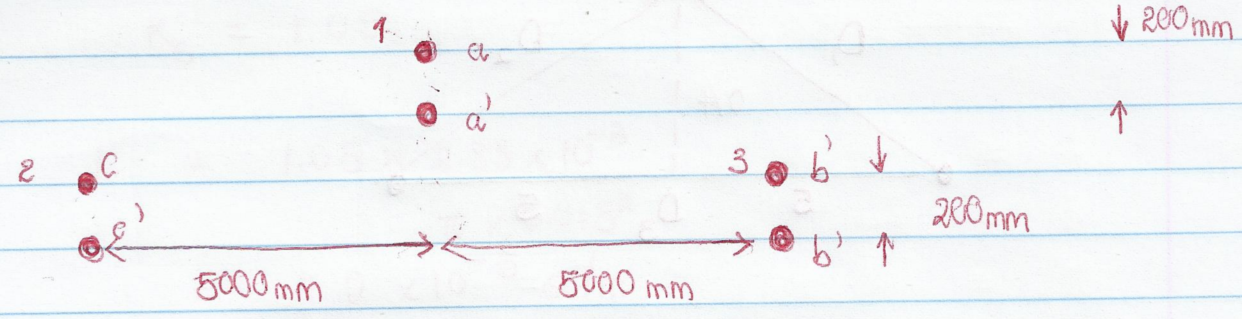
PtP 2012

1.



radius = 15mm .

$$G.M.R = \sqrt[n^2]{aa \times aa' \times a'a \times a'a'} \quad \text{or} \quad \sqrt{aa \times aa'}$$

$$aa' = a'a' = r\left(e^{-K_s \mu_r/4}\right)$$

$$m = \sqrt{\frac{2\pi(50) \times 4\pi \times 10^{-7}}{2.83 \times 10^{-8}}} = 118.11 \qquad \mu_r = 1$$

$$mr = 118.11 \times 0.015 = \underline{1.772} \rightarrow$$

$$K_s = 0.975$$

$$aa = a'a' = 0.015\ e^{-0.975/4}$$
$$= 0.0118\ m.$$

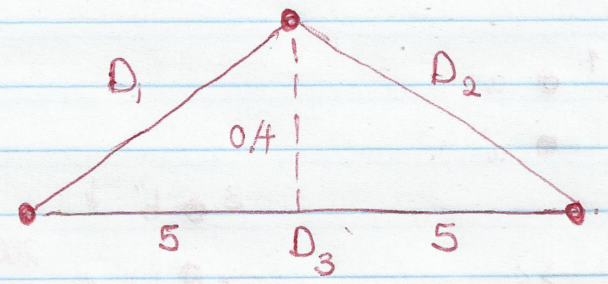
$$aa' = a'a = 0.2\ m \#$$

$$GMR = \sqrt[4]{0.0118^2 \times 0.2^2}$$

$$= 0.0486\ m.$$

Assuming distance btwn subconductors is << distance btwn conductors (phase)

$$G.M.D = \sqrt[3]{D_1 D_2 D_3}$$



$D_1 = 5.016\,m = D_2 \qquad D_3 = 10m.$

$$G.M.D = \sqrt[3]{5.016^2 \times 10} = 7.08\ m.$$

$$L' = 2\times10^{-7}\ln\left(\frac{7.08}{0.0486}\right)$$

$$= 9.96\times10^{-7}\ H/m.$$

$$C' = \frac{2\pi\varepsilon_0}{\ln\left(\frac{7.08}{D_{eq_{rc}}}\right)}$$

$D_{eq_{rc}}$: $aa = a'a' = 0.015\,e^{-1/4}$ (no skin effect)

$= 0.0117m.$

$$D_{eq_{rc}} = \sqrt[4]{0.0117^2 \times 0.2^2}$$

$$= 0.0484\ m.$$

$$\therefore C' = 1.115\times10^{-11}\ F/m.$$

$$R' = K_s\frac{\rho}{A}$$

$$K_s = 1.05$$

$$R' = \frac{1.05 \times 2.88 \times 10^{-8}}{\pi \times 0.015^2}$$

$$= 4.2 \times 10^{-5}\ \Omega/m$$

b) $$L' = 2 \times 10^{-7} \ln\left(\frac{D_m}{D_{eq}}\right)$$

~~For a~~ Conductor bundles ~~D_{eq}~~ increase D_{eq} values w.c in turn L'

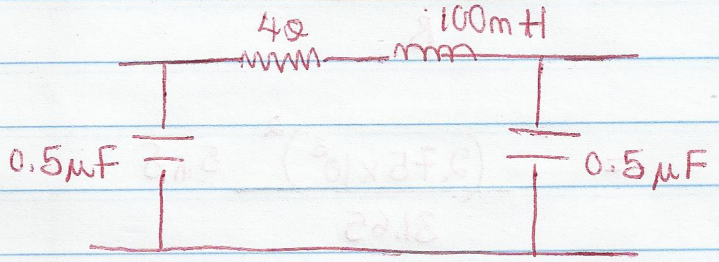
c) For a symmetrically spaced 3 ϕ conductor Geometry.

2 An overhead line has a higher $\frac{X}{R}$ ratio than similarly rated cable because there is flux cancellation in rated cables becoz ~~space~~ their spacing is small compared to overhead cables where there is small ~~Significant~~ flux cancellation due to a large separation distance between phase conductors.

$$L = 2 \times 10^{-7} \ln\left(\frac{D_m}{D_{eq}}\right) \quad (1)$$

From (1), D_m is >> D_{eq} ⇒ L is high. ⇒ X is high as well, compared to rated cables in w.c D_m/D_{eq} is very

b)



$V = \cancel{200\,kV}\ 275\,kV$, $P_R = 300\,MW$; $pf = 0.94$ lagging

$$A = 1 + Z_\pi y_\pi$$
$$B = Z_\pi$$
$$Z_\pi = (R' + j\omega L')\,l = R'l + j\omega L'$$
$$= 4\Omega + j\,100\,mH \times 2\pi f$$
$$= 4\Omega + j\,10\pi$$
$$= 4\Omega + j\,31.4\Omega$$

$$y_\pi = \frac{(G' + j\omega C')l}{2} = \frac{G'l + j\omega C'l}{2} \qquad (G=0)$$
$$= \frac{j\,2\pi(50) \times 0.5\times10^{-6}}{2}$$
$$= j\,78.54\ \cancel{\times}\ 10^{-6}\,\Omega$$

$$B = 4 + j\,31.4 = 31.65\angle 82.7^\circ$$
$$A = 1 + (31.65\angle 82.7^\circ)(78.54\times10^{-6}\angle 90)$$
$$= 1 + 2.49\times10^{-3}\angle 172.7$$
$$= 0.9975 + j\,316\times10^{-6}$$
$$= 0.9975\angle 0.018$$

$$V_S = AV_R + BI_R$$

$$\text{Load Real Power} = \frac{|V_S||V_r|}{B}\sin\delta$$

$$\left(\frac{300}{3}\right) = \frac{(275\times10^3)^2}{31.65}\sin\delta$$

$$\sin\delta = 41.9\times10^{-9}$$

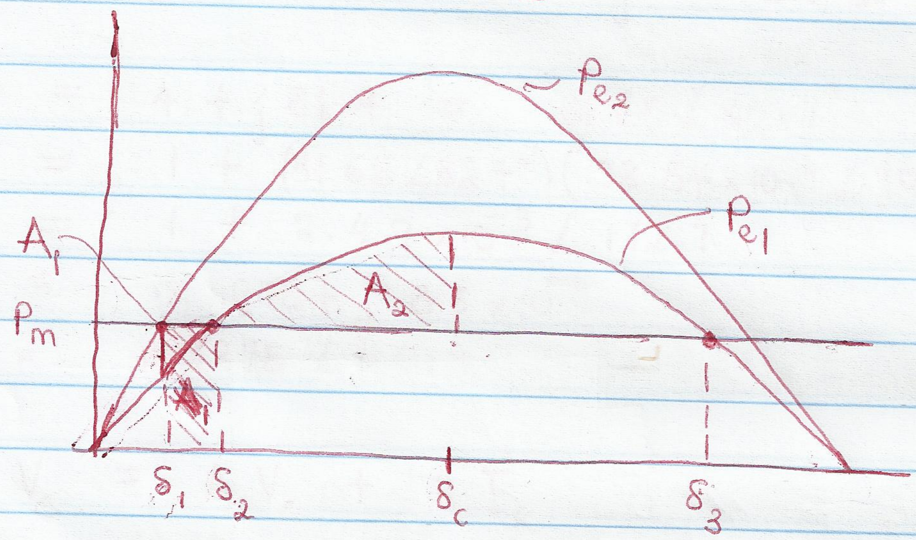
SIL : Refer to notes pge 4

Q 3a Transient Stability : refer to pge 52
An issue in Generating units and line switching ccts.

Q 4. $P_m = 500 MW$ $V = 275 KV$ $X_s = 30 \Omega$

$$P_{e(max)_1} = \frac{V_s^2}{X_s} = \frac{(275 \times 10^3)^2}{30}$$
$$= 2.52 \times 10^9 W$$

$$P_{e(max)_2} = 2 \times \frac{V_s^2}{X_s} = 5.04 \times 10^9 W.$$



Assuming the short cct is removed immediately after the fault occurs.

Using equal area criterion:

$$A_1 = (\delta_2 - \delta_1)P_m - \int_{\delta_1}^{\delta_2} P_{e(max)_1} \sin \delta \, d\delta$$

$$= (\delta_2 - \delta_1)P_m + P_{emax_1} [\cos \delta]_{\delta_1}^{\delta_2}$$

$$\delta_1 = \sin^{-1}\left(\frac{P_m}{P_{e(max)2}}\right) \qquad \delta_2 = \sin^{-1}\left(\frac{P_m}{P_{e(max)1}}\right)$$

$$\delta_1 = \sin^{-1}\left(\frac{500 \times 10^6}{5.04 \times 10^9}\right) \qquad \delta_2 = \sin^{-1}\left(\frac{500 \times 10^6}{2.52 \times 10^9}\right)$$

$$= 5.69^\circ \qquad = 11.44^\circ$$

$$A_1 = \overset{(\delta_2-\delta_1)}{\wedge} 500 \times 10^6 + 2.52 \times 10^9 [\cos 11.44 - \cos 5.69]$$

$$= 2.91 \times 10^9 \text{ GW-degrees.}$$

$$\delta_3 = 180 - \delta_2$$
$$= \underline{168.56}$$

$$A_2 = A_1$$

$$\int_{\delta_2}^{\delta_c} 2.52 \times 10^9 \sin\delta \, d\delta - 500 \times 10^6 (\delta_c - \delta_2) = 2.91 \times 10^9$$

$$-2.52 \times 10^9 [\cos\delta]_{\delta_2}^{\delta_c} - 500 \times 10^6 (\delta_c - \delta_2) = 2.91 \times 10^9$$

$$A_2 = \int_{11.4}^{168.56} 2.52 \times 10^9 \sin\delta \, d\delta - 500 \times 10^6 (168.56 - 11.4\ldots$$

$$= -2.52 \times 10^9 \cos\delta \Big]_{11.4}^{168.56} - 500 \times 10^{6} \left(\cancel{168.56}\right. \quad 2.94\ldots$$

$$-1.37 \times 10^9$$

$$= 3.57 \times 10^9$$

Using $A_1 = A_2$

$$\int_{5.69}^{\delta_4} P_m \, d\delta = 3.57 \times 10^9$$

$$\left(\delta_4 - 0.0993\right) P_m = 3.59 \times 10^9$$

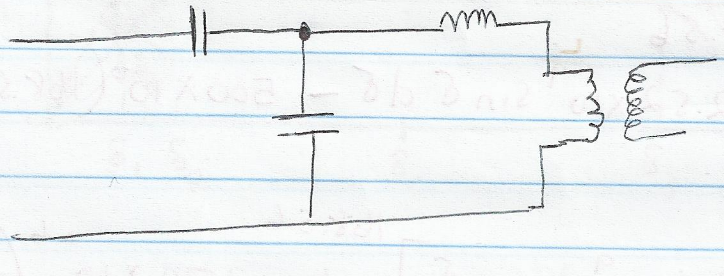
$$\delta_4 = 7.18 + 0.0993$$

$$\delta_4 = 7.23 \text{ rad.}$$

Question

a) Application of a circuit breaker in a circuit with a perspective Isc higher than the breaker's interupting capacity may result in failure of the breaker to interrupt the fault. In a worst case, the breaker may successful interrupt the fault, only to explode when reset.

b).



CVTs can only measure 50 Hz voltages accurately cannot easily be used to measure harmonic voltages. reactive

- Series resonant circuit and ~~electric~~ components have no effect.

c) 500/1A , 15VA - 10P20

- Rated primary current is 500A
- Rated secondary current is 1A
- rated output is 15 VA (15 V at 1A)
- Rated burden impedance is 15 Ω
- Accuracy class is 10 P
- Accuracy limit current of 20kA

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d)