EXAMPLE 22.2 For the three-phase system of Fig. 22.15:

a. Find the phase angles θ_2 and θ_3.
b. Find the current in each phase of the load.
c. Find the magnitude of the line currents.

Solutions:

a. For an ABC sequence,

$$\theta_2 = \mathbf{-120^\circ} \quad \text{and} \quad \theta_3 = \mathbf{+120^\circ}$$

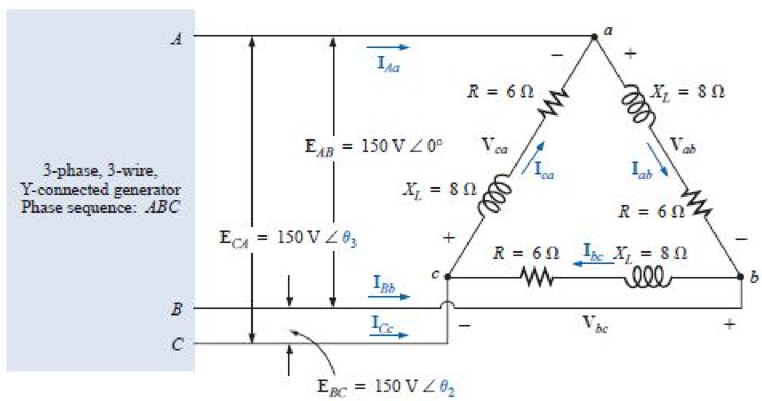

FIG. 22.15
Example 22.2.

b. $\mathbf{V}_\phi = \mathbf{E}_L$. Therefore,

$$\mathbf{V}_{ab} = \mathbf{E}_{AB} \qquad \mathbf{V}_{ca} = \mathbf{E}_{CA} \qquad \mathbf{V}_{bc} = \mathbf{E}_{BC}$$

The phase currents are

$$\mathbf{I}_{ab} = \frac{\mathbf{V}_{ab}}{\mathbf{Z}_{ab}} = \frac{150\text{ V}\angle 0^\circ}{6\ \Omega + j\,8\ \Omega} = \frac{150\text{ V}\angle 0^\circ}{10\ \Omega\angle 53.13^\circ} = \mathbf{15\ A\angle -53.13^\circ}$$

$$\mathbf{I}_{bc} = \frac{\mathbf{V}_{bc}}{\mathbf{Z}_{bc}} = \frac{150\text{ V}\angle -120^\circ}{10\ \Omega\angle 53.13^\circ} = \mathbf{15\ A\angle -173.13^\circ}$$

$$\mathbf{I}_{ca} = \frac{\mathbf{V}_{ca}}{\mathbf{Z}_{ca}} = \frac{150\text{ V}\angle +120^\circ}{10\ \Omega\angle 53.13^\circ} = \mathbf{15\ A\angle 66.87^\circ}$$

c. $I_L = \sqrt{3}I_\phi = (1.73)(15\text{ A}) = 25.95\text{ A}$. Therefore,

$$I_{Aa} = I_{Bb} = I_{Cc} = \mathbf{25.95\ A}$$

Example 33.1

In a three-phase four-wire system the line voltage is 400 V and non-inductive loads of 10 kW, 8 kW and 5 kW are connected between the three line conductors and the neutral as in Fig. 33.16. Calculate:

(a) the current in each line;
(b) the current in the neutral conductor.

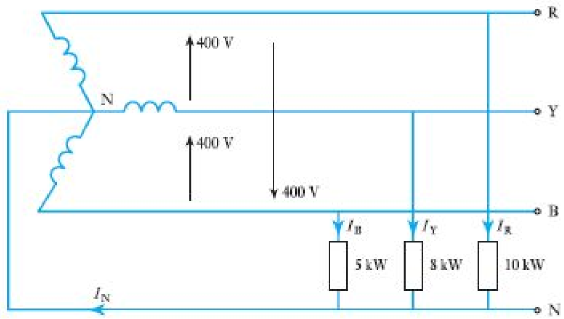

Fig. 33.16 Circuit diagram for Example 33.1

(a) Voltage to neutral $= \dfrac{\text{line voltage}}{1.73} = \dfrac{400}{1.73} = 230$ V

If I_R, I_Y and I_B are the currents taken by the 10 kW, 8 kW and 5 kW loads respectively,

$$I_R = 10 \times 1000/230 = \mathbf{43.5\ A}$$

$$I_Y = 8 \times 1000/230 = \mathbf{34.8\ A}$$

and $$I_B = 5 \times 1000/230 = \mathbf{21.7\ A}$$

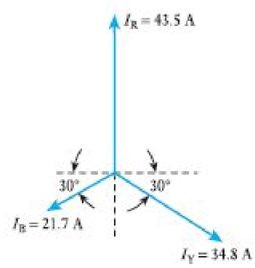

Fig. 33.17 Phasor diagram for Fig. 33.16

These currents are represented by the respective phasors in Fig. 33.17.

(b) The current in the neutral is the phasor sum of the three line currents. In general, the most convenient method of adding such quantities is to calculate the resultant horizontal and vertical components thus: horizontal component is

$$I_H = I_Y \cos 30° - I_B \cos 30°$$
$$= 0.866(34.8 - 21.7) = 11.3 \text{ A}$$

and vertical component is

$$I_V = I_R - I_Y \cos 60° - I_B \cos 60°$$
$$= 43.5 - 0.5(34.8 + 21.7) = 13.0 \text{ A}$$

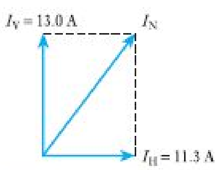

Fig. 33.18 Vertical and horizontal components of I_N

These components are represented in Fig. 33.18.

$$\text{Current in neutral} = I_N = \sqrt{\{(11.3)^2 + (13.0)^2\}}$$
$$= \mathbf{17.2\ A}$$