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Internal Assessment Test 1 – Sept. 2018

Sub:	Network Analysis					Sub Code:	17EC35	Branch:	ECE
Date:	10/09/2018	Duration:	90 min's	Max Marks:	50	Sem / Sec:	3A/3B/3C		OBE

<u>Answer any FIVE FULL Questions</u>

		MARKS	CO	RBT
1 .	Compute **V**1 and **V**2 in the circuit of Fig.1	[10]	CO1	L3

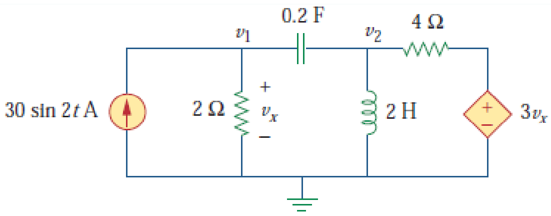


Fig.1

Answer: $v_1(t) = 33.96 \sin(2t + 60.01°)$ V,
$v_2(t) = 99.06 \sin(2t + 57.12°)$ V.

		MARKS	CO	RBT
2	Use mesh analysis to determine i1, i2, i3 and in Fig.2.	[10]	CO1	L3

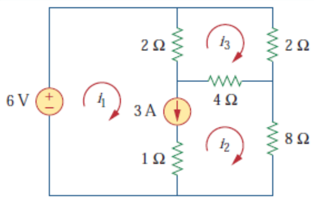


Fig.2

Answer: $i_1 = 3.474$ A, $i_2 = 0.4737$ A, $i_3 = 1.1052$ A.

		MARKS	CO	RBT
3 (a)	Derive star to delta transformation.	[04]	CO1	L1
(b)	Find i_0 in the circuit shown in Fig.3 using source transformation.	[06]	CO1	L3

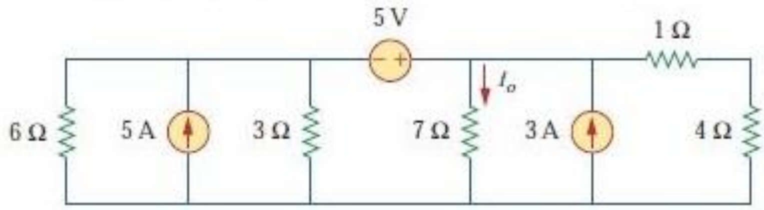


Fig.3

Answer: 1.78 A.

		MARKS	CO	RBT
4	Find *vo* of the circuit of Fig. 4 using the superposition theorem.	[10]	CO2	L3

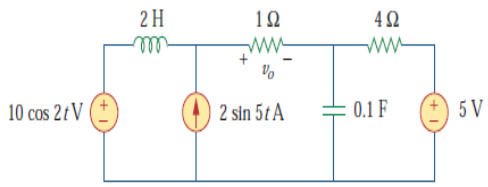


Fig.4

where v_1 is due to the 5-V dc voltage source, v_2 is due to the $10 \cos 2t$ V voltage source, and v_3 is due to the $2 \sin 5t$ A current source.

To find v_1, we set to zero all sources except the 5-V dc source. We recall that at steady state, a capacitor is an open circuit to dc while an inductor is a short circuit to dc. There is an alternative way of looking at this. Since $\omega = 0$, $j\omega L = 0$, $1/j\omega C = \infty$. Either way, the equivalent circuit is as shown in Fig. 10.14(a). By voltage division,

$$-v_1 = \frac{1}{1+4}(5) = 1 \text{ V} \qquad \textbf{(10.6.2)}$$

To find v_2, we set to zero both the 5-V source and the $2 \sin 5t$ current source and transform the circuit to the frequency domain.

$$10 \cos 2t \quad \Rightarrow \quad 10\underline{/0^\circ}, \qquad \omega = 2 \text{ rad/s}$$
$$2 \text{ H} \quad \Rightarrow \quad j\omega L = j4\ \Omega$$
$$0.1 \text{ F} \quad \Rightarrow \quad \frac{1}{j\omega C} = -j5\ \Omega$$

The equivalent circuit is now as shown in Fig. 10.14(b). Let

$$\mathbf{Z} = -j5 \parallel 4 = \frac{-j5 \times 4}{4 - j5} = 2.439 - j1.951$$

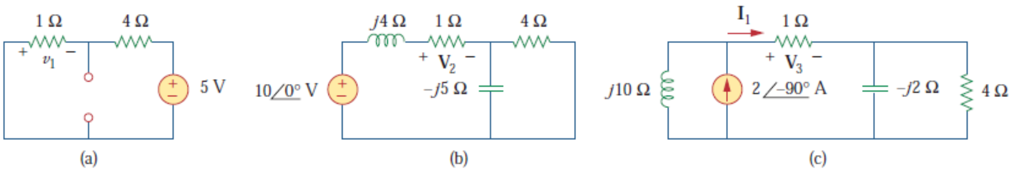


Figure 10.14
Solution of Example 10.6: (a) setting all sources to zero except the 5-V dc source, (b) setting all sources to zero except the ac voltage source, (c) setting all sources to zero except the ac current source.

By voltage division,

$$\mathbf{V}_2 = \frac{1}{1 + j4 + \mathbf{Z}}(10\underline{/0^\circ}) = \frac{10}{3.439 + j2.049} = 2.498\underline{/-30.79^\circ}$$

In the time domain,

$$v_2 = 2.498 \cos(2t - 30.79^\circ) \qquad \textbf{(10.6.3)}$$

To obtain v_3, we set the voltage sources to zero and transform what is left to the frequency domain.

$$2 \sin 5t \quad \Rightarrow \quad 2\underline{/-90^\circ}, \qquad \omega = 5 \text{ rad/s}$$
$$2 \text{ H} \quad \Rightarrow \quad j\omega L = j10\ \Omega$$
$$0.1 \text{ F} \quad \Rightarrow \quad \frac{1}{j\omega C} = -j2\ \Omega$$

The equivalent circuit is in Fig. 10.14(c). Let

$$\mathbf{Z}_1 = -j2 \parallel 4 = \frac{-j2 \times 4}{4 - j2} = 0.8 - j1.6\ \Omega$$

By current division,

$$\mathbf{I}_1 = \frac{j10}{j10 + 1 + \mathbf{Z}_1}(2\angle{-90^\circ})\ \text{A}$$

$$\mathbf{V}_3 = \mathbf{I}_1 \times 1 = \frac{j10}{1.8 + j8.4}(-j2) = 2.328\angle{-80^\circ}\ \text{V}$$

In the time domain,

$$v_3 = 2.33\cos(5t - 80^\circ) = 2.33\sin(5t + 10^\circ)\ \text{V} \qquad \textbf{(10.}$$

Substituting Eqs. (10.6.2) to (10.6.4) into Eq. (10.6.1), we have

$$v_o(t) = -1 + 2.498\cos(2t - 30.79^\circ) + 2.33\sin(5t + 10^\circ)\ \text{V}$$

5 Find the Thevenin equivalent of the circuit in Fig.5 as seen from terminals *a-b*. [10] CO2 L3

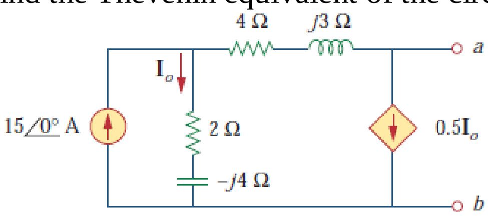


Fig.5

Solution:

To find $\mathbf{V}_{Th}$, we apply KCL at node 1 in Fig. 10.26(a).

$$15 = \mathbf{I}_o + 0.5\mathbf{I}_o \quad \Rightarrow \quad \mathbf{I}_o = 10\ \text{A}$$

Applying KVL to the loop on the right-hand side in Fig. 10.26(a), we obtain

$$-\mathbf{I}_o(2 - j4) + 0.5\mathbf{I}_o(4 + j3) + \mathbf{V}_{Th} = 0$$

or

$$\mathbf{V}_{Th} = 10(2 - j4) - 5(4 + j3) = -j55$$

Thus, the Thevenin voltage is

$$\mathbf{V}_{Th} = 55\angle{-90^\circ}\ \text{V}$$

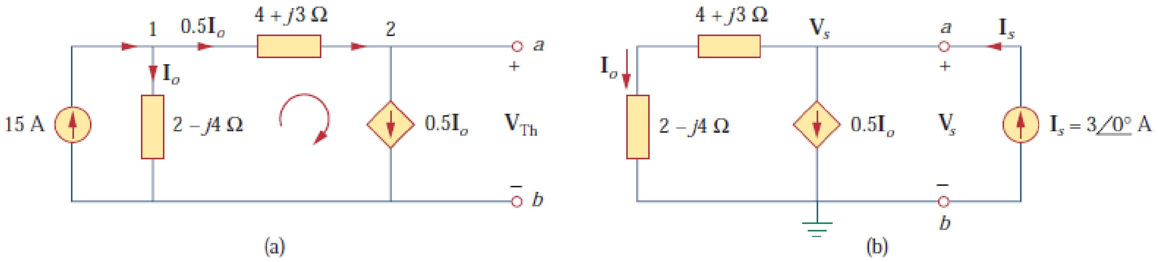


Figure 10.26
Solution of the problem in Fig. 10.25: (a) finding $\mathbf{V}_{Th}$, (b) finding $\mathbf{Z}_{Th}$.

To obtain $\mathbf{Z}_{Th}$, we remove the independent source. Due to the presence of the dependent current source, we connect a 3-A current source (3 is an arbitrary value chosen for convenience here, a number divisible by the sum of currents leaving the node) to terminals *a-b* as shown in Fig. 10.26(b). At the node, KCL gives

$$3 = \mathbf{I}_o + 0.5\mathbf{I}_o \quad \Rightarrow \quad \mathbf{I}_o = 2\text{ A}$$

Applying KVL to the outer loop in Fig. 10.26(b) gives

$$\mathbf{V}_s = \mathbf{I}_o(4 + j3 + 2 - j4) = 2(6 - j)$$

The Thevenin impedance is

$$\mathbf{Z}_{Th} = \frac{\mathbf{V}_s}{\mathbf{I}_s} = \frac{2(6 - j)}{3} = 4 - j0.6667\ \Omega$$

		MARKS	CO	RBT
6	State and explain Norton's equivalent circuit and Find the Norton equivalent circuit of the circuit in Fig. 6 at terminal a-b.	[10]	CO2	L3

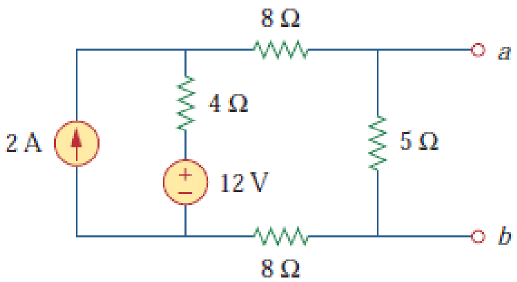


Fig.6

We find R_N in the same way we find R_{Th} in the Thevenin equivalent circuit. Set the independent sources equal to zero. This leads to the circuit in Fig. 4.40(a), from which we find R_N. Thus,

$$R_N = 5 \,\|\, (8 + 4 + 8) = 5 \,\|\, 20 = \frac{20 \times 5}{25} = 4\ \Omega$$

To find I_N, we short-circuit terminals *a* and *b*, as shown in Fig. 4.40(b). We ignore the 5-Ω resistor because it has been short-circuited. Applying mesh analysis, we obtain

$$i_1 = 2\text{ A}, \qquad 20i_2 - 4i_1 - 12 = 0$$

From these equations, we obtain

$$i_2 = 1\text{ A} = i_{sc} = I_N$$

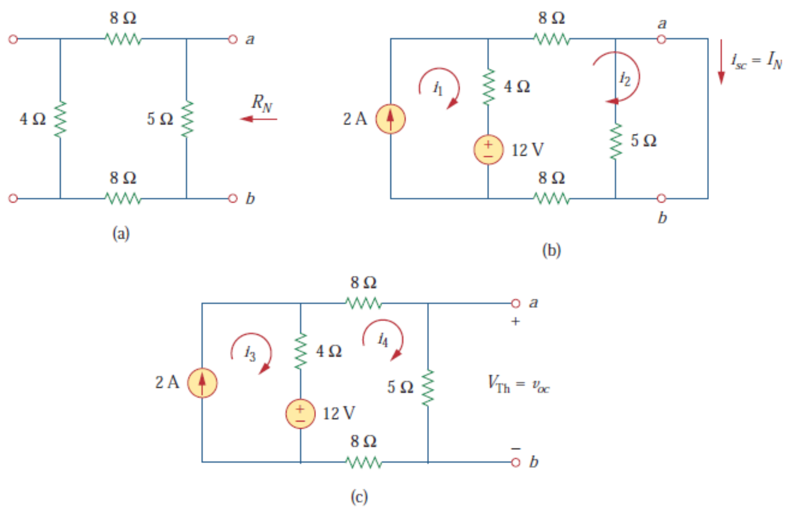


Figure 4.40
For Example 4.11; finding: (a) R_N, (b) $I_N = i_{sc}$, (c) $V_{Th} = v_{oc}$.

Alternatively, we may determine I_N from V_{Th}/R_{Th}. We obtain V_{Th} as the open-circuit voltage across terminals a and b in Fig. 4.40(c). Using mesh analysis, we obtain

$$i_3 = 2\text{ A}$$

$$25i_4 - 4i_3 - 12 = 0 \quad \Rightarrow \quad i_4 = 0.8\text{ A}$$

and

$$v_{oc} = V_{Th} = 5i_4 = 4\text{ V}$$

Hence,

$$I_N = \frac{V_{Th}}{R_{Th}} = \frac{4}{4} = 1\text{ A}$$

as obtained previously. This also serves to confirm Eq. (4.12c) that $R_{Th} = v_{oc}/i_{sc} = 4/1 = 4\ \Omega$. Thus, the Norton equivalent circuit is as shown in Fig. 4.41.

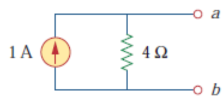


Figure 4.41
Norton equivalent of the circuit in Fig. 4.39.

7. For the circuit shown in Fig. 7, find the load impedance Z_L that absorbs the maximum power. Calculate that maximum power. [10] CO2 L3

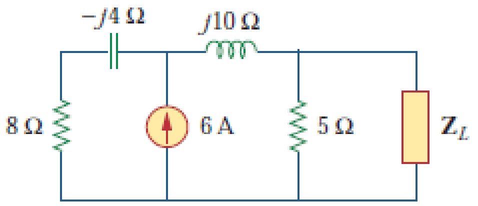


Fig. 7

Answer: $3.415 - j0.7317\ \Omega$, 12.861 W.

8. For the circuit shown in Fig. 8(a) & Fig. 8(b), find the load impedance R_L that absorbs the maximum power. Calculate that maximum power. [5+5] CO2 L3

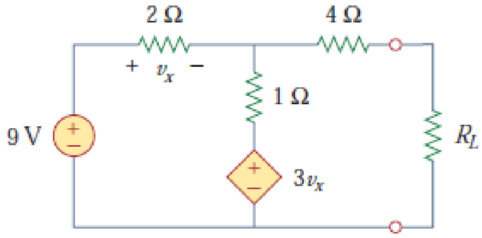


Fig 8(a)

Answer: 4.22 Ω, 2.901 W.

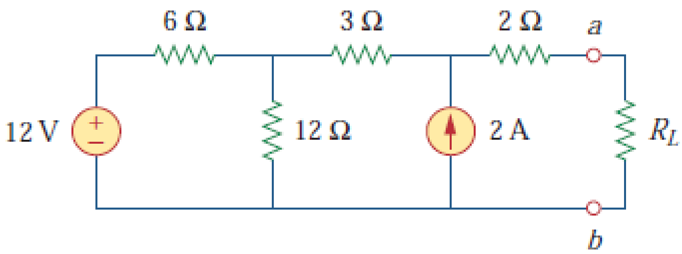
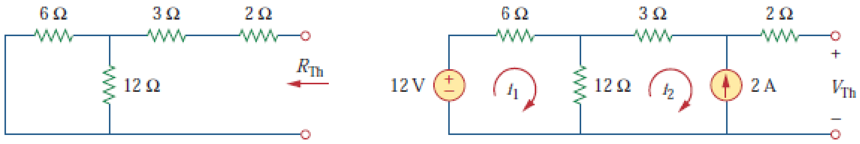


Fig 8(b)

Solution:

We need to find the Thevenin resistance R_{Th} and the Thevenin voltage V_{Th} across the terminals *a-b*. To get R_{Th}, we use the circuit in Fig. 4.51(a) and obtain

$$R_{Th} = 2 + 3 + 6 \| 12 = 5 + \frac{6 \times 12}{18} = 9\ \Omega$$



(a) (b)

Figure 4.51
For Example 4.13: (a) finding R_{Th}, (b) finding V_{Th}.

To get V_{Th}, we consider the circuit in Fig. 4.51(b). Applying mesh analysis gives

$$-12 + 18i_1 - 12i_2 = 0, \qquad i_2 = -2\text{ A}$$

Solving for i_1, we get $i_1 = -2/3$. Applying KVL around the outer loop to get V_{Th} across terminals *a-b*, we obtain

$$-12 + 6i_1 + 3i_2 + 2(0) + V_{Th} = 0 \qquad \Rightarrow \qquad V_{Th} = 22\text{ V}$$

For maximum power transfer,

$$R_L = R_{Th} = 9\ \Omega$$

and the maximum power is

$$p_{max} = \frac{V_{Th}^2}{4R_L} = \frac{22^2}{4 \times 9} = 13.44\text{ W}$$