A Novel Software Approach Scheme Analysis And Utility Of Transient Stability Analysis In Power System

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Abstract: -This paper is highlighting a basic analysis of Transient Stability. Transient stability limit is characterized by the highest magnitude of power flow just prior to the transient disturbance for which the system can remain in synchronism once the transient fault is withdrawn or cleared. So to maintained synchronism it is essential to analysis of transient analysis of every machine. So here we have analysis of transient condition of alternator parameters and transmission line parameter and get a clear idea of fault analysis of machines, which is the most costly equipment of power system. This analysis is done by MI POWER SIMULATION software. Transient Stability is the ability of the Power System to maintain Synchronism when subjected to a serve transient disturbance such as a fault on transmission facilities, loss of generation, or loss of a large load. The system response to such disturbances involves large excursions of generator rotor angles, power flows, bus voltages and other system variables. Stability is influenced by the nonlinear characteristics of power systems. If the resulting angular separation between the machines in the system remains within certain bounds, the system maintains synchronism. Loss of synchronism because of transient instability, if it occurs, will usually be evident within 2 To 3 seconds of initial disturbance.

This Paper illustrates the nature of transient Stability problems, identifies factors influencing them and describes modeling, analyses the Transient Stability. It is very essential because our every power network is very complex and any section fault is affected to other section.

Keywords:-
Synchronous generators, Transient stability, Faults, Loss of Synchronism.

I

Introduction:-

The large interconnected transmission networks i.e. made up of predominantly overhead transmission lines are susceptible to power system faults caused by lightning discharges, switching operation and decrease in insulation clearances by ground. The power flow in a transmission line which is determined by both active and reactive power injection can vary even under normal, steady state conditions. Due to the tripping of a line, generator can result in a sudden increase or decrease in the power flow by effect its prime mover speed. This can result in overloading of some lines and consequent threat to system security & stability.

MiPower simulation software is taken for simulation and analysis of a faulty power system network and observes how different section of generator, transmission lines parameters are varies with fault in one section. At first fault is created in one generator and voltages and other parameter has been analysis, then compares the variation of other parameter with other healthy sections and gets a clear idea of transmission line fault analysis. By analysis of this portion we can design better power system. Transient stability of a transmission is a major area of research from several decades. Transient stability restores the system after fault clearance. Any unbalance between the generation and load initiates a transients that causes the rotors of the synchronous machines to "swing" because net accelerating torques are exerted on these rotors. If these net torques are sufficiently large to cause some of the rotors to swing far enough so that one or more machines "slip a pole" and synchronism is lost. So the calculation of transient stability should be needed. A system analysis is required for it .The transient stability needs to be enhanced to optimize the load ability of a system, where the system can be loaded closer to its thermal limits. Power system stability is very important to generation, transmission and distribution. Maintaining some conditions synchronous machines are operated in Parallel to each other or "in step" with each other. Conversely, instability denotes a condition involving loss of synchronism, or falling "out of step" .Occurrence of a fault in a power system causes transients. To stabilize the system load flow and transient analysis is necessary. Actually in practice the fault generally occurs in the load side. So we controlling load side which will lead to complex problem in order to avoid that we are controlling the generator side.

A MIPOWER simulation has been carried out to demonstrate the performance of the three-machine six-bus system.

Literature review:-

In recent years, energy, environment, right-of-way, and cost problems have delayed the construction of both generation facilities and new transmission lines, while the demand for electric power has continued to grow. This situation has necessitated a review of the traditional power system concepts and practices to achieve greater operating flexibility and better utilization of existing power systems because today's power structure are depend upon grid network .So we have much focus on transient analysis, If in any system transient oscillations are stable then automatically system is going in steady state or large scale stable.

Overview of Transient Stability:-

Synchronous generators are operates at same Synchronous speed and frequency of 50 hertz while a delicate balance between the input mechanical power and output electrical power is maintained. Whenever generation is less than the actual consumer load, the system frequency falls. On the other hand, whenever the generation is more than the actual load, the system frequency rise. The generators are also interconnected with each other and with the loads they supply via high voltage transmission line. An important feature of the electric power system is that electricity has to be generated when it is needed because it cannot be efficiently stored. Hence using a sophisticated load forecasting procedure generators are scheduled for every hour in day to match the load. In addition, generators are also placed in active standby to provide electricity in times of emergency. This is referred as spinning reserved.

The power system is routinely subjected to a variety of disturbances. Even the act of switching on an appliance in the house can be regarded as a disturbance. However, given the size of the system and the scale of the perturbation caused by the switching of an appliance in comparison to the size and capability of the interconnected system, the effects are not measurable. Large disturbance do occur on the system. These include severe lightning strikes, loss of transmission line carrying bulk power due to overloading. The ability of power system to survive the transition following a large disturbance and reach an acceptable operating condition is called *transient stability*.

The physical phenomenon following a large disturbance can be described as follows. Any disturbance in the system will cause the imbalance between the mechanical power input to the generator and electrical power output of the generator to be affected. As a result, some of the generators will tend to speed up and some will tend to slow down. If, for a particular generator, this tendency is too great, it will no longer remain in synchronism with the rest of the system and will be automatically disconnected from the system. This phenomenon is referred to as a generator going out of step.

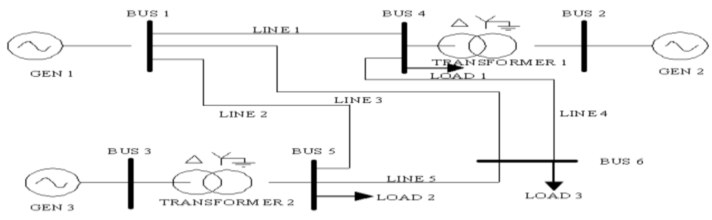
Acceleration or deceleration of these large generators causes severe mechanical stresses. Generators are also expensive. Damage to generators results in costly overhaul and long.

System Model Description:-

The single line diagram of 6-bus system with three generator unit, five transmission lines, two transformers and two loads is shown below. Per-unit values of all parameter are given on 100 MVA base and frequency 50 Hz. The generator 2 (Gen 2) and generator 3 (Gen 3) supply the power through the transformer 1 (Tr 1) and transformer 2 (Tr 2) respectively. The generator 1 (Gen 1) supply the power to Bus 1. The three load i.e. load 1, load 2 and load 3 is connected with Bus 4, Bus 5 and Bus 6 respectively. The five transmission lines of equal length are connected between six buses. Here we use three phase to ground fault occurs at bus 6.

All the parameter of generator, transformer, transmission line and load are given in Appendices –

Single Line Diagram of 6-Bus System.



Power System Model Analysis:-

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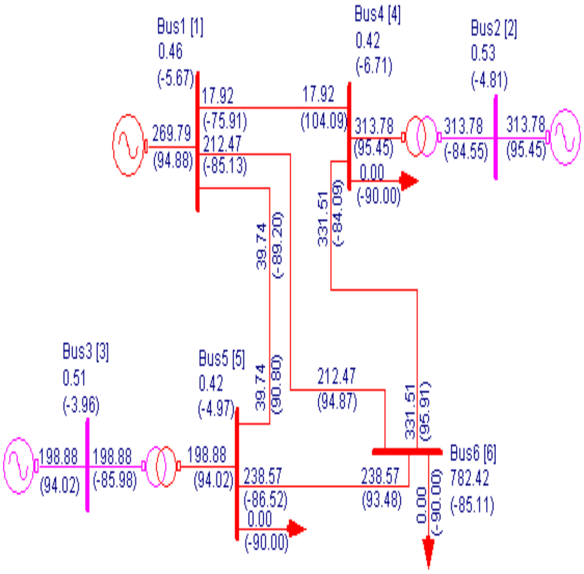
In the power transmission line, transient fault are occurred due to different cause such as switching, lighting, line to line fault, increasing and decreasing or change in load etc. The system should be operated in a good and healthy condition by overcoming transient fault, if the system is not return in good or healthy condition i.e. voltage stability, frequency stability diverted etc., then system consider huge amount of power loss and make it a unreliable system. Though system have so many protective device if transient current is not minimize at a few millisecond the connecting system should be damaged and concern system in uneconomical and create a huge amount in loss. So transient stability analysis is necessary in every aspect of power system as transient fault not only affect only the transmission line, it also directly affects generator, transformer, motor etc. The transient fault occurred in transmission line is also effect on our generator section as well as load section.

Problem Statement



In this paper a simple idea of transient stability analysis i.e. affect of transmission fault on generating station as well as load section is studies.

Here a three phase to ground fault is occur on line 5 near bus no 6 and fault is cleared by opening the circuit breaker at the ends of line 5 simultaneously at 0.25 seconds (fault clearing time), plot the swing curve and comment on transient stability of machine 2 and machine 3 considering bus no 1 as swing bus. System Model in MiPower, Here MiPower simulation software is taken for simulation. The power system model described above is drawn MiPower software.

Case Study: Fault at Bus no 6

It was assume that a three phase to ground fault is occur on line 5 near bus no 6 and fault is cleared by opening the circuit breaker at the ends of line 5 simultaneously at 0.25 seconds (fault clearing time), plot the swing curve and comment on transient stability of machine 2 and machine 3 considering bus no 1 as swing bus.

Result of Machine 2

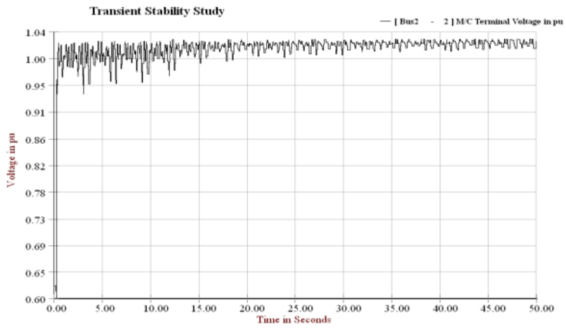


Fig.1.1Terminal Voltage (in pu) of Machine 1

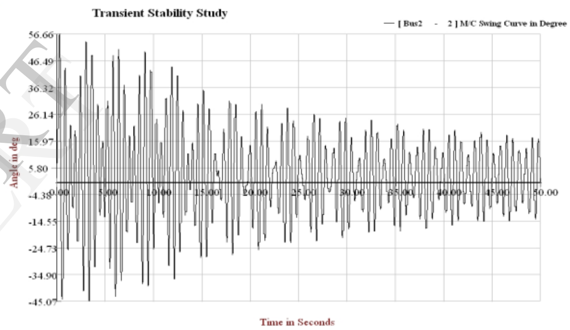


Fig.12 Swing Curve (in degree) of Machine 1

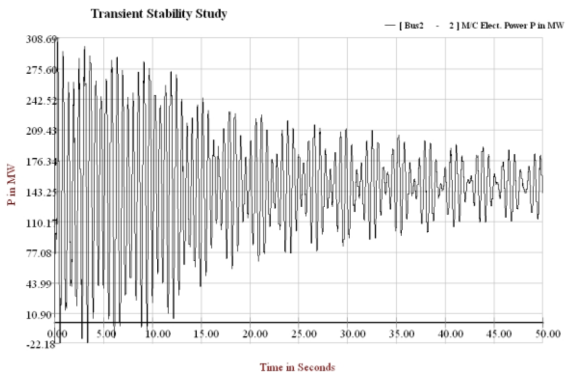


Fig. 1.3 Electrical Power P (in MW) of Machine 1

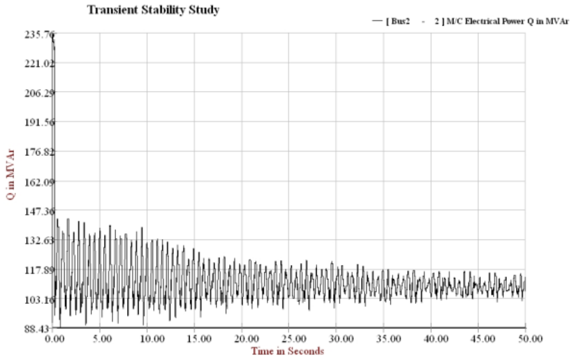


Fig. 1.4 Electrical Power Q (in MVAR) of Machine 1

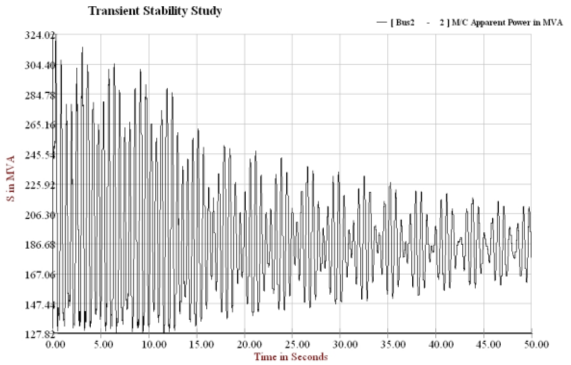


Fig. 1.5 Apparent Power S (in MVA) of Machine 1

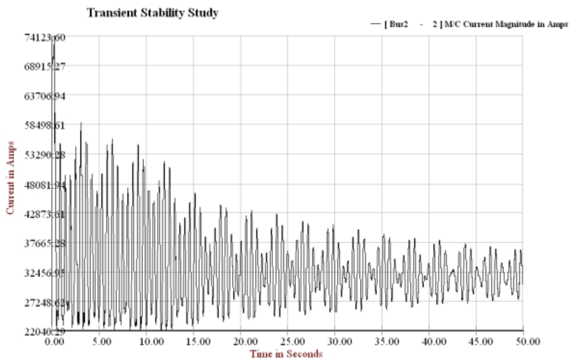


Fig. 1.6 Current (in Amp) of Machine 1

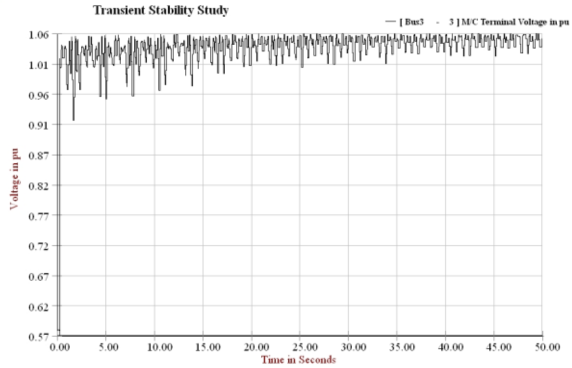


Fig.1.7 Terminal Voltage (in pu) of Machine 2

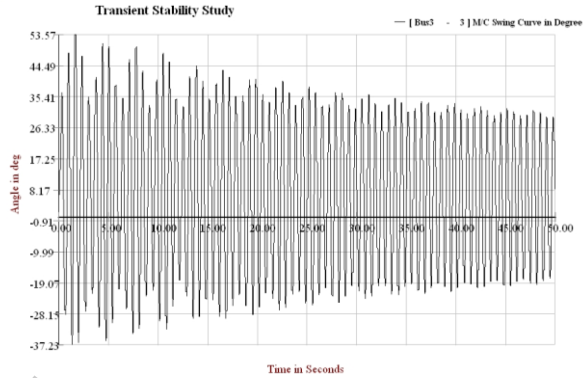


Fig. 1.8 Swing Curve (in degree) of Machine 2

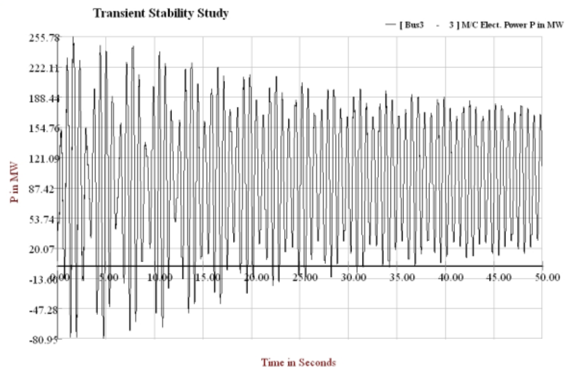


Fig. 1.9 Electrical Power P (in MW) of Machine 2

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Results of Machine3:-

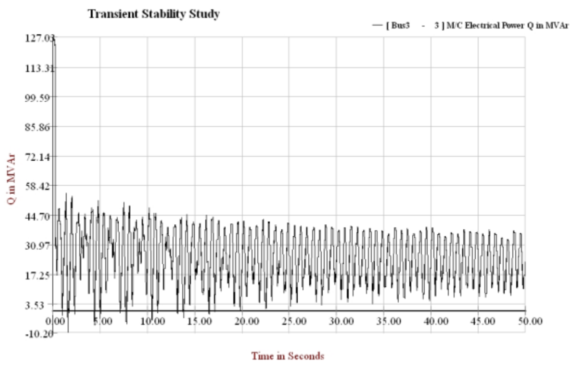

Fig1.10 Electrical Power Q (in MVAR) of Machine 2

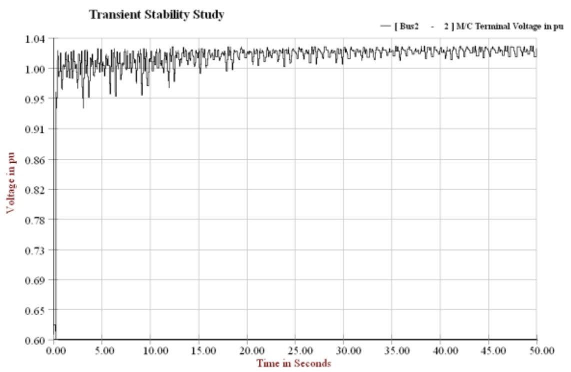

Fig. 1.11 Terminal Voltage (in pu) of Machine 2

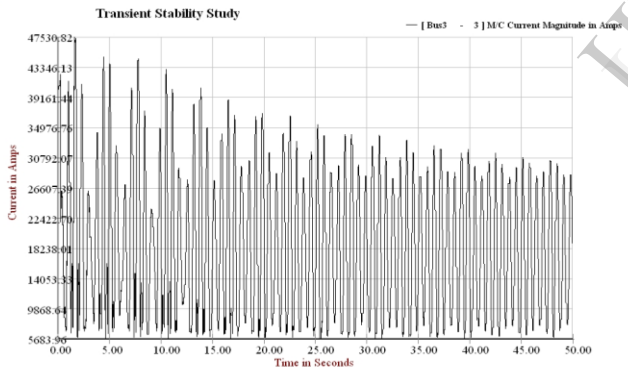

Fig. 1.12 Current (in Amp) of Machine 2

From the above curve of machine 1 and machine 2 it can be conclude that both machine have oscillatory in nature but nearly stable.

Comment on Simulation Result :-

From the above transient stability analysis by MiPower software it can be conclude that transient stability of generator is dependent on following criterion

i. Generator is loaded
ii. Generator output during fault and it depends on fault location and time
iii. Post fault transient system
iv. Generator reactance : a lower reactance increase peak power and reduces initial rotor angle
v. Generator inertia : the higher inertia has slower rate of change and this reduces kinetic energy gain during fault
vi. Generator internal voltage magnitude : this depends on field excitation
vii. Infinite bus magnitude

In this work the basic concept of transient stability is analyzed by representing a simple model by using graphical approach. Here no computation is done but analyze and simulate a model. But practically power systems have complex network structure, so for accurate analysis of transient stability detail model of generating unit and other related equipment is required.

At present the most practical and available method for transient stability analysis is time domain simulation in which non linear differential equation are solved by using step by step numerical integration. But here this job is done by software simulation. As the practical case in generating station as well as substation has been analyzed by this simulation software, so it will helpful for further study work.

Conclusion: -

In A.C power transmission vital analysis is stability. It is the property of the power system that enables its operation in the intended mode where the power flows through the entire network and the power angles have their magnitudes within the specified limits maintaining synchronism between the synchronous machines as well as the system voltage and currents do not exceed the rated values. So stability of an A.C power system is also denoted by its capability to recover from planned and random electrical disturbances via switching operations, faults, variation in load demand etc.So transient stability is very vital analysis of power system. This analysis made easy by computer simulation through MIPOWER software. This work aims to present a methodology to transient stability analysis of electrical energy system. This will help and guide the improvement of stability analysis. As we had observed that the controlling in the load side is complex. So, we will be controlling generation side. By controlling the generation side the synchronism of the system is always maintained whether the fault is caused by voltage or current. It also helps in maintaining the system efficiency and providing better service to consumer. So maintain complex system in synchronous condition transient analysis is must.

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