P10.3-3

$$f = \frac{\omega}{2\pi} = \frac{1200\pi}{2\pi} = 600 \text{ Hz}$$

$$i(2\times10^{-3}) = 300\cos(1200\,\pi(2\times10^{-3}) + 55°) = 3\cos(2.4\pi + 55°)$$

$$2.4\,\pi\times\left(\frac{180°}{\pi}\right) = 432° \quad \Rightarrow \quad i(2\times10^{-3}) = 300\ \cos(432°+55°) = 300\ \cos(127°) = -180.5 \text{ mA}$$

P10.4-1

$$L\frac{di}{dt} + R_i = -v_s \quad \Rightarrow \quad \frac{di}{dt} + 120\,i = -400\cos 300t$$

Try $i_f = A\cos 300t + B\sin 300t$ then $\frac{di_f}{dt} = -300\,A\sin 300t + 300\,B\cos 300t$. Substituting and equating coefficients gives

$$\left.\begin{aligned} -300\,A + 120\,B &= 0 \\ 300\,B + 120\,A &= -400 \end{aligned}\right\} \begin{aligned} A &= -0.46 \\ B &= -1.15 \end{aligned}$$

Then

$$i(t) = -0.46\cos 300t - 1.15\sin 300t = 1.24\cos(300t - 68°) \text{ A}$$

P10.5-2

$$5\angle+81.87^{\circ}\left[4 - j3 + \frac{3\sqrt{2}\angle-45°}{5\sqrt{2}\angle-8.13°}\right] = 5\angle+81.87°[4 - j3 + \frac{3}{5}\angle-36.87°]$$

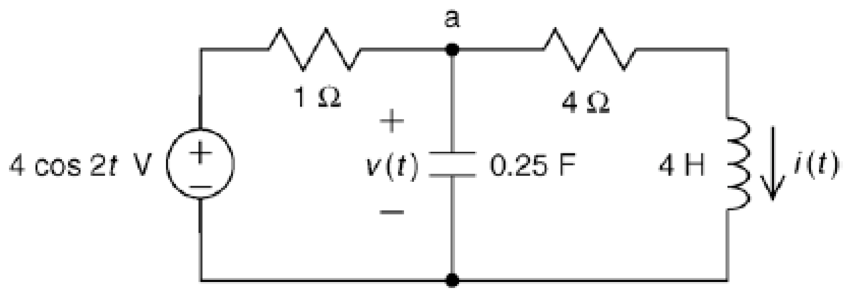
$$= 5\angle+81.87°(4.48 - j3.36) = 5\angle+81.87°(5.6\angle-36.87°)$$

$$= 28\angle+45° = \underline{14\sqrt{2} + j14\sqrt{2}}$$

P10.5-4

$$(6\angle120^{\circ})\,(-4 + j3 + 2e^{j15}) = -12.1 - j21.3 \quad \Rightarrow \quad \underline{a = -12.1} \text{ and } \underline{b = -21.3}$$

P10.6-2



Apply KCL at node a:

$$\frac{v-4\cos 2t}{1}+0.25\frac{d}{dt}v+i=0$$

Apply KVL to the right mesh:

$$4i+4\frac{d}{dt}i-v=0 \quad\Rightarrow\quad v=4i+4\frac{d}{dt}i_L$$

After some algebra:

$$\frac{d^2}{dt^2}i+5\frac{d}{dt}i+5i=4\cos 2t$$

Now use $i=I_m\,\mathrm{Re}\{e^{j(2t+\theta)}\}$ and $4\cos 2t=4\,\mathrm{Re}\{e^{2t}\}$ to write

$$\frac{d^2}{dt^2}\left[I_m\,\mathrm{Re}\{e^{j(2t+\theta)}\}\right]+5\frac{d}{dt}\left[I_m\,\mathrm{Re}\{e^{j(2t+\theta)}\}\right]+5\left[I_m\,\mathrm{Re}\{e^{j(2t+\theta)}\}\right]=4\,\mathrm{Re}\{e^{2t}\}$$

$$\mathrm{Re}\left\{\frac{d^2}{dt^2}\left[I_m\,e^{j(2t+\theta)}\right]+5\frac{d}{dt}\left[I_m\,e^{j(2t+\theta)}\right]+5\left[I_m\,e^{j(2t+\theta)}\right]\right\}=\mathrm{Re}\{4\,e^{2t}\}$$

$$\mathrm{Re}\left\{-4\,e^{j\theta}I_m\,e^{j2t}+5\left(j2\,e^{j\theta}I_m\,e^{j2t}\right)+5\,e^{j\theta}I_m\,e^{j2t}\right\}=\mathrm{Re}\{4\,e^{2t}\}$$

$$-4\,e^{j\theta}I_m+5\left(j2\,e^{j\theta}I_m\right)+5\,e^{j\theta}I_m=4$$

$$I_m\,e^{j\theta}=\frac{4}{-4+5(j2)+5}=\frac{4}{1+j10}=\frac{4}{10.05\angle 84}=0.398\angle-84^\circ$$

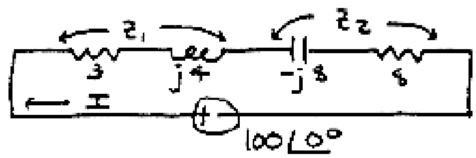
$$i(t)=0.398\cos\left(2t-85^\circ\right)\ \ \mathrm{A}$$

P10.8-2

$$\mathbf{Z}=\frac{\mathbf{V}}{-\mathbf{I}}=\frac{-10\ \angle 40^\circ}{2\times 10^{-3}\ \angle 195^\circ}=\ -5000\angle -155^\circ\Omega\ =4532+2113\,j=\ R+j\,\omega\,L$$

so $\underline{R=4532\ \Omega}$ and $L=\frac{2113}{\omega}=\frac{2113}{2\times 10^{6}}=\underline{1.06\text{ m H}}$

P10.9-1



(a) $\underline{\mathbf{Z}_1=3+j4\ =\ 5\angle 53.1^\circ\ \Omega}$ and $\underline{\mathbf{Z}_2=8-j8\ =\ 8\sqrt{2}\ \angle -45^\circ\ \Omega}$

(b) Total impedance $=\ \mathbf{Z}_1+\mathbf{Z}_2=3+j4+8-j8=11-j4=\ \underline{11.7\angle -20.0^\circ\ \Omega}$

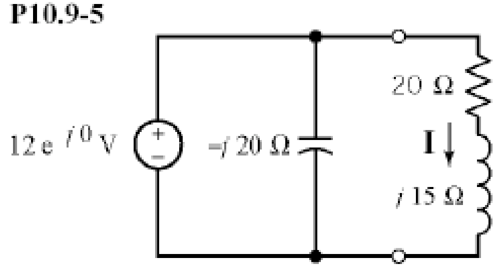
(c) $\mathbf{I}=\frac{100\angle 0^\circ}{\mathbf{Z}_1+\mathbf{Z}_2}=\frac{100}{11.7\ \angle -20^\circ}=\frac{100}{11.7}\angle 20.0^\circ\ \ \Rightarrow\ \ \underline{i(t)\ =\ 8.55\ \cos\ (1250t+20.0^\circ)\ \text{A}}$

P10.9-3

$$\begin{aligned}\mathbf{I}=\mathbf{I}_1+\mathbf{I}_2=0.744\angle -118^\circ+0.5405\angle 100 &=\left(-0.349-j\,0.657\right)+\left(-0.094+j0.532\right)\\ &=\left(-0.349-0.094\right)+j\left(-0.657+0.532\right)\\ &=-0.443-j\,0.125\\ &=0.460\angle 196^\circ\end{aligned}$$

$$i\left(t\right)=460\cos\left(2\,t+196^\circ\right)\ \text{mA}$$

P10.9-5



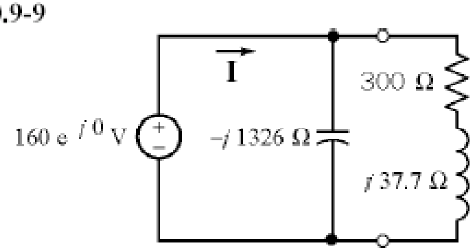
$$j15=j\,(2\pi\cdot 796)(3\cdot 10^{-3})$$

$$\mathbf{I}=\frac{12}{20+j15}=0.48\ \angle -37^\circ\ \text{A}$$

$$i(t)=\ 0.48\cos(2\pi\cdot 796\,t-37^\circ)\ \text{A}$$

P10.9-9

(a)

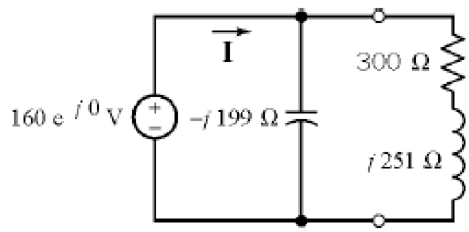


$$\mathbf{I} = \frac{160\angle 0^\circ}{\dfrac{(-1326)\,(300+j37.7)}{-j1326 + 300+j\,37.7}} = \frac{160\angle 0^\circ}{303\angle -5.9^\circ}$$

$$= 0.53\angle 5.9^\circ \text{ A}$$

$\underline{i(t) = 0.53\cos(120\pi t + 5.9^\circ)\text{ A}}$

(b)

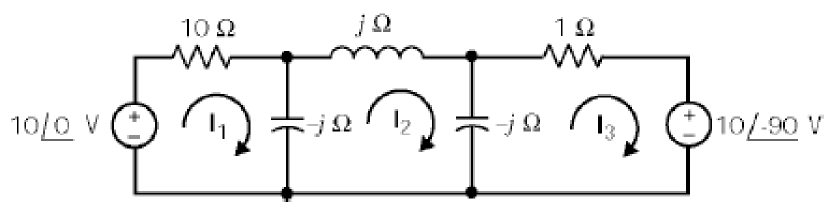


$$\mathbf{I} = \frac{160\angle 0^\circ}{\dfrac{(-j199)(300+j251)}{-j199+300+j251}} = \frac{160\angle 0^\circ}{256\angle -59.9^\circ}$$

$$= 0.625\angle 59.9^\circ \text{ A}$$

$\underline{i(t) = 0.625\ \cos\ (800\pi t + 59.9^\circ)\text{ A}}$

P10.10-9



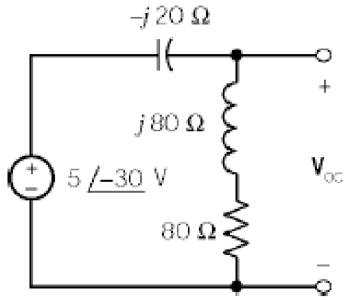
The mesh equations are:

$$\begin{aligned}(10-j)\,\mathbf{I}_1 + (j)\,\mathbf{I}_2 + 0\,\mathbf{I}_3 &= 10\\ j\,\mathbf{I}_1 - j\,\mathbf{I}_2 \ + \ j\,\mathbf{I}_3 &= 0\\ 0\,\mathbf{I}_1 + j\,\mathbf{I}_2 + (1-j)\,\mathbf{I}_3 &= j10\end{aligned}$$

Solving these mesh equations using Cramer's rule yields:

$$\mathbf{I}_2 = \frac{\begin{vmatrix}(10-j) & 10 & 0\\ j & 0 & j\\ 0 & j\,10 & (1-j)\end{vmatrix}}{\begin{vmatrix}(10-j) & j & 0\\ j & -j & j\\ 0 & j & (1-j)\end{vmatrix}} = \frac{90-j20}{-11j} = 8.38\angle 77.5^\circ \text{ A} \quad \Rightarrow \quad i(t) = 8.38\cos\left(10^3 t + 77.5^\circ\right)\ \text{A}$$

P10.11-4

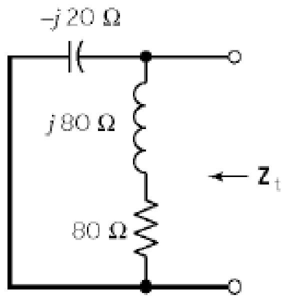


Find $\mathbf{V}_{oc}$:

$$\mathbf{V}_{oc} = (5\ \angle -30°)\left(\frac{80 + j80}{80 + j80 - j20}\right)$$

$$= (5\ \angle -30°)\left(\frac{80\sqrt{2}\angle -21.9°}{100\angle 36.90°}\right)$$

$$= 4\sqrt{2}\angle -21.9°\ \text{V}$$



Find $\mathbf{Z}_t$:

$$\mathbf{Z}_t = \frac{(-j20)(80 + j80)}{-j20 + 80 + j80} = 23\ \angle -81.9°\ \ \Omega$$

The Thevenin equivalent is