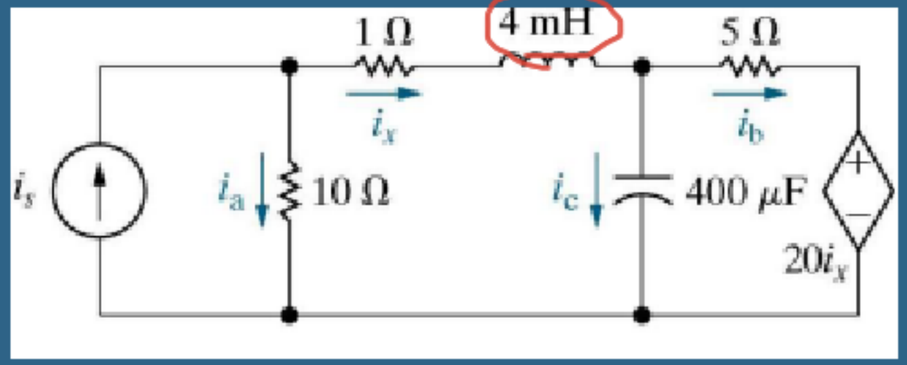
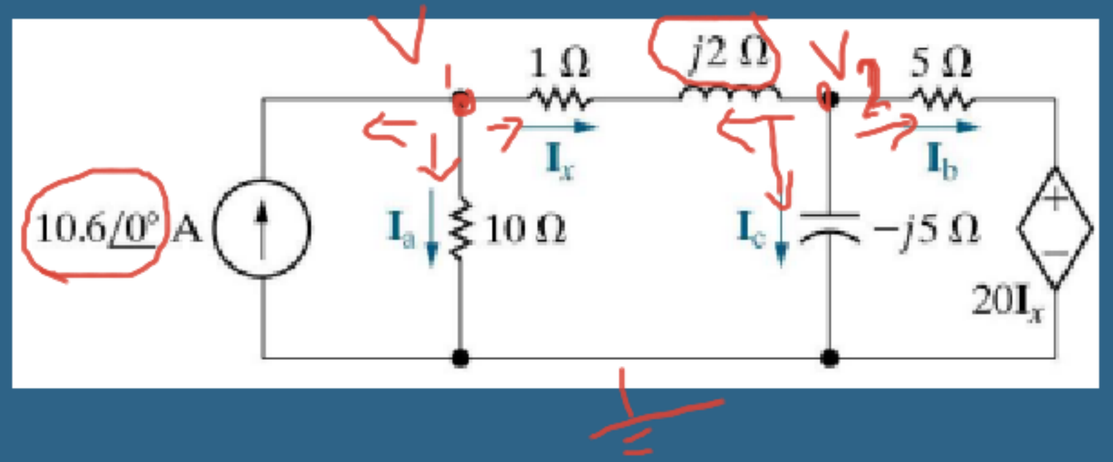
Source transformations

The Node - Voltage Method



Steps:
1- replace the source values.
2- L,C to impedence.
3- KCL (reference node)

- Use the node-voltage method to find the branch currents i_a, i_b, and i_c in the steady-state.
- The value of the current source in this circuit is $i_s = 10.6\cos(500t)$ A.



Solution

freq domain: $\omega = 500$ rad/s

$L = j\omega L = 2j\ \Omega$

$C = 1/j\omega C = -5j\ \Omega$

KCL: $-10.6 + \frac{V_1 - 0}{10} + \frac{V_1 - V_2}{1+2j} = 0$

$\frac{V_2 - V_1}{1+2j} + \frac{V_2 - 0}{-5j} + \frac{V_2 - 20I_x}{5} = 0$

$I_x = \frac{V_1 - V_2}{1+2j}$

$\mathbf{V}_1 = 68.4 - j16.8$ V,

$\mathbf{V}_2 = 68 - j26$ V,

$\mathbf{I}_x = 3.76 + j1.68$ A.

$$\mathbf{I}_a = \frac{\mathbf{V}_1}{10} = 6.84 - j1.68 \text{ A} = 7.04\angle -13.8° \text{ A},$$

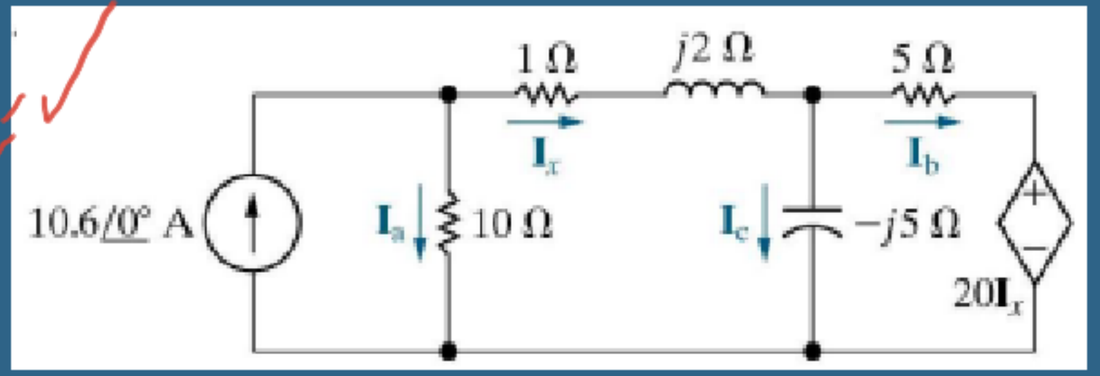
$$\mathbf{I}_b = \frac{\mathbf{V}_2 - 20\mathbf{I}_x}{5} = -1.44 - j11.92 \text{ A} = 12\angle -96.89° \text{ A},$$

$$\mathbf{I}_c = \frac{\mathbf{V}_2}{-j5} = 5.2 + j13.6 \text{ A} = 14.56\angle 69.08° \text{ A}.$$

$$i_a = 7.04 \cos(500t - 13.8°) \text{ A},$$

$$i_b = 12 \cos(500t - 96.89°) \text{ A},$$

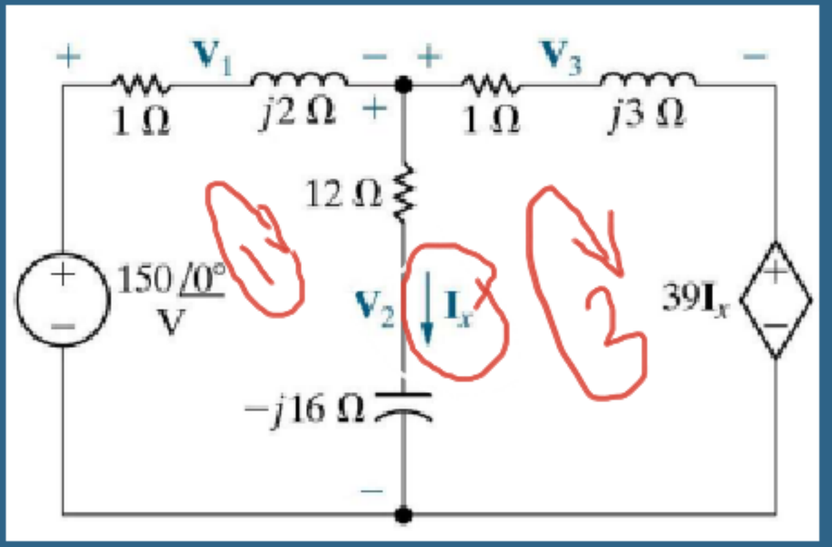
$$i_c = 14.56 \cos(500t + 69.08°) \text{ A}.$$



The mesh-current method

- Use the mesh-current method to find the voltages $\mathbf{V}_1$, $\mathbf{V}_2$, and $\mathbf{V}_3$ in the circuit

Steps:
1- replace the source values.
2- L,C to impedence.
3- KVL



$$-150 + (1+2j)I_1 + (12-16j)(I_1 - I_2) = 0$$

$$(12-16j)(I_2 - I_1) + (1+3j)(I_2) + 39I_x = 0$$

$$I_x = I_1 - I_2$$

$$\mathbf{I}_1 = -26 - j52 \text{ A},$$

$$\mathbf{I}_2 = -24 - j58 \text{ A},$$

$$\mathbf{I}_x = -2 + j6 \text{ A}.$$

$$\mathbf{V}_1 = (1 + j2)\mathbf{I}_1 = 78 - j104 \text{ V},$$

$$\mathbf{V}_2 = (12 - j16)\mathbf{I}_x = 72 + j104 \text{ V},$$

$$\mathbf{V}_3 = (1 + j3)\mathbf{I}_2 = 150 - j130 \text{ V}.$$