Electric Circuits II – Assignment 08

#	Student ID	Student Name	Grade (10)
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Delivery Date	

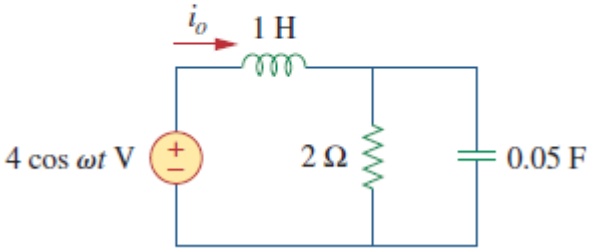
١. يتم تسليم التمرين محلولا في خلال أسبوع من تاريخ التمرين، و يتم حذف درجتين من التمرين عن كل أسبوع تأخير
٢. يتم التسليم لمعيد المقرر مباشرة
٣. تتم أجابه التمرين في نفس ورق الأسئلة

Q1

In the circuit of Fig. , find i_o when:

(a) $\omega = 1$ rad/s (b) $\omega = 5$ rad/s

(c) $\omega = 10$ rad/s



Sol 1

(a) For $\omega = 1$,

$$1\text{ H} \longrightarrow j\omega L = j(1)(1) = j$$

$$0.05\text{ F} \longrightarrow \frac{1}{j\omega C} = \frac{1}{j(1)(0.05)} = -j20$$

$$\mathbf{Z} = j + 2 \,||\, (-j20) = j + \frac{-j40}{2 - j20} = 1.98 + j0.802$$

$$\mathbf{I}_o = \frac{\mathbf{V}}{\mathbf{Z}} = \frac{4\angle 0°}{1.98 + j0.802} = \frac{4\angle 0°}{2.136\angle 22.05°} = 1.872\angle -22.05°$$

Hence,

$$i_o(t) = \mathbf{1.872\cos(t - 22.05°)\ A}$$

(b) For $\omega = 5$,

$$1\text{ H} \longrightarrow j\omega L = j(5)(1) = j5$$

$$0.05\text{ F} \longrightarrow \frac{1}{j\omega C} = \frac{1}{j(5)(0.05)} = -j4$$

$$\mathbf{Z} = j5 + 2 \,||\, (-j4) = j5 + \frac{-j4}{1 - j2} = 1.6 + j4.2$$

$$\mathbf{I}_o = \frac{\mathbf{V}}{\mathbf{Z}} = \frac{4\angle 0°}{1.6 + j4} = \frac{4\angle 0°}{4.494\angle 69.14°} = 0.89\angle -69.14°$$

Hence,

$$i_o(t) = \mathbf{890\cos(5t - 69.14°)\ mA}$$

(c) For $\omega = 10$,

$$1\,\text{H} \longrightarrow j\omega L = j(10)(1) = j10$$

$$0.05\,\text{F} \longrightarrow \frac{1}{j\omega C} = \frac{1}{j(10)(0.05)} = -j2$$

$$\mathbf{Z} = j10 + 2 \,||\, (-j2) = j10 + \frac{-j4}{2 - j2} = 1 + j9$$

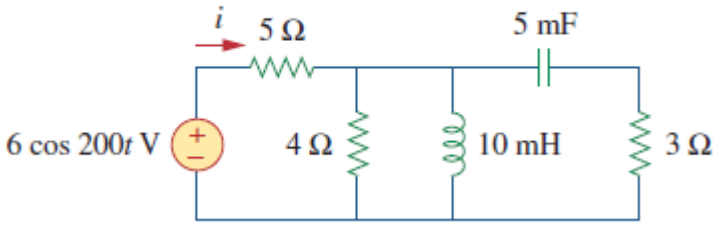
$$\mathbf{I}_o = \frac{\mathbf{V}}{\mathbf{Z}} = \frac{4\angle 0^\circ}{1 + j9} = \frac{4\angle 0^\circ}{9.055\angle 83.66^\circ} = 0.4417\angle -83.66^\circ$$

Hence,

$$i_o(t) = \mathbf{441.7\cos(10t - 83.66^\circ)\ mA}$$

Q2

Calculate $i(t)$ in the circuit of Fig.



Sol 2

$\omega = 200$

$10\text{ mH} \longrightarrow j\omega L = j(200)(10\times10^{-3}) = j2$

$5\text{ mF} \longrightarrow \dfrac{1}{j\omega C} = \dfrac{1}{j(200)(5\times10^{-3})} = -j$

$$\mathbf{Y} = \frac{1}{4} + \frac{1}{j2} + \frac{1}{3-j} = 0.25 - j0.5 + \frac{3+j}{10} = 0.55 - j0.4$$

$$\mathbf{Z} = \frac{1}{\mathbf{Y}} = \frac{1}{0.55 - j0.4} = 1.1892 + j0.865$$

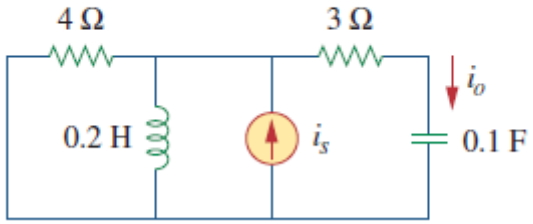
$$\mathbf{I} = \frac{6\angle 0°}{5 + \mathbf{Z}} = \frac{6\angle 0°}{6.1892 + j0.865} = 0.96\angle -7.956°$$

Thus,

$$\mathbf{i(t) = 960\cos(200t - 7.956°)\ mA}$$

Q3

If $i_s = 5\cos(10t + 40°)$ A in the circuit of Fig. find i_o.



Sol 3

$$i_s = 5\cos(10t + 40°) \longrightarrow \mathbf{I}_s = 5\angle 40°$$

$$0.1\,\text{F} \longrightarrow \frac{1}{j\omega C} = \frac{1}{j(10)(0.1)} = -j$$

$$0.2\,\text{H} \longrightarrow j\omega L = j(10)(0.2) = j2$$

Let $\mathbf{Z}_1 = 4 \,\|\, j2 = \dfrac{j8}{4 + j2} = 0.8 + j1.6$, $\mathbf{Z}_2 = 3 - j$

$$\mathbf{I}_o = \frac{\mathbf{Z}_1}{\mathbf{Z}_1 + \mathbf{Z}_2}\mathbf{I}_s = \frac{0.8 + j1.6}{3.8 + j0.6}(5\angle 40°)$$

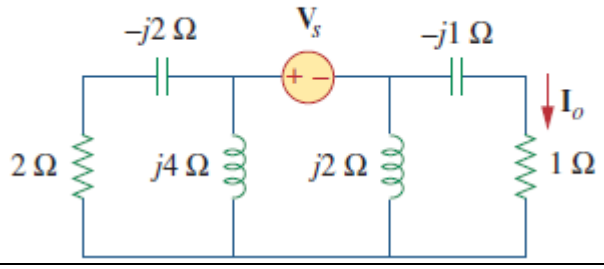
$$\mathbf{I}_o = \frac{(1.789\angle 63.43°)(5\angle 40°)}{3.847\angle 8.97°} = 2.325\angle 94.46°$$

Thus,

$$i_o(t) = \mathbf{2.325\cos(10t + 94.46°)\ A}$$

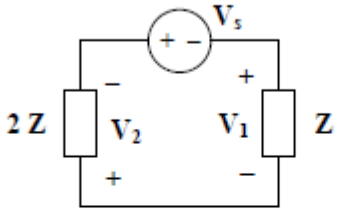
Q4

In the circuit of Fig. find $\mathbf{V}_s$ if $\mathbf{I}_o = 2\angle 0^\circ$ A.



Sol 4

Since the left portion of the circuit is twice as large as the right portion, the equivalent circuit is shown below.

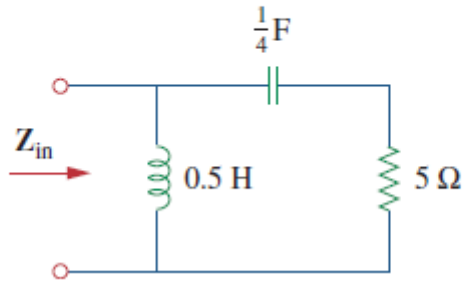


$$\mathbf{V}_1 = \mathbf{I}_o(1-j) = 2(1-j)$$
$$\mathbf{V}_2 = 2\mathbf{V}_1 = 4(1-j)$$
$$\mathbf{V}_2 + \mathbf{V}_s + \mathbf{V}_1 = 0 \text{ or}$$
$$\mathbf{V}_s = -\mathbf{V}_1 - \mathbf{V}_2 = -6(1-j) = (6\angle 180^\circ)(1.4142\angle -45^\circ)$$

$$\mathbf{V}_s = 8.485\angle 135^\circ \text{ V}$$

Q5

For the network in Fig. find $\mathbf{Z}_{in}$. Let $\omega =$ 10 rad/s.



Sol 5

$$0.25F \longrightarrow \frac{1}{j\omega C} = \frac{1}{j10x0.25} = -j0.4$$

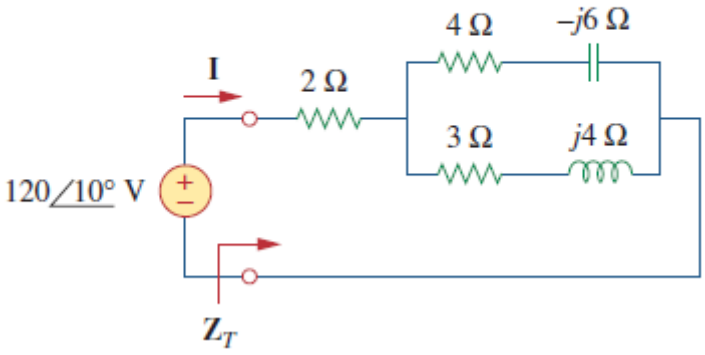
$$0.5H \longrightarrow j\omega L = j10x0.5 = j5$$

$$\mathbf{Z}_{in} = j5 \| (5 - j0.4) = \frac{(5\angle 90°)(5.016\angle -4.57°)}{6.794\angle 42.61°} = 3.691\angle 42.82°$$

$$= \mathbf{(2.707+j2.509)\ \Omega}.$$

Q6

Determine $\mathbf{Z}_T$ and $\mathbf{I}$ for the circuit in Fig.



Sol 6

$$\mathbf{Z}_T = 2 + (4 - j6) \,||\, (3 + j4)$$

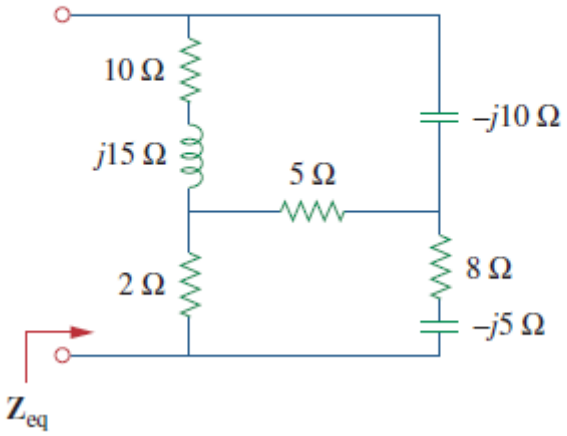
$$\mathbf{Z}_T = 2 + \frac{(4 - j6)(3 + j4)}{7 - j2}$$

$$\mathbf{Z}_T = \mathbf{6.83 + j1.094\ \Omega} = 6.917\angle 9.1^\circ\ \Omega$$

$$\mathbf{I} = \frac{\mathbf{V}}{\mathbf{Z}_T} = \frac{120\angle 10^\circ}{6.917\angle 9.1^\circ} = \mathbf{17.35\angle 0.9^\circ\ A}$$

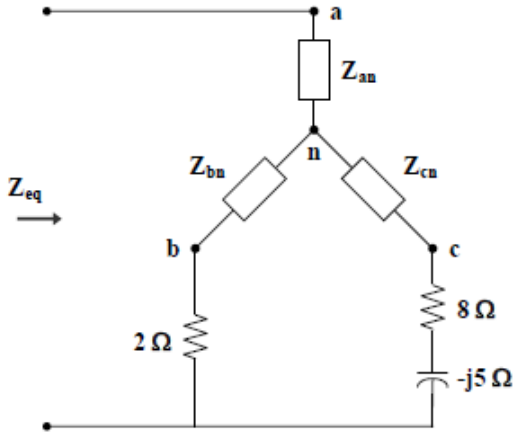
Q7

Find the equivalent impedance of the circuit in Fig.



Sol 7

Make a delta-to-wye transformation as shown in the figure below.



$$\mathbf{Z}_{an} = \frac{(-j10)(10+j15)}{5-j10+10+j15} = \frac{(10)(15-j10)}{15+j5} = 7-j9$$

$$\mathbf{Z}_{bn} = \frac{(5)(10+j15)}{15+j5} = 4.5+j3.5$$

$$\mathbf{Z}_{cn} = \frac{(5)(-j10)}{15+j5} = -1-j3$$

$$\mathbf{Z}_{eq} = \mathbf{Z}_{an} + (\mathbf{Z}_{bn}+2) \,||\, (\mathbf{Z}_{cn}+8-j5)$$

$$\mathbf{Z}_{eq} = 7-j9+(6.5+j3.5) \,||\, (7-j8)$$

$$\mathbf{Z}_{eq} = 7-j9+\frac{(6.5+j3.5)(7-j8)}{13.5-j4.5}$$

$$\mathbf{Z}_{eq} = 7-j9+5.511-j0.2$$

$$\mathbf{Z}_{eq} = 12.51-j9.2 = \mathbf{15.53\angle -36.33^\circ\ \Omega}$$