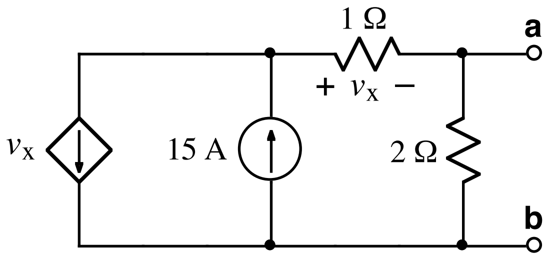
HOMEWORK #17 solution

Ex:



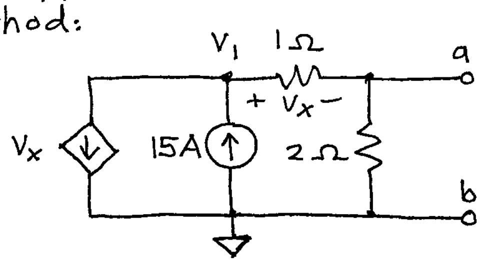
a) Find the Thevenin equivalent of the above circuit relative to terminals **a** and **b**.

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.

sol'n: a) $v_{Th} = v_{a,b}$ with nothing connected across a, b

One approach is to use the node-voltage method:



Using the voltage-divider formula, we relate v_X to v_1:

$$v_X = v_1 \cdot \frac{1\Omega}{1\Omega + 2\Omega} = \frac{v_1}{3}$$

Node v_1 eq'n:

$$\frac{v_1}{3} - 15A + \frac{v_1}{1\Omega + 2\Omega} = 0A$$

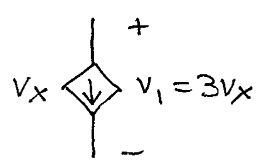
or $\dfrac{2v_1}{3\Omega} = 15A$

or $v_1 = \dfrac{3}{2}\Omega \cdot 15A = 22.5\ V$

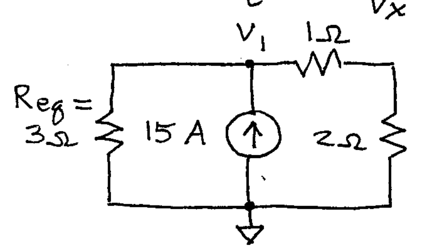
To find V_{Th}, we again use a voltage-divider formula:

$$V_{Th} = v_1 \cdot \frac{2\Omega}{1\Omega + 2\Omega} = 22.5\,V \cdot \frac{2}{3} = 15\ V$$

Note: Another approach is to replace the dependent source with a resistor. To do so, we write the voltage across the dependent source in terms of dependent variable v_x. From an eq'n above, we have $v_1 = 3v_x$.



$$R_{eq} = \frac{v}{i} = \frac{3v_x}{v_x} = 3\Omega$$



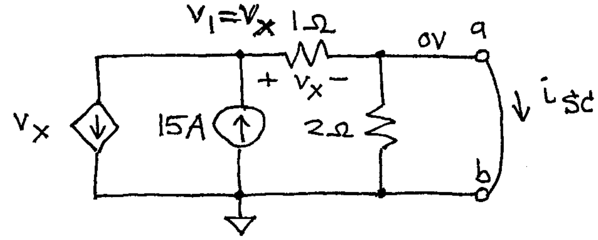
$$v_1 = 15A \cdot 3\Omega \| 3\Omega = 22.5V$$

Note: R_{eq} changes with R across a, b.

One way to find R_{Th} is to use

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

where $i_{sc} \equiv$ short circuit from **a** to **b**



We may ignore the 2Ω resistor that is shorted out.

Node v_1 eq'n: (Note that $v_x = v_1$.)

$$v_1 - 15A + \frac{v_1}{1\Omega} = 0A$$

or

$$\frac{2v_1}{1\Omega} = 15A$$

or

$$v_1 = 15A \cdot \frac{1\Omega}{2} = 7.5\,V$$

Our current is $i_{sc} = \dfrac{v_1}{1\Omega} = \dfrac{7.5V}{1\Omega} = 7.5A.$

$$R_{Th} = \frac{v_{Th}}{i_{sc}} = \frac{15V}{7.5A} = 2\Omega$$

Note: we could replace the dependent source with $R_{eq} = \dfrac{v}{i} = \dfrac{v_x}{v_x} = 1\Omega$ for i_{sc}.

b) $R_L = R_{Th} = 2\Omega$ for max pwr xfer

c) $P_{max} = \dfrac{V_{Th}^2}{4R_{Th}} = \dfrac{15^2}{4 \cdot 2\Omega} = 28.125\,W$