TEST 3

Q1

For the circuit of Fig. 15.143:

a. Find the total admittance $\mathbf{Y}_T$ in polar form.
b. Draw the admittance diagram.
c. Find the value of C in microfarads and L in henries.
d. Find the voltage $\mathbf{E}$ and currents $\mathbf{I}_R$, $\mathbf{I}_L$, and $\mathbf{I}_C$ in phasor form.
e. Draw the phasor diagram of the currents $\mathbf{I}_s$, $\mathbf{I}_R$, $\mathbf{I}_L$, and $\mathbf{I}_C$, and the voltage $\mathbf{E}$.
f. Verify Kirchhoff's current law at one node.
g. Find the average power delivered to the circuit.
h. Find the power factor of the circuit, and indicate whether it is leading or lagging.

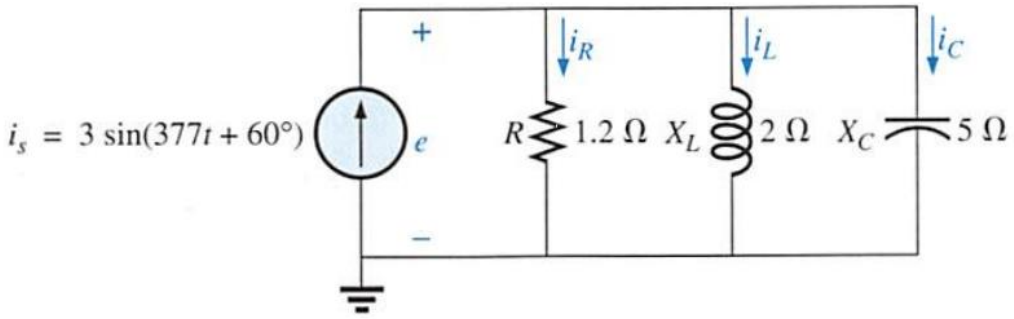


FIG. 15.143

Q2

Using mesh analysis, determine the current $\mathbf{I}_L$ (in terms of $\mathbf{V}$) for the network of Fig. 17.65.

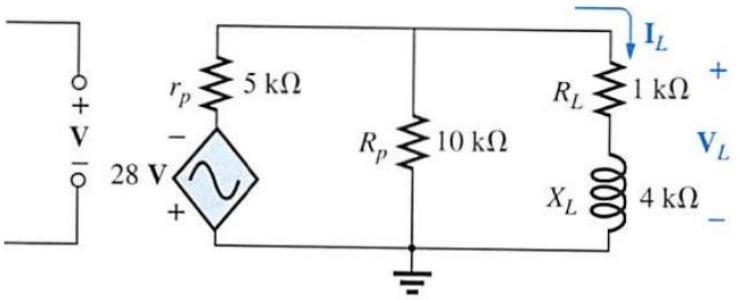


FIG. 17.65

Q3

a. The bandwidth of a series resonant circuit is 200 Hz. If the resonant frequency is 2000 Hz, what is the value of Q_s for the circuit?

b. If $R = 2\ \Omega$, what is the value of X_L at resonance?

c. Find the value of L and C at resonance.

d. Find the cutoff frequencies.

Q4

***8.** Compute the magnitude of the voltage E_{AB} for the balanced three-phase system of Fig. 23.42.

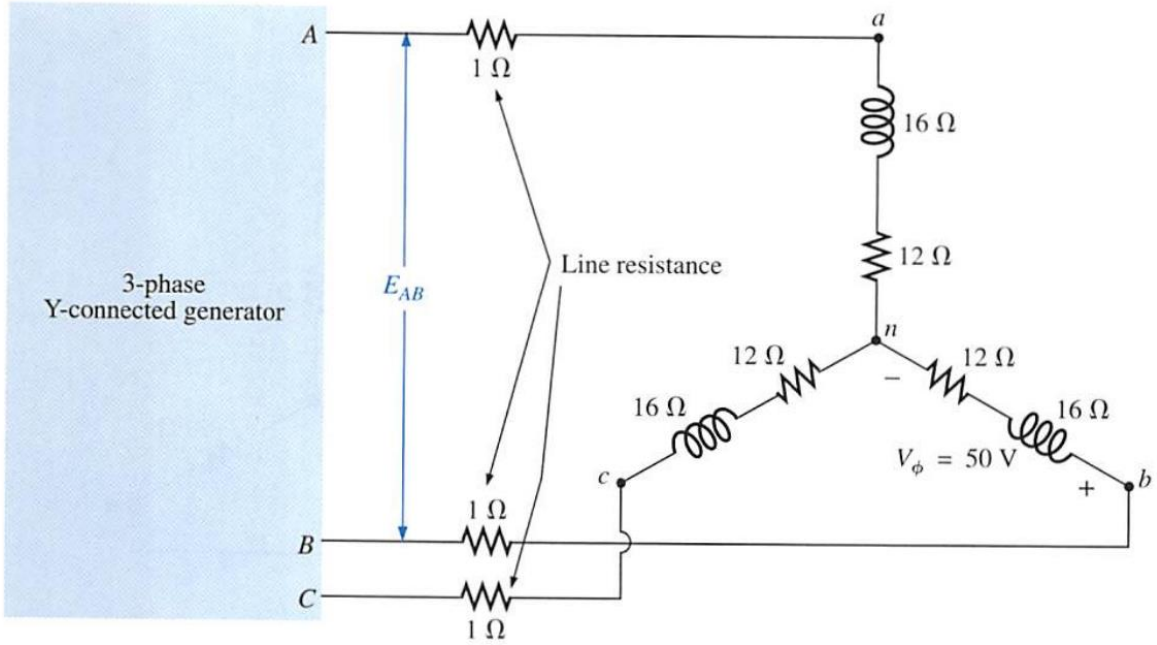


FIG. 23.42

SOLUTION

Q1

30. a. $$\mathbf{Y}_T = \frac{1}{1.2\ \Omega\ \angle 0^\circ} + \frac{1}{2\ \Omega\ \angle 90^\circ} + \frac{1}{5\ \Omega\ \angle -90^\circ}$$
$$= 0.833\ \text{S}\ \angle 0^\circ + 0.5\ \text{S}\ \angle -90^\circ + 0.2\ \text{S}\ \angle 90^\circ$$
$$= 0.833\ \text{S} - j0.3\ \text{S} = \mathbf{0.885\ S\ \angle -19.81^\circ}$$

b. $$X_C = \frac{1}{\omega C} \Rightarrow C = \frac{1}{\omega X_C} = \frac{1}{(377\ \text{rad/s})(5\ \Omega)} = \mathbf{531\ \mu F}$$
$$X_L = \omega L \Rightarrow L = \frac{X_L}{\omega} = \frac{2\ \Omega}{377\ \text{rad/s}} = \mathbf{5.31\ mH}$$

d. $$\mathbf{E} = \frac{\mathbf{I}_s}{\mathbf{Y}_T} = \frac{(0.707)(3\ \text{A})\ \angle 60^\circ}{0.885\ \text{S}\ \angle -19.81^\circ} = \frac{2.121\ \text{A}\ \angle 60^\circ}{0.885\ \text{S}\ \angle -19.81^\circ} = \mathbf{2.397\ V\ \angle 79.81^\circ}$$
$$\mathbf{I}_R = \frac{E\ \angle \theta}{R\ \angle 0^\circ} = \frac{2.397\ \text{V}\ \angle 79.81^\circ}{1.2\ \Omega\ \angle 0^\circ} = \mathbf{1.998\ A\ \angle 79.81^\circ}$$
$$\mathbf{I}_L = \frac{E\ \angle \theta}{X_L\ \angle 90^\circ} = \frac{2.397\ \text{V}\ \angle 79.81^\circ}{2\ \Omega\ \angle 90^\circ} = \mathbf{1.199\ A\ \angle -10.19^\circ}$$
$$\mathbf{I}_C = \frac{E\ \angle \theta}{X_C\ \angle -90^\circ} = \frac{2.397\ \text{V}\ \angle 79.81^\circ}{5\ \Omega\ \angle -90^\circ} = \mathbf{0.479\ A\ \angle 169.81^\circ}$$

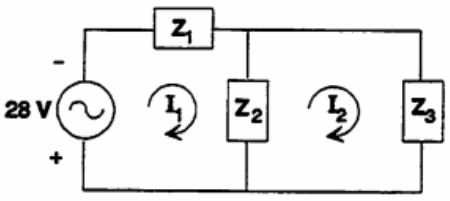
f. $$\mathbf{I}_s = \mathbf{I}_R + \mathbf{I}_L + \mathbf{I}_C$$
$$2.121\ \text{A}\ \angle 60^\circ = 1.998\ \text{A}\ \angle 79.81^\circ + 1.199\ \text{A}\ \angle -10.19^\circ + 0.479\ \text{A}\ \angle 169.81^\circ$$
$$= (0.353 + j1.966) + (1.18 - j0.212) + (-0.471 + j0.086)$$
$$2.121\ \text{A}\ \angle 60^\circ \checkmark 1.062 + j1.84 = 2.124\ \angle 60^\circ$$

g. $$P = I^2R = (1.998\ \text{A})^2\ 1.2\ \Omega = \mathbf{4.79\ W}$$

h. $$F_p = \frac{G}{Y_T} = \frac{0.833\ \text{S}}{0.885\ \text{S}} = \mathbf{0.941\ lagging}$$

Q2

9.



$$\mathbf{Z}_1 = 5\ \text{k}\Omega\ \angle 0^\circ$$
$$\mathbf{Z}_2 = 10\ \text{k}\Omega\ \angle 0^\circ$$
$$\mathbf{Z}_3 = 1\ \text{k}\Omega + j4\ \text{k}\Omega = 4.123\ \text{k}\Omega\ \angle 75.96^\circ$$

$$\mathbf{I}_1(\mathbf{Z}_1 + \mathbf{Z}_2) - \mathbf{Z}_2\mathbf{I}_2 = -28\ \text{V}$$
$$\mathbf{I}_2(\mathbf{Z}_2 + \mathbf{Z}_3) - \mathbf{Z}_2\mathbf{I}_1 = 0$$

$$(\mathbf{Z}_1 + \mathbf{Z}_2)\mathbf{I}_1 - \mathbf{Z}_2\mathbf{I}_2 = -28\ \text{V}$$
$$-\mathbf{Z}_2\mathbf{I}_1 + (\mathbf{Z}_2 + \mathbf{Z}_3)\mathbf{I}_2 = 0$$

$$\mathbf{I}_L = \mathbf{I}_2 = \frac{-\mathbf{Z}_2\ 28\ \text{V}}{\mathbf{Z}_1\mathbf{Z}_2 + \mathbf{Z}_1\mathbf{Z}_3 + \mathbf{Z}_2\mathbf{Z}_3} = \mathbf{-3.165 \times 10^{-3}\ V\ \angle 137.29^\circ}$$

Q3

7. a. $BW = \frac{f_s}{Q_s} \Rightarrow Q_s = f_s/BW = 2000\ \text{Hz}/200\ \text{Hz} = \mathbf{10}$

b. $Q_s = \frac{X_L}{R} \Rightarrow X_L = Q_s R = (10)(2\ \Omega) = \mathbf{20\ \Omega}$

c. $L = \frac{X_L}{2\pi f} = \frac{20\ \Omega}{(6.28)(2\ \text{kHz})} = \mathbf{1.59\ mH}$

$C = \frac{1}{2\pi f X_C} = \frac{1}{(6.28)(2\ \text{kHz})(20\ \Omega)} = \mathbf{3.98\ \mu F}$

d. $f_2 = f_s + BW/2 = 2000\ \text{Hz} + 100\ \text{Hz} = \mathbf{2100\ Hz}$

$f_1 = f_s - BW/2 = 2000\ \text{Hz} - 100\ \text{Hz} = \mathbf{1900\ Hz}$

Q4

8. $\mathbf{Z}_\phi = 12\ \Omega + j16\ \Omega = 20\ \Omega \angle 53.13°$

$I_\phi = \frac{V_\phi}{Z_\phi} = \frac{50\ \text{V}}{20\ \Omega} = \mathbf{2.5\ A}$

$\mathbf{Z}_{T_\phi} = 13\ \Omega + j16\ \Omega = 20.62\ \Omega \angle 50.91°$

$V_\phi = I_\phi Z_{T_\phi} = (2.5\ \text{A})(20.62\ \Omega) = 51.55\ \text{V}$

$V_L = \sqrt{3}\, V_\phi = (\sqrt{3})(51.55\ \text{V}) = \mathbf{89.285\ V}$