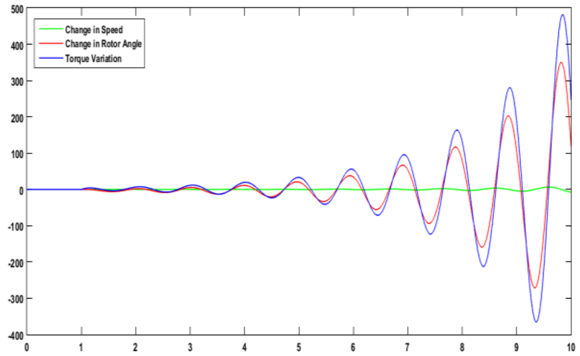

Fig. 1.9 The waveform of 5% change in system value

C. Performance with PSS

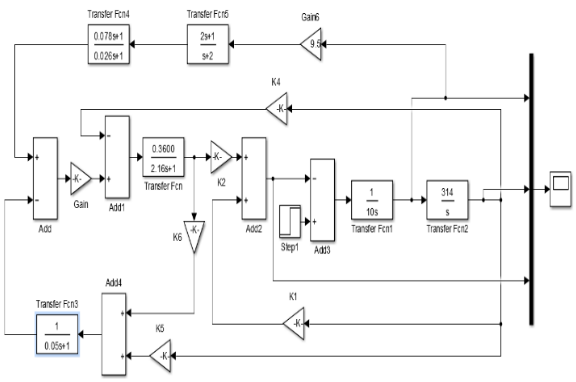

Fig. 1.10 Simulink model of PSS

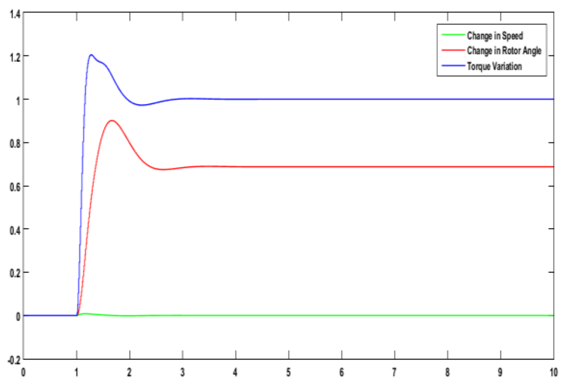

Fig. 1.11 Value of K5 is negative

IV. CONCLUSION

In the power system, the major component has dynamic behaviour and the important component is the synchronous generator associate controls excitation and prime mover. The main aim is analyse the stability of the system. So, consider the excitation system and ignore the prime mover. After the study of the

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Mathematical equation of the SMIB system and analysis of the Heffron-Phillips model in the SMIB system in Mat-lab. To analysis in a different condition, the effect of different value of active and reactive power in the system and use the AVR and PSS for stability. Observe the analysis, the PSS gives a better solution over the AVR.

V. REFERENCES

[1] Moudud Ahmed, Naruttam Kumar Roy, “A Comparative Analysis on Different Type of Power System Stabilizer”. IEEE 5th International Conference on Informatics, Electronics and Vision (ICIEV) 978-1-5090-1259 May 16 2016.

[2] Manish Kushwaha, Mrs. Ranjeeta Khare, “Dynamic Stability Enhancement of Power System using Fuzzy Logic Based Power System Stability”. IEEE international conference on power, Energy and control (ICPCE) 978-4673-6030 Feb. 13 2013.

[3] K.R. Padiyar, Power System Dynamics Stability and Control 2nd Edition B.S publications.

[4] P. Kundur, Power System Stability and Control. New York: McGraw Hill, 1994.

[5] Gurunath Gurrala, Indraneel Sen, “A Modified Heffron-Phillip’s Model for The Design of Power System Stabilizers”IEEE 978-1-4244-1762 Sep.08 2008.

[6] Rahmat Khezri, Hassan Bevrani, “AVR and PSS Coordinated Based Fuzzy Approach for Transient Enhancement”. IEEE 23rd Iranian Conference on Electrical Engineering (ICEE) 978-4799-1972 Dec. 7 2015.

[7] Anindita Mohanty, R. Behera, B.P Panigrahi, “Fuzzified Phillips-Hefforn Model Power System Stabilizer for Improvisation of Voltage Stability”. IEEE International Conference on Electrical, Electronics and Optimization Techniques (ICEEOT) 978-1-4673 May 16 2016.

[8] Kahouli. A, Guesmi. T, Hadj Abdallah. H, Ouali. A. “A Genetic Algorithm PSS and AVR Controller for Electrical Power System Stability” IEEE 6th International Multi-Conference on System, Signal and Devices 978-1-4244-4346 Sep. 8 2009.

[9] Rajendraprasad Narne, P. C. Panda, Senior Member IEEE, Jose. P.Therattil, “Transient Stability Enhancement of SMIB System using PSS and TCSC-Based Controller.” IEEE PESDS978-1-4577-0001 NOV. 9 2011.

[10] F. Mayouf (Adjeroud), F.Djahli, A. Mayouf, “Study of Excitation and Governor Power System Stabilizers Effect the Stability Enhancement of a Single Machine Infinite –Bus Power System”. IEEE 978-1-4673-3059 June 13 2013.

[11] Salma KESES, Nouha BOUCHIBA, Souhir SALLEM, Larbi CHRIFI-ALAOUI, MBAKAMMOUN, “ Transient Stability Enhancement and Voltage Regulation in SMIB Power system using SVC With PI Controller” IEEE Proceeding of the 6th International Conference On System and Control, University of Batna 978-1-3960 Sep. 17 2017 .

[12] Bousaadia BAADJI, Hamid BENTARZI, Abdelhakim Bouaoud, “SMIB Power System Model with PSS for Transient Stability Studies”.

[13] Salma KESES, Nouha BOUCHIBA, Souhir SALLEM, Larbi CHRIFI-ALAOUI, MBAKAMMOUN, “Modified Direct Feedback Linearization Excitation Controller For Transient Stability and Regulation of SMIB Power System” IEEE Proceeding of the 7th International Conference on System and Control, University Polytechnica de Valencia, Spain 978-1-5386-8537 Feb 18 2018.

[14] Bidyadhar Rout, B. B. Patil, Ashribad Pattnaik, “Small Signal Stability Enhancement of Power System With GA Optimized PD type PSS and AVR Control” IEEE Recent Advance on Engineering , Technology and Computation Science (RAETCS) 978-1-5386-1686 Apr. 18 2018.

[15] Zakaria Ebrahim Khalil, Abd EI-Fath EI-Said Eliwa, Waheed Sabry, “ A Design of a Modified Power System Stabilizer for Power System Transient Stability Enhancement” IEEE 20th international Middle East Power System Conference (MEPCON) 978-1-5386-6654 Aug. 18 2018.

[16] Muhammad Ridwan, Joko Hartono, Didik Fauzi Dakhlan , Eko Aptono Tri Yuwono, “ Small Signal Stability Analysis as Impact of System Reconfiguration” IEEE 2nd International Conference on High Voltage Engineering and Power System(ICHVEPS) 978-1-7281-2669 Feb.19 2019.