KING FAHD UNIVERSITY OF PETROLEUM & MINERALS

ELECTRICAL ENGINEERING DEPARTMENT

EE-201 ELECTRIC CIRCUITS

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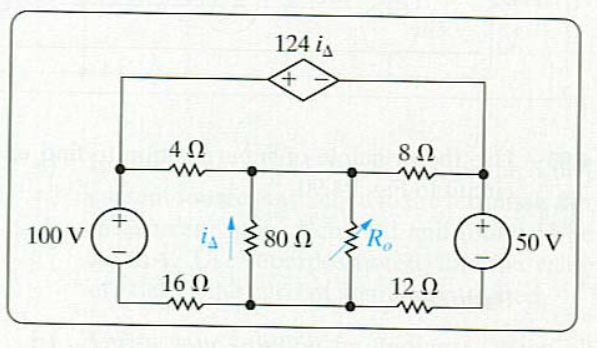
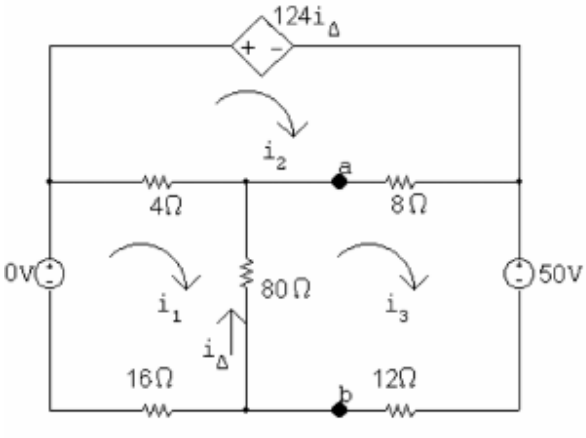
Sec: 8 Quiz # 3 Ser. # Name: I.D.#

For the circuit shown below, find the maximum power transfer to R_o.



Solution



The mesh current equations are:

$$-100 + 4(i_1 - i_2) + 80(i_1 - i_3) + 16i_1 = 0$$

$$124i_\Delta + 8(i_2 - i_3) + 4(i_2 - i_1) = 0$$

$$50 + 12i_3 + 80(i_3 - i_1) + 8(i_3 - i_2) = 0$$

The constraint equation is:

$$i_\Delta = i_3 - i_1$$

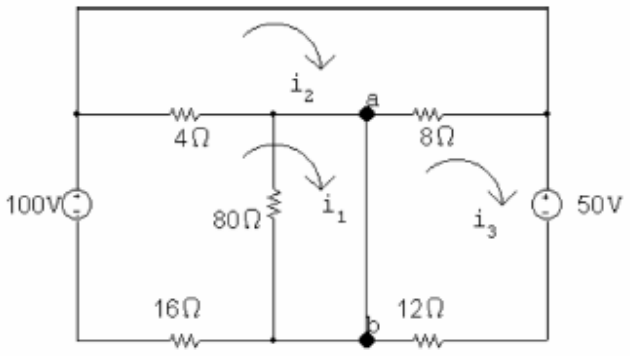
Place these equations in standard form:

$$\begin{aligned} i_1(4+80+16)+i_2(-4)+i_3(-80)+i_\Delta(0) &= 100 \\ i_1(-4)+i_2(8+4)+i_3(-8)+i_\Delta(124) &= 0 \\ i_1(-80)+i_2(-8)+i_3(12+80+8)+i_\Delta(0) &= -50 \\ i_1(1)+i_2(0)+i_3(-1)+i_\Delta(1) &= 0 \end{aligned}$$

Solving, $i_1 = 4.7$ A; $i_2 = 10.5$ A; $i_3 = 4.1$ A; $i_\Delta = -0.6$ A

Also, $V_{\text{Th}} = v_{\text{ab}} = -80 i_\Delta = 48$ V

Now find the short-circuit current.



Note with the short circuit from a to b that i_Δ is zero, hence $124 i_\Delta$ is also zero.

The mesh currents are:

$$\begin{aligned} -100+4(i_1-i_2)+16i_1 &= 0 \\ 8(i_2-i_3)+4(i_2-i_1) &= 0 \\ 50+12i_3+8(i_3-i_2) &= 0 \end{aligned}$$

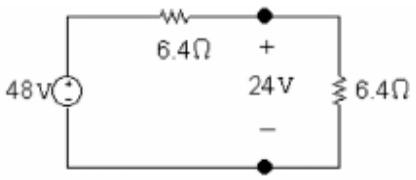
Place these equations in standard form:

$$\begin{aligned} i_1(4+16)+i_2(-4)+i_3(0) &= 100 \\ i_1(-4)+i_2(8+4)+i_3(-8) &= 0 \\ i_1(0)+i_2(-8)+i_3(12+8) &= -50 \end{aligned}$$

Solving, $i_1 = 5$ A; $i_2 = 0$ A; $i_3 = -2.5$ A

Then, $i_{\text{sc}} = i_1 - i_3 = 7.5$ A

$R_{\text{Th}} = 48/7.5 = 6.4\,\Omega$



For maximum power transfer $R_o = R_{\text{Th}} = 6.4\,\Omega$

$$p_{\max} = \frac{24^2}{6.4} = 90 \text{ W}$$