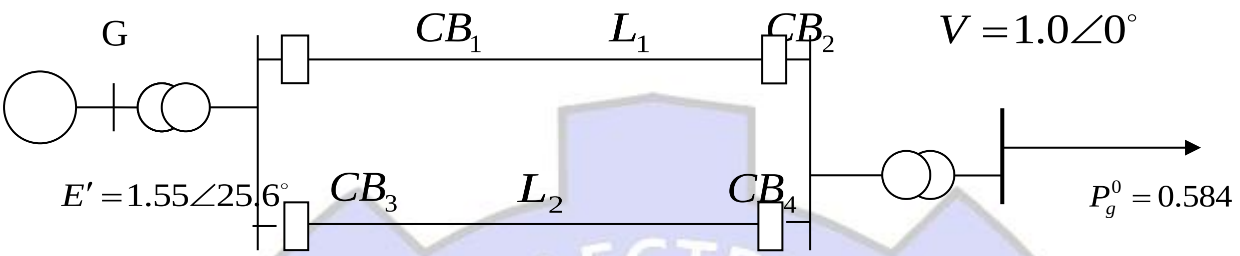
Example (1) : For the circuit shown in fig. below , it is assumed that both lines are first open and then re-closed , determine the maximum time (t_{ON}) (time of re-closed) during which the system is capable of preserving its transient stability when energy is not supplied to it .



$$P_T^0 = P_g^0 = 0.584$$

$$X_{EV} = 1.15 \;;\; M = 7Sec.$$

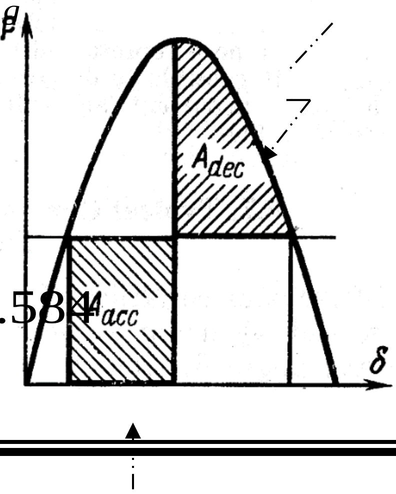
Solution:

$$P_{\max}^{I} = P_{\max}^{III} = \frac{|E'||V|}{X_{EV}} = \frac{1.55 \times 1}{1.15} = 1.35\ pu$$

When both lines are switched off $P_{\max}^{II} = 0$

$\delta_c(\delta_{ON})$ - is the max. angle at which the lines should be switched ON (re-closed) .

$$P_g^I = P_g^{III}$$



$$P_T = P_g^0 = 0.584$$

$$\delta_0 \quad \delta_c \quad \delta_m \; 180$$

$$P_g^{II} = 0$$

$$\cos\delta_c = \frac{P_g^0(\delta_m - \delta_0) - P_{\max}^{II}\cos\delta_0 + P_{\max}^{III}\cos\delta_m}{P_{\max}^{III} - P_{\max}^{II}}$$

$$\delta_m = 180^\circ - \delta_0 = 180^\circ - \sin^{-1}\frac{P_g^0}{P_{\max}^{I}}$$

$$= 180^\circ - \sin^{-1}\frac{0.584}{1.35} = 154.4^\circ$$

$$\cos\delta_c = \frac{0.584(154.6^\circ - 25.6^\circ)\frac{\pi}{180} - 0 + 1.35\cos 154.6^\circ}{1.35 - 0} = 0.0665$$

$$\delta_c = \cos^{-1} 0.0665 = 86.2^0$$

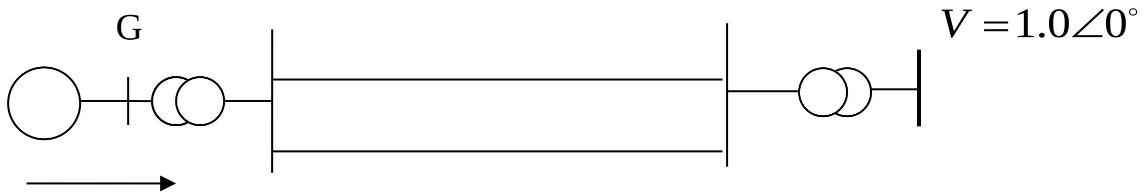
$$t_{ON} = \sqrt{\frac{2M(\delta_{ON} - \delta_0)}{P^0}} = \sqrt{\frac{2\frac{7}{2\pi f_0}(86.2 - 25.6)\frac{\pi}{180}}{0.584}}$$

$$= \sqrt{\frac{7(86.2 - 25.6)}{0.584 \times 180 \times 50}} = 0.284\ Sec.$$

Example (2) :

For the circuit shown in fig. , if the fault occurs on one line .

Determine the critical clearing angle .

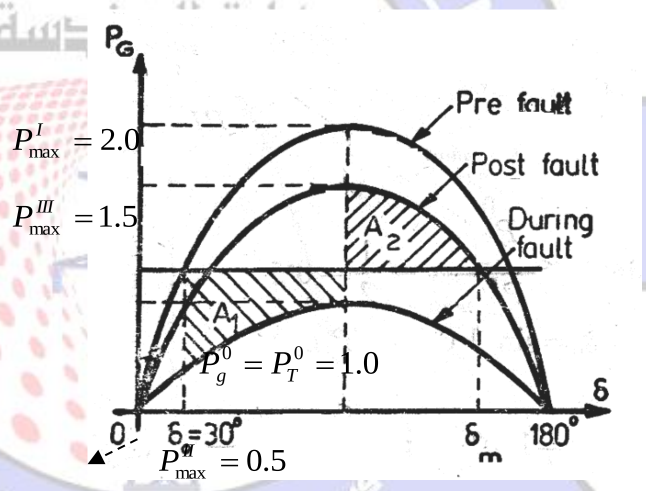


$$P_g^0 = P_T^0 = 1.0$$

$$P_{\max}^{I} = 2.0 \quad ; \quad P_{\max}^{II} = 0.5 \quad ; \quad P_{\max}^{III} = 1.5$$

Solution :

From data we can draw the ($P-\delta$) curve .



$$P_g^0 = P_{\max}^{I} \sin\delta_0$$

$$\sin\delta_0 = \frac{P_g^0}{P_{\max}^{I}} = \frac{1}{2}$$

$\delta_1 = \delta_c$

$$\delta_0 = \sin^{-1} 0.5 = 30^\circ \quad elec.$$

$$\delta_m = 180^\circ - \sin^{-1}\frac{P_g^0}{P_{\max}^{III}}$$

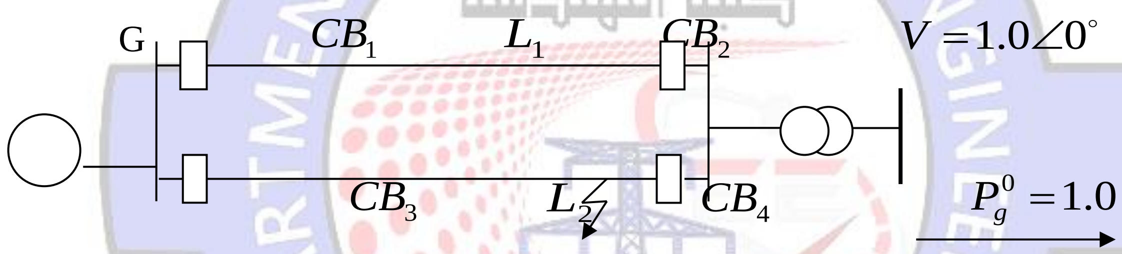
$$= 180^\circ - \sin^{-1}\frac{1}{1.5} = 138.2^\circ$$

$$\cos\delta_c = \frac{1\times(138.2^\circ - 30^\circ)\dfrac{\pi}{180} - 0.5\cos 30^\circ + 1.5\cos 138.2^\circ}{1.5 - 0.5} = 0.337$$

$$\delta_c = \cos^{-1} 0.337 = 70.3^\circ \quad elect.$$

Example (3) :

For the circuit shown in fig. , find the critical fault clearing angle , when 3-phase short circuit occurs at point shown in fig. The breakers CB_3 and CB_4 are opened after the fault .



$|E| = 1.25$

$P_T^0 = P_g^0 = 1.0$

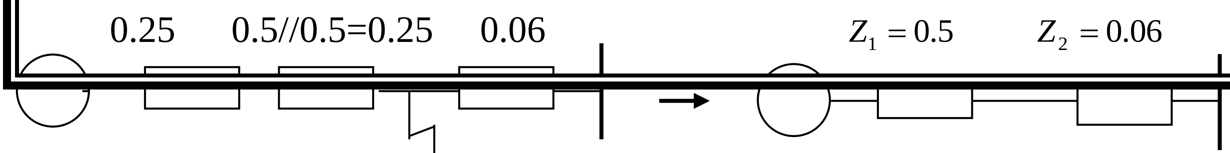
$$X_d = j0.25 \;;\; X_T = j0.06 \;;\; X_{L1} = X_{L2} = 0.5 \;;$$

i) pre fault operation :

$$X^I = 0.25 + \frac{0.5\times 0.5}{0.5+0.5} + 0.06 = 0.56$$

$$P_{max}^I = \frac{1.25\times 1}{0.56} = 2.232$$

ii) during fault :



$$X^{II} = Z_1 + Z_2 + \frac{Z_1 Z_2}{Z_3}$$

$$X^{II} = j0.5 + j0.06 + \frac{j0.5 \times j0.06}{j0.0} = \infty$$

That is mean , no transfer power at the receiving end .

$$P_{\max}^{II} = 0$$

iii) post fault operation (CB_3 and CB_4 are opened)

$$X^{III} = 0.25 + 0.5 + 0.06 = 0.81$$

$$P_{\max}^{III} = \frac{1.25 \times 1}{0.81} = 1.543$$

$$P_g^0 = P_{\max}^I \sin\delta_0$$

$$\sin\delta_0 = \frac{1}{2.232} = 0.448 \quad ; \quad \delta_0 = \sin^{-1} 0.448 = 26.6^\circ$$

$$\delta_m = 180 - \sin^{-1} \frac{P_g^0}{P_{\max}^{III}} = 180 - \sin\frac{1}{1.54} = 139.6^\circ$$

$$\cos\delta_c = \frac{1 \times (139.6 - 26.6)\frac{\pi}{180} - 0 + 1.543\cos 139.6}{1.543 - 0} = 0.516$$

$$\delta_c = \cos^{-1} 0.516 = 58.9^\circ$$