Circuits II

Home Work # 2 (Ch9) Solution

P 9.11 [a] $\mathbf{Y} = 30\angle -160^\circ + 15\angle 70^\circ = 29.38\angle 170.56^\circ$

$$y = 28.38\cos(200t + 170.56^\circ)$$

[b] $\mathbf{Y} = 90\angle -110^\circ + 60\angle -70^\circ = 141.33\angle -94.16^\circ$

$$y = 141.33\cos(50t - 94.16^\circ)$$

[c] $\mathbf{Y} = 50\angle -60^\circ + 25\angle 20^\circ - 75\angle -30^\circ = 16.7\angle 170.52^\circ$

$$y = 16.7\cos(5000t + 170.52^\circ)$$

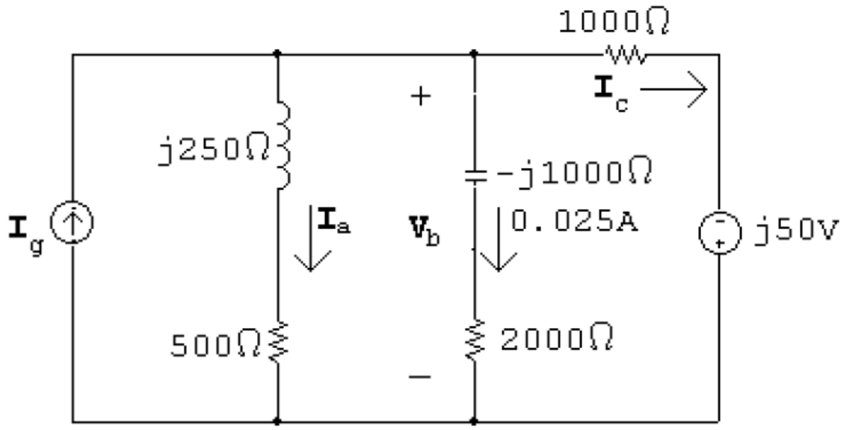
[d] $\mathbf{Y} = 10\angle 30^\circ + 10\angle -90^\circ + 10\angle 150^\circ = 0$

$$y = 0$$

P 9.22 $Z_{\text{ab}} = 5 + j8 + 10\| - j20 + (8 + j16)\|(40 - j80)$

$$= 5 + j8 + 8 - j4 + 12 + j16 = 25 + j20\,\Omega = 32.02\angle 38.66^\circ\,\Omega$$

P 9.36 **[a]**



$$\mathbf{V}_{\rm b} = (2000 - j1000)(0.025) = 50 - j25\,\text{V}$$

$$\mathbf{I}_{\rm a} = \frac{50 - j25}{500 + j250} = 60 - j80\,\text{mA} = 100\underline{/-53.13^\circ}\,\text{mA}$$

$$\mathbf{I}_{\rm c} = \frac{50 - j25 + j50}{1000} = 50 + j25\,\text{mA} = 55.9\underline{/26.57^\circ}\,\text{mA}$$

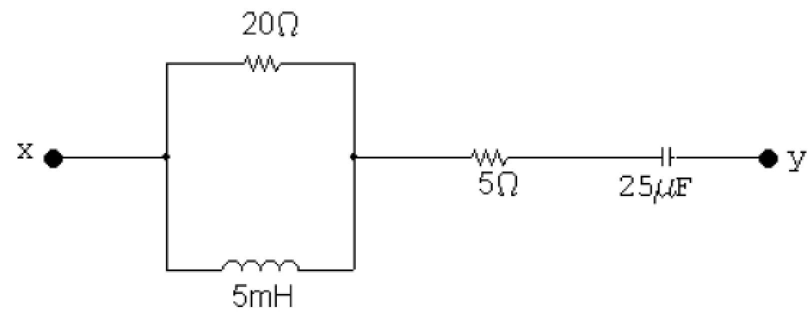
$$\mathbf{I}_g = \mathbf{I}_{\rm a} + \mathbf{I}_{\rm b} + \mathbf{I}_{\rm c} = 135 - j55\,\text{mA} = 145.77\underline{/-22.17^\circ}\,\text{mA}$$

[b] $i_{\rm a} = 100\cos(1500t - 53.13^\circ)\,\text{mA}$

$i_{\rm c} = 55.9\cos(1500t + 26.57^\circ)\,\text{mA}$

$i_g = 145.77\cos(1500t - 22.17^\circ)\,\text{mA}$

AP 9.7 [a]



$$\omega = 2000\,\text{rad/s}$$

$$\omega L = 10\,\Omega, \qquad \frac{-1}{\omega C} = -20\,\Omega$$

$$Z_{xy} = 20\|j10 + 5 + j20 = \frac{20(j10)}{(20+j10)} + 5 - j20$$

$$= 4 + j8 + 5 - j20 = (9 - j12)\,\Omega$$

[b] $\omega L = 40\,\Omega, \qquad \dfrac{-1}{\omega C} = -5\,\Omega$

$$Z_{xy} = 5 - j5 + 20\|j40 = 5 - j5 + \left[\frac{(20)(j40)}{20+j40}\right]$$

$$= 5 - j5 + 16 + j8 = (21 + j3)\,\Omega$$

[c] $Z_{xy} = \left[\dfrac{20(j\omega L)}{20 + j\omega L}\right] + \left(5 - \dfrac{j10^6}{25\omega}\right)$

$$= \frac{20\omega^2 L^2}{400 + \omega^2 L^2} + \frac{j400\omega L}{400 + \omega^2 L^2} + 5 - \frac{j10^6}{25\omega}$$

The impedance will be purely resistive when the j terms cancel, i.e.,

$$\frac{400\omega L}{400 + \omega^2 L^2} = \frac{10^6}{25\omega}$$

Solving for ω yields $\omega = 4000\,\text{rad/s}$.

[d] $Z_{xy} = \dfrac{20\omega^2 L^2}{400 + \omega^2 L^2} + 5 = 10 + 5 = 15\,\Omega$

AP 9.13 Let $\mathbf{I}_\mathrm{a}$, $\mathbf{I}_\mathrm{b}$, and $\mathbf{I}_\mathrm{c}$ be the three clockwise mesh currents going from left to right. Summing the voltages around meshes a and b gives

$$33.8 = (1 + j2)\mathbf{I}_\mathrm{a} + (3 - j5)(\mathbf{I}_\mathrm{a} - \mathbf{I}_\mathrm{b})$$

and

$$0 = (3 - j5)(\mathbf{I}_\mathrm{b} - \mathbf{I}_\mathrm{a}) + 2(\mathbf{I}_\mathrm{b} - \mathbf{I}_\mathrm{c}).$$

But

$$\mathbf{V}_x = -j5(\mathbf{I}_\mathrm{a} - \mathbf{I}_\mathrm{b}),$$

therefore

$$\mathbf{I}_\mathrm{c} = -0.75[-j5(\mathbf{I}_\mathrm{a} - \mathbf{I}_\mathrm{b})].$$

Solving for $\mathbf{I} = \mathbf{I}_\mathrm{a} = 29 + j2 = 29.07\underline{/3.95^\circ}\,\mathrm{A}$.