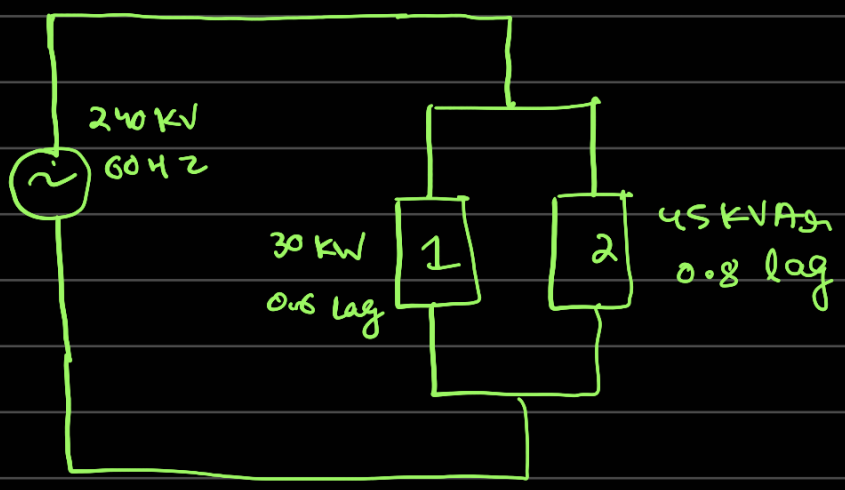
# Day – 10

1) 2 balance loads are connected to a 240 kV RMS, 60 Hz line. Load 1 draws 30 kV at 0.6 power factor lagging while load 2 draws 45 KVAr at 0.8 power factor lagging. Find real, reactive and apparent power absorbed by the combined load.




Ans:)

$$S = \frac{30}{0.6} \angle 53^\circ + \frac{45}{0.6} \angle 37^\circ$$

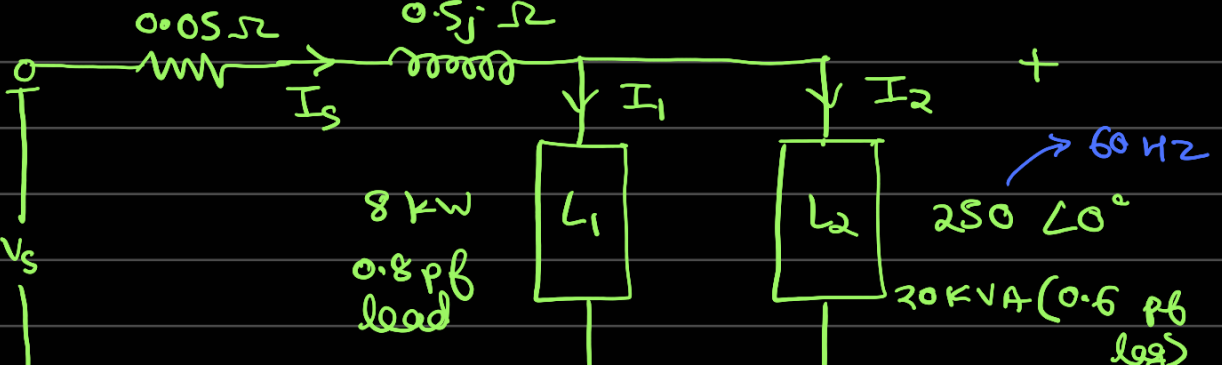
$$= 50\left(\frac{3}{5} + \frac{4j}{5}\right) + 75\left(\frac{4}{5} + \frac{3j}{5}\right)$$

$$= 30 + 40j + 60 + 45j$$

$$= 90 + 85j \text{ KW}$$

$P_{total}$ $Q_{total}$

2)



a.) Find p.f. combined of $L_1$, $L_2$

b.) Find $I_1 + I_2$

c.) What capacitance must be added in || to $L_1$ $L_2$ to make p.f = 1?

Ans.) a.) $\frac{8}{0.8} \angle 37^\circ + 20\,(0.6 - 0.8j)$

$= 2(4 + 3j) - 2(6 + 8j)$

$= 20 - 10j$ kw

$pf = \frac{1}{\sqrt{1 + (0.5)^2}} = \frac{1}{\sqrt{1.25}}$ lag

$\simeq 0.894$

b.) $250 \times I_1 \times 0.8 = 8000$

$\Rightarrow I_1 = 40$ A (rms)

$\hookrightarrow \angle 37^\circ$

$250 \times I_2 \times 0.6 = 12000$

$\Rightarrow I_2 = 80 \angle -53^\circ$

$I_1 + I_2 = 8(4 + 3j) + 16(3 - 4j)$

$= 80 - 40j$

c.) Let $X_c$ be added.

so $10 \times 1000 = 250 \times 250 \times 2\pi \times 60 \times C$

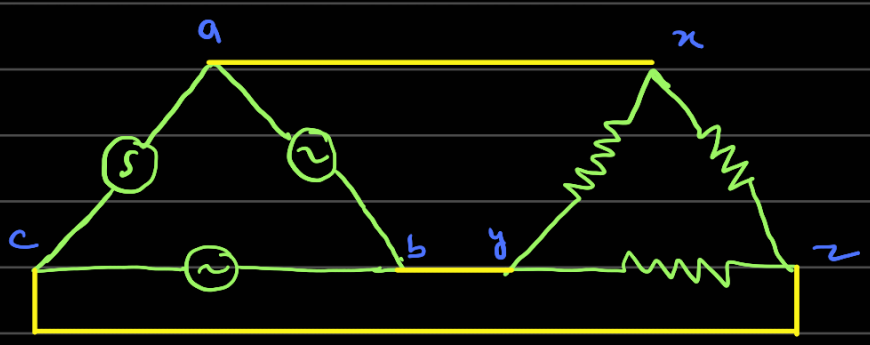
$$\Rightarrow C = \frac{10000}{250 \times 500 \times 60\pi} \text{ F}$$

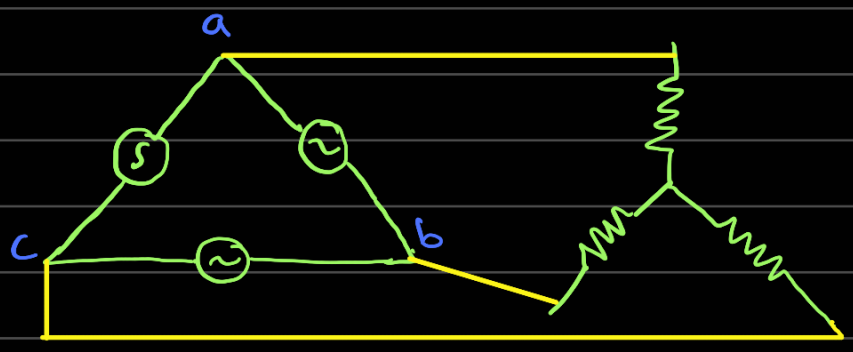
$$= \frac{1}{750\pi} \text{ F}$$

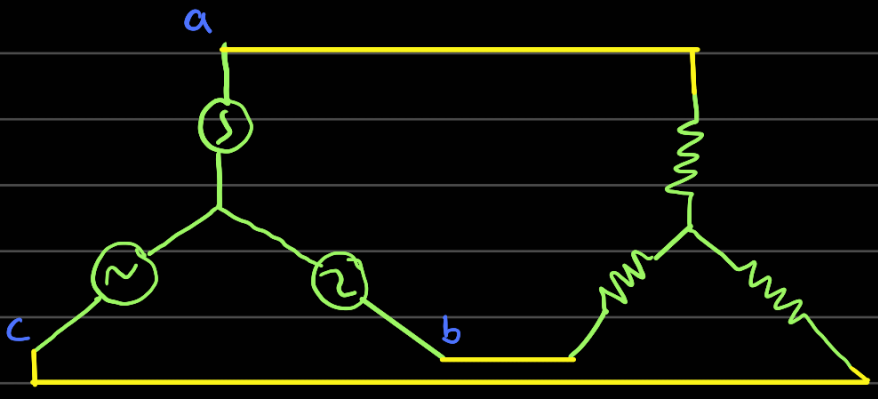
$$\simeq 0.424413 \text{ mF}$$

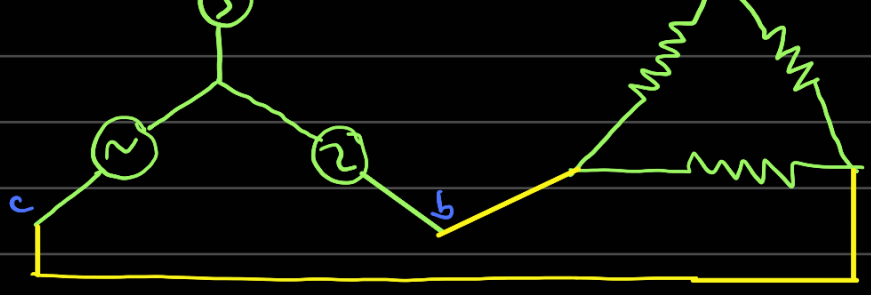
$$\approx 424.413 \text{ } \mu\text{F}$$

→ 3-phase circuit:

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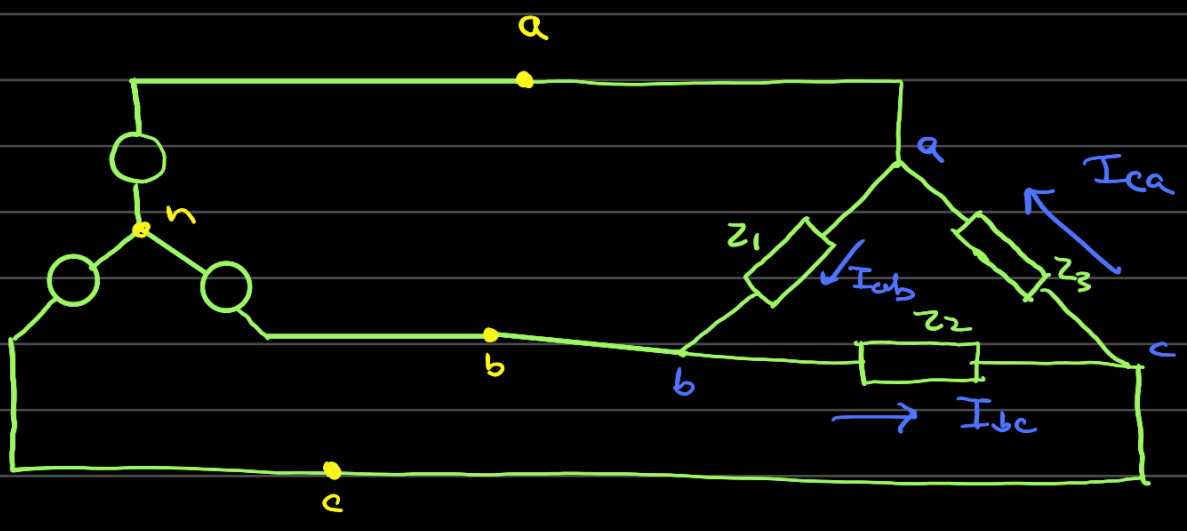


$$V_{ab} = V_{an} - V_{bn}$$

$$= V_m \cos\omega t - V_m \cos(\omega t - 2\pi/3)$$

$$= 2V_m \sin(\omega t - \pi/3) \sin(-2\pi/3)$$

$$= \sqrt{3}\, V_m \cos(\omega t + \pi/6)$$

$V_{an}$, $V_{bn}$, $V_{cn}$ ⟶ phase voltage
$V_{ab}$, $V_{bc}$, $V_{ac}$ ⟶ line voltage

$$V_{ab} = \sqrt{3} V_A \angle 30^\circ$$
$$V_{bc} = \sqrt{3} V_b \angle 30^\circ$$
$$V_{ca} = \sqrt{3} V_c \angle 30^\circ$$

$$I_{ab} = \frac{V_{ab}}{R_1} = \frac{\sqrt{3} V_A}{Z_1} \angle 30^\circ$$

$$I_{bc} = \frac{V_{bc}}{R} = \frac{\sqrt{3} V_b}{Z_2} \angle 30^\circ$$

$$I_{ca} = \frac{V_{ca}}{R_3} = \frac{\sqrt{3}V_c}{Z_3} \angle 30^\circ$$

$$I_a = \sqrt{3} I_{ab} \angle -30^\circ$$
$$I_b = \sqrt{3} I_{bc} \angle -30^\circ$$
$$I_c = \sqrt{3} I_{ca} \angle -30^\circ$$