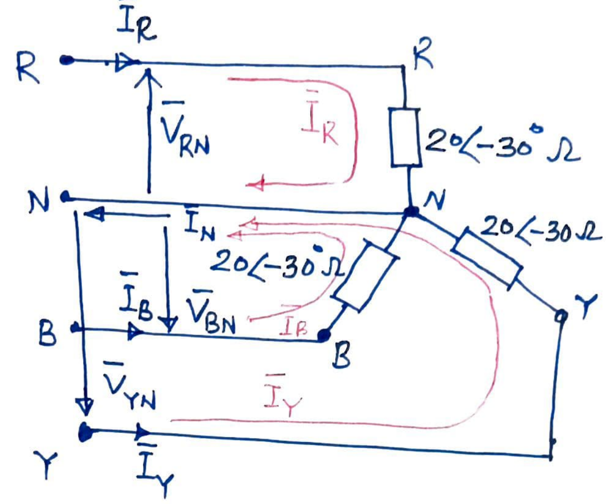
Ex. A 3-ϕ, 4 wire system with an effective line voltage of 120 V, has three impedances of $20\angle -30^\circ\ \Omega$ in a Y-connection. Determine the line currents and draw the voltage-current phasor diagram.



$\bar{Z} = 20\angle -30^\circ\ \Omega$

Line voltage, $V_L = 120\ V$

Phase voltage, $V_{ph} = \dfrac{V_L}{\sqrt{3}}$ (for Y)

$= \dfrac{120}{\sqrt{3}}\ V$

$= 69.28\ V$

Considering sequence RYB and phase voltages

$\bar{V}_{RN} = |\bar{V}_{RN}|\angle 0^\circ$, $\bar{V}_{YN} = |\bar{V}_{YN}|\angle -120^\circ$, $\bar{V}_{BN} = |\bar{V}_{BN}|\angle -240^\circ$

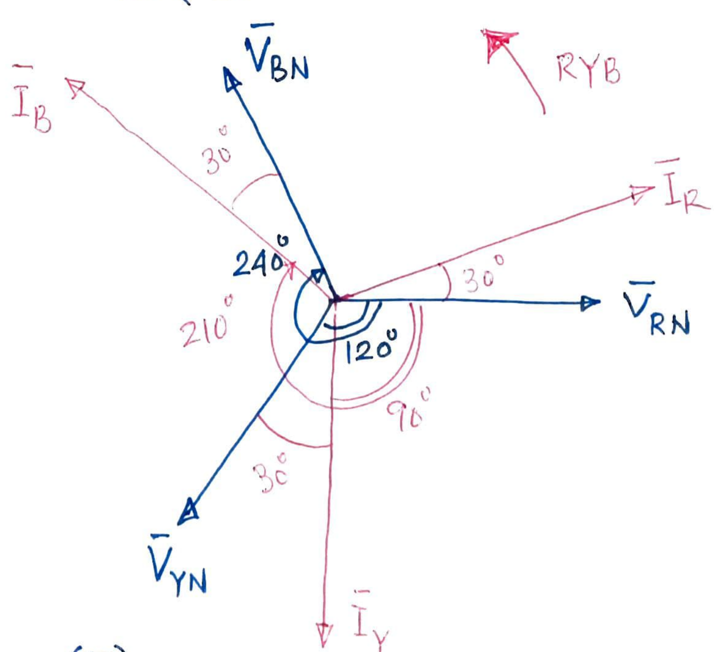
$= V_{ph}\angle 0^\circ$, $= V_{ph}\angle -120^\circ$, $= V_{ph}\angle -240^\circ$

Phase currents = Line currents (in case of Y)

$\therefore \bar{I}_R = \dfrac{\bar{V}_{RN}}{\bar{Z}} = \dfrac{V_{ph}\angle 0^\circ}{20\angle -30^\circ} = 3.464\angle 30^\circ\ A$

$\bar{I}_Y = \dfrac{\bar{V}_{YN}}{\bar{Z}} = \dfrac{V_{ph}\angle -120^\circ}{20\angle -30^\circ} = 3.464\angle -90^\circ\ A$

$\bar{I}_B = \dfrac{\bar{V}_{BN}}{\bar{Z}} = \dfrac{V_{ph}\angle -240^\circ}{20\angle -30^\circ} = 3.464\angle -210^\circ\ A$

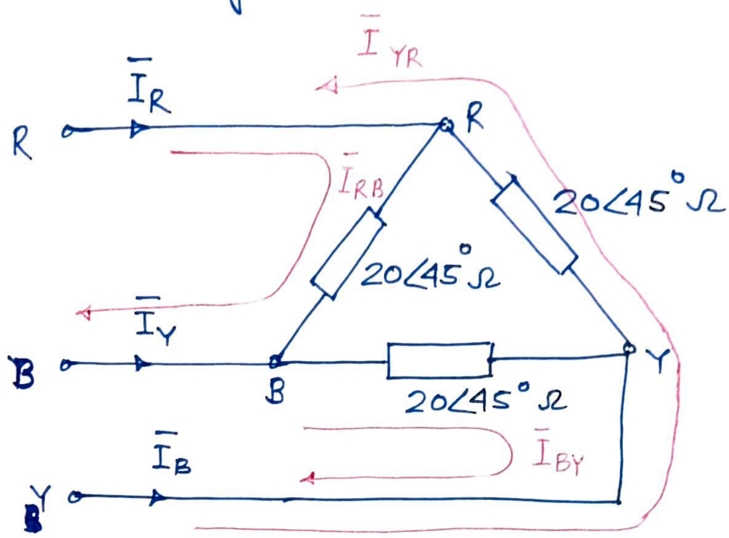


Ex A 3-ϕ, [redacted] system, with an effective voltage 70·7V, has a balanced Δ-connected load with impedance $20\angle 45^\circ\ \Omega$. obtain the line currents and draw the voltage-current phasor diagram.

$V_L = V_{ph}$ (in Δ)

$= 70{\cdot}7V$

$\bar{Z} = 20\angle 45^\circ\ \Omega$



Phase voltages :- $\bar{V}_{RY} = |\bar{V}_{RY}|\angle 0^\circ$, $\bar{V}_{YB} = |\bar{V}_{YB}|\angle -120^\circ$

$\bar{V}_{BR} = |\bar{V}_{BR}|\angle -240^\circ$, $|\bar{V}_{RY}| = |\bar{V}_{YB}| = |\bar{V}_{BR}| = 70{\cdot}7V$

$\bar{I}_{RY} = \dfrac{70{\cdot}7\angle 0^\circ}{20\angle 45^\circ} = 3{\cdot}535\angle -45^\circ A$, $\bar{I}_{YB} = \dfrac{70{\cdot}7\angle -120^\circ}{20\angle 45^\circ} = 3{\cdot}535\angle -165^\circ (A)$

$\bar{I}_{BR} = \dfrac{70{\cdot}7\angle -240^\circ}{20\angle 45^\circ} = 3{\cdot}535\angle -285^\circ = 3{\cdot}535\angle 75^\circ (A)$

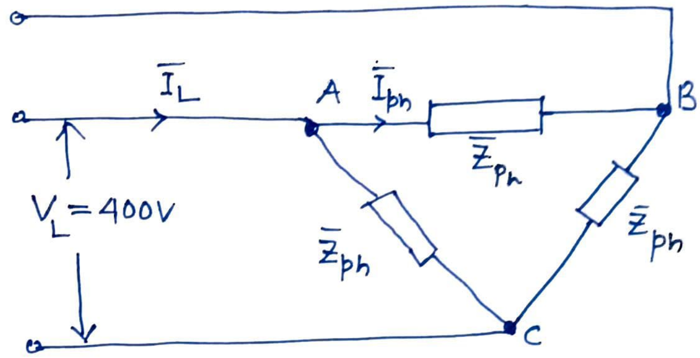
$\bar{I}_R = \bar{I}_{RB} + \bar{I}_{RY} = -\bar{I}_{BR} + \bar{I}_{RY}$

Ex A 3-ϕ power system with a line voltage of 400 V is supplying a Δ-connected load of 1500 W at 0.8 power factor lagging. Determine the phase and line currents and also the phase impedance.

$V_L = 400\,V$

$V_P = V_L = 400\,V$

(Δ-connected)



Power, $P = \sqrt{3}\, V_L I_L \cos\theta$

$\Rightarrow 1500 = \sqrt{3} \times 400 \times I_L \times 0.8$

$\Rightarrow I_L = \dfrac{1500}{\sqrt{3} \times 400 \times 0.8} = 2.71\text{ A}$

In Δ-connected system $I_L = \sqrt{3}\, I_{ph}$ $\quad \therefore I_{ph} = 1.56\text{ A}$

Since the pf is 0.8 lagging, $\cos\theta = 0.8 \Rightarrow \theta = 36.9^\circ$

$\therefore \bar{I}_{ph} = 1.56\angle{-36.9^\circ}$

$\therefore \bar{Z}_{ph} = \dfrac{V_{ph}}{I_{ph}} = \dfrac{400\angle 0^\circ}{1.56\angle{-36.9^\circ}} = 256\angle 36.9^\circ\ (\Omega)$ //

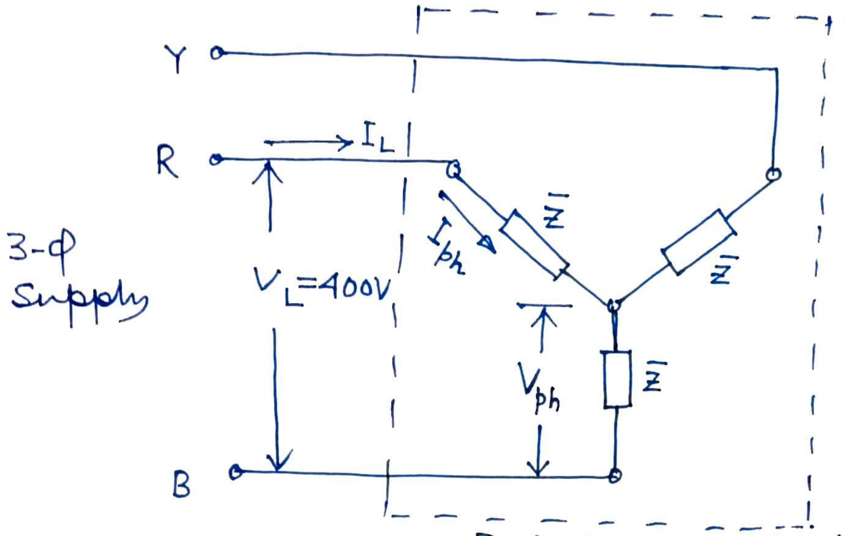
Ex. A balanced Δ-connected load of impedance $16 + j12\ \Omega$/phase is connected to a 3-ϕ 400V supply. Find the phase current, line current, power factor, power, reactive VA and total VA. Also draw a phasor diagram.

[Ans. $\bar{I}_{ph} = 20\angle{-36.9^\circ}$ A, pf = 0.8 (lag), P = 19.2 kW,

Q = 14.4 kVAR, S = 24 kVA]

Ex A balanced star-connected load is supplied from a symmetrical 3-ϕ, 400V (line-to-line) supply. The current in each phase is 50A and lags 30° behind the phase voltage. Find (a) phase voltage (b) phase impedance and (c) active power drawn by the load. Also draw the phasor diagram.

[Ans. (a) 231 V (b) $4 + j2.31\ \Omega$ (c) 30 kW.]



~~V_L~~ $V_L = \sqrt{3}\,V_{ph}$ $V_{ph} = \dfrac{400}{\sqrt{3}} = 231\text{ V}$ (reference phasor)

$\bar{I}_L = \bar{I}_{ph} = 50\text{ A}$ and lags $30^\circ = 50\angle -30^\circ$ A

$\therefore\ \bar{Z} = \dfrac{\bar{V}_{ph}}{\bar{I}_{ph}} = \dfrac{231\angle 0^\circ}{50\angle -30^\circ} =$

$P = \sqrt{3}\,V_L I_L \cos\theta$

$= \sqrt{3} \times 400 \times 50 \cos 30^\circ$