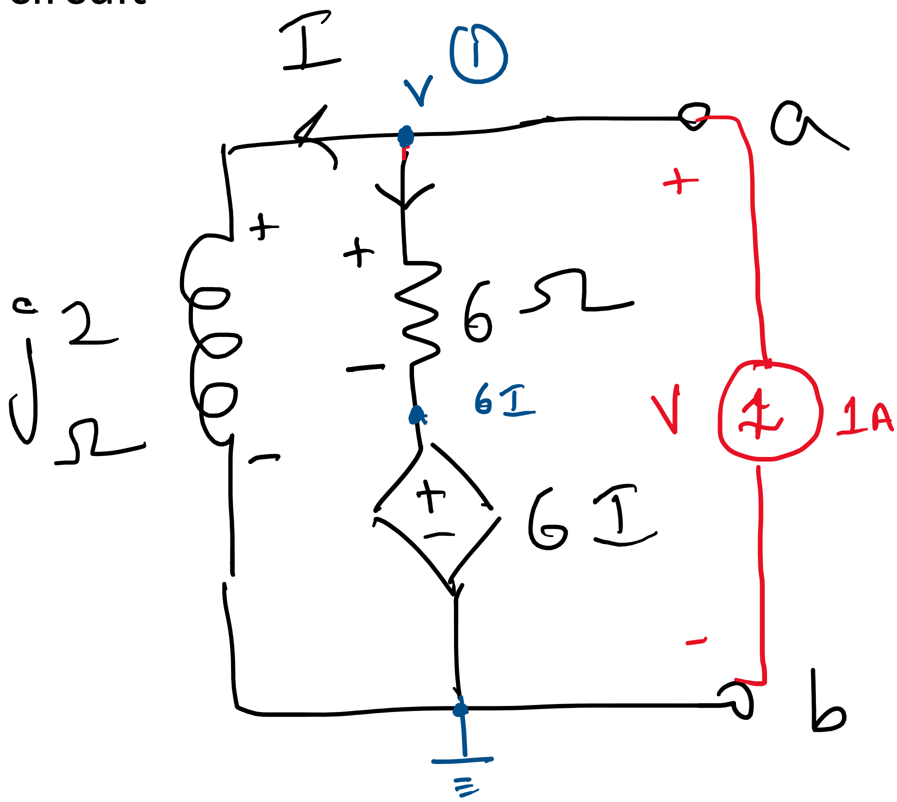
- Find the Thevenin's equivalent of the following circuit



$V_{th} = 0$

$Z_{th} = ?$

$Z_{th} = \dfrac{V}{1}$

Node 1

$$1 = \frac{V-0}{j2} + \frac{V-6I}{6}$$

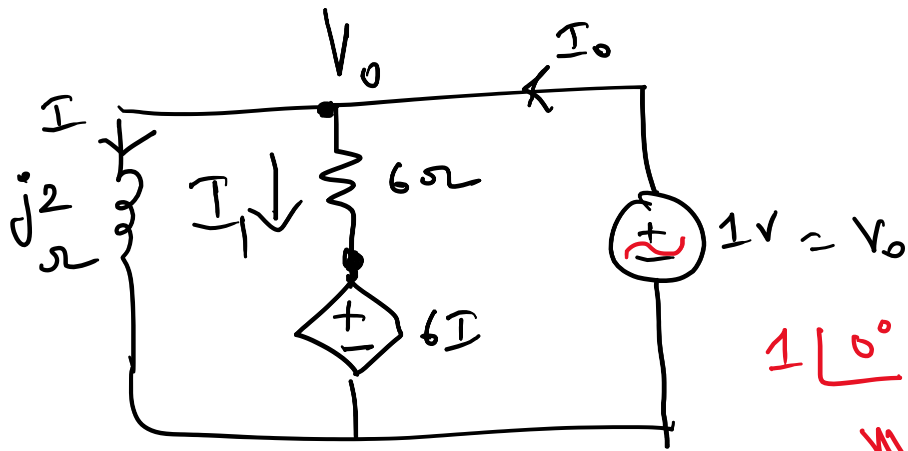
$$1 = V\left(\frac{1}{j2} + \frac{1}{6}\right) - I$$

$$= \cancel{\frac{V}{j2}} + \frac{V}{6} - \cancel{\frac{V}{j2}} \Rightarrow V = 6\,V$$

$$Z_{th} = \frac{6V}{1A} = 6\,\Omega$$

$$\cancel{\frac{V-0}{6+6I}}$$

Method – II



$1\angle 0°$

$\Downarrow$

$1\cos(\omega t + 0°)$ V

$$I = \frac{V - 0}{j2} = \frac{1}{j2} = -j0.5$$

$$6I = 6 \times (-j0.5) = -j3$$

$$I_1 = \frac{V - 6I}{6} = \frac{1 - (-j3)}{6}$$

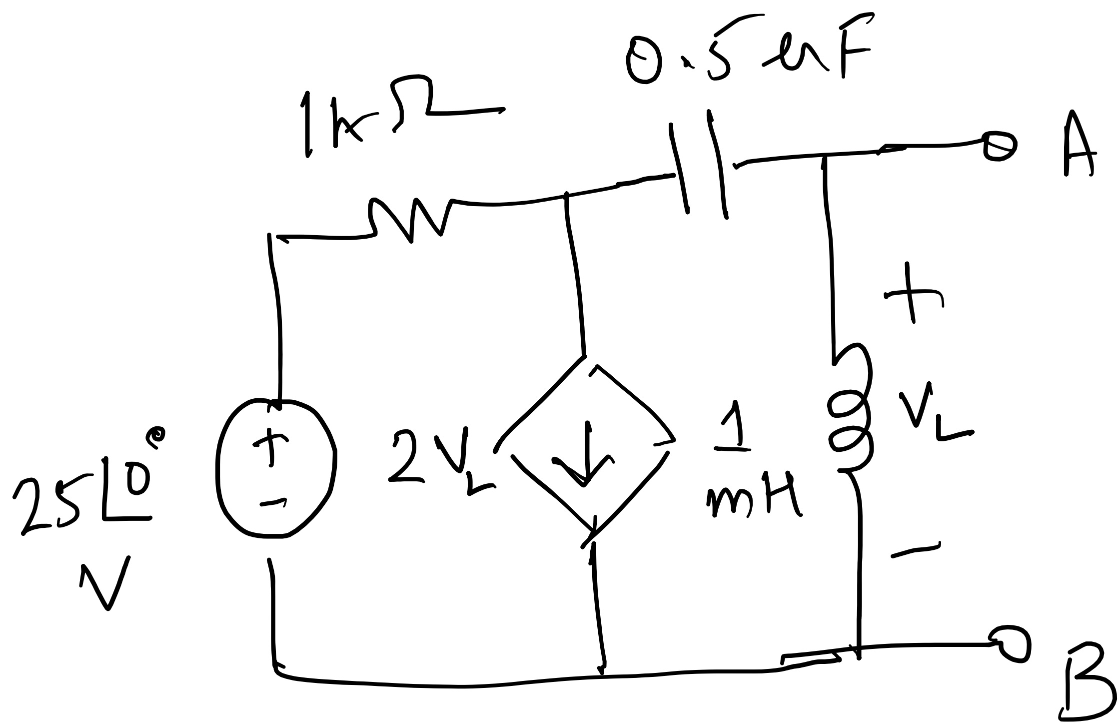
$$= \frac{1}{6} + j0.5$$

$$I_0 = I + I_1 = \cancel{-j0.5} + \frac{1}{6} + \cancel{j0.5}$$

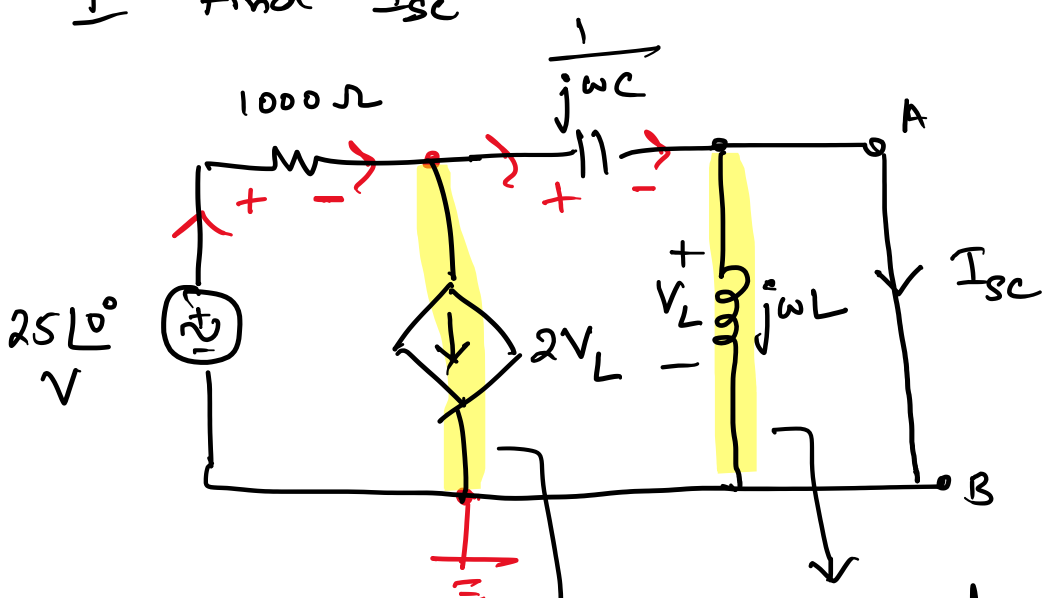
$$= \frac{1}{6}\ A$$

$$\Rightarrow Z_{th} = V_0 / I_0 = 1/(1/6) = 6\ \Omega$$

- Find the Norton's equivalent of the following circuit, $\omega = 1$ rad/s

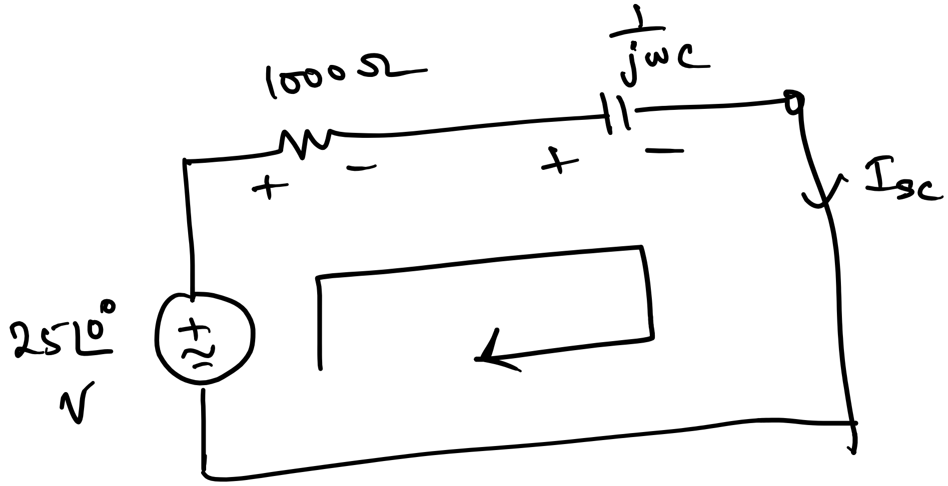


I Find I_{sc}



removed

removed because when $V_L = 0$, current becomes zero + open ckt

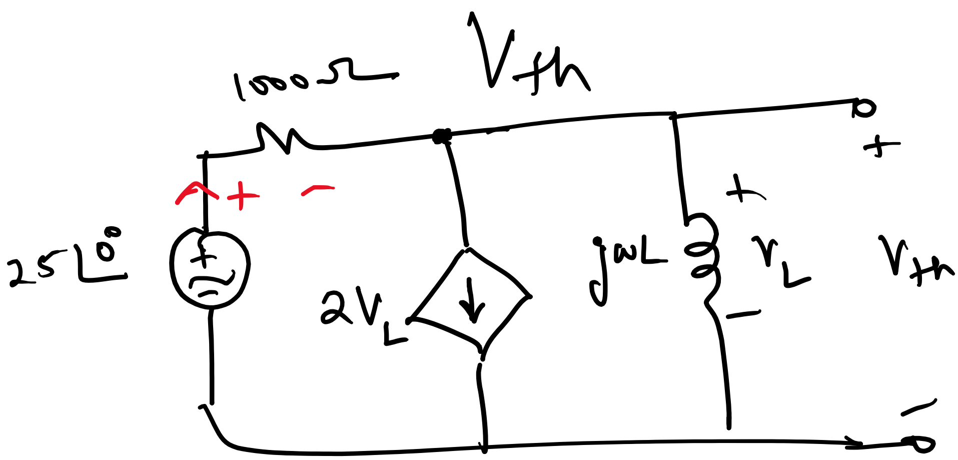


$$+25\angle 0^\circ - 1000\times I_{sc} - \left(\frac{1}{j\omega C}\right) I_{sc} = 0$$

$$\Rightarrow I_{sc} = \frac{25}{1000+\frac{1}{j\omega C}} = 12.5\,\mu A\angle -90^\circ$$

$$= -j\,12.5\,\mu A$$

$\underline{V_{oc}}$ — find on your own



$$\frac{25 - V_{th}}{1000} = 2V_L + \frac{V_L - 0}{j\omega L}$$

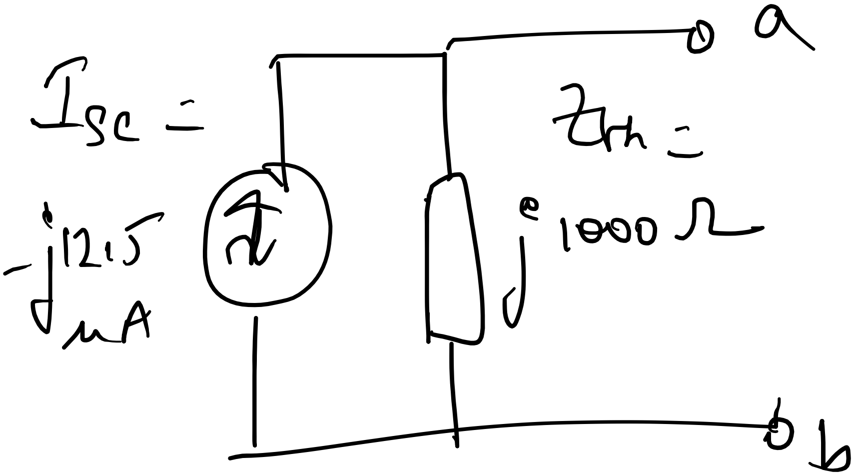
$$V_L = V_{th}$$

$$\Rightarrow \frac{25}{1000} = V_{th}\left(\frac{1}{1000} + 2 + \frac{1}{j\omega L}\right)$$

$$\Rightarrow V_{th} = 0.0125 \angle 0^\circ \ V$$

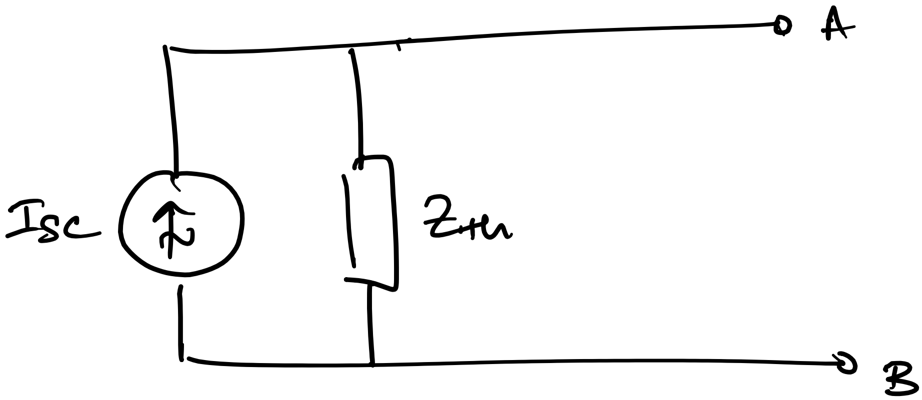
$$Z_{th} = \frac{V_{th}}{I_{sc}} = \frac{0.0125 \ V}{-j12.5 \ \mu A}$$

$$= +j1000 \ \Omega$$



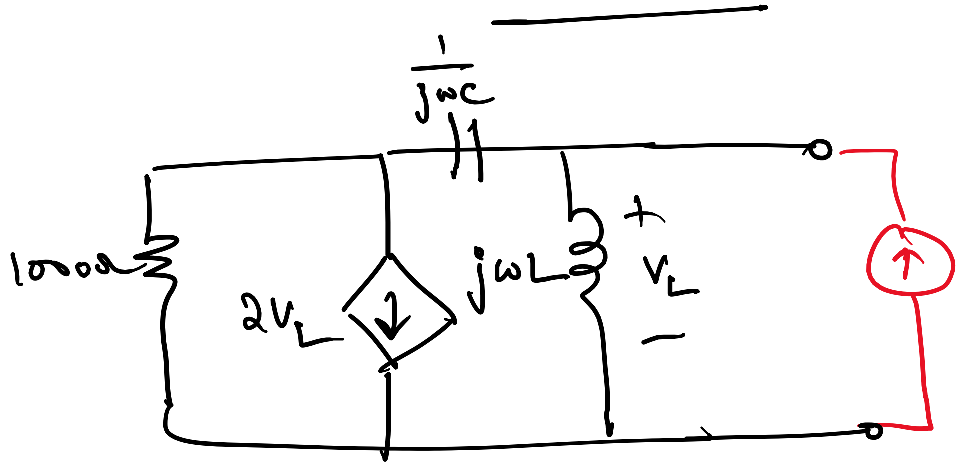
6

$$Z_{th} = \frac{V_{oc}}{I_{sc}}$$

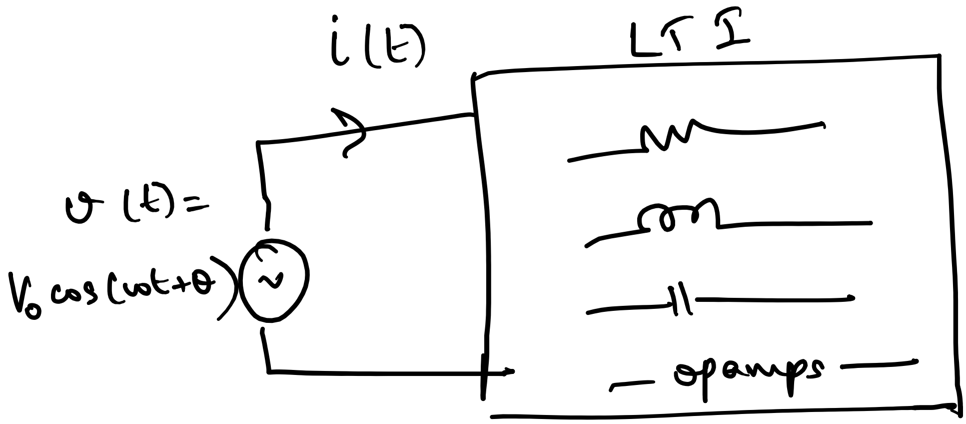


Method II

Z_{th}



Power



$$v(t) = V_0 \cos(\omega t + \theta) \quad V$$

$$i(t) = I_0 \cos(\omega t + \phi) \quad A$$

Instantaneous power

$$p(t) = v(t)\, i(t) = V_0 \cos(\omega t + \theta)\, I_0 \cos(\omega t + \phi)$$

$$= \underbrace{\frac{V_0 I_0}{2} \cos(\theta - \phi)}_{\text{DC term}} + \underbrace{\frac{V_0 I_0}{2} \cos(2\omega t + \theta + \phi)}_{\text{twice the harmonic}}$$

Time averaged power = $\langle P_{avg} \rangle$

$$\langle P_{avg} \rangle = \frac{1}{T} \int_0^T p(t)\, dt$$

= Please do the math

$$= \frac{V_0 I_0}{2} \cos(\theta - \phi)$$

$$\langle P_{avg} \rangle = \frac{V_0 I_0}{2} \cos(\theta - \phi) \quad \text{Watts}$$

$$v(t) = V_0 \cos(\omega t + \theta), \quad V = V_0 \angle \theta$$

$$i(t) = I_0 \cos(\omega t + \phi), \quad I = I_0 \angle \phi$$

$$\cancel{P = VI}$$ No phasor power

Complex Power $= S = \frac{1}{2} V I^*$

$$S = \frac{1}{2} V_0 \angle \theta \; I_0 \angle -\phi$$

$$= \frac{V_0 I_0}{2} \angle \theta - \phi$$ Volt-Amps

VA

$$= \frac{V_0 I_0}{2} \cos(\theta - \phi) + j \frac{V_0 I_0}{2} \sin(\theta - \phi)$$

$= P_{avg} + j$ Reactive Power

Watts VAR

$\cos(\theta - \phi) \rightarrow$ power factor

- leading
- lagging

P_{avg}

→ purely inductive circuit

$$v(t) = V_0 \cos(\omega t + \theta)$$

$$i(t) = \frac{V_0}{\omega L} \cos\left(\omega t + \theta - \frac{\pi}{2}\right)$$

$$\langle P_{avg} \rangle = \frac{1}{2} \times V_0 \times \frac{V_0}{\omega L} \cos\left(\theta - \left(\theta - \frac{\pi}{2}\right)\right)$$

$$= \underline{\qquad\qquad} \cos(\pi/2) = 0 \text{ Watts}$$

→ purely capacitive ckt

$$v(t) = V_0 \cos(\omega t + \theta)$$

$$i(t) = V_0 \omega C \cos(\omega t + \theta + \pi/2)$$

$$\langle P_{avg} \rangle = \frac{1}{2} V_0 \times V_0 \omega C \cos(-\pi/2) = 0 \text{ Watts}$$