Chapter 10, Solution 7.

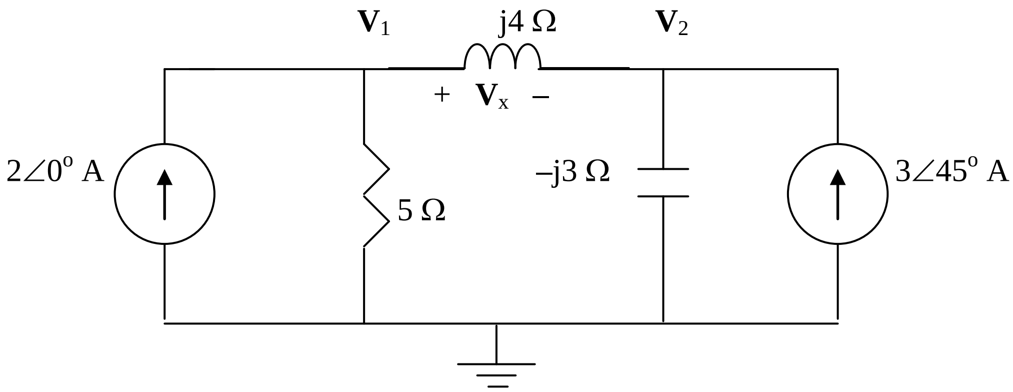
At the main node,

$$\frac{120\angle -15^{o} - V}{40 + j20} = 6\angle 30^{o} + \frac{V}{-j30} + \frac{V}{50} \longrightarrow \frac{115.91 - j31.058}{40 + j20} - 5.196 - j3 = V\left(\frac{1}{40 + j20} + \frac{j}{30} + \frac{1}{50}\right)$$

$$V = \frac{-3.1885 - j4.7805}{0.04 + j0.0233} = \underline{124.08\angle -154^{o}\ \ V}$$

Chapter 10, Solution 16.

Consider the circuit as shown in the figure below.



At node 1,

$$-2+\frac{V_1-0}{5}+\frac{V_1-V_2}{j4}=0 \qquad (1)$$

$$(0.2-j0.25)V_1+j0.25V_2=2$$

At node 2,

$$\frac{V_2-V_1}{j4}+\frac{V_2-0}{-j3}-3\angle 45^\circ=0 \qquad (2)$$

$$j0.25V_1+j0.08333V_2=2.121+j2.121$$

In matrix form, (1) and (2) become

$$\begin{bmatrix}0.2-j0.25 & j0.25\\ j0.25 & j0.08333\end{bmatrix}\begin{bmatrix}V_1\\ V_2\end{bmatrix}=\begin{bmatrix}2\\ 2.121+j2.121\end{bmatrix}$$

Solving this using MATLAB, we get,

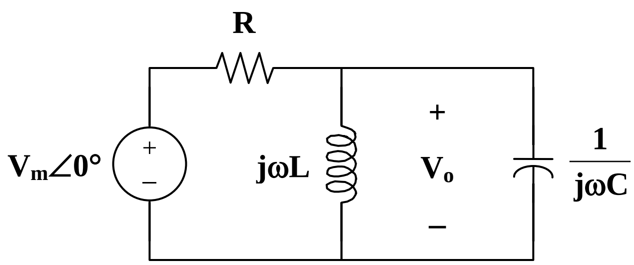
```
>> Y=[(0.2-0.25i),0.25i;0.25i,0.08333i]

Y =

   0.2000 - 0.2500i        0 + 0.2500i
        0 + 0.2500i        0 + 0.0833i

>> I=[2;(2.121+2.121i)]

I =
```

```
   2.0000
   2.1210 + 2.1210i

>> V=inv(Y)*I

V =

   5.2793 - 5.4190i
   9.6145 - 9.1955i
```

$$V_s = V_1 - V_2 = -4.335 + j3.776 = \underline{\mathbf{5.749\angle 138.94^\circ\ V}}.$$

Chapter 10, Solution 20.

The circuit is converted to its frequency-domain equivalent circuit as shown below.



Let $$\mathbf{Z} = j\omega L \parallel \frac{1}{j\omega C} = \frac{\frac{L}{C}}{j\omega L + \frac{1}{j\omega C}} = \frac{j\omega L}{1-\omega^2 LC}$$

$$\mathbf{V}_o = \frac{\mathbf{Z}}{R+\mathbf{Z}} V_m = \frac{\frac{j\omega L}{1-\omega^2 LC}}{R + \frac{j\omega L}{1-\omega^2 LC}} V_m = \frac{j\omega L}{R(1-\omega^2 LC) + j\omega L} V_m$$

$$\mathbf{V}_o = \frac{\omega L V_m}{\sqrt{R^2 (1-\omega^2 LC)^2 + \omega^2 L^2}} \angle\left(90° - \tan^{-1}\frac{\omega L}{R(1-\omega^2 LC)}\right)$$

If $\mathbf{V}_o = A\angle\phi$, then

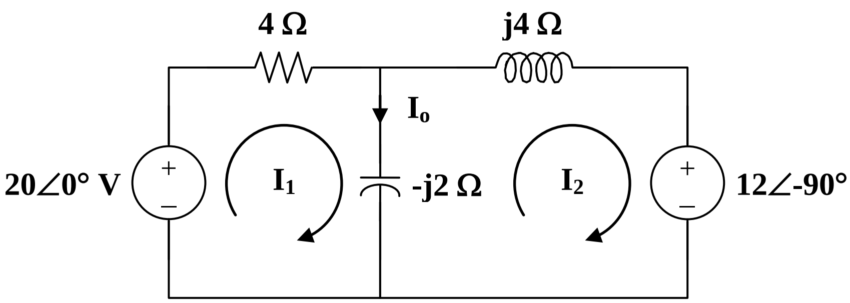
$$A = \underline{\frac{\boldsymbol{\omega L V_m}}{\sqrt{\mathbf{R^2 (1-\omega^2 LC)^2 + \omega^2 L^2}}}}$$

and $$\phi = \underline{\mathbf{90° - \tan^{-1}\frac{\omega L}{R(1-\omega^2 LC)}}}$$

Chapter 10, Solution 25.

$$\omega = 2$$
$$10\cos(2t) \longrightarrow 20\angle 0°$$
$$6\sin(2t) \longrightarrow 12\angle -90° = -j12$$
$$2\text{ H} \longrightarrow j\omega L = j4$$
$$0.25\text{ F} \longrightarrow \frac{1}{j\omega C} = \frac{1}{j(2)(1/4)} = -j2$$

The circuit is shown below.



For loop 1,

$$-20 + (4 - j2)\mathbf{I}_1 + j2\mathbf{I}_2 = 0$$
$$10 = (2 - j)\mathbf{I}_1 + j\mathbf{I}_2 \qquad (1)$$

For loop 2,

$$j2\mathbf{I}_1 + (j4 - j2)\mathbf{I}_2 + (-j12) = 0$$
$$\mathbf{I}_1 + \mathbf{I}_2 = 6 \qquad (2)$$

In matrix form (1) and (2) become

$$\begin{bmatrix} 2-j & j \\ 1 & 1 \end{bmatrix}\begin{bmatrix} \mathbf{I}_1 \\ \mathbf{I}_2 \end{bmatrix} = \begin{bmatrix} 10 \\ 6 \end{bmatrix}$$

$$\Delta = 2(1 - j), \qquad \Delta_1 = 10 - j6, \qquad \Delta_2 = 2 - j6$$

$$\mathbf{I}_o = \mathbf{I}_1 - \mathbf{I}_2 = \frac{\Delta_1 - \Delta_2}{\Delta} = \frac{8}{2(1-j)} = 2 + j2 = 2.828\angle 45°$$

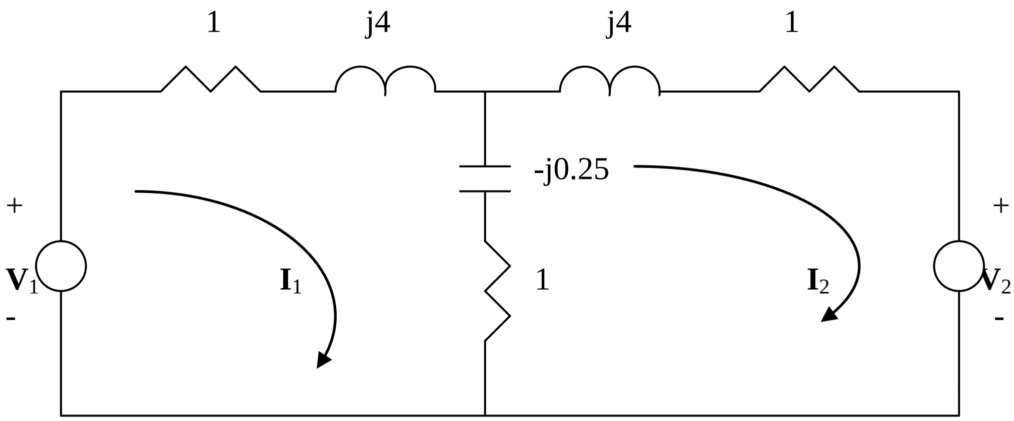
Therefore, $i_o(t) =$ **2.828 cos(2t + 45°) A**

Chapter 10, Solution 28.

$$1H \longrightarrow j\omega L = j4, \qquad 1F \longrightarrow \frac{1}{j\omega C} = \frac{1}{j1x4} = -j0.25$$

The frequency-domain version of the circuit is shown below, where

$$V_1 = 10\angle 0^o, \qquad V_2 = 20\angle -30^o \ .$$



$$V_1 = 10\angle 0^o, \qquad V_2 = 20\angle -30^o$$

Applying mesh analysis,

$$10 = (2 + j3.75)I_1 - (1 - j0.25)I_2 \qquad (1)$$

$$-20\angle -30^o = -(1 - j0.25)I_1 + (2 + j3.75)I_2 \qquad (2)$$

From (1) and (2), we obtain

$$\begin{pmatrix} 10 \\ -17.32 + j10 \end{pmatrix} = \begin{pmatrix} 2 + j3.75 & -1 + j0.25 \\ -1 + j0.25 & 2 + j3.75 \end{pmatrix} \begin{pmatrix} I_1 \\ I_2 \end{pmatrix}$$

Solving this leads to

$$I_1 = 2.741\angle -41.07^o, \qquad I_2 = 4.114\angle 92^o$$

Hence,

$i_1(t)$ = **$2.741\cos(4t-41.07^\circ)$A**, $i_2(t)$ = **$4.114\cos(4t+92^\circ)$A**.