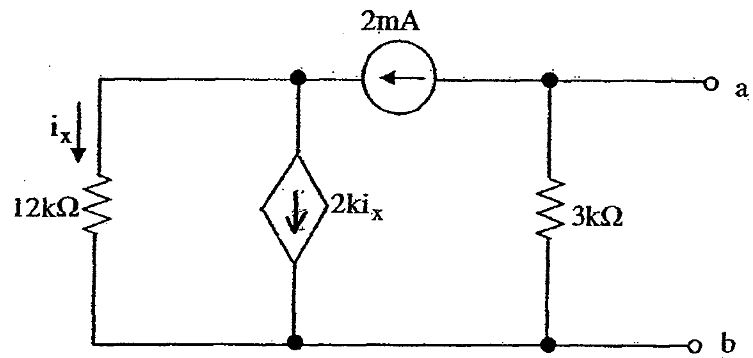
HW #10 Cont.

3.



a. Find the Thevenin equivalent of the above circuit relative to terminals a and b.

b. If we attach R_L to terminals a and b, find the value of R_L that will absorb maximum power.

c. Calculate the value of that maximum power absorbed by R_L.

HW#10 Cont.

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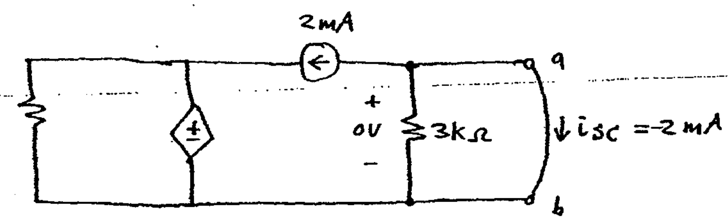
sol'n: 3. a) $V_{Th} = V_{a,b \text{ open circ}} = -2\,mA \cdot 3k\Omega = -6V$

The current source is between a, b and the 12kΩ and dependent source. The current source thus isolates behavior at a, b from the 12kΩ and dependent source.

Use i_{sc} to find R_{Th}:



we short a, b so no v-drop across 3kΩ.

So $i_{3k\Omega} = 0$ and $i_{sc} = -2mA$.

$$R_{Th} = \frac{V_{Th}}{i_s} = \frac{-6V}{-2mA} = 3k\Omega$$

$$\boxed{V_{Th} = -6V \qquad R_{Th} = 3k\Omega}$$

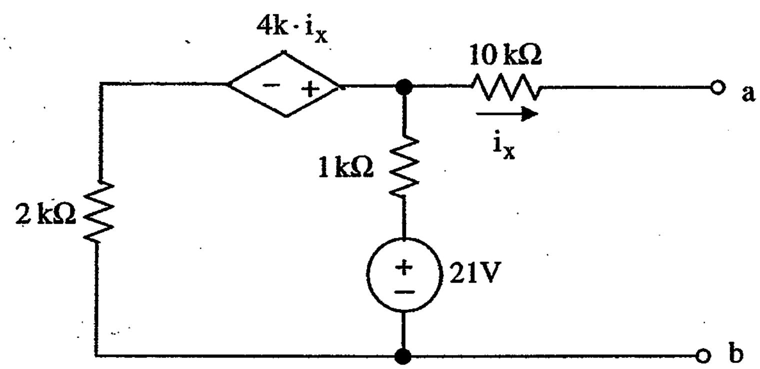
Comments: 1) We could also just turn off the 2mA source and look into a, b to see $R_{Th} = 3k\Omega$.

2) We really just started with a Norton equivalent that we converted to Thevenin equivalent.

b) max pwr when $R_L = R_{Th} = \boxed{3k\Omega = R_L}$

c) max pwr $P_{max} = \frac{V_{Th}^2}{4R_{Th}} = \frac{(-6V)^2}{4 \cdot 3k\Omega} = \boxed{3\,mW = P_{max}}$

3.

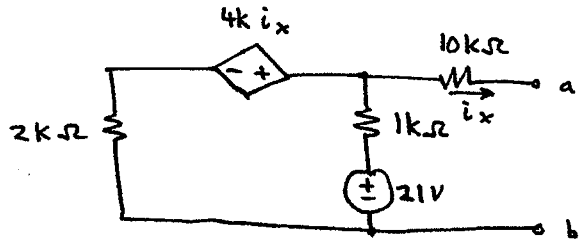


a. Find the Thevenin equivalent of the above circuit relative to terminals a and b.

b. If we attach R_L to terminals a and b, find the value of R_L that will absorb maximum power.

c. Calculate the value of that maximum power absorbed by R_L.

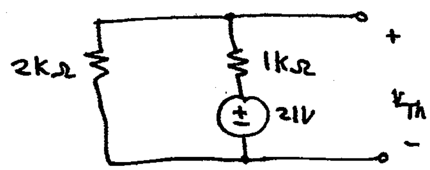
soln: 3. a)



$V_{Th} = V_{ab}$ open circuit

$i_x = 0$ for open circuit a, b. $\therefore 4k \cdot i_x = 0V$

No $i_x \Rightarrow$ no V drop across 10kΩ $\Rightarrow$ ignore 10kΩ

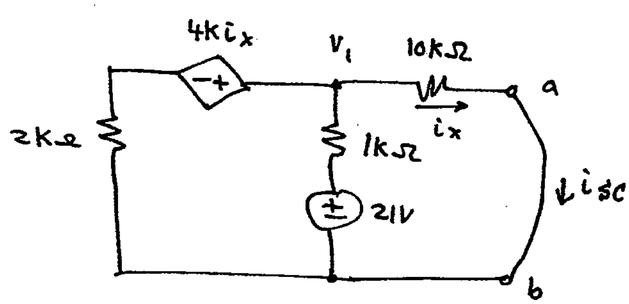


This is V-divider.

$$V_{Th} = 21V \cdot \frac{2k\Omega}{2k\Omega + 1k\Omega} = 14V$$

$$\boxed{V_{Th} = 14V}$$

To find R_{Th} we can use the i_{sc} method:



$$R_{Th} = \frac{V_{Th}}{i_{sc}}$$

Need to find i_{sc}. $\therefore$ Find V_1

Find V_1 by node-voltage method:

$i_x = \frac{V_1}{10k\Omega}$ so we can eliminate i_x

$$\frac{V_1 - 4k\frac{V_1}{10k\Omega}}{2k\Omega} + \frac{V_1 - 21V}{1k\Omega} + \frac{V_1}{10k\Omega} = 0A$$

mult everything by 10kΩ

$$V_1 \cdot 5 - V_1 \cdot 2 + V_1 \cdot 10 + V_1 \cdot 1 = 210\ V$$

$V_1(5 - 2 + 10 + 1) = 210V$ $\quad V_1 \cdot 14 = 210V$ $\quad V_1 = 15V$

$i_{sc} = i_x = \frac{V_1}{10k\Omega} = 1.5\ mA$ $\qquad R_{Th} = \frac{V_{Th}}{i_{sc}} = \frac{14V}{1.5mA}$

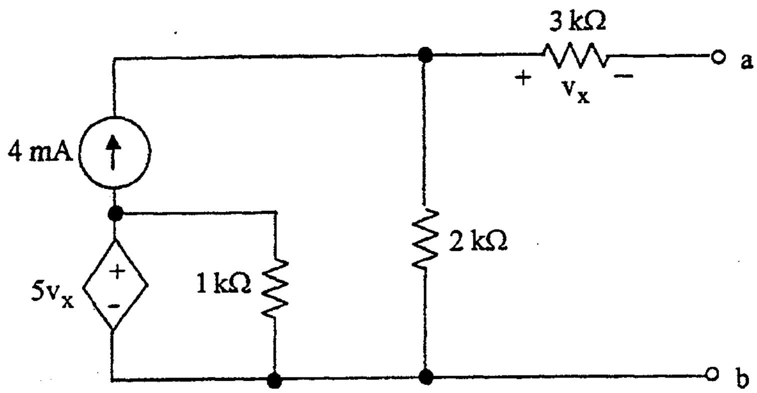
$$\boxed{R_{Th} = 9.33\ k\Omega}$$

sol'n: 3.b) max pwr when $\boxed{R_L = R_{Th} = 9.33\ k\Omega}$

c) max pwr $P_{max} = \frac{v_{Th}^2}{4R_{Th}} = \frac{(14V)^2}{4 \cdot \frac{14}{1.5}\ k\Omega} = \frac{14\ (1.5)}{4}\ mW$

$$\boxed{P_{max} = \frac{21}{4}\ mW = 5.25\ mW}$$

3. (30 points)



Pts		
20	a.	Find the Thevenin equivalent of the above circuit relative to terminals a and b.
5	b.	If we attach R_L to terminals a and b, find the value of R_L that will absorb maximum power.
5	c.	Calculate the value of that maximum power absorbed by R_L.

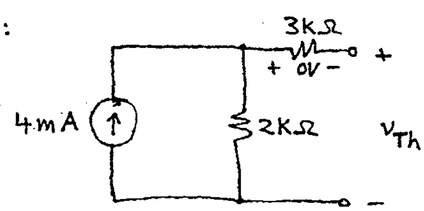
sol'n: a) $V_{Th} = V_{a,b}$ open circuit

open circuit ⇒ $V_x = 0$ since no current in 3kΩ.

∴ $5V_x$ src $= 0V$ = wire

1kΩ across V_x shorted so can be ignored.

So we have:



$V_{Th} = 4mA \cdot 2k\Omega = 8V$

$\boxed{V_{Th} = 8V}$

$R_{Th} = \dfrac{V_{Th}}{i_{sc}}$ If we short a,b we have current divider. $i_{sc} = 4mA \cdot \dfrac{2k\Omega}{2k\Omega + 3k\Omega} = \dfrac{8}{5}$ mA

$R_{Th} = \dfrac{8V}{8/5\ mA} = 5k\Omega$ $\boxed{R_{Th} = 5k\Omega}$

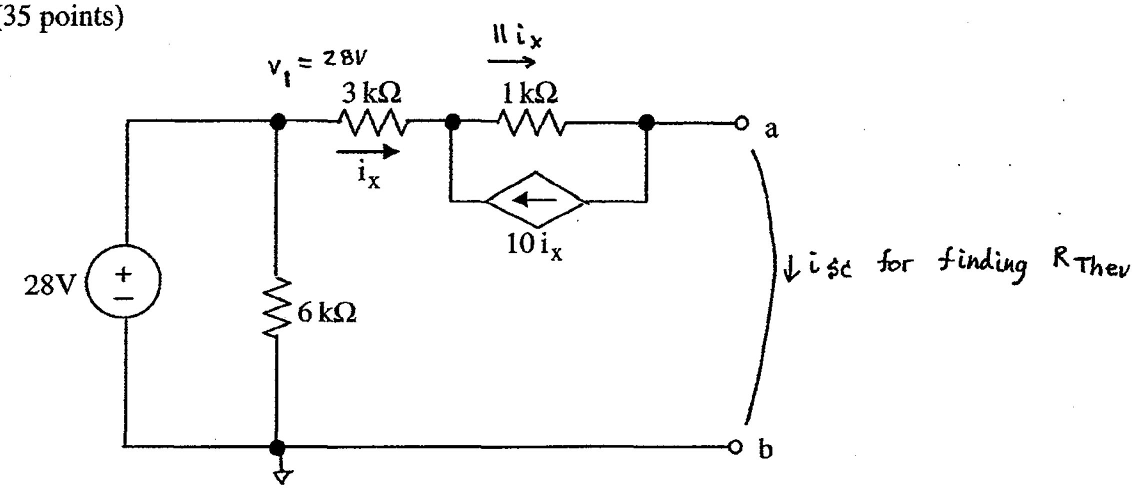
Note: Easier sol'n is to say $5V_x$ and 1kΩ don't matter because they are in series with current source. Then $R_{Th} = 2k\Omega + 3k\Omega$ seen from a,b with 4mA off.

sol'n: 3.b) max pwr when $R_L = R_{Th} = 5\,k\Omega$

3.c) max pwr $= \dfrac{V_{Th}^2}{4 R_{Th}} = \dfrac{(8V)^2}{4 \cdot 5k\Omega} = \dfrac{64}{20}\,mW = 3.2\,mW$

max pwr = 3.2 mW

3. (35 points)



Pts

25 a. Find the Thevenin equivalent of the above circuit relative to terminals a and b.

5 b. If we attach R_L to terminals a and b, find the value of R_L that will absorb maximum power.

5 c. Calculate the value of that maximum power absorbed by R_L.

sol'n: a) The 6kΩ resistor is across the 28V source, so it may be ignored.

For V_{Thev} we use $V_{a,b}$ with no load. Since no current flows out of the 'a' terminal, $i_x = 0$.

$\therefore$ $10 i_x = 0A$ and v drop across 3kΩ and 1kΩ is zero.

$\therefore$ $V_{a,b} = 28V$ from v src $\therefore$ $\boxed{V_{Thev} = 28V}$

Now find i_{sc} flowing in wire connected from a to b.

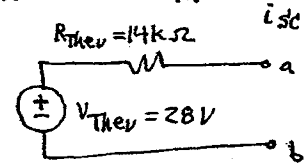
From current sum at node on left end of 1kΩ, we have current $11 i_x$ flowing in 1kΩ resistor.

Using v drops for 3kΩ and 1kΩ, we must have

$i_x \cdot 3k\Omega + 11 i_x \cdot 1k\Omega = 28V$ or $14k\Omega \cdot i_x = 28V$

or $i_x = 2\ mA$. Since $i_{sc} = i_x$ and $R_{Th} = \frac{V_{Th}}{i_{sc}}$,

$\boxed{R_{Th} = \frac{28V}{2mA} = 14k\Omega}$



sol'n: 3. b) Max pwr when $\boxed{R_L = R_{Thev} = 14\,k\Omega}$

3. c) Max pwr $= \dfrac{V_{Thev}^2}{4 R_{Thev}} = \dfrac{(28V)^2}{4 \cdot 14 k\Omega} = 7(2) W/k$

$\boxed{\text{Max pwr} = 14mW}$