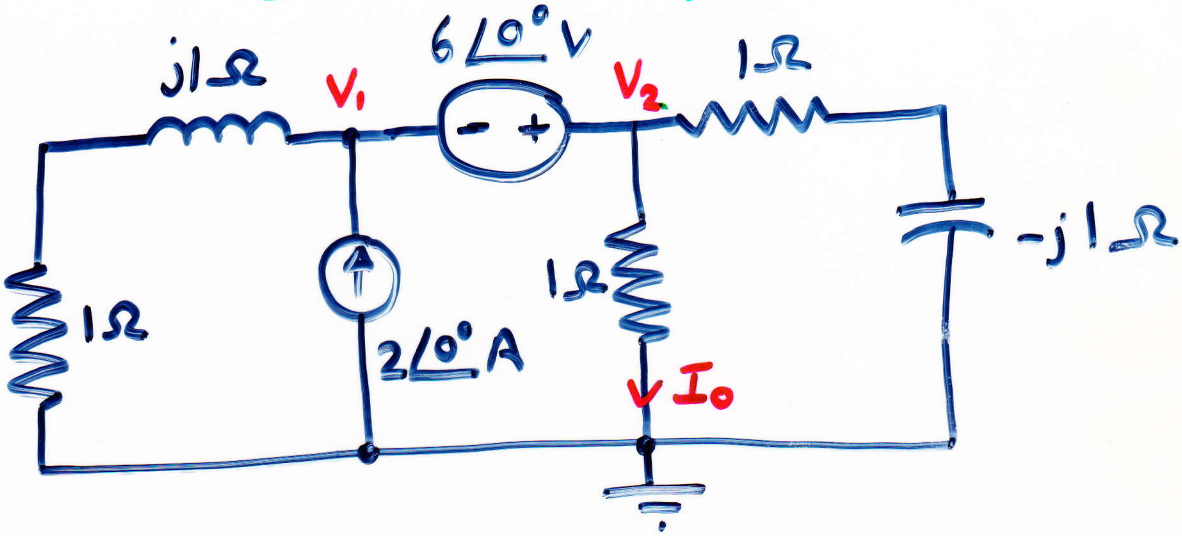
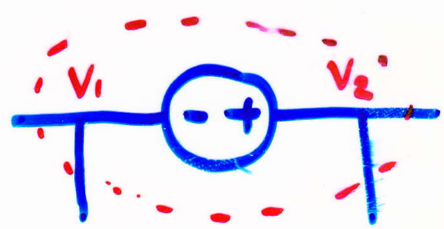
Examples of Different Analysis Techniques with Phasors.



Employ nodal analysis.

Apply KCL to a supernode centred on the voltage source.



$$\frac{\underline{V}_1}{1+j} - 2\angle 0^\circ + \frac{\underline{V}_2}{1} + \frac{\underline{V}_2}{1-j} = 0$$

Also $\underline{V}_2 = \underline{V}_1 + 6\angle 0^\circ$

$$\therefore \quad \frac{\underline{V}_2 - 6\angle 0^\circ}{1+j} - 2\angle 0^\circ + \frac{\underline{V}_2}{1} + \frac{\underline{V}_2}{1-j} = 0$$

$$\underline{V}_2\left[\frac{1}{1+j} + 1 + \frac{1}{1-j}\right] = \frac{6 + 2 + 2j}{1+j}$$

Considering L.H.S.

$$\underline{V}_2\left[\frac{1}{1+j} + \frac{1+j}{1+j} + \frac{j}{1+j}\right] = \underline{V}_2\left[\frac{2+2j}{1+j}\right]$$

$$\therefore \quad \underline{V}_2 = \frac{8+2j}{\cancel{1+j}} \times \frac{\cancel{1+j}}{2+2j}$$

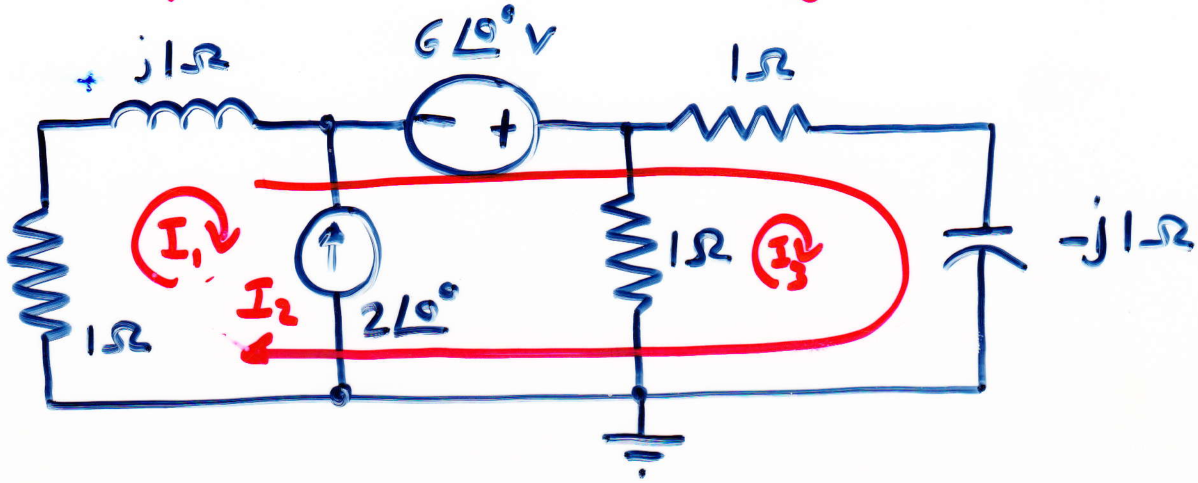
$$= \frac{4+1j}{1+j}$$

Since $I_o = \dfrac{V_2}{1\Omega}$

$$I_o = \frac{4+1j}{1+j} = \frac{4+1j}{1+j}\,\frac{(1-j)}{(1-j)}$$

$$= \frac{4+1j-4j+1}{2} = \frac{5}{2} - \frac{3j}{2}\text{ A.}$$

Same problem but employ Loop analysis



$$\underline{I}_1 = -2\angle 0^\circ \quad (1)$$

$$1(\underline{I}_1 + \underline{I}_2) + j1(\underline{I}_1 + \underline{I}_2) - 6\angle 0^\circ + 1(\underline{I}_2 + \underline{I}_3) - j1(\underline{I}_2 + \underline{I}_3) = 0 \quad (2)$$

$$1\underline{I}_3 + 1(\underline{I}_2 + \underline{I}_3) - j1(I_2 + I_3) = 0 \quad (3)$$

From (1) & (2)

$$-2 + \underline{I}_2 - 2j + j\underline{I}_2 - 6 + \underline{I}_2 + \underline{I}_3 - j\underline{I}_2 - j\underline{I}_3 = 0$$

$$2\underline{I}_2 + \underline{I}_3(1 - j) = 8 + 2j$$

Simplifying (3)

$$\underline{I}_2(1 - j) + \underline{I}_3(2 - j) = 0$$

25.4

$$\text{So} \quad I_2 = -I_3 \frac{(2-j)}{(1-j)}$$

$$\therefore \quad I_3 \left\{ \frac{-2(2-j)}{(1-j)} + 1-j \right\} = 8+2j$$

$$I_3 \left(-(2-j)(1+j) + 1-j \right) = 8+2j$$

$$I_3 \left(-2 - 2j + j - 1 + 1 - j \right) = 8+2j$$

$$I_3 \left(-2 - 2j \right) = 8+2j$$

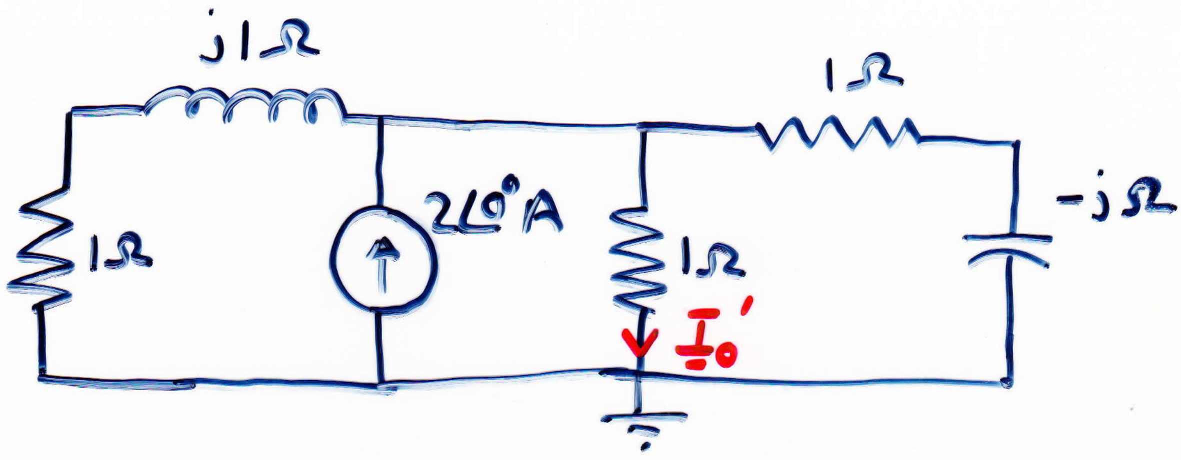
$$I_3 = \frac{-(4+j)}{(1+j)} = \frac{-(4+j)(1-j)}{2}$$

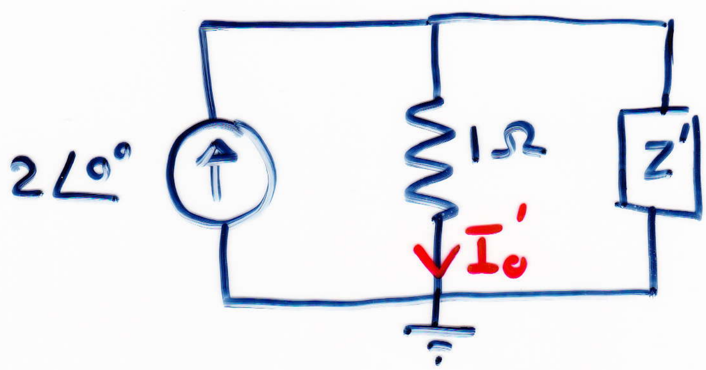
$$= \frac{-5+3j}{2}$$

$$\underline{I}_0 = -\underline{I}_3 = \frac{5}{2} - \frac{3}{2}j$$

Apply Superposition to the circuit.

Consider first the current source.



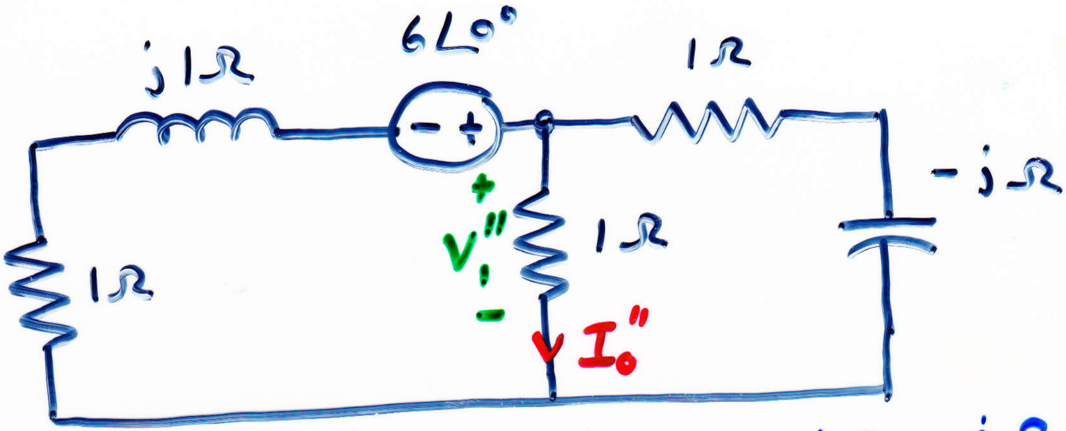


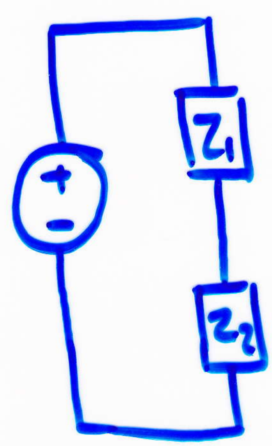
$$Z' = \frac{(1-j)(1+j)}{1-j+1+j}$$

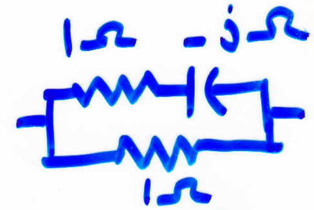
$$Z' = 1\,\Omega$$

$$\therefore\ I_o' = 1\angle 0^\circ\ \text{A}$$

Consider the voltage source (only).





$Z_1 =$ 

$$= \frac{(1)(1-j)}{1+1-j}$$

$Z_2 =$ 

$$= 1+j$$

Voltage division

$$\underline{V}_1'' = \frac{6\angle 0° \times \left(\frac{1-j}{2-j}\right)}{1+j+\left(\frac{1-j}{2-j}\right)}$$

$$= \frac{6 \times \left(\frac{1-j}{2-j}\right)}{\frac{2+2j-j+1+1-j}{2-j}} = \frac{6(1-j)}{4}$$

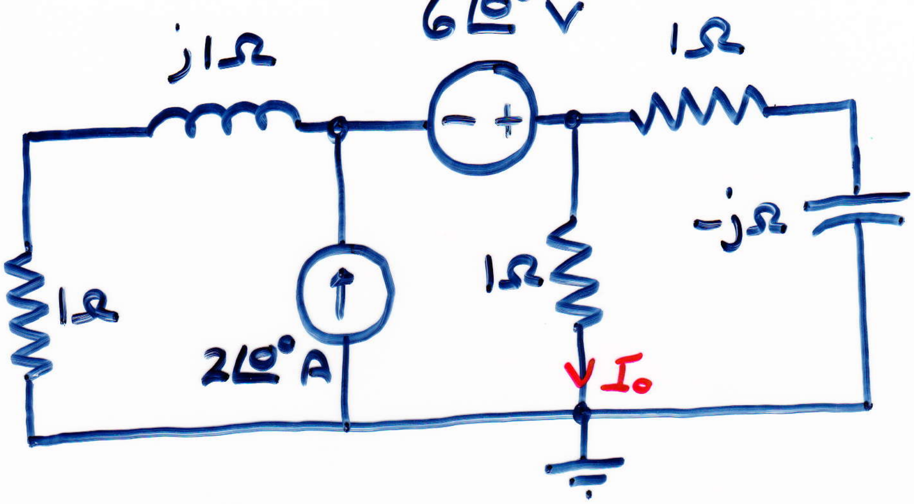
$$\underline{I}_0'' = \frac{\underline{V}_1''}{1\Omega} = \frac{6}{4}(1-j)$$

Now combining results from the individual sources:

$$\underline{I}_0 = \underline{I}_0' + \underline{I}_0'' = 1 + \frac{6}{4}(1-j)$$

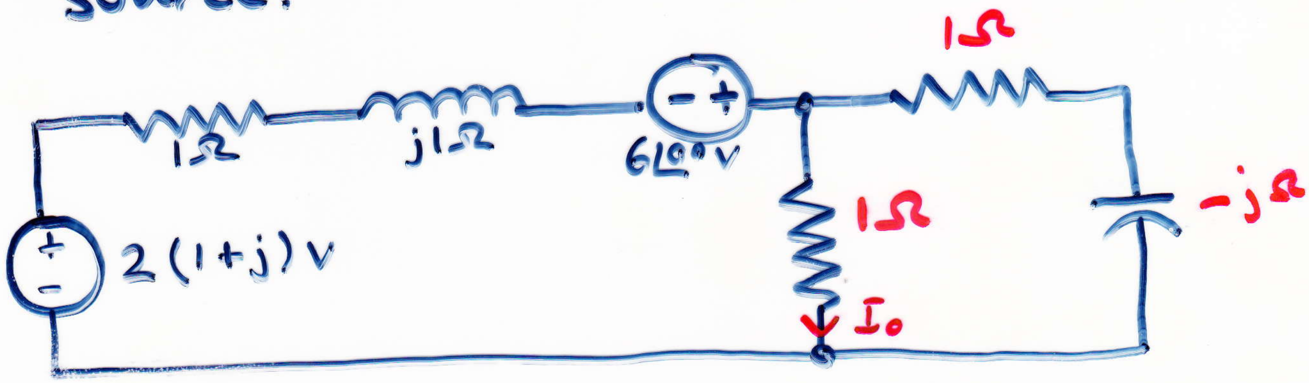
$$= \frac{5}{2} - \frac{3}{2}j$$

Analysis techniques (continued)



Source Exchange

- Replace current source with a voltage source.

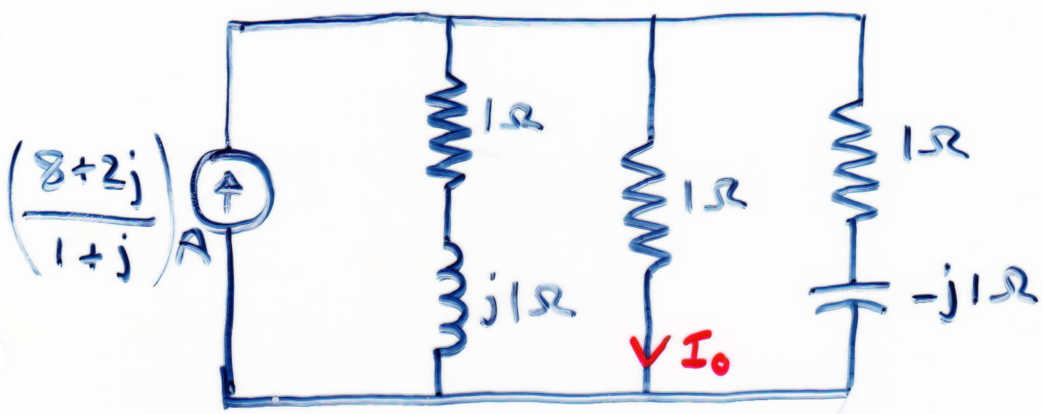


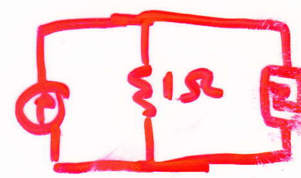
- Combine voltage sources $6 + 2(1+j)$ V
- Transform

voltage source + series impedance

↓

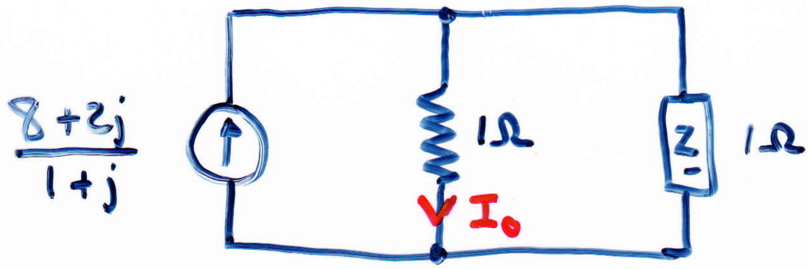
current source + parallel impedance





- Combine all impedances EXCEPT the 1Ω resistor that $\underline{I}_o$ passes through.

$$\underline{Z} = \frac{(1+j)(1-j)}{1+j+1-j} = 1\,\Omega$$



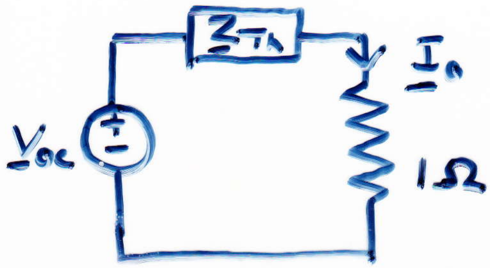
- $\underline{I}_o$ can be determined by current division

$$I_o = \left(\frac{8+2j}{1+j}\right)\left(\frac{1}{2}\right) = \frac{4+j}{1+j}$$

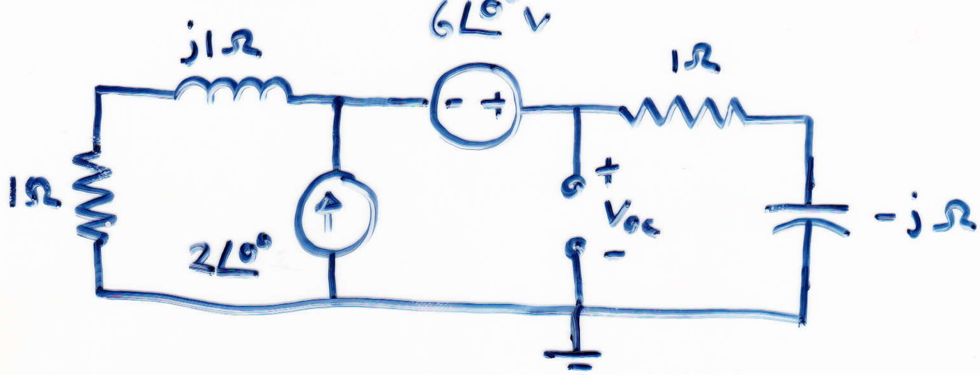
$$= \left(\frac{5}{2} - \frac{3}{2}j\right) \text{ A}$$

Thévenin analysis.

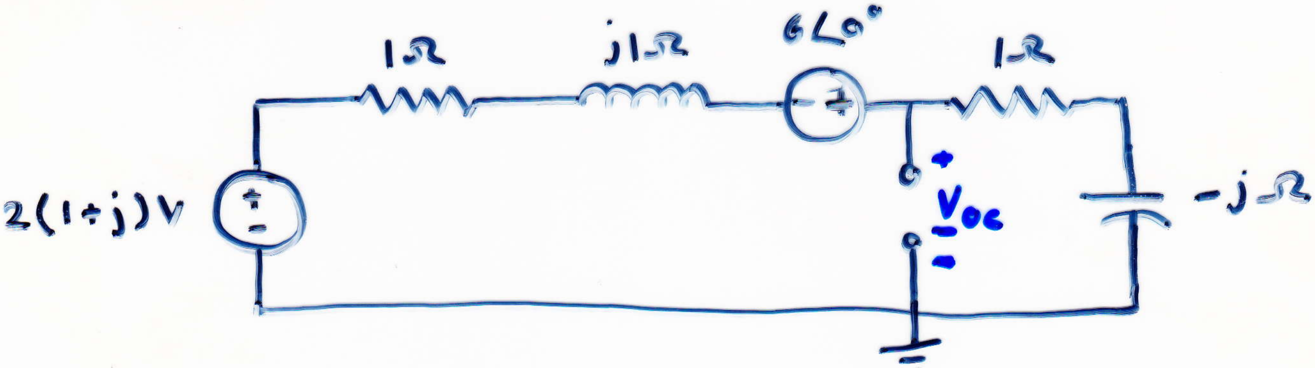
- Aim to obtain

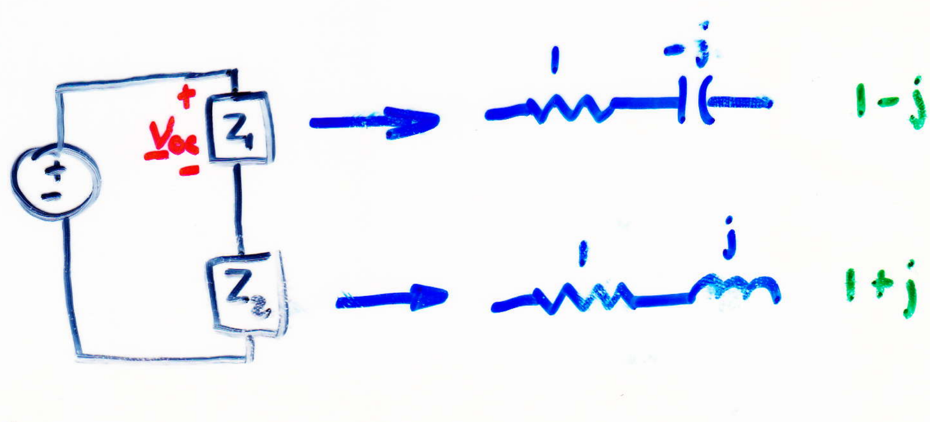


- Find $\underline{V}_{oc}$



- Source transformation



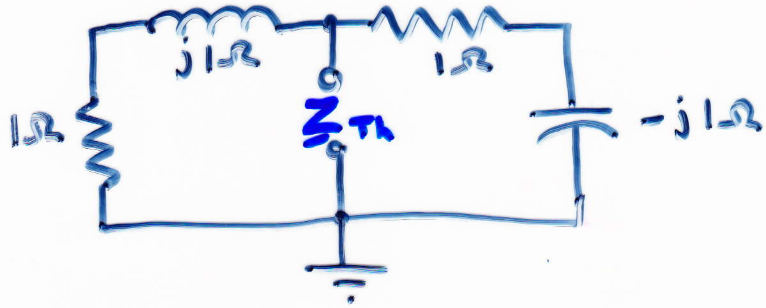


- Voltage division

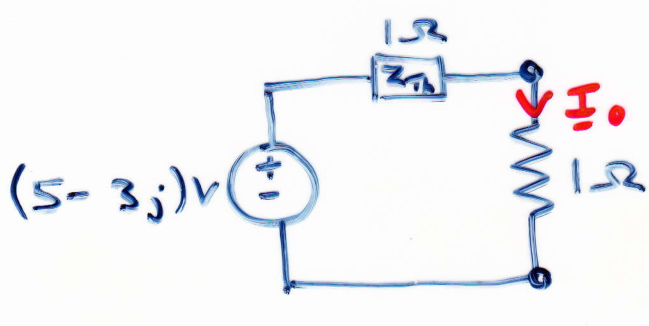
$$\underline{V}_{oc} = (8+2j)\left(\frac{1-j}{1-j+1+j}\right) = (4+j)(1-j)$$

$$= (5-3j)\ v$$

- Determine Thevenin impedance, Z_{Th}.



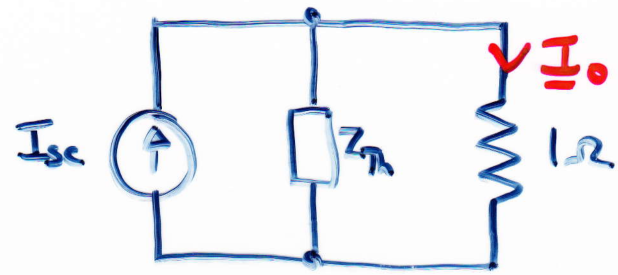
$$Z_{Th} = \frac{(1+j)(1-j)}{1+j+1-j} = 1\Omega$$



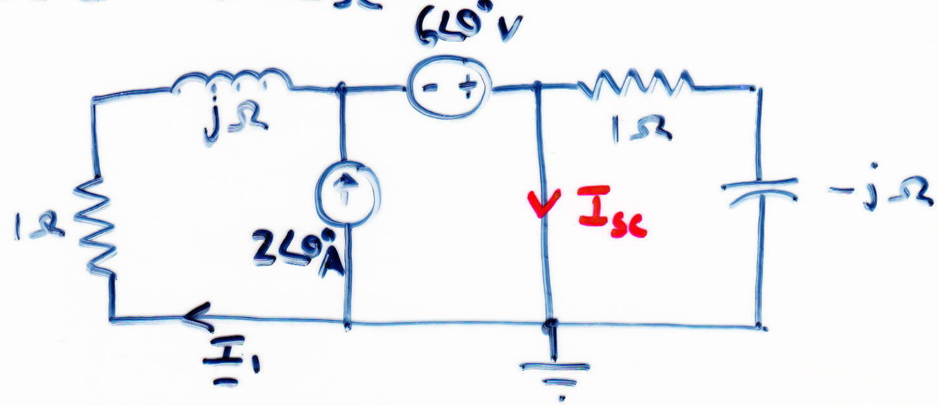
$$\underline{I}_o = \frac{(5-3j)}{2}$$

$$= \frac{5}{2} - \frac{3}{2}j$$

Norton Analysis



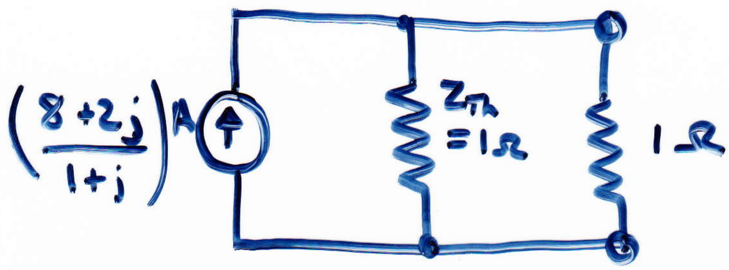
- Determine I_{sc}



$$\underline{I}_1 = \frac{6\angle 0°}{1+j} = \frac{6}{1+j}$$

$$\underline{I}_{sc} = \underline{I}_1 + 2\angle 0° = 2 + \frac{6}{1+j}$$

$$= \frac{8+2j}{1+j} \text{ A}$$



- Current division

$$I_o = \frac{1}{2}\left(\frac{8+2j}{1+j}\right)$$

$$= \left(\frac{5}{2} - \frac{3}{2}j\right) A$$