Answer on Question #81607 - Physics - Electric Circuits

6. Outline the steps taken with a help of an example how to reduce a circuit connected to points A-B can be reduced to a Thevenin'sand Norton's sources

Solution

Example of applying Thevenin's theorem

Determine the Thevenin equivalent circuit with respect to terminals AB of the circuit shown in Figure 1. Determine the magnitude of the current flowing in a 3.75+j11 Ω impedance connected across terminals AB.

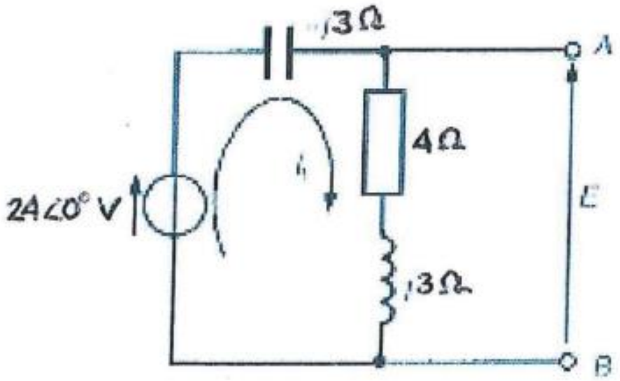


Figure 11

1. Short-circuit the voltage source and determine the equivalent impedance:

$$Z_{Th} = \frac{(4+j3)(-j3)}{4+j3-j3} = 3.75\angle-53.13°\ \Omega.$$

2. Calculate the supply current i_1:

$$i_1 = \frac{V}{-j3+4+j3} = 6\ \text{A}.$$

3. Find the equivalent voltage across AB:

$$V_{Th} = i_1(4+j3) = 30\angle36.87°\ \text{V}.$$

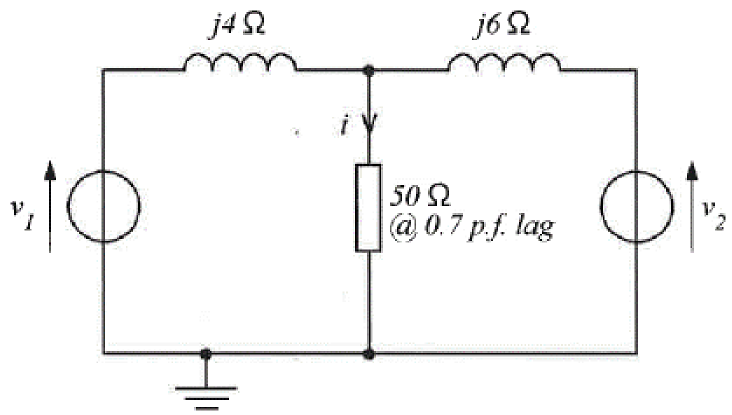
4. Calculate the current flowing in a 3.75+j11 Ω impedance connected across terminals AB:

$$I = \frac{V_{Th}}{Z_{Th}+3.75+j11} = \frac{30\angle36.87°.}{3.75\angle-53.13°+11.62\angle71.18°} = 3\angle-16.26°\ \text{A}.$$

Solution

Example of applying Norton's theorem

Figure 2 shows a 50 Ω load being fed from two voltage sources via their associated reactances.



$$v_1 = \sqrt{2}\times 415\cos(100\pi t) \quad \text{volts}$$
$$v_2 = \sqrt{2}\times 415\sin(100\pi t) \quad \text{volts}$$

Figure 2

Determine the current i flowing in the load by transforming the two voltage sources and their associated reactances into current sources (and thus form a pair of Norton generators).

1. Short-circuit the load and calculate the Norton current provided by v_1 only:

$$J_1 = \frac{V_1}{X_1} = \frac{415\angle 90°}{4\angle 90°} = 103.75\angle 0° \text{ A.}$$

2. Short-circuit the load and calculate the current created by v_2 only:

$$J_2 = \frac{V_2}{X_2} = \frac{415\angle 0°}{6\angle 90°} = 69.17\angle -90° \text{ A.}$$

Since two Norton generators are needed, the Norton reactances from the condition $Z_N = X_1X_2/(X_1 + X_2)$ are:

$$X_1 = 4\cdot e^{j90°} = 4\angle 90°\ \Omega,$$
$$X_2 = 6\cdot e^{j90°} = 6\angle 90°\ \Omega.$$

3. Now calculate the current i in the load:

$$i = \frac{\dfrac{(J_1 + J_2)\cdot Z_1Z_2}{(Z_1+Z_2)}}{\dfrac{Z_1Z_2}{Z_1+Z_2} + Z} = \frac{\dfrac{(103.75 + 69.17\angle -90°)\cdot 4\angle 90°\cdot 6\angle 90°}{(4\angle 90° + 6\angle 90°)}}{\dfrac{4\angle 90°\cdot 6\angle 90°}{4\angle 90° + 6\angle 90°} + 50\angle 45.6°} = 5.78\angle 8.85° \text{ A}$$

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