$$W_1 + W_2 = 8{,}000 + 4{,}000 = 12{,}000 \text{ watts}$$

The actual power consumed by the load = $I_R^2 R_R + I_Y^2 R_Y + I_B^2 R_B$

$= 23.094^2 \times 10 + 23.094^2 \times 10 \cos 30° + 11.547^2 \times 20 \cos 60°$

$= 5333.33 + 4618.8 + 1333.33 = 11{,}285.462$ watts

$(W_1 + W_2)$ is not equal to the total power drawn by the load. The wattmeters read more, because, they also measure the power loss that occurs in the neutral wire.

9.16 An unbalanced star connected load is fed from a symmetrical 440 V, 3 phase system. The supply voltage of phase R is $254 \angle -30°$ V, and the voltage across the load R is $206 \angle -25°$ V. Draw the vector diagram. Calculate (a) the voltage between the star point of the load and the supply neutral and (b) the voltages across the loads Y and B.
(Kuvempu University)

Solution: The vector diagram of voltages is as shown in Fig. 9.29.

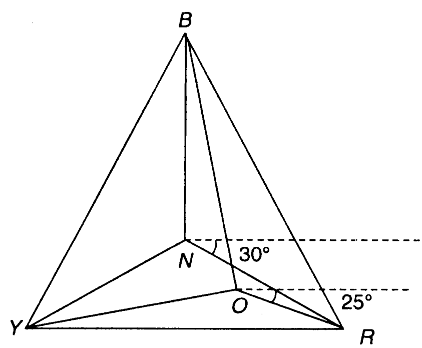


Fig. 9.29

Note: V_{RN} is given as $254 \angle -30°$ V

Hence, the sequence is RYB

$$V_{RN} = 254 \angle -30° \text{ V}$$

$$V_{YN} = 254 \angle -150° \text{ V}$$

and $$V_{BN} = 254 \angle +90° \text{ V}$$

The voltage between the star point O and the neutral N is given by,

(a) $V_{ON} = V_{OR} + V_{RN} = V_{RN} - V_{RO}$

$$= 254 \angle -30° - 206 \angle -25° = 51.98 \angle -50.21° \text{ V}$$

To show that $AD - BC = 1$

$$AD-BC = (1+Z_a Y_c)(1+Z_b Y_c)-(Z_a+Z_b+Z_a Z_b Y_c) Y_c$$

$$=1+Z_a Y_c+Z_b Y_c+Z_a Z_b Y_c^2-Z_a Y_c-Z_b Y_c-Z_a Z_b Y_c^2=1$$

14.8 Π REPRESENTATION OF A TWO-PORT NETWORK

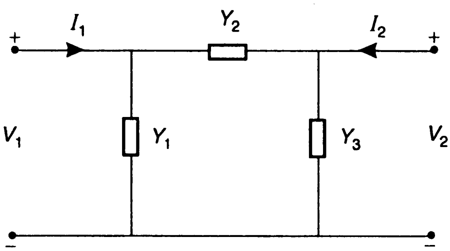


Fig. 14.9

Y_1, Y_2 and Y_3 are the three admittances connected as a π network. The admittance parameters for the network are given by

$$y_{11} = \left.\frac{V_1}{I_1}\right|_{V_2=0} = Y_1 + Y_2$$

$$y_{21} = \left.\frac{I_2}{V_1}\right|_{V_2=0} = -Y_2 \qquad \left[\because V_1 + \frac{I_2}{Y_2} = 0\right]$$

$$y_{12} = \left.\frac{I_1}{V_2}\right|_{V_1=0} = -Y_2 \qquad \left[\because V_2 + \frac{I_1}{Y_2} = 0\right]$$

$$y_{22} = \left.\frac{I_2}{V_2}\right|_{V_1=0} = Y_2 + Y_3$$

Conversely

$$A = -\frac{y_{22}}{y_{21}} = \frac{Y_2 + Y_3}{Y_2} = 1 + \frac{Y_3}{Y_2} \tag{14.49}$$

$$B = -\frac{1}{y_{21}} = \frac{1}{Y_2} = Z_2 \tag{14.50}$$

$$C = -\frac{\Delta_y}{y_{21}} = \frac{y_{11}\, y_{22} - y_{12}\, y_{21}}{y_{21}}$$

Equilibrium equations are:

$$\begin{bmatrix} 0.4 & -0.1 & -0.1 \\ -0.1 & +0.4 & -0.1 \\ -0.1 & -0.1 & +0.4 \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \\ v_3 \end{bmatrix} = \begin{bmatrix} 0.5 \\ 0.0 \\ -0.5 \end{bmatrix}$$

$$v_b = \begin{bmatrix} 1.0 \\ 0.0 \\ -1.0 \\ -2.0 \\ 1.0 \\ 1.0 \end{bmatrix} \text{volts} \qquad \text{and} \qquad i_b = \begin{bmatrix} 0.2 \\ 0.0 \\ -0.2 \\ 0.3 \\ 0.1 \\ 0.1 \end{bmatrix} \text{amps}$$

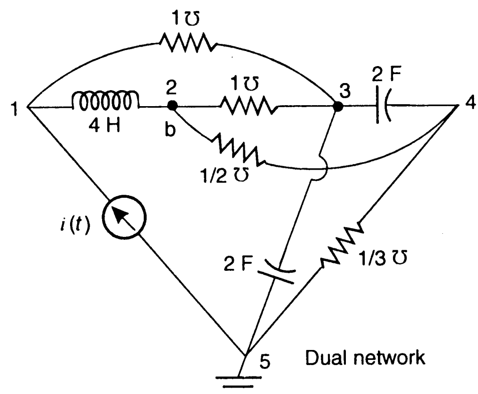
5.25

$$\begin{bmatrix} 8 & 5 & -5 \\ 5 & 6 & -3 \\ -5 & -3 & 7 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} -1 \\ -1 \\ -1 \end{bmatrix}$$

$$i_b = \begin{bmatrix} -0.3146 \\ 0.426 \\ -0.4157 \\ -0.112 \\ -0.011 \\ 0.1011 \end{bmatrix} \text{amps} \qquad \text{and} \qquad v_b = \begin{bmatrix} -0.3146 \\ 4.852 \\ 5.168 \\ 4.888 \\ -0.033 \\ 5.202 \end{bmatrix} \text{volts}$$

5.26

$$\mathbf{B} = \begin{array}{c} \\ i_1 \\ i_2 \\ i_3 \end{array} \begin{array}{c} \begin{array}{cccccc} 1 & 2 & 3 & 4 & 5 & 6 \end{array} \\ \begin{bmatrix} +1 & 0 & 0 & -1 & 0 & -1 \\ 0 & +1 & 0 & 0 & +1 & +1 \\ 0 & 0 & +1 & -1 & +1 & 0 \end{bmatrix} \end{array}$$



The nodal equations are:

$$1(v_1 - v_3) + \frac{1}{4}\int(v_1 - v_2)dt = i(t)$$

$$\frac{1}{4}\int(v_2 - v_1)dt + 1(v_2 - v_3) + \frac{1}{2}(v_2 - v_4) = 0$$

$$1(v_3 - v_1) + 2\frac{dv_3}{dt} + 2\frac{d}{dt}(v_3 - v_4) + 1(v_3 - v_2) = 0$$

$$\frac{1}{3}v_4 + \frac{1}{2}(v_4 - v_2) + 2\frac{d}{dt}(v_4 - v_3) = 0$$

5.31