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ELECTRICAL POWER ENGINEERING

Study and Analysis of Machine Parameters Effect on Power System Stability

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***Abstract*— The stability study of a power system is an important factor in the planning or increasing of facilities. The studies are helpful in determining such thing as nature of the relaying system needed, critical clearing time of circuit breakers, voltage level, and transfer capability between systems. In this paper, the effects of machine parameters (*inertia constant, damping constant and transient reactance*) on the critical clearing time of the power system stability have been analyzed. These parameters are the main contribution to the angular acceleration and power transfer capability that affected the power system stability. The analysis has been done for two types of power system: single machine infinite bus system and multi-machine system. From the analysis, it is found that the stability of the system is affected by studied parameters and important in the design of the improving power system stability and protection system..**

Keywords— **Power System Stability, Machine Parameters**

I. INTRODUCTION

Power system stability is that property of a power system which ensures that the operation of the system is within the specified limits of voltage and power angle during normal and abnormal changes in operating condition [1]. Since power systems rely on synchronous machines for the generation of electrical power, a necessary condition for the transmission and exchange of power is that all generators rotate in synchronism. The concept of power system stability relates to the ability of generators on a system to maintain synchronism and the tendency to return to and remain at a steady-state operation point following a system disturbance. The mechanism by which interconnected synchronous machines maintain synchronism with one another is through restoring forces, whenever there are forces tending to accelerate or decelerate one or more machines with respect to other machines [2]. If the forces tending to hold machines in synchronism with one another are sufficient to overcome the disturbing forces, the system is said to remain stable i.e., to stay in synchronism [2].

In order to maintain the stability, the fault must be removed from the system in a shorter time. Duration of fault clearing time is depends by the amount of power that may be transmitted to the system. If the system has a higher power limit, then a larger percentage of the transmission line capacity will have to be removed to clear the fault. If a smaller percentage of the transmission line capacity removed, then the system would be able to transmit a larger amount of power and the clearing time is increased. The benefit of studying the power system stability is to know the detailed knowledge of their transmission systems stability constraints and know the preventive control to improving the system operation reliability and increasing transfer capability.

This paper provides the machine parameters that effect on steady-state stability and transient stability of power system network. The model for single machine and multi-machine power system is described in section II. Effects of machine parameters are discussed in section III. Analysis of effect of machine parameter is demonstrated in section IV. And, a conclusion is made based on the simulation results of both single and multi-machine power systems.

II. POWER SYSTEM MODELS AND EQUATIONS

A. *Synchronous Machine Model for Stability Study*

The simplest model for stability analysis is the classical model, where saliency is ignored, and the machine is represented by a constant voltage E' behind the direct axis transient reactance X'_d [2]. If V_g is the generator terminal voltage and I_a is the pre-fault steady state generator current, the model is represented by

$$E' = V_g + jX'_d I_a \tag{1}$$

B. *Swing Equation*

The swing equation of the machine is given by

$$\frac{H}{pf}\frac{d^2 d}{dt^2} = P_m - P_e \tag{2}$$

where, P_e is the electrical power output and P_m is mechanical power input and δ is the load angle and then, H is inertia constant in terms of,

$$H = \frac{\text{kinetic energy in MJ at rated speed}}{\text{machine rating in MVA}} = \frac{W_K}{S_B} \tag{3}$$

If damping is account for, assuming that the damping torque is introduced by a term proportional to the derivative of the angle, the swing equation becomes

$$\frac{H}{pf}\frac{d^2 d}{dt^2} + D\frac{dd}{dt} = P_m - P_e \tag{4}$$