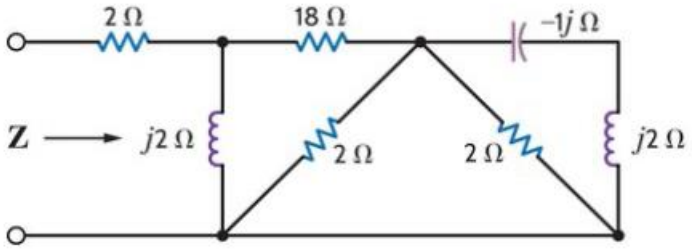
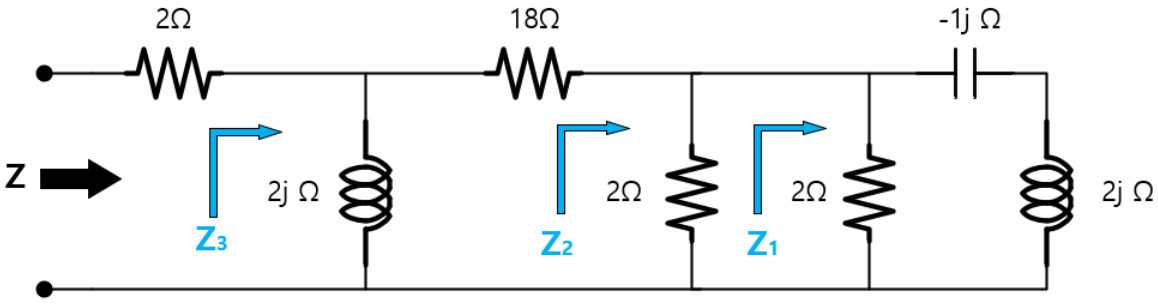
1. (6 Points) Find Z in the network shown below.





$Z_1 = (-1j + j2) || 2 = 0.4 + j0.8$ (a)1.5pts

$Z_2 = 2 || Z_1 = 2 || (0.4 + j0.8) = 0.5 + j0.5$ (b)1.5pts

$Z_3 = (18 + Z_2) || j2 = (18.5 + j0.5) || j2 = 0.2123 + j1.9713$ (c)1.5pts

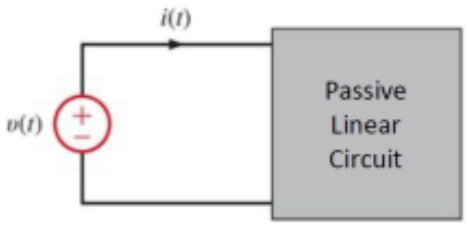
$\mathbf{Z = 2 + Z_3 = 2.21 + j1.97\ (ohm)}$ (d)1.5pts

In the each partial score,

-0.5pts for incorrect sign (+, -)

-0.5pts No unit (e)

2. (6 Points) In the diagram shown below, when $v(t) = 5\cos 500t$ V, $i(t) = 0.4\cos(500t - 30°)$ A. Calculate $i(t)$ if $v(t) = 5\cos 1000t$ V.



<Phasor>

$V_o = 5\angle 0°$, $I_o = 0.4\angle -30°$

Process of Z : +2

$Z = \frac{V_o}{I_o} = \frac{5\angle 0°}{0.4\angle -30°} = 12.5\angle 30°\ (\Omega)$ Z : +1

$Z = 10.83 + j\,6.25\ (\Omega)$

As $j\,6.25$ belongs to the passive inductor,

which is from $jwL = j\cdot 500L = j\,6.25$

So, when $w_{new} = 1000$, $jw_{new}L = j\cdot 1000L = j\,12.5$

Then, $Z_{new} = 10.83 + j\,12.5\ (\Omega)$

$I_1 = \frac{V_1}{Z_{new}} = \frac{5\angle 0°}{16.54\angle 49.1°} = 0.3023\angle -49.1°$

$\therefore i(t) = 0.3023\cos(1000t - 49.1°)$ [A]

or

$0.3023\cos(1000t - 0.857)$

Process of Z : +2 Z : +1

Process of Z_{new} : +1 $i(t)$: +1

Process of I_1 : +1

3. (6 Points) Use nodal analysis to find IO in the circuit shown below.

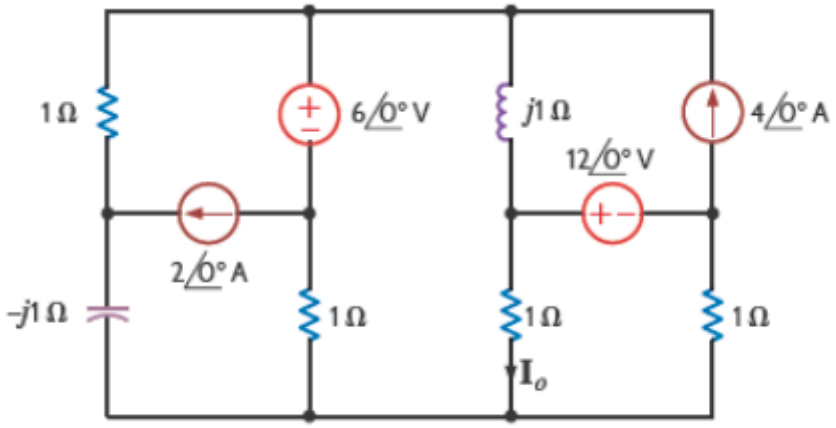
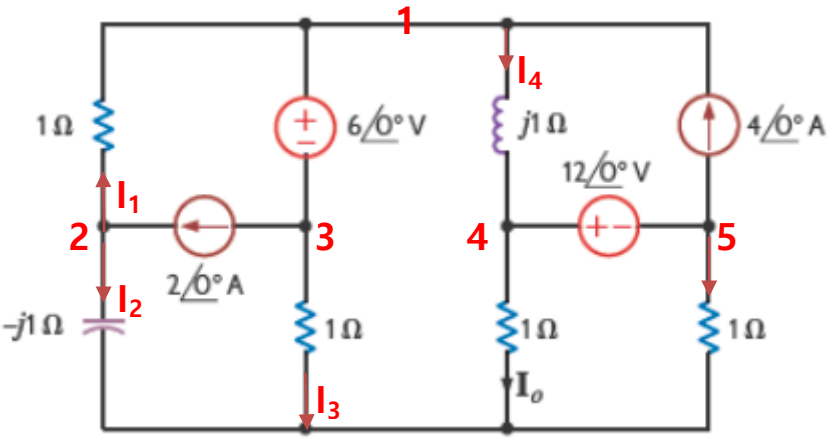


Figure P8.41



$$I_1 + I_2 = 2\angle 0$$

$$\frac{V_2 - V_1}{1} + \frac{V_2}{-j1} = 2\angle 0$$

$$j1V_1 + (1 - j1)V_2 = 2\angle -90 \quad ①$$

(+1pt)

$$V_4 - V_5 = 12\angle 0 \quad ②$$

$$V_1 - V_3 = 6\angle 0 \quad ③$$

(+1pt)

KCL at the negative node:

$$I_2 + I_3 + I_0 + I_5 = 0$$

$$\frac{V_2}{-j} + V_3 + V_4 + V_5 = 0 \quad ④$$

(+1pt)

KCL at the supernode (Node 4 & 5):

$$I_4 = 4\angle 0 + I_0 + I_5$$

$$\frac{V_1 - V_4}{j} = 4\angle 0 + V_4 + V_5$$

$$V_1 + (-1 - j)V_4 - jV_5 = 4\angle 90 \quad ⑤$$

(+1pt)

Calculate equation ① to ⑤

$$V_1 = \frac{214}{37} - \frac{48}{37}i = 5.39\angle -12.64°$$

$$V_2 = \frac{120}{37} - \frac{168}{37}i = 5.58\angle -54.46°$$

$$V_3 = -\frac{8}{37} - \frac{48}{37}i = 1.32\angle -99.46°$$

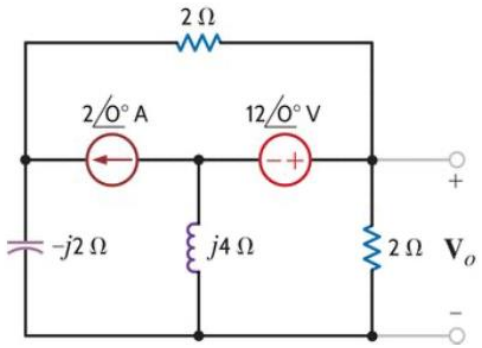
$$V_4 = \frac{142}{37} - \frac{36}{37}i = 3.96\angle -14.226°$$

$$V_5 = -\frac{302}{37} - \frac{36}{37}i = 8.22\angle -173.2°$$

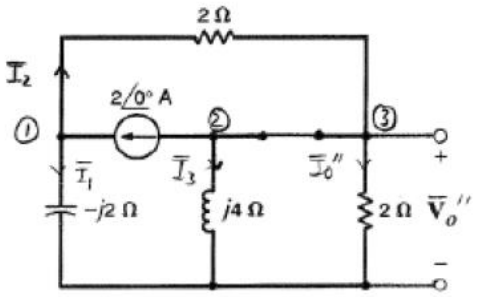
$$I_o = \frac{V_4}{1} = 3.96\angle -14.226°$$

(+2pt)

4. (6 Points) Find $\mathbf{V_o}$ in the network shown below using superposition.



Solution)



Equivalent Circuit (+1 pts)

KCL at reference node: $\bar{I}_1 + \bar{I}_3 + \bar{I}_o'' = 0$

$$\frac{\bar{V}}{-j2} + \frac{\bar{V}_2}{j4} + \frac{\bar{V}_3}{2} = 0$$

$$-2\bar{V}_1 + \bar{V}_2 + j2\bar{V}_3 = 0$$

KCL at ①: $2\angle 0° = \bar{I}_1 + \bar{I}_2$

$$\frac{\bar{V}_1}{-j2} + \frac{\bar{V}_1 - \bar{V}_3}{2} = 2\angle 0°$$

$$\bar{V}_1 - j1(\bar{V}_1 - \bar{V}_3) = -j2(2\angle 0°)$$

$$(1-j1)\bar{V}_1 + j1\bar{V}_3 = 4\angle -90°$$

$$\bar{V}_2 - \bar{V}_3 = 0$$

$$-2\bar{V}_1 + \bar{V}_2 + j2\bar{V}_3 = 0$$

$$(1-j1)\,\bar{V}_1 + j1\,\bar{V}_3 = 4\angle -90^\circ$$

$$\bar{V}_2 - \bar{V}_3 = 0$$

$$\bar{V}_1 = 2.11\angle -71.57^\circ V$$

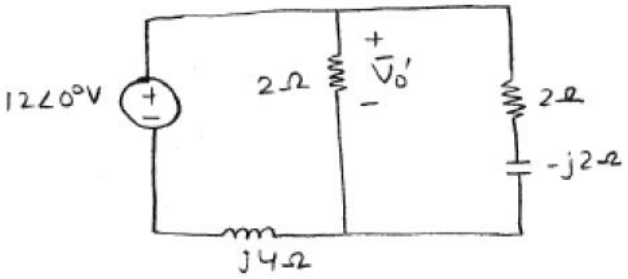
$$\bar{V}_2 = 1.89\angle -135^\circ V$$

$$\bar{V}_3 = 1.89\angle -135^\circ V$$

$$\bar{V}_o'' = \bar{V}_3$$

$$\bar{V}_o'' = 1.89\angle -135^\circ V$$

Vo" (+1.5 pts)



Equivalent Circuit (+1 pts)

$$\bar{Z} = 2\,||\,(2-j2) = \frac{2(2-j2)}{2+2-j2}$$

$$\bar{Z} = 1.26\angle -18.43^\circ$$

$$\bar{V}_o' = \left(\frac{1.26\angle -18.43^\circ}{1.26\angle -18.43^\circ + j4}\right)(12\angle 0^\circ)$$

$$\bar{V}_o' = 4\angle -90^\circ V$$

$$\bar{V}_o = \bar{V}_o' + \bar{V}_o''$$

Vo' (+1.5 pts)

$$\bar{V}_o = 4\angle -90^\circ + 1.89\angle -135^\circ$$

$$\bar{V}_o = 5.5\angle -104.1^\circ V$$

Vo=Vo'+Vo" (+0.5 pts)

Vo (+0.5 pts)

Vo without superposition (+4 pts)

5. (6 Points)

Everyone got the 6 points. (+6 pts)

There is a problem error, so all of you are correct answer.

I'm sorry for making it difficult for you to solve the problem in the quiz, because I couldn't check the problem error.

It was difficult to set the scoring criteria for problems with errors, so we decided to process all correct answers.

We ask for your understanding that it is difficult to satisfy all many people.