

## ECE 423: Lecture 41

### Example 16.11

Initial Data

$$H := 8s \quad f := 60\text{Hz}$$

$$k := \frac{180 \cdot f}{H} \cdot \Delta t^2 \cdot \text{deg} \quad k = 0.14 \text{deg}$$

$$P_m := 1.85$$

Swing Equation during fault conditions

$$\gamma_{\text{fault}} := 0.755 \cdot \text{deg} \quad \gamma_{\text{fault}} = 0.76 \text{deg}$$

$$P_{c\_fault} := 0.1545 \quad P_{\text{max\_fault}} := 5.5023$$

$$P_{e\_fault}(\delta) := P_{c\_fault} + P_{\text{max\_fault}} \cdot \sin(\delta - \gamma_{\text{fault}})$$

Accelerating power during fault conditions

$$P_{a\_fault}(\delta) := P_m - P_{e\_fault}(\delta)$$

Swing Equation during post-fault conditions

$$\gamma_{\text{post}} := 0.847 \cdot \text{deg} \quad \gamma_{\text{post}} = 0.85 \text{deg}$$

$$P_{c\_post} := 0.1804 \quad P_{\text{max\_post}} := 6.4934$$

$$P_{e\_post}(\delta) := P_{c\_post} + P_{\text{max\_post}} \cdot \sin(\delta - \gamma_{\text{post}})$$

Accelerating power during post-fault conditions

$$P_{a\_post}(\delta) := P_m - P_{e\_post}(\delta)$$

Initial Data

$$H := 8s \quad f := 60\text{Hz}$$

$$k := \frac{180 \cdot f}{H} \cdot \Delta t^2 \cdot \text{deg} \quad k = 0.14 \text{deg}$$

### Initial Conditions

$$\delta_0 := 16.19 \cdot \text{deg} \qquad \delta_0 = 16.19 \text{ deg}$$

$$P_{e\_fault}(\delta_0) = 1.62$$

$$P_{a\_fault}(\delta_0) = 0.23$$

$$P_{a\_0} := \frac{P_{a\_fault}(\delta_0) - 0}{2} \qquad P_{a\_0} = 0.12$$

Clearing time iteration number

$$n_{cl} := \text{ceil}\left(\frac{t_{cl}}{\Delta t}\right) \qquad n_{cl} = 23$$

Simulation time iteration number

$$n_{max} := \text{ceil}\left(\frac{t_{max}}{\Delta t}\right) \qquad n_{max} = 100$$

$$\text{delta} := \left| \begin{array}{l} P_0 \leftarrow P_{a\_0} \\ \delta_0 \leftarrow \delta_0 \\ \Delta\delta_0 \leftarrow 0 \\ \text{for } n \in 1..n_{max} \\ \quad \left| \begin{array}{l} \Delta\delta_n \leftarrow \Delta\delta_{n-1} + k \cdot P_{n-1} \\ \delta_n \leftarrow \delta_{n-1} + \Delta\delta_n \\ P_n \leftarrow \left| \begin{array}{l} P_{a\_fault}(\delta_n) \text{ if } n < n_{cl} \\ P_{a\_post}(\delta_n) \text{ otherwise} \end{array} \right. \\ n \leftarrow n + 1 \end{array} \right. \\ \delta \end{array} \right.$$

### Find New Operating Angle

Initial guess  $\delta_{\text{new}} := \delta_0$

Given

$$P_m = P_{e\_post}(\delta_{\text{new}})$$

$$\delta_{\text{new}} := \text{Find}(\delta_{\text{new}})$$

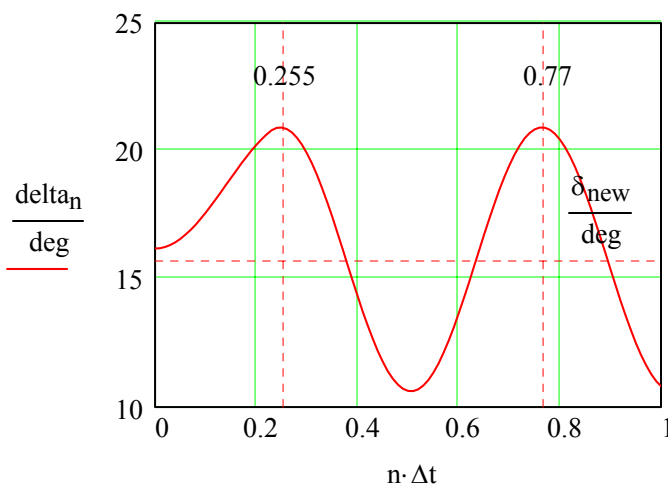
$$\delta_{\text{new}} = 15.75 \text{ deg}$$

$t_{cl} \equiv 0.225 \cdot s$  Clearing Time

$t_{\text{max}} \equiv 1 \cdot s$  Simulation Time

$\Delta t \equiv 0.01s$  Solution interval

$n := 0 .. n_{\text{max}}$



$\delta_{n}$	deg
16.19	
16.21	
16.25	
16.33	
16.44	
16.57	
16.73	
16.92	
17.12	
17.35	
17.6	
17.85	
18.12	
18.4	
18.68	
18.95	

### Oscillation Period

$$T := 0.77s - 0.255s$$

$$T = 0.52s$$

$$S_p := P_{\text{max\_post}} \cdot \cos(\delta_{\text{new}} - \gamma_{\text{post}})$$

$$S_p = 6.28$$

$$f_n := \frac{1}{2 \cdot \pi} \cdot \sqrt{\frac{2 \cdot \pi \cdot f \cdot S_p}{2 \cdot H}}$$

$$f_n = 1.94 \text{ Hz}$$

$$T_n := \frac{1}{f_n}$$

$$T_n = 0.52s$$