SNS COLLEGE OF ENGINEERING

Kurumbapalayam (Po), Coimbatore – 641 107

An Autonomous Institution

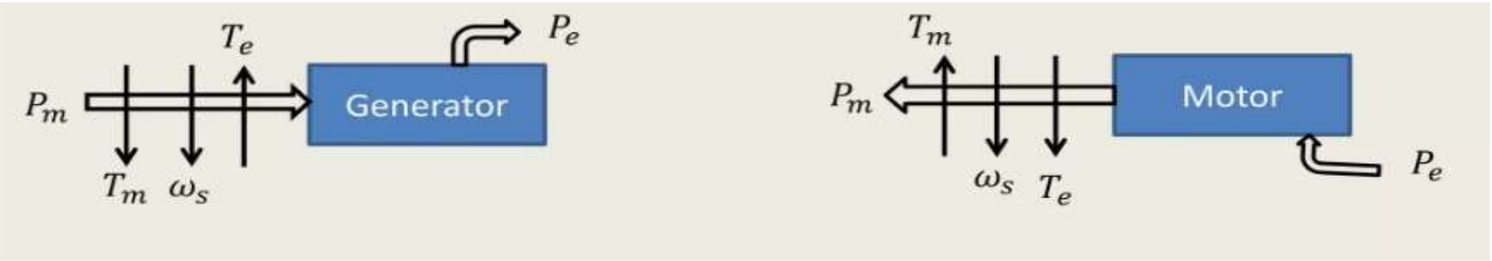
Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A' Grade
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

UNIT – V
Stability Studies and Reactive Power
Swing Equation of Synchronous Machine

Swing Equation – Synchronous Machine

- Under normal operating conditions , the relative position of the rotor axis and the resultant magnetic field axis is fixed.
- The angle between the two is known as the power angle and torque angle.
- During any disturbance , the rotor decelerates or accelerates with respect to the synchronously rotating air gap mmf, creating relative motion.
- The equation describing the relative motion is known as swing equation , which is non linear second order differential equation that describes the swing of the rotor of synchronous machine.



Swing Equation – Synchronous Machine

- A synchronous generator s driven by prime mover.
- The equation governing the rotor motion is given by :

$$J\frac{d^2\theta_m}{dt^2} = T_m - T_e = T_a \ldots\ldots\ldots 1$$

- Where
  - J is the total moment of inertia of the rotor mass in kg
  - Tm is the mechanical torque supplied by prime mover in N-m
  - Te is electrical torque output of alternator in N-m

$$J\omega_{sm}\frac{d^2\theta_m}{dt^2} = P_m - P_e \quad \text{MW} \ldots\ldots\ldots 2$$

$$\left(J\left(\frac{2}{P}\right)^2 \omega_s \times 10^{-6}\right)\frac{d^2\theta_e}{dt^2} = P_m - P_e \quad \text{MW} \ldots\ldots\ldots 3$$

Swing Equation – Synchronous Machine

$$\left(J\left(\frac{2}{P}\right)^2 \omega_s \times 10^{-6}\right)\frac{d^2\theta_e}{dt^2} = P_m - P_e \quad \text{MW}.....3$$

- The above equation can be rewritten as,

$$\mathbf{M} = J\left(\frac{2}{P}\right)^2 \omega_s \times 10^{-6}\ \textit{moment of inertia in MJ.S/(elect rad)}$$

$$M\frac{d^2\theta_e}{dt^2} = P_m - P_e \quad \text{MW} \ldots\ldots\ldots 4$$

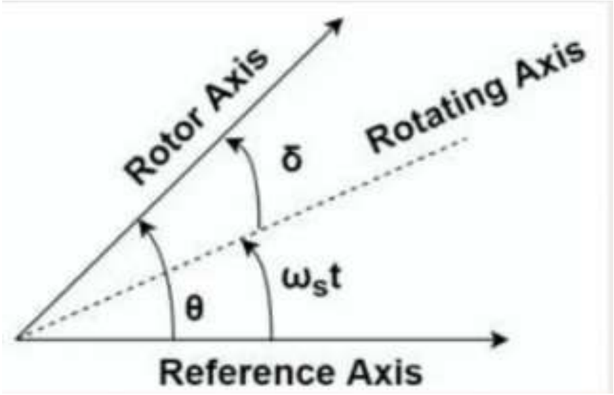
$$\delta = \theta_e - \omega_s T.....5$$

Swing Equation – Synchronous Machine

- Rotor angle displacement from synchronously rotating frame called as torque angle or power angle.

$$\frac{d^2\delta}{dt^2} = \frac{d^2\theta_e}{dt^2} \ldots\ldots\ldots 6$$

$$M\frac{d^2\delta}{dt^2} = P_m - P_e \ldots\ldots\ldots 7$$



- The above equation is called swing equation of synchronous alternator.

ASSESSMENT

1. For coherent machines the equivalent inertia constant (H) is given by

- H1H2
- H1 – H2
- **H1 + H2**
- H1 / H2

ASSESSMENT

2. Equal area criterion and swing equation are used for _____ and _____stability respectively.

- Steady state, Transient
- Transient , Steady state
- Both are used for steady state stability
- Both are used for transient stability


thank
you