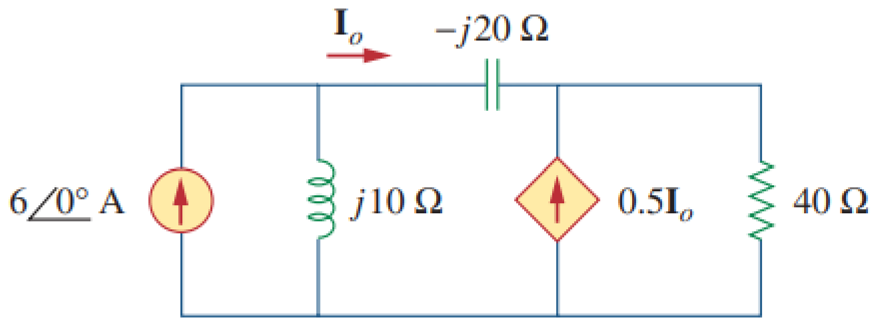
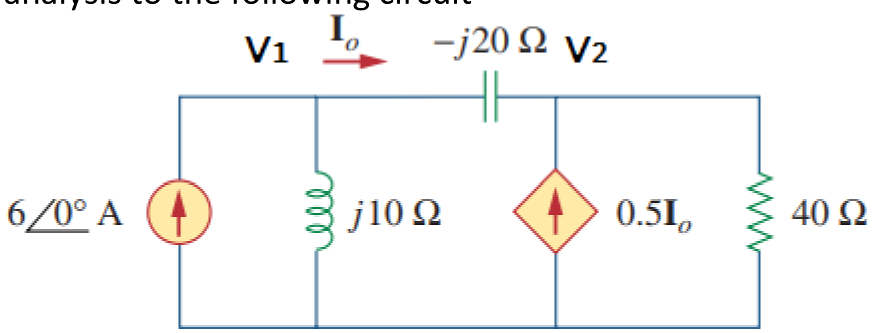
EENG 224, Quiz#1 Solution, 2022-23 FALL

<u>Q.1</u> For the circuit shown below determine **<u>the average power</u>** absorbed by 40 Ω resistor.



<u>Solution#1</u>

By applying Nodal analysis to the following circuit



<u>At node 1;</u>

$$6 = \frac{V_1}{j10} + \frac{V_1 - V_2}{-j20}$$

Multiply both sides by 20 j and rearrange the above equation;

$$V_1 = j120 - V_2 \qquad (1)$$

<u>At node 2;</u>

$$0.5I_o + I_o = \frac{V_2}{40}$$

But, $$I_o = \frac{V_1 - V_2}{-j20}$$

Hence, $$\frac{1.5(V_1 - V_2)}{-j20} = \frac{V_2}{40}$$

Multiply both sides by 40 j and rearrange

$$3V_1 = (3 - j)V_2 \qquad (2)$$

Substituting (1) into (2),

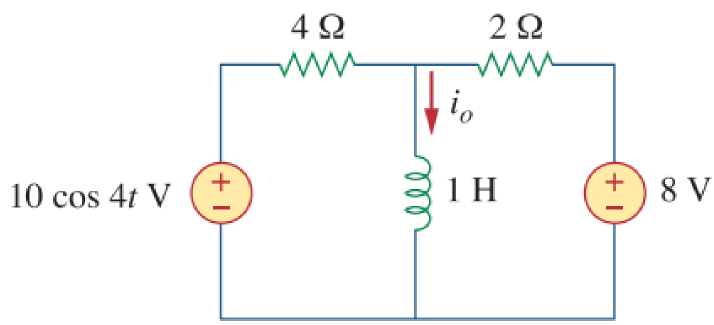
$$j360 - 3\mathbf{V}_2 - 3\mathbf{V}_2 + j\mathbf{V}_2 = 0$$

$$\mathbf{V}_2 = \frac{j360}{6-j} = \frac{360}{37}(-1+j6) \quad \Rightarrow \quad \mathbf{I}_2 = \frac{\mathbf{V}_2}{40} = \frac{9}{37}(-1+j6)$$

$$P = \frac{1}{2}|\mathbf{I}_2|^2 R = \frac{1}{2}\left(\frac{9}{\sqrt{37}}\right)^2 (40) = \mathbf{43.78\ W}$$

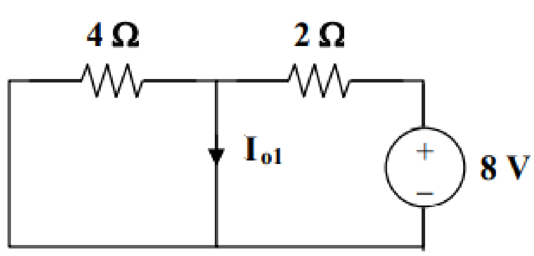
Q.2

By using principles of superposition find i_0 in the circuit shown below.



Solution#2

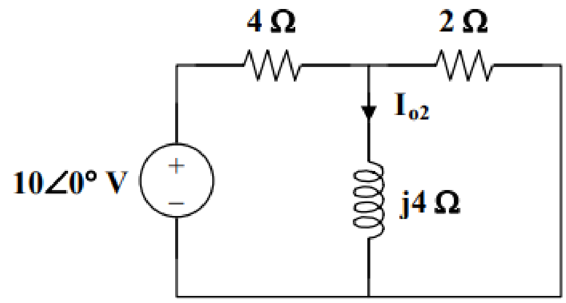
Let Io = Io1 + Io2, where Io1 is due to the **dc source** and Io2 is due to the **ac source**. For Io1, consider the circuit shown below.



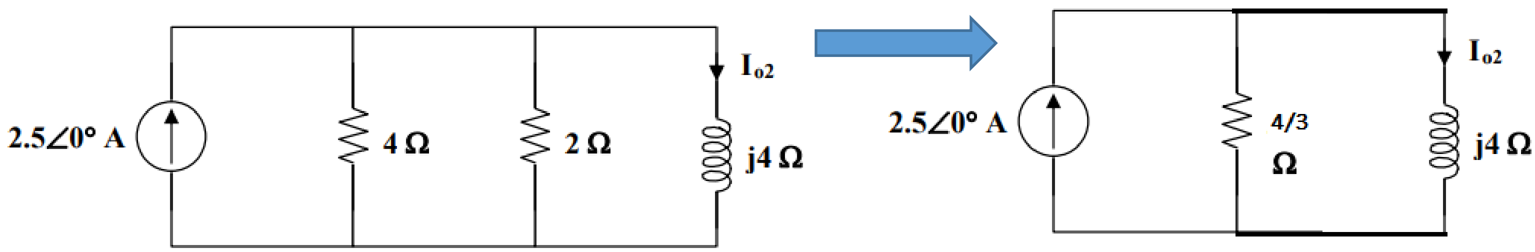
Clearly,

$$I_{o1} = 8/2 = 4\ A$$

For Io2, consider the circuit shown below.



If we transform the voltage source, we have the circuit shown below, where (4Ω || 2Ω) = 4/3 Ω .



By the current division principle,

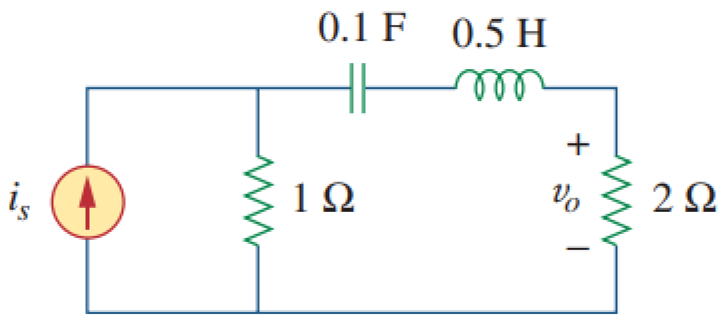
$$\mathbf{I}_{o2} = \frac{4/3}{4/3 + j4}(2.5\angle 0^\circ) \quad = 0.25 - j0.75 = 0.79\angle -71.56^\circ$$

Thus

$$i_0 = i_{01} + i_{02} = [4 + 0.79 \cos(4t - 71.56^\circ)] \text{ A}$$

Q.3

If the voltage v_0 across the 2 Ω resistor is 10 Cos 2t V, find i_S .

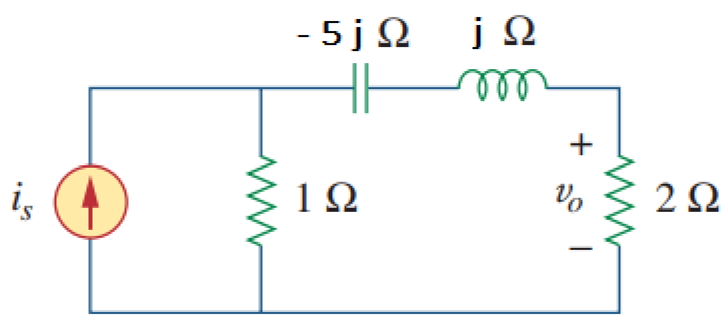


Solution#3

$$0.1\text{ F} \longrightarrow \frac{1}{j\omega C} = \frac{1}{j(2)(0.1)} = -j5$$

$$0.5\text{ H} \longrightarrow j\omega L = j(2)(0.5) = j$$

where $V_o = 10 \angle 0^0$



The current I through the 2-Ω resistor is

$$\mathbf{I} = \frac{1}{1 - j5 + j + 2}\mathbf{I}_s = \frac{\mathbf{I}_s}{3 - j4}, \qquad \text{where } \mathbf{I} = \frac{10}{2}\angle 0° = 5$$

Therefore

$$\mathbf{I}_S = (5)(3 - j4) = 25\angle -53.13°$$

Hence

$$i_S = 25 \text{ Cos } (2t - 53.13°) \text{ A}$$