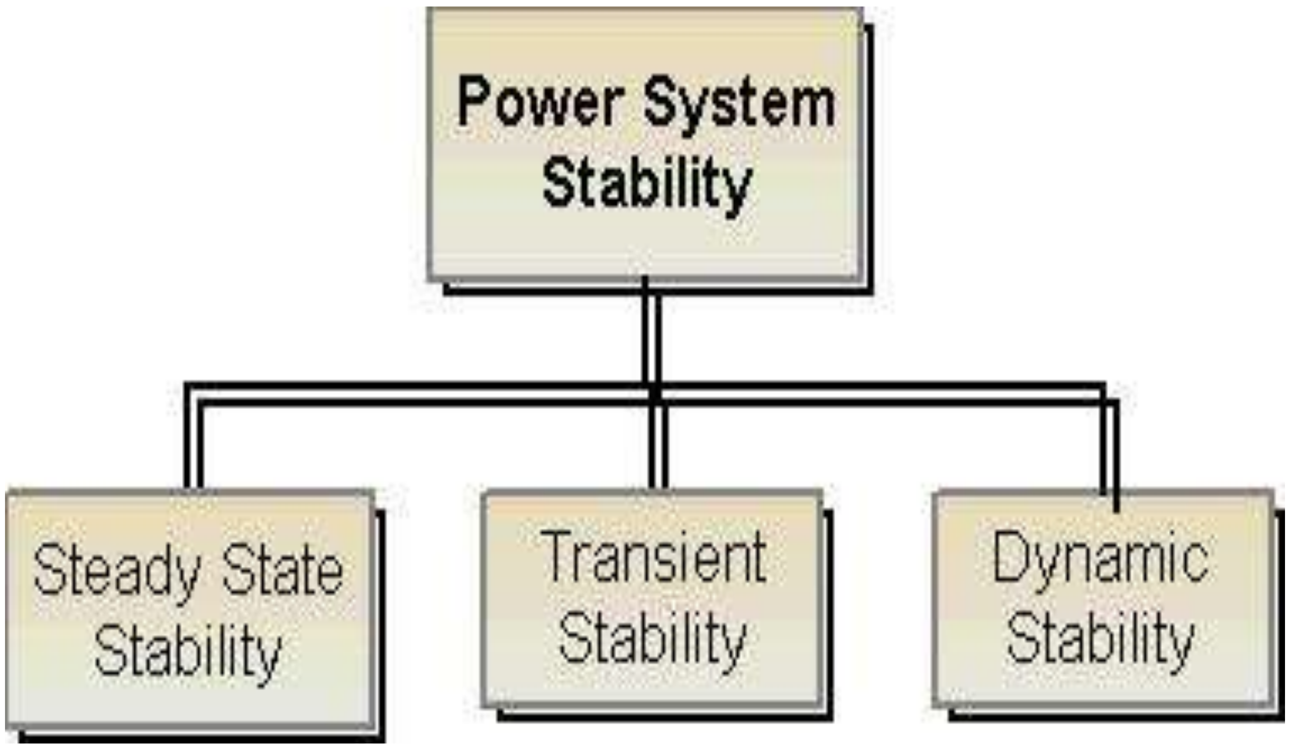
UNIT V

STEADY STATE STABILITY ANALYSIS

STABILITY

- The tendency of a power system to develop restoring forces equal to or greater than the disturbing forces to maintain the state of equilibrium.
- Ability to keep the machines in synchronism with another machine

Classification Of Stability



Classification Of Stability

- Steady state stability

  Ability of the power system to regain synchronism after small and slow disturbances (like gradual power changes)

- Dynamic stability

  Ability of the power system to regain synchronism after small disturbances occurring for a long time (like changes in turbine speed, change in load)

- Transient stability

  This concern with sudden and large changes in the network conditions i.e. . sudden changes in application or removal of loads, line switching operating operations, line faults, or loss of excitation.

Steady State Stability Power Limit

- Steady state limit is the maximum power that can be transferred without the system become unstable when the load in increased gradually under steady state conditions.

Transfer Reactance

- steady-state power delivered by a lossless synchronous machine.

$$P_e = P_d = \frac{|E_g||V_t|}{x_d} \sin\delta$$

$$= P_{max} \sin\delta.$$

- Where X_d is called transfer reactance

Synchronizing Power Coefficient

- From swing equation

$$M_{(pu)} \cdot \frac{d^2\delta}{dt^2} = (P_i - P_e)\ pu$$

- And

$$P_e = P_d = \frac{|E_g||V_t|}{x_d} \sin\delta$$

$$= P_{max} \sin\delta.$$

Synchronizing Power Coefficient

- Linearizing the operating point $\Delta P_e = (\frac{\partial P_e}{\partial \delta})_0 \Delta\delta$.

$$M \frac{d^2 \Delta\delta}{dt^2} = P_i - (P_{e0} + \Delta P_e) = -\Delta P_e$$

$$M \frac{d^2 \Delta\delta}{dt^2} + \left[\frac{\partial P_e}{\partial \delta}\right]_0 \Delta\delta = 0$$

- ${\partial P_e}/_{\partial \delta}$ is called synchronizing power coeffincient.

Power Angle Curve

- Swing equation is $\frac{H}{\pi f_0}\frac{d^2\delta}{dt^2} = P_m - P_e = P_0$
- The power flow equation of a single machine
- connected to infinite bus (SMIB) system is given as

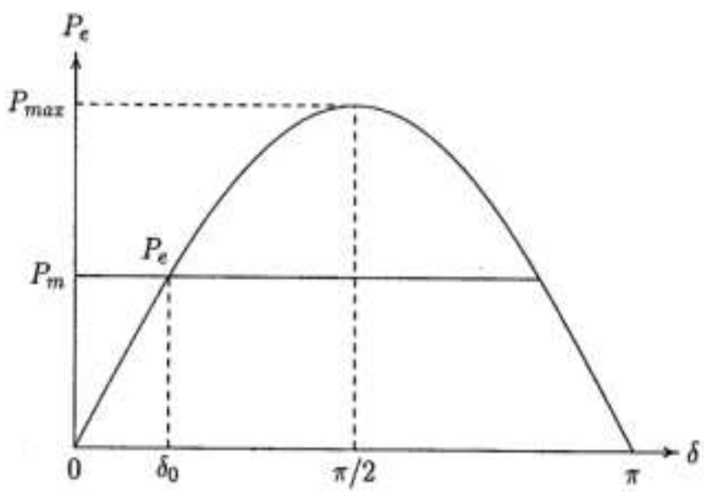
$$P_e = \frac{|E'||V|}{X_{12}}\sin\delta$$

where

$$P_{max} = \frac{|E'||V|}{X_{12}}$$

Power Angle Curve

- Therefore $P_e = P_{max} \sin \delta$
- The curve Pe versus ὁ ıs called power angle curve



Methods to improve Stability

- Use of Bundled Conductors
- Use of Double-Circuit Lines
- Operate Transmission Lines in Parallel
- Series Compensation of the Lines
- Series Compensation of the Lines
- High-Speed Excitation Systems
- Fast Switching
- Breaking Resistors
- Single-Pole Switching
- HVDC Links
- Load Shedding