* Last note on average power *

$$P_{avg} = \frac{1}{2} V_{pk} \cdot I_{pk} \cdot \cos(\theta_V - \theta_I)$$
$$= \frac{1}{2}(V_{pk}^2/R) = \frac{1}{2}(I_{pk}^2 \cdot R)$$

For resistors, $\theta_V - \theta_I = 0°$:

$$\rightarrow P_{avg} = \frac{1}{2} V_{pk} \cdot I_{pk} \quad \{W\}$$

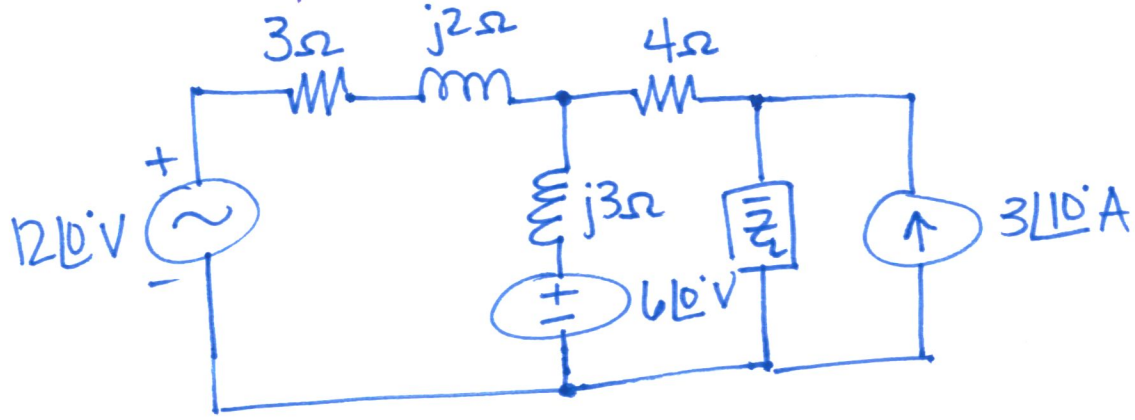
For L's & C's, $\theta_V - \theta_I = \pm 90°$:

$$\rightarrow P_{avg} = 0 \quad \{W\}$$

& $$P_{avg} = V_{rms} \cdot I_{rms} \cdot \cos(\theta_V - \theta_I)$$
$$= \frac{V_{rms}^2}{R} = I_{rms}^2 \cdot R$$

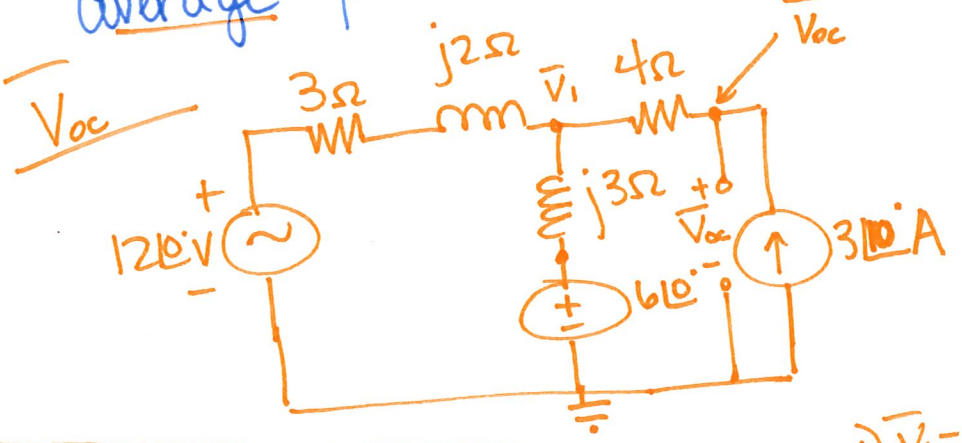
So basically, if you have peak values, you divide by 2; If you have RMS values you do not divide by 2.

* Extra max power transfer example *

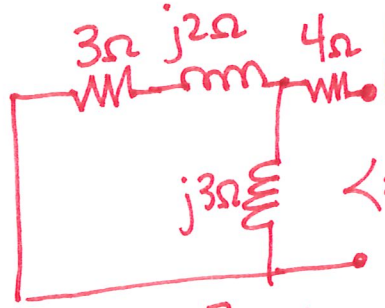


Determine $\bar{Z}_L$ for maximum average power transfer and the value of the maximum average power transferred to $\bar{Z}_L$.

$\bar{V}_{oc}$



$\bar{Z}_{th}$



Nodal →

1) $\frac{\bar{V}_1 - (12\angle 0^\circ)}{3+j2} + \frac{\bar{V}_1 - (6\angle 0^\circ)}{j3} + \frac{\bar{V}_1 - \bar{V}_{oc}}{4} = 0$

2) $\frac{\bar{V}_{oc} - \bar{V}_1}{4} = 3\angle 10^\circ$

$\rightarrow \bar{V}_1 = 12.23\angle 34.5^\circ$ V

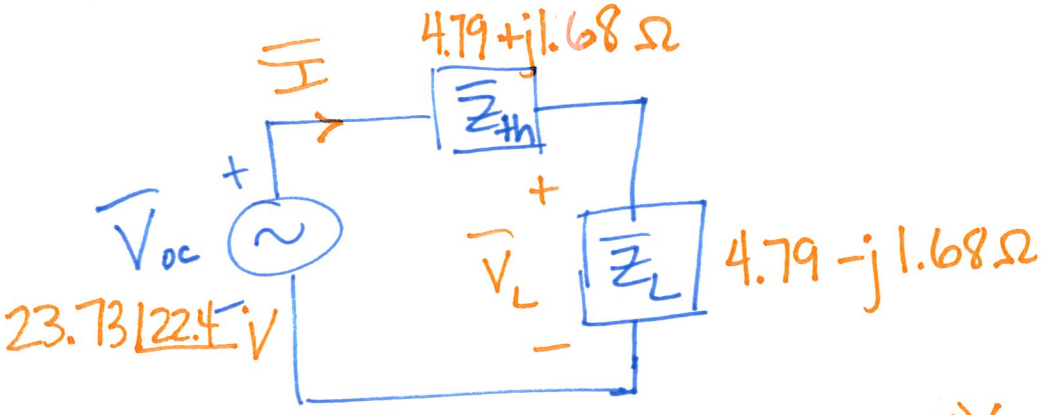
$\bar{V}_{oc} = 23.73\angle 22.4^\circ$ V

$\bar{Z}_{th} = [(3+j2) \| j3] + 4 = 0.79 + j1.68 + 4$

$\bar{Z}_{th} = 4.79 + j1.68\ \Omega$ →

$\bar{Z}_L = \bar{Z}_{th}^*$ (for max power transfer)

$\bar{Z}_L = 4.79 - j1.68\ \Omega$



$$\bar{V}_L = \frac{\bar{V}_{oc} \cdot \bar{Z}_L}{\bar{Z}_{th} + \bar{Z}_L} = \frac{(23.73\angle 22.4^\circ)(4.79 - j1.68)}{4.79 + j1.68 + 4.79 - j1.68}$$

$$\bar{V}_L = 12.57\angle 3.13^\circ \text{ V}$$

$$\bar{I} = \frac{\bar{V}_{oc}}{\bar{Z}_{th} + \bar{Z}_L} = \frac{(23.73\angle 22.4^\circ)}{4.79 + j1.68 + 4.79 - j1.68}$$

$$\bar{I} = 2.47\angle 22.4^\circ \text{ A}$$

$$P_{max} = P_{avg} = \frac{1}{2} V \cdot I \cdot \cos(\theta_V - \theta_I)$$

$$= \frac{1}{2}(12.57)(2.47)\cos(3.13 - 22.4)$$

$$\boxed{P_{avg} = 14.7 \text{ W}}$$

OR

$$P_{max} = P_{avg} = \frac{1}{2} \cdot (I^2 \cdot R)$$

$$= \frac{1}{2} \cdot (2.47^2)(4.79)$$

$$\boxed{P_{avg} = 14.7 \text{ W}}$$

OR

$$\bar{V}_{RL} = \frac{\bar{V}_{oc} \cdot R_L}{\bar{Z}_{th} + \bar{Z}_L}$$

$$= \frac{(23.73\angle 22.4)(4.79)}{4.79 + 4.79}$$

$$\bar{V}_{RL} = 11.87\angle 22.4 \text{ V}$$

$$P_{max} = P_{avg} = \frac{1}{2}(V_{RL}^2/R)$$

$$= \frac{1}{2}(11.87^2/4.79)$$

$$\boxed{P_{avg} = 14.7 \text{ W}}$$