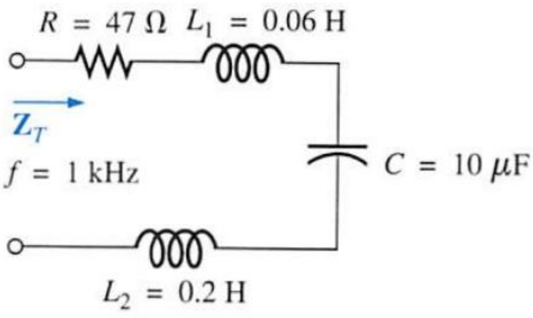
Tutorial - 1-02-h

Question 1 (15-3-5-c)

Calculate the total impedance of the circuits of Fig. 15.121. Express your answer in rectangular and polar forms, and draw the impedance diagram.



(c)

Question 2 (15-4-17)

*17. For the circuit of Fig. 15.133:

a. Determine **I**, $\mathbf{V}_R$, and $\mathbf{V}_C$ in phasor form.
b. Calculate the total power factor, and indicate whether it is leading or lagging.

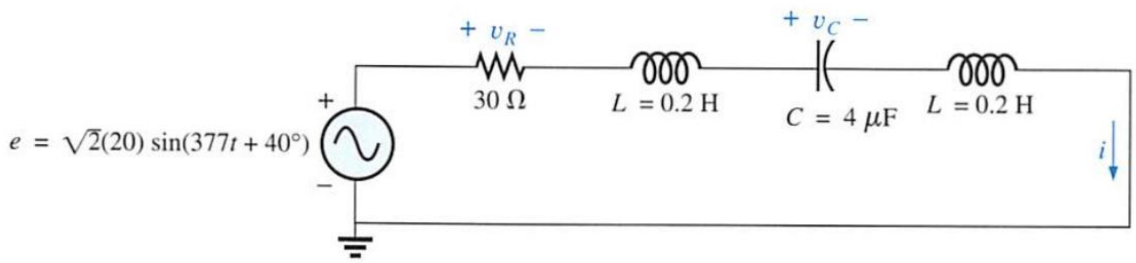
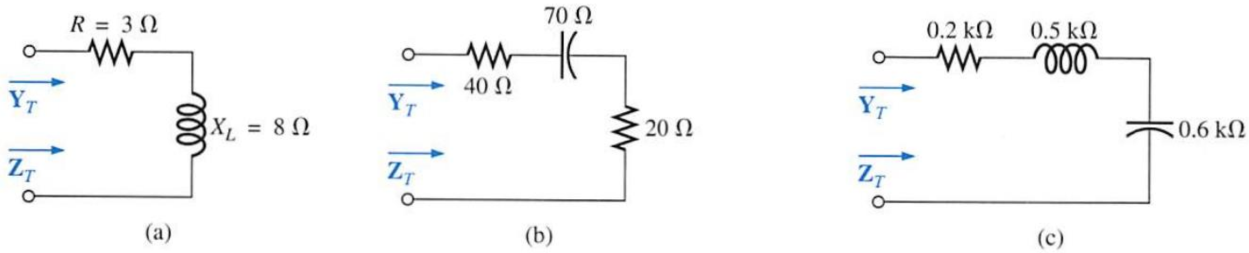


FIG. 15.133

c. Calculate the average power delivered to the circuit.
d. Draw the impedance diagram.
e. Draw the phasor diagram of the voltages **E**, $\mathbf{V}_R$, and $\mathbf{V}_C$, and the current **I**.
f. Find the voltages $\mathbf{V}_R$ and $\mathbf{V}_C$ using the voltage divider rule, and compare them with the results of part (a) above.
g. Draw the equivalent series circuit of the above as far as the total impedance and the current i are concerned.

Question 3 (15-7-25)

25. Find the total admittance and impedance of the circuits of Fig. 15.139. Identify the values of conductance and susceptance, and draw the admittance diagram.



Question 4 (16-2-7)

***7.** For the network of Fig. 16.42:

a. Find the current $\mathbf{I}_1$.

b. Find the voltage $\mathbf{V}_1$.

c. Calculate the average power delivered to the network.

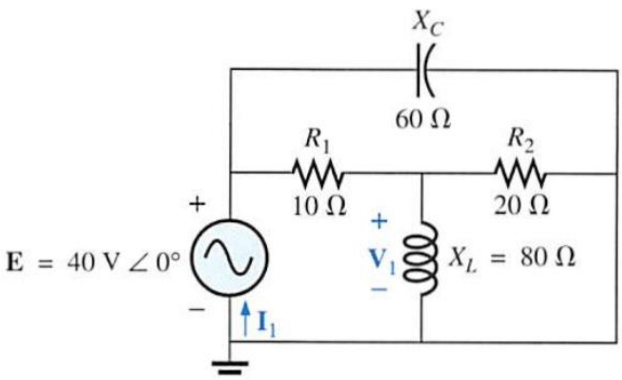


FIG. 16.42

Question 5 (16-2-10)

***10.** For the network of Fig. 16.45:

a. Find the total impedance $\mathbf{Z}_T$ and the admittance $\mathbf{Y}_T$.

b. Find the source current $\mathbf{I}_s$ in phasor form.

c. Find the currents $\mathbf{I}_1$ and $\mathbf{I}_2$ in phasor form.

d. Find the voltages $\mathbf{V}_1$ and $\mathbf{V}_{ab}$ in phasor form.

e. Find the average power delivered to the network.

f. Find the power factor of the network, and indicate whether it is leading or lagging.

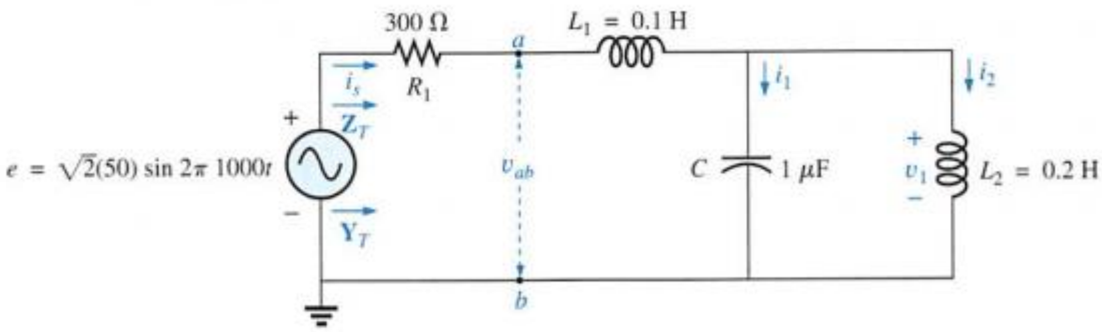


FIG. 16.45

SOLUTION

Q1

c. $L_T = 0.26\text{ H} = 260 \times 10^{-3}\text{ H} = 260\text{ mH}$

$X_L = \omega L = 2\pi fL = 2\pi(10^3\text{ Hz})(260 \times 10^{-3}\text{ H}) = 1632.8\ \Omega$

$X_C = \dfrac{1}{2\pi fC} = \dfrac{1}{2\pi(10^3\text{ Hz})(10 \times 10^{-6}\text{ F})} = 15.92\ \Omega$

$\mathbf{Z}_T = 47\ \Omega + j1632.8\ \Omega - j15.92\ \Omega$
$= 47\ \Omega + j1616.88\ \Omega = 1617.56\ \Omega\ \angle 88.33°$

Q2

17. a. $X_L = \omega L = (377\text{ rad/s})(0.4\text{ H}) = 150.8\ \Omega$

$X_C = \dfrac{1}{\omega C} = \dfrac{1}{(377\text{ rad/s})(4\ \mu\text{F})} = 663\ \Omega$

$\mathbf{Z}_T = 30\ \Omega + j150.8\ \Omega - j663\ \Omega = 30\ \Omega - j512.2\ \Omega = 513.08\ \Omega\ \angle -86.65°$

$\mathbf{I} = \dfrac{\mathbf{E}}{\mathbf{Z}_T} = \dfrac{20\text{ V}\ \angle 40°}{513.08\ \Omega\ \angle -86.65°} = 39\text{ mA}\ \angle 126.65°$

$\mathbf{V}_R = (I\ \angle\theta)(R\ \angle 0°) = (39\text{ mA}\ \angle 126.65°)(30\ \Omega\ \angle 0°) = 1.17\text{ V}\ \angle 126.65°$

$\mathbf{V}_C = (39\text{ mA}\ \angle 126.65°)(0.663\text{ k}\Omega\ \angle -90°) = 25.86\text{ V}\ \angle 36.65°$

b. $\cos\theta_T = \dfrac{R}{Z_T} = \dfrac{30\ \Omega}{513.08\ \Omega} = 0.058$ leading

c. $P = I^2R = (39\text{ mA})^2\ 30\ \Omega = 45.63\text{ mW}$

f. $\mathbf{V}_R = \dfrac{(30\ \Omega\ \angle 0°)(20\text{ V}\ \angle 40°)}{\mathbf{Z}_T} = \dfrac{600\text{ V}\ \angle 40°}{513.08\ \angle -86.65°} = 1.17\text{ V}\ \angle 126.65°$

$\mathbf{V}_C = \dfrac{(0.663\text{ k}\Omega\ \angle -90°)(20\text{ V}\ \angle 40°)}{513.08\ \Omega\ \angle -86.65°} = 25.84\text{ V}\ \angle 36.65°$

g. $\mathbf{Z}_T = 30\ \Omega - j512.2\ \Omega = R - jX_C$

Q3

25. a. $\mathbf{Z}_T = 3\ \Omega + j8\ \Omega = 8.544\ \Omega\ \angle 69.44°$, $\mathbf{Y}_T = 0.117\text{ S}\ \angle -69.44$

$\mathbf{Y}_T = 41.1\text{ mS} - j109.5\text{ mS} = G - jB_L$

b. $\mathbf{Z}_T = 40\ \Omega + 20\ \Omega - j70\ \Omega = 60\ \Omega - j70\ \Omega = 92.195\ \Omega\ \angle -49.40°$

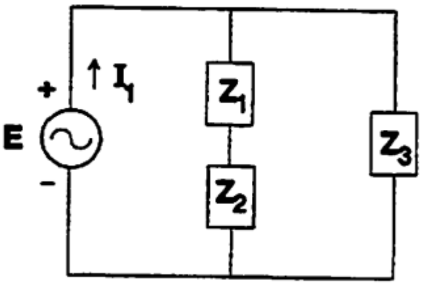
$\mathbf{Y}_T = 10.9\text{ mS}\ \angle 49.40° = 7.1\text{ mS} + j8.3\text{ mS} = G + jB_C$

c. $\mathbf{Z}_T = 200\ \Omega + j500\ \Omega - j600\ \Omega = 200\ \Omega - j100\ \Omega = 223.61\ \Omega\ \angle -26.57°$

$\mathbf{Y}_T = 4.47\text{ mS}\ \angle 26.57° = 4\text{ mS} + j2\text{ mS} = G + jB_C$

Q4

7. a.



$$\mathbf{Z}_1 = 10\ \Omega\ \angle 0^\circ$$
$$\mathbf{Z}_2 = 80\ \Omega\ \angle 90^\circ \parallel 20\ \Omega\ \angle 0^\circ = \frac{1600\ \Omega\ \angle 90^\circ}{20 + j80} = \frac{1600\ \Omega\ \angle 90^\circ}{82.462\ \angle 75.964^\circ} = 19.403\ \Omega\ \angle 14.036^\circ$$
$$\mathbf{Z}_3 = 60\ \Omega\ \angle -90^\circ$$

$$\begin{aligned}\mathbf{Z}_T &= (\mathbf{Z}_1 + \mathbf{Z}_2) \parallel \mathbf{Z}_3 \\ &= (10\ \Omega + 18.824\ \Omega + j4.706\ \Omega) \parallel 60\ \Omega\ \angle -90^\circ \\ &= 29.206\ \Omega\ \angle 9.273^\circ \parallel 6\Omega\ \angle -90^\circ = \frac{1752.36\ \Omega\ \angle -80.727^\circ}{28.824 + j4.706 - j60} \\ &= \frac{1752.36\ \Omega\ \angle -80.727^\circ}{62.356\ \angle -62.468^\circ} = 28.103\ \Omega\ \angle -18.259^\circ\end{aligned}$$

$$\mathbf{I}_1 = \frac{\mathbf{E}}{\mathbf{Z}_T} = \frac{40\ \text{V}\ \angle 0^\circ}{28.103\ \Omega\ \angle -18.259^\circ} = 1.423\ \text{A}\ \angle 18.259^\circ$$

b. $$\mathbf{V}_1 = \frac{\mathbf{Z}_2\mathbf{E}}{\mathbf{Z}_2 + \mathbf{Z}_1} = \frac{(19.403\ \Omega\ \angle 14.036^\circ)(40\ \text{V}\ \angle 0^\circ)}{29.206\ \Omega\ \angle 9.273^\circ} = \frac{776.12\ \text{V}\ \angle 14.036^\circ}{29.206\ \angle 9.273^\circ} = 26.574\ \text{V}\ \angle 4.763^\circ$$

c. $$P = EI\cos\theta = (40\ \text{V})(1.423\ \text{A})\cos 18.259^\circ = 54.074\ \text{W}$$

Q5

10. a.

$$X_{L_1} = \omega L_1 = 2\pi(10^3\ \text{Hz})(0.1\ \text{H}) = 628\ \Omega$$
$$X_{L_2} = \omega L_2 = 2\pi(10^3\ \text{Hz})(0.2\ \text{H}) = 1.256\ \text{k}\Omega$$
$$X_C = \frac{1}{\omega C} = \frac{1}{2\pi(10^3\ \text{Hz})(1\ \mu\text{F})} = 0.159\ \text{k}\Omega$$
$$\begin{aligned}\mathbf{Z}_T &= R\ \angle 0^\circ + X_{L_1}\ \angle 90^\circ + X_C\ \angle -90^\circ \parallel X_{L_2}\ \angle 90^\circ \\ &= 300\ \Omega + j628\ \Omega + 0.159\ \text{k}\Omega\ \angle -90^\circ \parallel 1.256\ \text{k}\Omega\ \angle 90^\circ \\ &= 300\ \Omega + j628\ \Omega - j182\ \Omega \\ &= 300\ \Omega + j446\ \Omega = 537.51\ \Omega\ \angle 56.07^\circ\end{aligned}$$
$$\mathbf{Y}_T = \frac{1}{\mathbf{Z}_T} = \frac{1}{537.51\ \Omega\ \angle 56.07^\circ} = 1.86\ \text{mS}\ \angle -56.07^\circ$$

b. $$\mathbf{I}_s = \frac{\mathbf{E}}{\mathbf{Z}_T} = \frac{50\ \text{V}\ \angle 0^\circ}{537.51\ \Omega\ \angle 56.07^\circ} = 93\ \text{mA}\ \angle -56.07^\circ$$

c. (CDR): $\mathbf{I}_1 = \dfrac{\mathbf{Z}_{L_2}\mathbf{I}_s}{\mathbf{Z}_{L_2} + \mathbf{Z}_C} = \dfrac{(1.256\text{ k}\Omega\ \angle 90^\circ)(93\text{ mA}\ \angle -56.07^\circ)}{+j1.256\text{ k}\Omega - j0.159\text{ k}\Omega}$

$$= \frac{116.81\text{ mA}\ \angle 33.93^\circ}{1.097\ \angle 90^\circ} = \mathbf{106.48\ mA\ \angle -56.07^\circ}$$

$$\mathbf{I}_2 = \frac{\mathbf{Z}_C\mathbf{I}_s}{\mathbf{Z}_{L_2} + \mathbf{Z}_C} = \frac{(0.159\text{ k}\Omega\ \angle -90^\circ)(93\text{ mA}\ \angle -56.07^\circ)}{1.097\text{ k}\Omega\ \angle 90^\circ}$$

$$= \frac{14.79\text{ mA}\ \angle -146.07^\circ}{1.097\ \angle 90^\circ} = 13.48\text{ mA}\ \angle -236.07^\circ$$

$$= \mathbf{13.48\ mA\ \angle 123.93^\circ}$$

d. $\mathbf{V}_1 = (I_2\ \angle\theta)(X_{L_2}\ \angle 90^\circ) = (13.48\text{ mA}\ \angle 123.92^\circ)(1.256\text{ k}\Omega\ \angle 90^\circ)$

$$= \mathbf{16.931\ V\ \angle 213.93^\circ}$$

$$\underset{+-}{V_{ab}} = \mathbf{E} - (I_s\ \angle\theta)(R\ \angle 0^\circ) = 50\text{ V}\ \angle 0^\circ - (93\text{ mA}\ \angle -56.07^\circ)(300\ \Omega\ \angle 0^\circ)$$

$$= 50\text{ V} - 27.9\text{ V}\ \angle -56.07^\circ$$

$$= 50\text{ V} - (15.573\text{ V} - j23.149\text{ V})$$

$$= 34.43\text{ V} + j23.149\text{ V} = \mathbf{41.49\ V\ \angle 33.92^\circ}$$

e. $P = I_s^2 R = (93\text{ mA})^2 300\ \Omega = \mathbf{2.595\ W}$

f. $F_p = \dfrac{R}{Z_T} = \dfrac{300\ \Omega}{537.51\ \Omega} = \mathbf{0.558\ (lagging)}$