14. In the three-wire system of Fig. 12.32, (*a*) replace the 50 Ω resistor with a 200 Ω resistor, and calculate the current flowing through the neutral wire. (*b*) Determine a new value for the 50 Ω resistor such that the neutral wire current magnitude is 25% that of line current $\mathbf{I}_{aA}$.

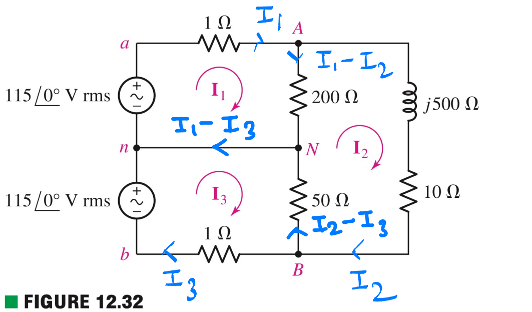


FIGURE 12.32

Solⁿ: (a) KVL.

$$-115 + I_1 + 200(I_1 - I_2) = 0$$

$$\Rightarrow \quad 201 I_1 - 200 I_2 = 115 \qquad -(1)$$

$$-115 - 200(I_2 - I_3) + I_3 = 0$$

$$\Rightarrow \quad -115 - 200 I_2 + 201 I_3 = 0$$

$$\Rightarrow \quad 201 I_3 - 200 I_2 = 115 \qquad -(2)$$

subtracting (1) − (2)

$$201(I_1 - I_3) = 0$$

$$\therefore \quad I_1 - I_3 = 0$$: current through neutral wire

(6) $$I_1 - I_3 = 0.25 I_1$$

$$\Rightarrow \quad 0.75 I_1 = I_3 \qquad -(1)$$

as $$201 I_1 - 200 I_2 = 115 \qquad -(2)$$

let new value for $50\Omega = R$

$$- R(I - I_3) + I_3 = 115$$

$$\Rightarrow \quad (R+1) I_3 - R I_2 = 115 \qquad -(3)$$

$$\Rightarrow \quad 0.75(R+1) I_1 - R I_2 = 201 I_1 - 200 I_2$$

$$\Rightarrow \quad (0.75(R+1) - 201) I_1 + (200 - R) I_2 = 0 \quad -(4)$$

KVL :

$$(10 + 500j) I_2 + R(I_2 - I_3) - 200(I_1 - I_2) = 0$$

$$\Rightarrow \quad (210 + R + 500j) I_2 - 0.75 R I_1 - 200 I_1 = 0$$

$$\Rightarrow \quad (210 + R + 500j) I_2 - (0.75R + 200) I_1 = 0 \quad -(5)$$

from (4) and (5)

$$\Rightarrow \quad (1.5R + 1.75) I_1 = (1 + 2R + 500j) I_2$$

$$\Rightarrow \quad I_2 = \frac{(1.5R + 1.75) I_1}{(2R + 1 + 500j)}$$

substituting I_2 in (5)

$$\Rightarrow \left\{ (210 + R + 500j) - \frac{(0.75R + 200)(1.5R + 1.75)}{(2R + 1 + 500j)} \right\} I_1 = 0$$

$$\Rightarrow \left\{ (210 + R + 500j) - \frac{(0.75R+200)(1.5R+1.75)}{(2R+1+500j)} \right\} I_1 = 0$$

since $I_1 \neq 0$ A

$$\Rightarrow (210 + R + 500j)(2R+1+500j) - (0.75R+200)(1.5R+1.75) = 0$$

$$\Rightarrow 420R + 210 + 105000j + 2R^2 + R + 500Rj + 1000Rj + 500j - 250000 - \{1.125R^2 + 1.31R + 300R + 350\} = 0$$

$$\Rightarrow (421 + 1500j - 301.31)R + 0.875R^2 + 105500j - 249650 = 0$$

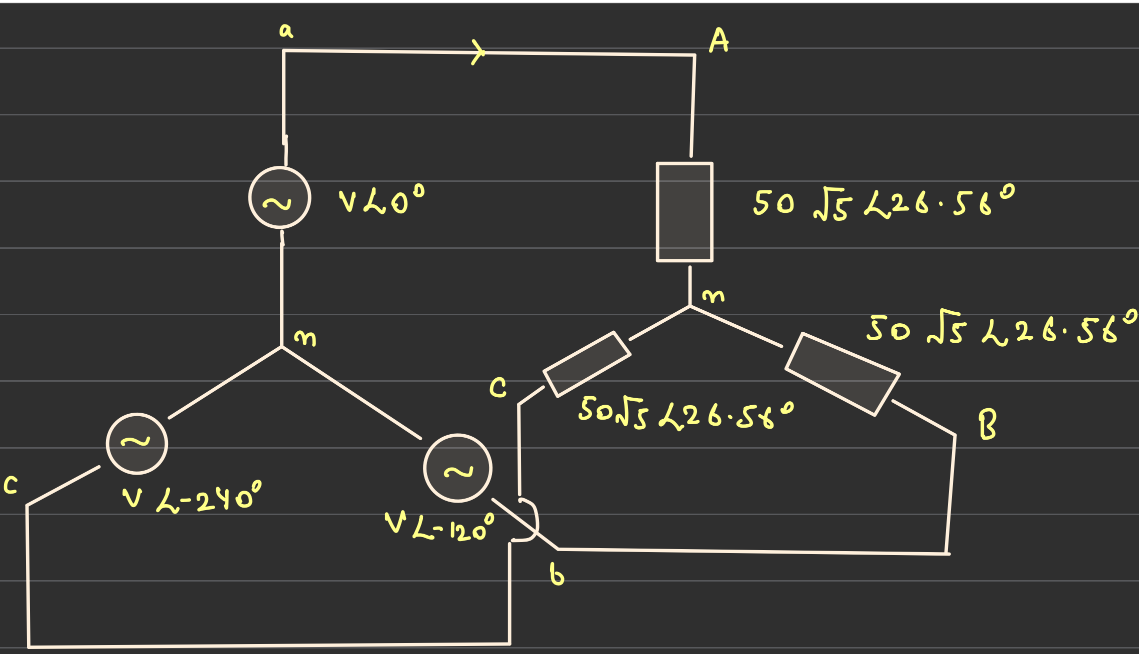
$$\Rightarrow 0.875R^2 + 119.69R - 249650 + j(1500R + 105500) = 0$$

$$\Rightarrow 0.875R^2 + 119.69R - 249650 = 0 \qquad 1500R + 105500 = 0$$

(Not Possible)

$\therefore R = 470.11\,\Omega$

22. A balanced Y-connected load of $100 + j50\ \Omega$ is connected to a balanced three-phase source. If the line current is 42 A and the source supplies 12 kW, determine (*a*) the line voltage; (*b*) the phase voltage.



Line voltages: V_{ab}, V_{bc}, V_{ca}

Phase voltages: V_{an}, V_{bn}, V_{cn}

Line currents: I_{aA}, I_{bB}, I_{cC}

some angle

Also $\boxed{V_{Line} = \sqrt{3}\, V_{phase} \angle \alpha + 30^\circ}$

$I_{aA} = I_0 \angle -\theta$, $I_{bB} = I_0 \angle -\theta - 120^\circ$

$I_{cC} = I_0 \angle -\theta - 240^\circ$

$\theta = 26.56^\circ$

$$|I_{aA}| = \left| \frac{V}{50\sqrt{5}} \right| = \left| \frac{V}{50\sqrt{5}} \right| = 42$$

$$V = 2100\sqrt{5}$$

$$\boxed{V = 4695.74 \text{ watt}}$$

phase voltage

$\sqrt{3}\, V_{phase} = V_{Line} \Rightarrow 4695.74\sqrt{3}$

$\therefore$ $\boxed{V_{phase} = 4695.74\sqrt{3}}$

Line voltage

(39). Two Δ connected load are connected in parallel and powered by a balanced Y-connected system. Smaller of the two load draws 10 KVA at a lagging voltage PF of 0.75. larger 25 KVA at a leading PF of 0.80. The line voltage is 400 V.

(a) Power factor at which the source is operating
(b) The total power drawn by the two loads
(c) The phase current of each load.

Smaller load,

Apparent Power $S_1 = 10KVA = 10,000\ VA$

Power factor $PF_1 = 0.75$ (lagging)

larger load,

Apparent Power $S_2 = 25\ KVA = 25,000\ VA$

Power factor $PF_2 = 0.80$ (leading)

Line voltage

$V_{Line} = 400V$

(a) Power factor of the source:

$\boxed{\text{Real Power}(P)}$ ⇒ for the Smaller load

$P_1 = S_1 \times PF_1 = 10,000 \times 0.75 = 7,500 W$

⇒ for the larger load

$P_2 = S_2 \times Pf_2 = 25,000 \times 0.80 = 20,000 W$

$\boxed{\text{Reactive Power}(Q)}$

→ for the Smaller load (lagging, inductive):

$Q_1 = S_1 \times \sin(\cos^{-1}(PF_1)) = 10,000 \times \sin(\cos^{-1}(0.75))$

$= 10,000 \times 0.6614$

$Q_1 = 6,614\ VAR$

→ for the larger load (leading, Capacitive);

$$Q_2 = S_2 \times \sin(\cos^{-1}(Pf_2)) = 25,000 \times \sin(\cos^{-1}(0.80))$$

$$Q_2 = 25,000 \times 0.6 = 15,000 \text{ VAR}$$

Total Real Power (P_{total}) = $P_1 + P_2 = 7,500 + 20,000 = 27,500$ W

Total Reactive Power (Q_{total}) = $Q_1 - Q_2 = 6614 - 15,000 = -8,386$ VAR

Total Apparent Power S_{total}:

$$S_{total} = \sqrt{P^2_{total} + Q^2_{total}} = \sqrt{(27,500)^2 + (-8386)^2}$$

$$S_{total} = \sqrt{756,250,000 + 70,307,396} = \sqrt{826,557,396} \approx 28,742 \text{ VA}$$

Power factor of the Source (Pf_{total}) $= \dfrac{P_{total}}{S_{total}} = \dfrac{27,500}{28,742} \approx 0.956$

(b) Total Power Drawn by the two loads

$$S_{total} = 28,742 \text{ VA}$$

(c) Phase Current of Each load

$$I = \frac{S}{\sqrt{3} \times V_{line}}$$

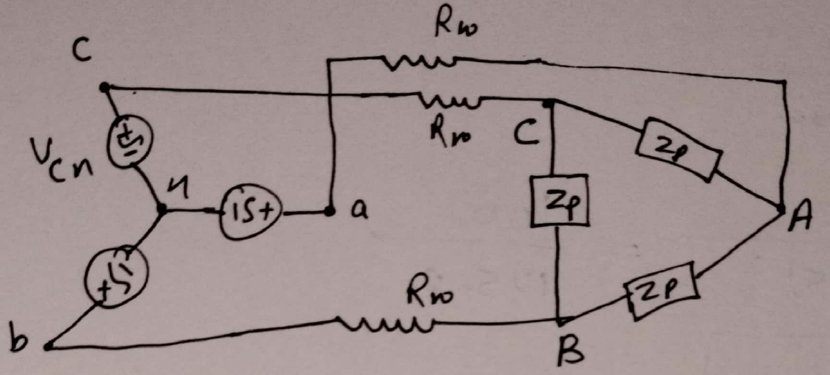
for the Smaller load:- $I_1 = \dfrac{S_1}{\sqrt{3} \times V_{line}} = \dfrac{10,000}{\sqrt{3} \times 400} = \dfrac{10,000}{692.82}$

≈ 14.44 A

for the larger load:- $I_2 = \dfrac{S_2}{\sqrt{3} \times V_{line}} = \dfrac{25,000}{\sqrt{3} \times 400} \approx \dfrac{25,000}{692.82}$

≈ 36.1 A.

(8) for the balanced three-phase system shown in fig. It is Determined that 100w is lost in each wire. If the phase. Voltage of the source is 400v. and the load draws 12kw at a lagging PF of 0.83. determine the wire Resistance R_w



Power loss in each wire $P_{loss} = 100w$

Phase Voltage $V_{an} = 400V$

Load Power $P_{load} = 12\ kw = 1200\ w$

Power factor of the load $PF = 0.83$ (lagging)

Determine the total Current in the system

$$P_{load} = \sqrt{3} \times V_{line} \times I \times PF$$

$$V_{line} = \sqrt{3} \times V_{phase}$$

$$P_{load} = 3 \times V_{phase} \times I_{phase} \times PF$$

$$I_{phase} = \frac{P_{load}}{3 \times V_{phase} \times PF}$$

$$I_{phase} = \frac{12{,}000}{3 \times 400 \times 0.83} = \frac{12{,}000}{996}$$

$$I_{phase} \approx 12.05A$$

use power loss to find R_w

$$P_{loss} = I^2 R$$

$$P_{loss} = I_{phase}^2 \times R_w$$

$$R_w = \frac{P_{loss}}{I^2_{phase}}$$

$$R_w = \frac{100}{(12.05)^2} = \frac{100}{145.2}$$

$$\boxed{R_w \simeq 0.688\ \Omega}$$