Phasors & Mesh

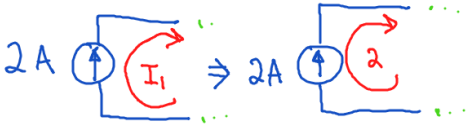
organized KVL

$\sum_{\text{mesh}} V\text{'s} = 0$

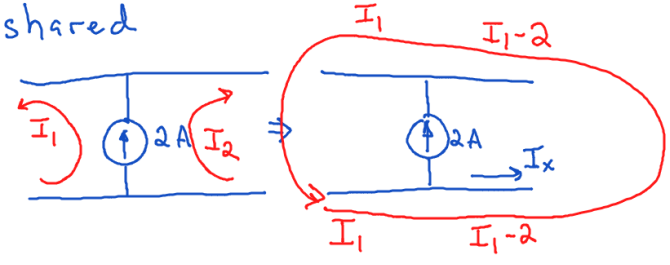
① Create I_1, I_2 etc variables direction

② For each I_{source}, reduce 1 unknown

not shared



shared



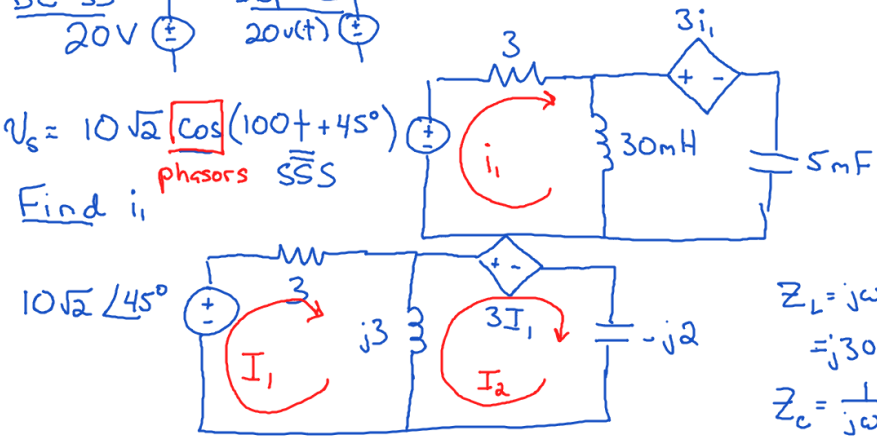
③ Dep? Extra eqn

④ Matrix

DC SS 20V ⏀ Step DC 20u(t) ⏀

$v_s = 10\sqrt{2}\cos(100t + 45°)$ phasors SS

Find i_1



$Z_L = j\omega L = j100(30m)$

$= j3000m = j3$

$Z_c = \frac{1}{j\omega C} = \frac{1}{j100 \cdot 5m}$

$= \frac{-j}{0.5} = -j2$

I_1: $-10\sqrt{2}\angle 45° + 3I_1 + j3(I_1 - I_2) = 0$

$I_1(3 + j3) + I_2(-j3) = 10\sqrt{2}\angle 45°$

I_2: $j3(I_2 - I_1) + 3I_1 - j2I_2 = 0$

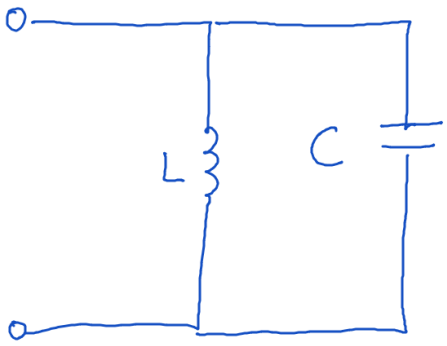
$I_1(3 - j3) + I_2(j3 - j2 = j) = 0$

$$\begin{bmatrix} 3+j3 & -j3 \\ 3-j3 & j \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 10\sqrt{2}\angle 45° \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 1.05\angle 71.6° \\ \sim \end{bmatrix}$$

$i_1(t) = 1.05\cos(100t + 71.6°)$

Ex

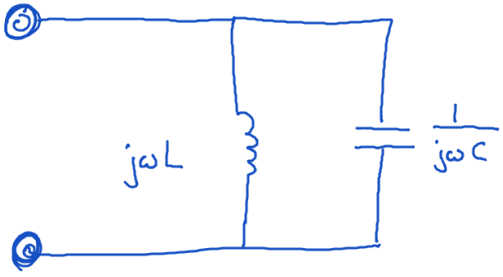


a) Is there any freq at which this ckt looks like a wire? (what freq?)

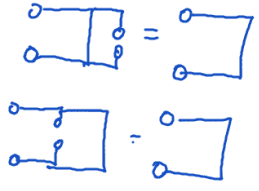
b) Is there any freq at which this ckt looks like an open? (what freq?)

$j = \sqrt{-1}$ $\qquad \frac{1}{j} = -j$

$j^2 = -1$



a) $\omega = 0$, $\omega = \infty$



b) $Z = j\omega L \,/\!/\, \frac{1}{j\omega C}$

$$= \frac{\frac{j\omega L}{j\omega C}}{j\omega L + \frac{1}{j\omega C}} \cdot \frac{j\omega C}{j\omega C}$$

$$= \frac{j\omega L}{j^2\omega^2 LC + 1}$$

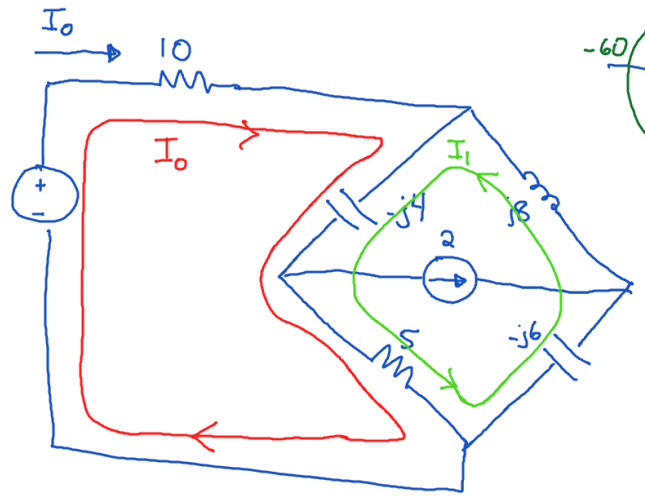
$$= \left[\frac{j\omega L}{1 - \omega^2 LC}\right]$$

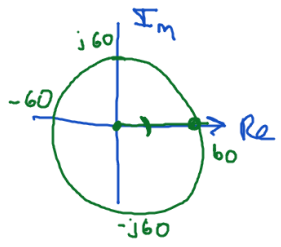
$1 = \omega^2 LC$

$\omega^2 = \frac{1}{LC}$

$\omega = \frac{1}{\sqrt{LC}}$

Ex





Find I_o

$$I_o: \quad -60 + 10I_o + -j4(I_o + I_1) + 5(I_o + I_1) = 0$$

$$I_o(15 - j4) + I_1(5 - j4) = 60$$

$$I_1: \quad -j4(I_o + I_1) + 5(I_o + I_1) - j6I_1 + j8I_1 = 0$$

$$I_o(5 - j4) + I_1(5 - j4 - j6 + j8) = 0$$

$$I_o(5 - j4) + I(5 - j2) = 0$$

$$\begin{bmatrix} 15 - j4 & 5 - j4 \\ 5 - j4 & 5 - j2 \end{bmatrix} \begin{bmatrix} I_o \\ I_1 \end{bmatrix} = \begin{bmatrix} 60 \\ 0 \end{bmatrix} \qquad \begin{bmatrix} I_o \\ I_1 \end{bmatrix} = \begin{bmatrix} 5.95\angle 3.2° \\ 4.34\angle 176° \end{bmatrix}$$

$$\boxed{I_o = 5.95\angle 3.2° \text{ A}}$$

$$Z_{eq} = \frac{V}{I} = \frac{60\angle 0°}{5.95\angle 3.2°}$$

$$= \frac{60}{5.95}\angle -3.2°$$