Mechanical-to-Electrical Energy Conversion

6. Synchronous generators connected to a utility grid

Hideaki Fujita

fujita@ee.e.titech.ac.jp

Tokyo Institute of Technology

Contents Today

1. Dynamic Stability

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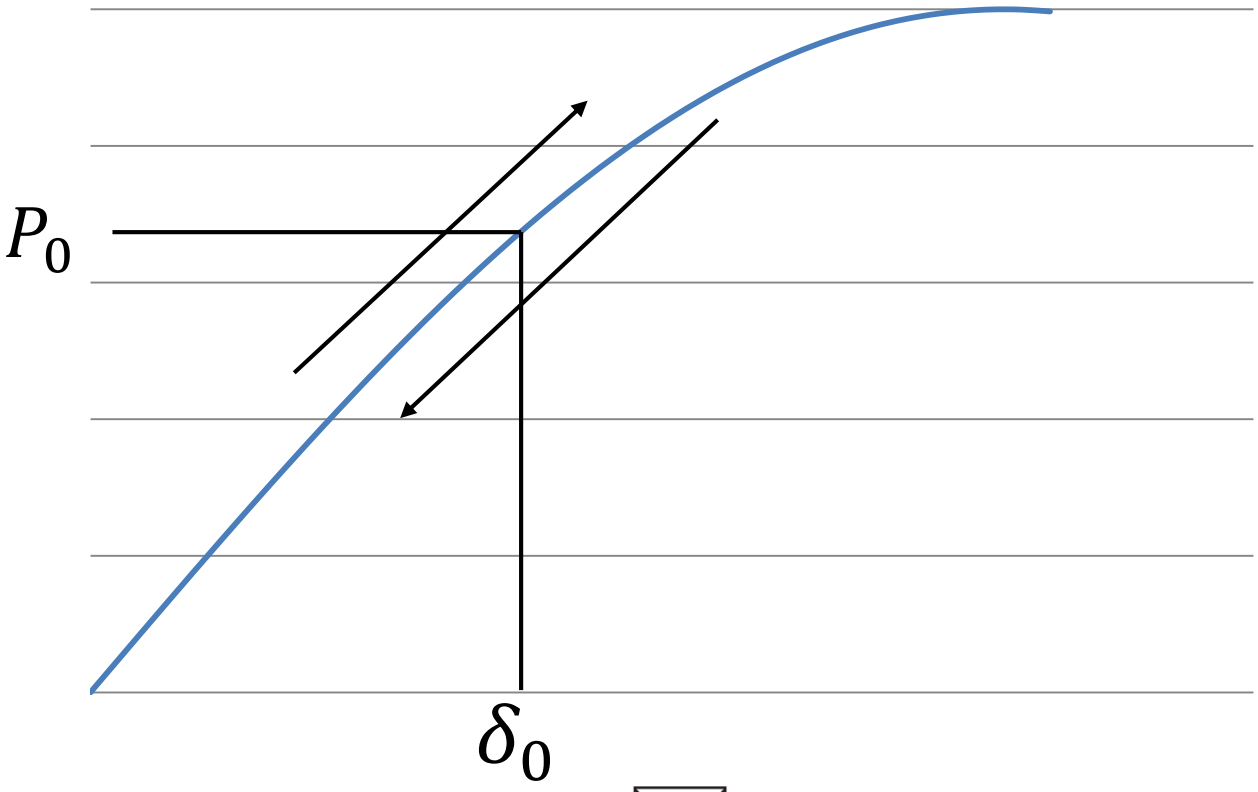
Power Swings

$$\Delta\delta = C_1 \sin\left(\sqrt{\frac{VE_0 \cos\delta_0}{p\omega_m J X_s}}\, t + C_2\right)$$



Dynamic Response

- Assumption:

$$P_m = \frac{VE_0}{X_s}\sin\delta_0$$

- Power Relationship:

$$P_m - P = -\frac{VE_0\cos\delta_0}{X_s}\Delta\delta = p\omega_m J\frac{d^2}{dt^2}\Delta\delta$$

$$\frac{d^2}{dt^2}\Delta\delta = -\frac{VE_0\cos\delta_0}{p\omega_m J X_s}\Delta\delta$$

$$\Delta\delta = C_1\sin\left(\sqrt{\frac{VE_0\cos\delta_0}{p\omega_m J X_s}}\,t + C_2\right)$$

Kinetic Energy Stored in the Rotor

- Initial Position: δ_1

  $\delta < \delta_1$

  $T_m > T$ Decelaration

- Kinetic Energy at δ_0:

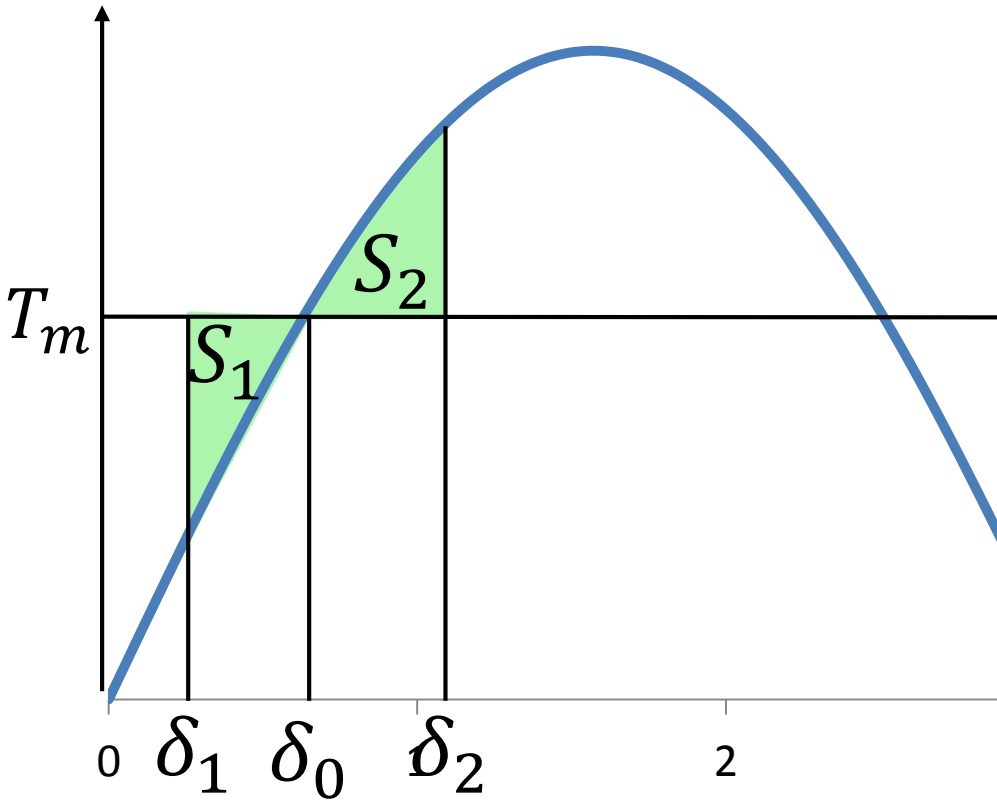
$$S_1 = \int_{\delta_1}^{\delta_0} (T_m - T) d\delta$$

- Released Energy:

  $\delta < \delta_1$

$$S_2 = \int_{\delta_0}^{\delta_2} (T - T_m) d\delta$$

$$S_1 = S_2$$



To be Continued in the Lecture…..