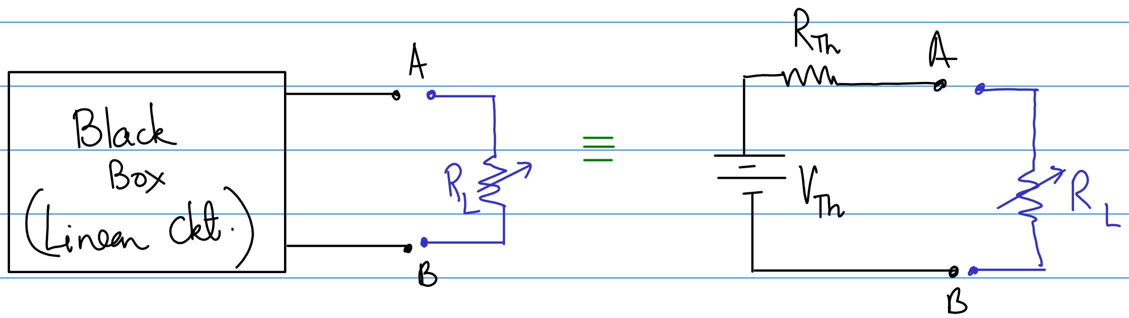
31.12.2021

Circuit Theorems

Recap:

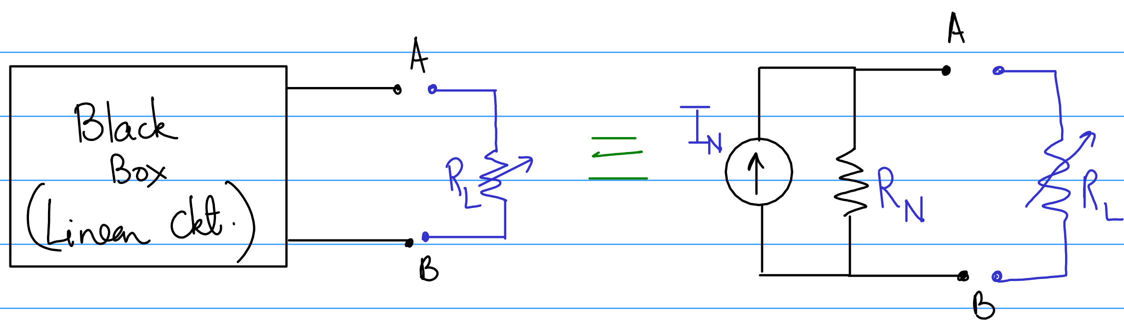
1) Superposition Theorem

2) Thevenin Theorem



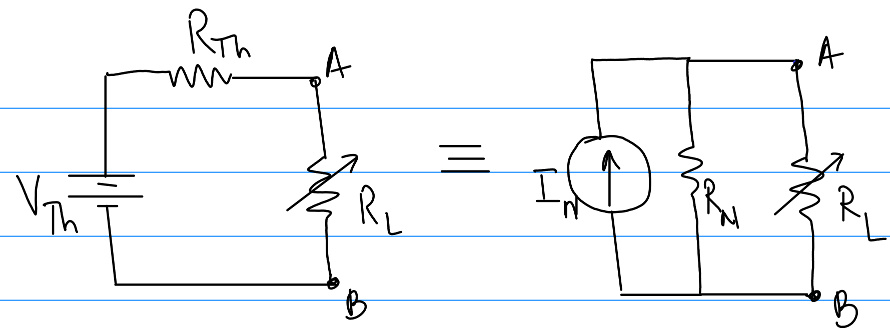
Black Box $\equiv$ replaced with a single voltage source V_{Th}. & a series resistance R_{Th}.

3) **Norton Theorem :**



here, $I_N = I_{sc}$ in Thevenin's equivalent ckt.

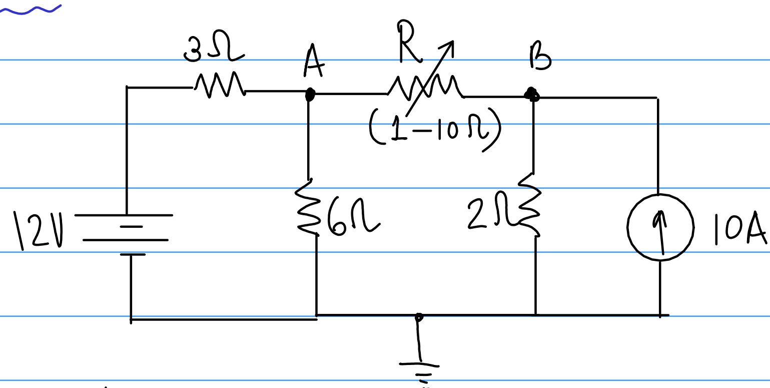
$$\boxed{I_N = \frac{V_{Th}}{R_{Th}}} \qquad \boxed{R_N = R_{Th}}$$



Thevenin's voltage $V_{Th} = V_{oc}$ (open ckt. voltage)

Norton's Current $I_N = I_{sc}$ (short ckt. current)

Example :



Fill this table :

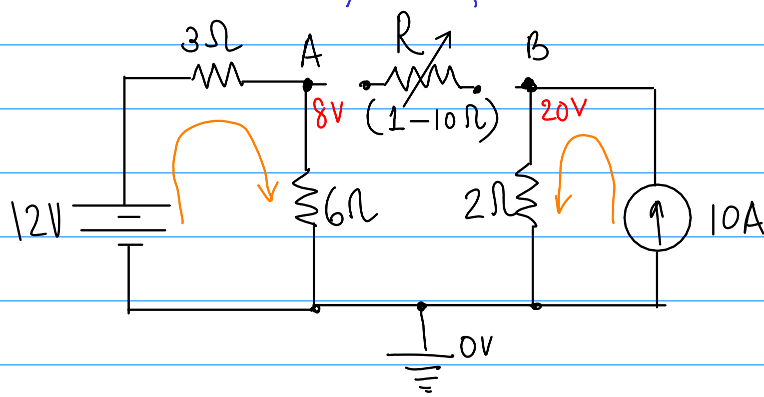
$\left[\frac{12V}{4\Omega+R}\right]\cdot R$ $\qquad$ $\left[\frac{12V}{4\Omega+R}\right]$

R (in Ω)	V_{AB} (in V)	I_{AB} (in A
1	2.4 V	2.4 A
2	4.0 V	2 A
3	5.1 V	1.7 A
4	⋮	⋮
⋮		
10		

Here we make use of Thevenin's theorem :

ie Thevenize the ckt. across the terminals A & B

Open the resistance R across 'A' & 'B'



$$V_{AB}\,(\text{open ckt.}) = V_A - V_B$$

$$V_B = 2\Omega \cdot 10A = 20V$$

$$V_A = \frac{6\Omega}{3\Omega + 6\Omega} \cdot 12V = 8V$$

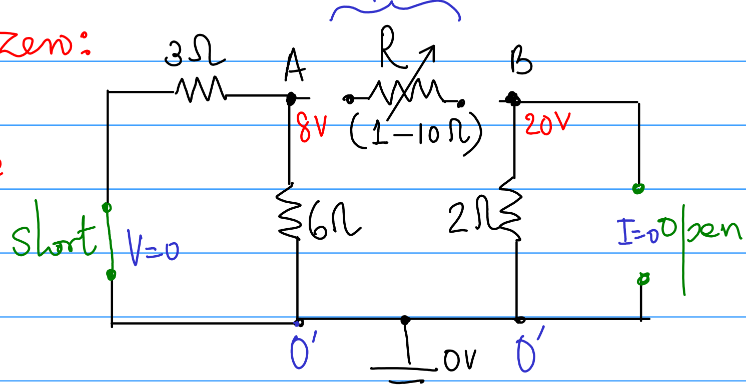
$$V_{AB} = V_A - V_B = 8V - 20V = -12V$$

$$\boxed{V_{Th} = V_{AB} = -12V}$$

Determination of R_{Th}:

Open the resistance R across 'A' & 'B'

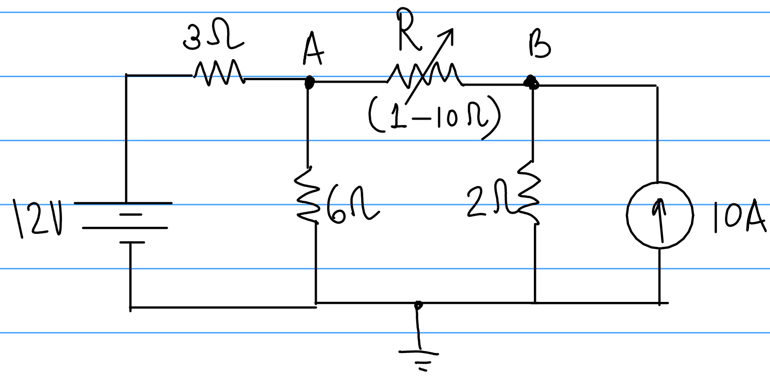
To make the source zero:
- Short voltage source
- open current source



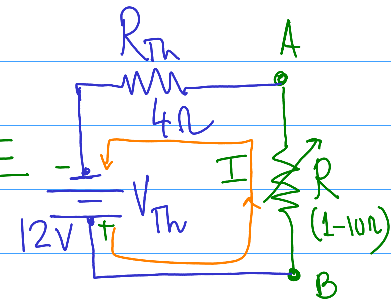
$$R_{eq(AB)} = R_{Th}$$

$$R_{Th} = (3\Omega \| 6\Omega) + 2\Omega$$

$$R_{Th} = 4\Omega$$

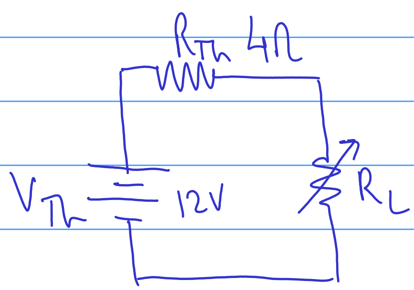


$\equiv$

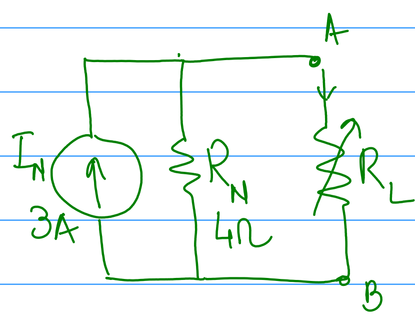


$$I_{AB} = \frac{V_{Th}}{R_{Th} + R} = \frac{12V}{4\Omega + R}$$

$$V_{AB} = I_{AB} \cdot R = \left[\frac{12V}{4\Omega + R}\right] \cdot R$$



$\equiv$



$I_{AB} =$

$V_{AB} =$

$$I_N = I_{sc} = \frac{V_{Th}}{R_{Th}} = \frac{12V}{4\Omega} = 3A$$