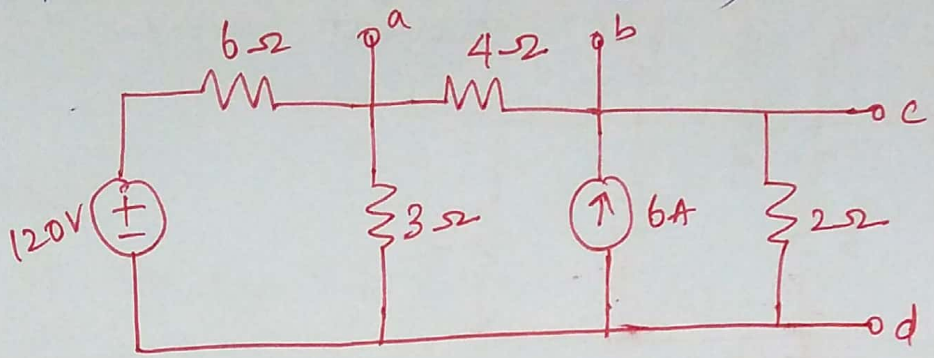
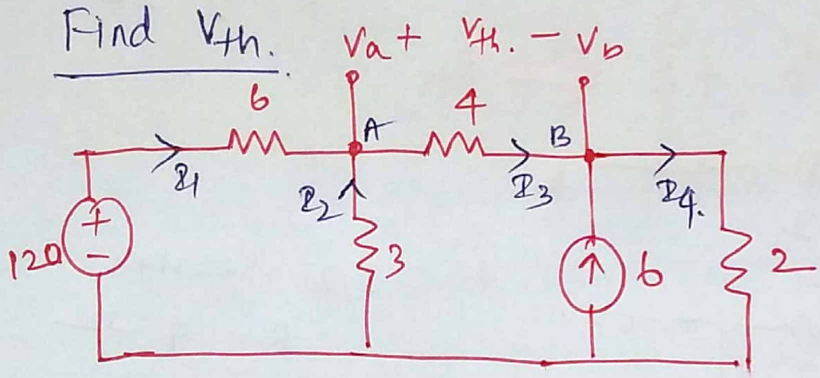
THEVENIN & NORTON EXAMPLES

(1) Find the Thevenin & Norton Equivalents from the terminals (a-b) and (c-d)



From terminals (a-b)

Find V_{th}.



$V_{th} = V_a - V_b$.

using nodal analysis find V_a, V_b, V_{th}.

At node (A), $I_1 + I_2 = I_3$

$$\frac{120 - V_a}{6} + \frac{0 - V_a}{3} = \frac{V_a - V_b}{4}$$

×12

$$240 - 2V_a - 4V_a = 3V_a - 3V_b$$

$$9V_a - 3V_b = 240.$$

$$3V_a - V_b = 80 \longrightarrow (1).$$

At node (B).

$$6 + I_3 = I_4.$$

×4

$$6 + \frac{V_a - V_b}{4} = \frac{V_b}{2}$$

$$24 + V_a - V_b = 2V_b$$

$$-V_a + 3V_b = 24 \rightarrow (2)$$

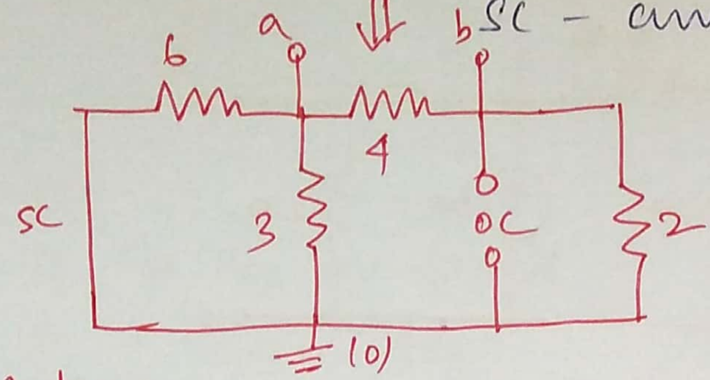
Solving (1), (2), we get $V_a = 33$ $V_b = 19V$

$V_{th} = V_a - V_b$. $\therefore \boxed{V_{th} = 14\text{ V}.}$

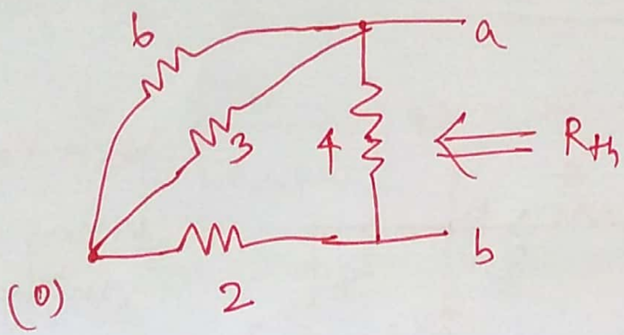
2

<u>To find R_{th}</u>. [Turn off independent voltage and current sources).

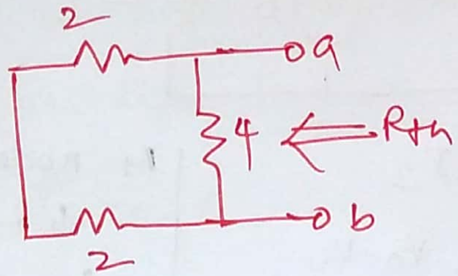
R_{th} OC – voltage source and.
SC – current source.



Redraw

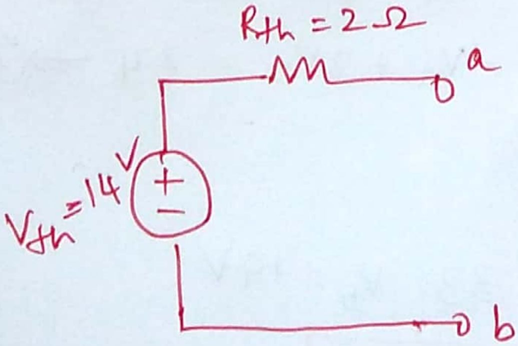


6, 3 parallel.
$R = 2\ \Omega$

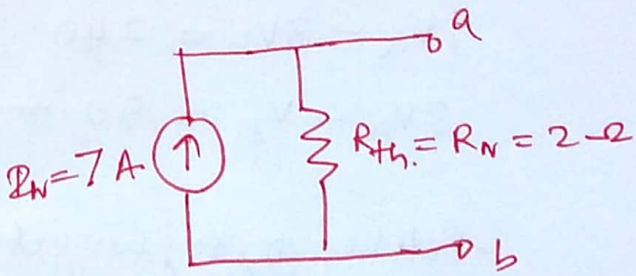


2, 2 series
$R = 4\ \Omega$
4, 4 parallel.
$R_{th} = 2\ \Omega$

THEVENIN EQUIVALENT.



NORTON EQUIVALENT.



$I_N = \frac{V_{th}}{R_{th}}$ $R_{th} = R_N$

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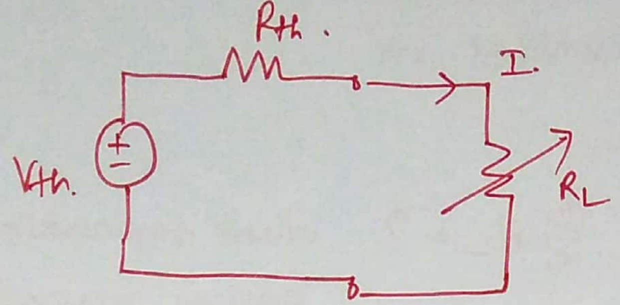
MAXIMUM POWER TRANSFER



How?

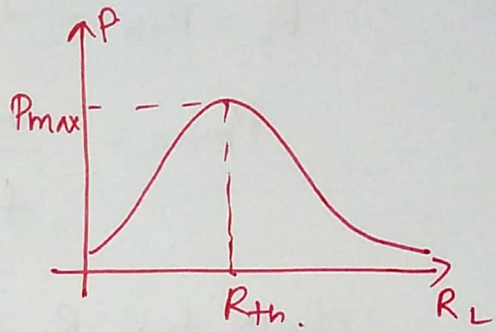
If V_{th}, R_{th} are fixed

$R_L \rightarrow$ variable load.

power $P = i^2 R_L$

$$P = \left(\frac{V_{th}}{R_{th}+R_L}\right)^2 R_L$$

Power delivered to the load RL



To find the maximum power and the value of R_L at which maximum power can be, differentiat P with repect to R_L,

$$\frac{dP}{dR_L} = 0.$$

$$R_{th} + R_L - 2R_L = R_{th} - R_L.$$

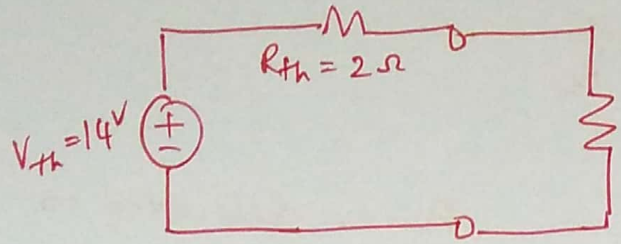
$$\boxed{R_L = R_{th}.}$$

$$\boxed{P_{max} = \frac{V_{th}^2}{4R_{th}}}$$

(A)

For the circuit solved,

Thevenin equivalent is



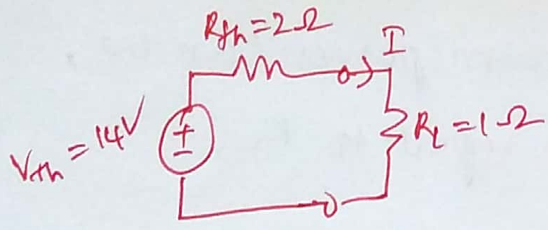
what for maximum power transfer.

$$R_L = R_{th} = 2\Omega.$$

$$P_{max} = \frac{V_{th}^2}{4R_{th}} = \frac{14^2}{4\times 2} = \underline{\underline{24.5\ W}}.$$

Check for $R_L = 1\Omega$.

Power delivered $= I^2 R_L$



$$= \left(\frac{V_{th}}{R_L + R_{th}}\right)^2 R_L$$

$$= \frac{14^2}{(1+2)^2} \times 1$$

$$P_{1\Omega} = \underline{\underline{21.77\ W}}$$

Check for $R_L = 3\Omega$

power delivered $= I^2 R_L$

$$= \frac{V_{th}^2}{(3+2)^2} \times 3$$

$$= \underline{\underline{23.52\ W}}.$$