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Power System Stability Evaluation by Multi-Machine Technique

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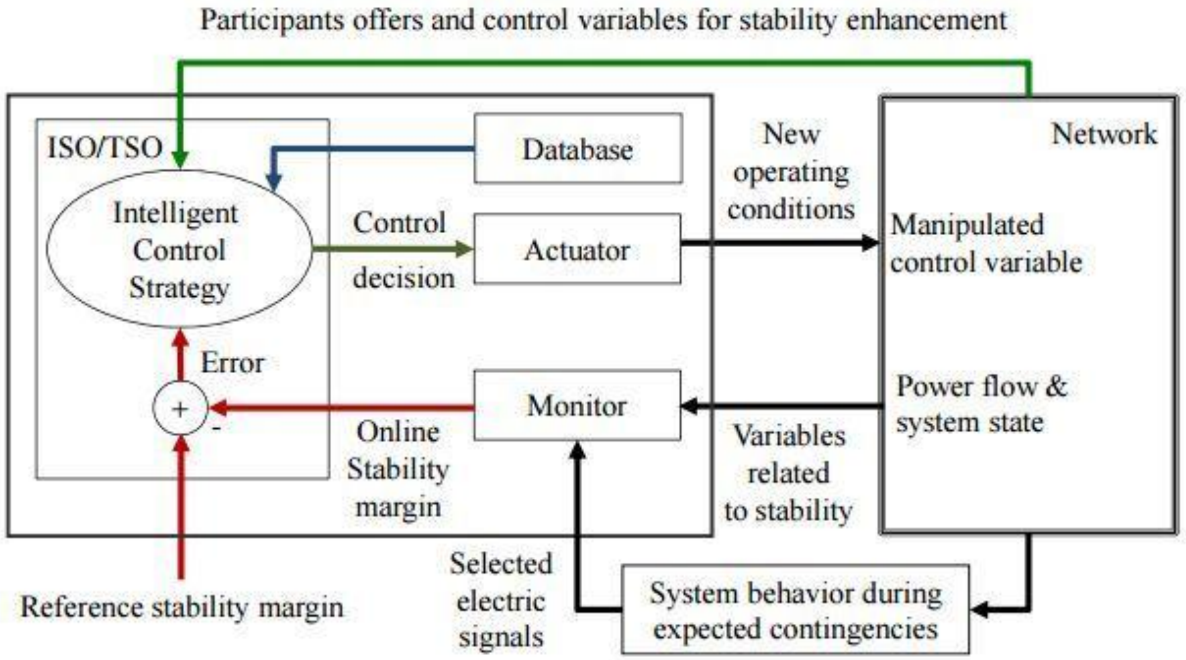
Abstract: The Primary objective of this paper is to understand the stability of Power System. In this study we will explore the security threats of power system as well and also determine the disturbance level in unsafe executions. In this modern era of time the power stability is most necessarily required factor for society, but due to some indecisive reasons the power is not being supplied as per the demand and the evaluation of voltage supplied is become very tricky. In this paper we will study and discuss various aspects of power system stability.

Keywords: CCT, TSA, OSA, MDA, FCT, Multi machine.

1. INTRODUCTION

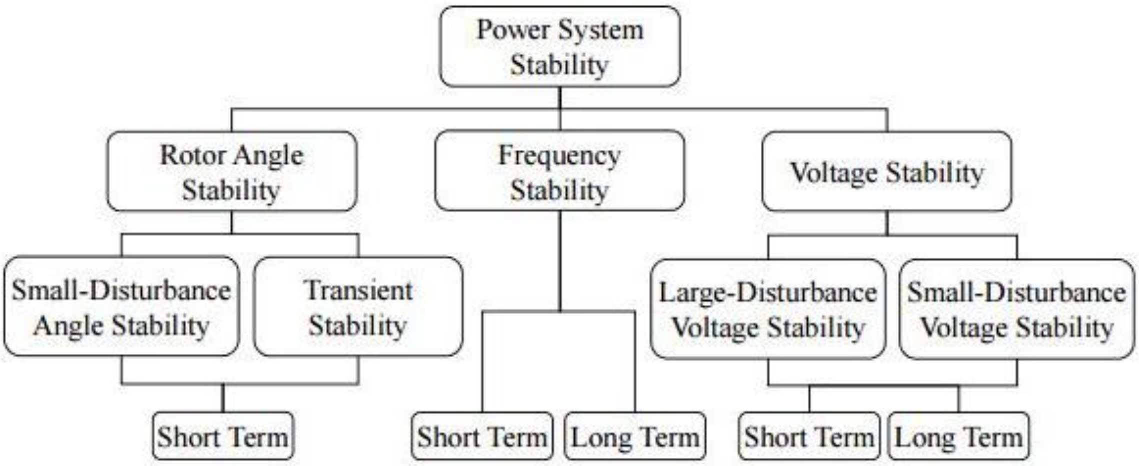
The electric power systems in India have recently grown exceptionally quick such as European interconnected power system. The load dispatch centers should persistently determine the load scheduling and dispatching without violating the system constraints to guarantee secure and reliable suppliers to all consumers. Utilities try to forecast the future energy demand in their areas and build up new generation strategies accordingly to account risks due to broad interconnection on system stability especially in deregulated electricity markets. A consistent action requires fast apparatus to observe system strength that can process an extensive range of network connectivity and generation dispatches during regular and irregular operations.



Dynamic system stability is observed based on power system transitory strength and oscillatory stability. Critical fault clearing time (CCT) is used as pointer for TSA and minimum damping of oscillation (MDO) works as indicator for OSA. The values of CCT and MDO at the most believable incident can be used as dynamic stability indices in typical control centers. of Dynamic stability level can be calculated from these values, as the values increase, one has an increased prospect to isolate and clear the effect of the disturbance. This implies that the power system is secure for that particular event. On the other hand, very short values of CCT and MDO are very difficult to deal with during the design and coordination of protective relays and circuit breakers. Generators should have CCT higher than FCT of its protection devices to avoid disconnection due to loss of synchronism or overloading. Which further implies that if the system may encounter such shorter values for a possible disturbance the system is insecure in that operating environment. Therefore, increasing CCT improves the system transient stability.

2. DEFINITION OF POWER SYSTEM STABILITY

Power system stability is the ability of an electric power system, for a given initial operating condition, to regain a situation of operating equilibrium after being subjected to a physical disturbance, with most system variables restricted so that practically the entire system remains intact [9]. Stability phenomenon is a single problem associated with various forms of instabilities affected on power system due to the high dimensionality and complexity of power system constructions and behaviors. For properly understood of stability, the classification is essential for significant power system stability analysis. Stability classified based on the nature of resulting system instability (voltage instability, frequency instability), the size of the disturbance (small disturbance, large disturbance) and timeframe of stability (short term, long term). In the other hand, stability broadly classified as steady state stability and dynamic stability. Steady state stability is the ability of the system to transit from one operating point to another under the condition of small load changes. Power system dynamic stability appears in the literature as a class of rotor angle stability to describe whether the system can maintain the stable operation after various disturbances are present or not.



3. PRECAUTIONARY PROCEDURES TO AVOID SYSTEM INSTABILITY

In power system design and preparation stage, a wide number of disturbances have to be assessed by system operators. If the system is found to be unstable (or marginally stable) following any contingency, variety of actions can be taken to improve the system stability. These preventive actions can be classified mainly into Offline and online preventive actions. Offline preventive measures: Improvement of system stability can be achieved by many actions including:

- Organizing the system pattern and maintenances in such that being suitable for the particular operating circumstances without overloading during abnormal conditions.
- Reduction of transmission system reactance which can be achieved by adding additional parallel transmission circuits, providing series compensation on existing circuits and by using transformers with lower leakage reactance
- Activating new invention for imprudent power carrying and voltage control service such as power system stabilizers, FACTs, distributed generation technologies and quick thermal units with fast valving ability and fast acting automatic excitation systems.
- Involving dynamic breaking resistors at the generator and substation terminals in order to break the acceleration of the rotor of generators during faults. Shunt resistors can be switched in to create an artificial load following a fault, in order to improve the damping of accelerated generators
- Installing capable protective devices and coordinating between the consistent system operators for faster fault clearing and initiating proper corrective actions during abnormal conditions.
- Varying the system topology such as tripping of critical generator to ensure that the other generators maintain in synchronism. In addition, generation rescheduling/re-dispatching can be used to reallocate power production in order to avoid system overloads and relieve constraints.

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- Automatic load shedding of interruptible consumers is an efficient corrective counter-measure to maintain the frequency at nominal value during abnormal conditions. In the simple implementation, under frequency relays installed at fixed points and with fixed settings can be made adaptive by adjusting the location and level of shedding in accordance with power flow and voltage conditions on the transmission network
- Assuring reactive-power generation or combination control and using special control of HVDC links to control the DC power and maintain generation/load balance in AC networks during disturbance

Multimachine System

In a multimachine system a common system base must be chosen.

G_{mach} = machine rating (base)
G_{system} = system base

Equation (12.11) can then be written as

^{G}mach F H_{mach} $d^2\delta$ I ^{G}mach

G 2J = $(P_m – P_e)$

^{G}system H f dt K ^{G}system

Hsystem
$d^2\delta$

or π f dt^2 = $P_m – P_e$ pu in system base

F G I
^{H}system = ^{H}machmach

where G J

H ^{G}system K

= machine inertia constant in system base

Consider the swing equations of two machines on a common system base.

H $d^2\delta$
1 1
= P m – P e pu
1 1
p f dt^2
H 2 $d^2\delta$ 2
= P m – P e pu
p f dt ^{2} 2 2

Since the machine rotors swing together (coherently or in unison)
$d_1 = d_2 = d$

Adding Eqs (12.14) and (12.15)
Heq d2 $_2^{\delta}$ = $P_m – P_e$

π f dt

where
$P_m = P_{m1} + P_{m2}$
$P_e = P_{e1} + P_{e2}$
$H_{eq} = H_1 + H_2$

The two machines swinging coherently are thus reduced to a single machine as in Eq. (12.16). The equivalent inertia in Eq. (12.17) can be written as

^{H}eq = ^{H}1 mach ^{G}1 mach/^{G}system + ^{H}2 mach
^{G}2 mach/^{G}system (12.18)

The above results are easily extendable to any number of machines swinging coherently.

4. CONCLUSION

In this paper mainly stability of power system discussed and also the use of Multimachine technique illustrated over here, some basic preventions to avoid instability is also being explained. The overall study is based on simple methods and in commonly used terminology.

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