Electrical Engineering

Electronics and Communication Engineering

Instrumentation Engineering

Network Theory

Lecture No. 03

Basics of Network Theory

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1. Basic electrical Quantity
2. Energy conservation.
3. Condition for circuit.
4.
5.
6.

1. Different types of Sources.
2. KVL & KCL.
3. Question Discussion.
4.
5.
6.

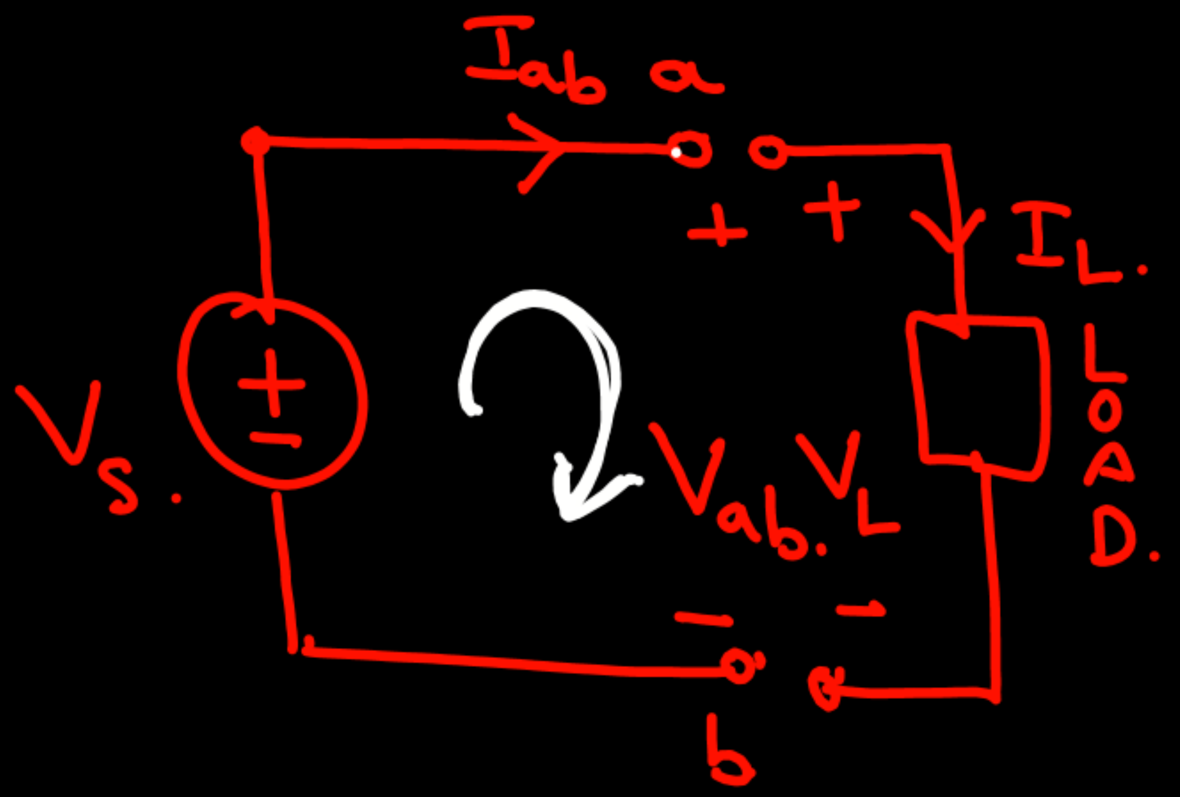
Topic-04 (Different kind of Sources)

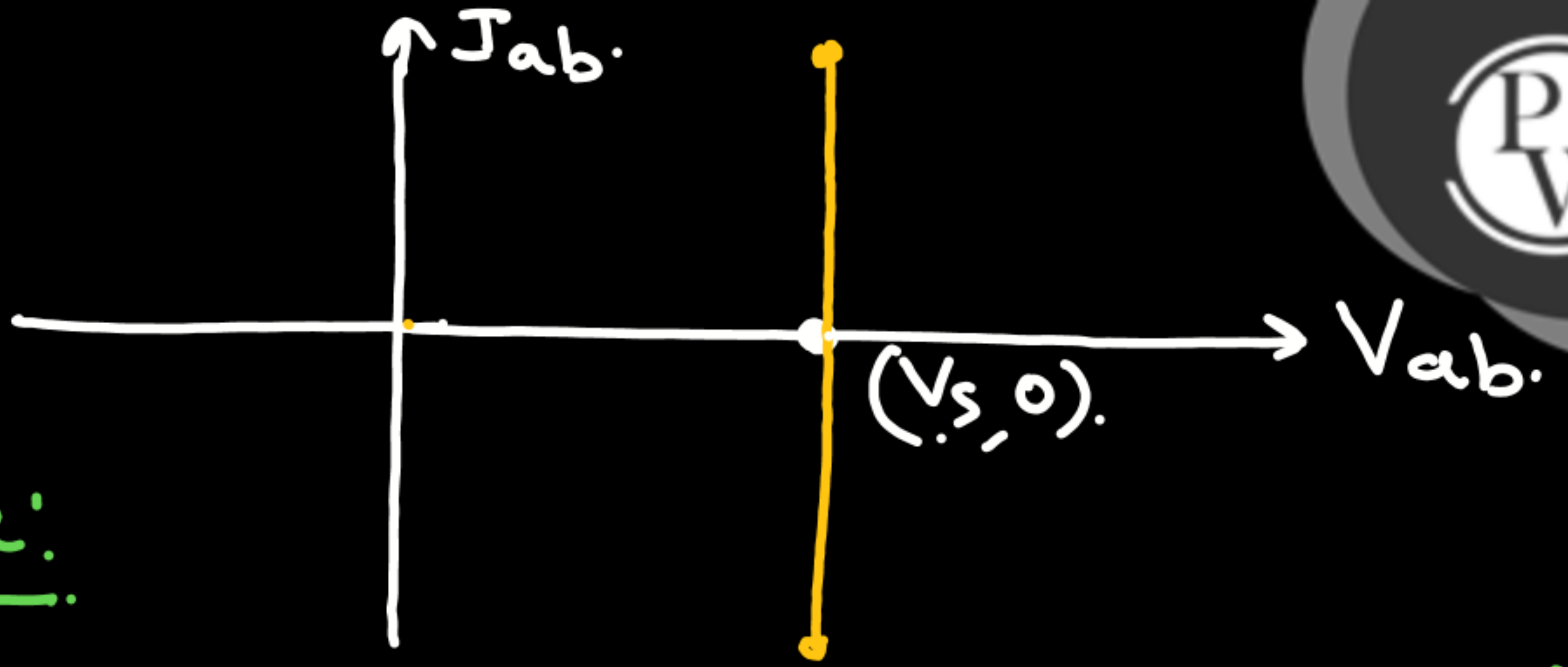
- Independent Sources.
  - Ideal Sources.
  - Practical Sources.
    - Voltage Sources
    - Current Source.
- Dependent Sources.
  - Ideal Source
  - Practical Sources.
    - Voltage Source
    - Current Source

(1) Independent Sources:

(a) Voltage Sources:

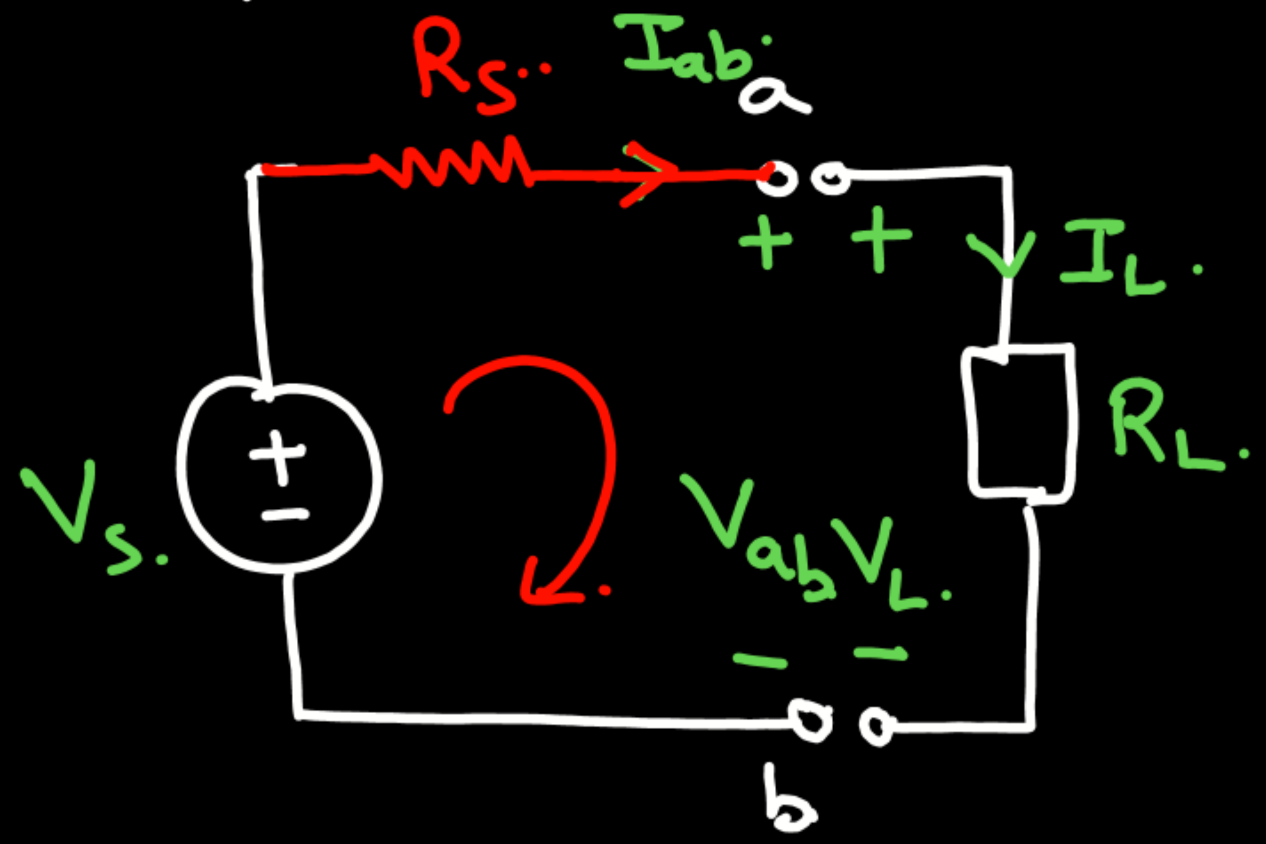
(1) Ideal voltage Source:





- $V_{ab} = V_s$ → Always (fixed).
  - → Independent of Load.
- I_{ab}. ⇒ ⊕, ⊖, 0 → can be any value.
  - → It will depend upon the load.
- I_{ab} Vs V_{ab} curve:

(2) Practical voltage Source:



- $V_{ab} \rightarrow$ Is not fixed. i.e it can be any value.
- $I_{ab} \rightarrow$ It can be any value.

Here V_{ab} & I_{ab} bath are decided by Load.

- $$\left[V_{ab} = V_S - I_{ab} \times R_S \right]$$

- I_{ab} V_s V_{ab} curve:

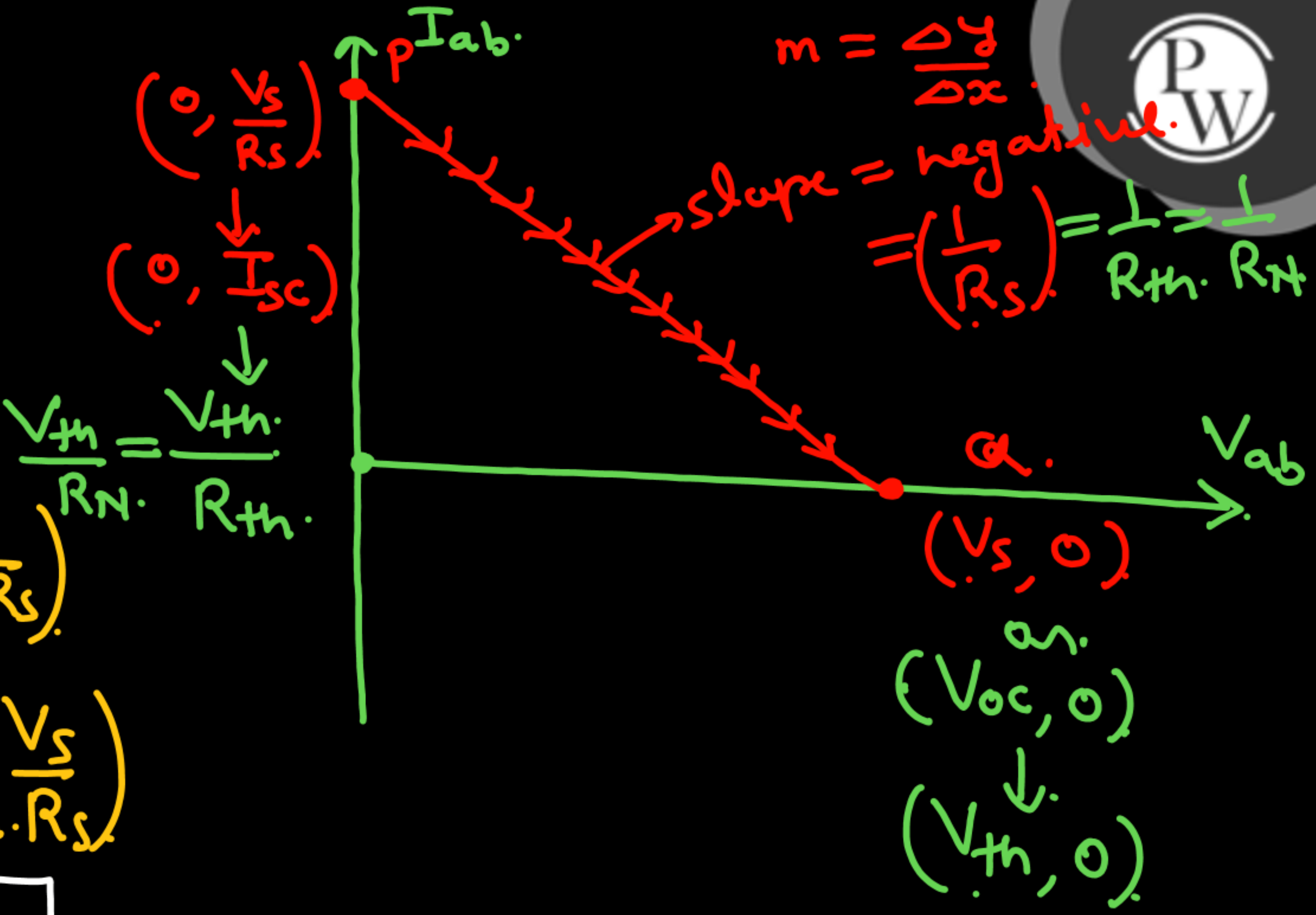
$$V_{ab} = V_s - I_{ab} \cdot R_s$$

$$I_{ab} = \frac{V_s - V_{ab}}{R_s}$$

$$I_{ab} = \frac{V_s}{R_s} - V_{ab} \times \left(\frac{1}{R_s}\right)$$

$$I_{ab} = -\left(\frac{1}{R_s}\right) \cdot V_{ab} + \left(\frac{V_s}{R_s}\right)$$

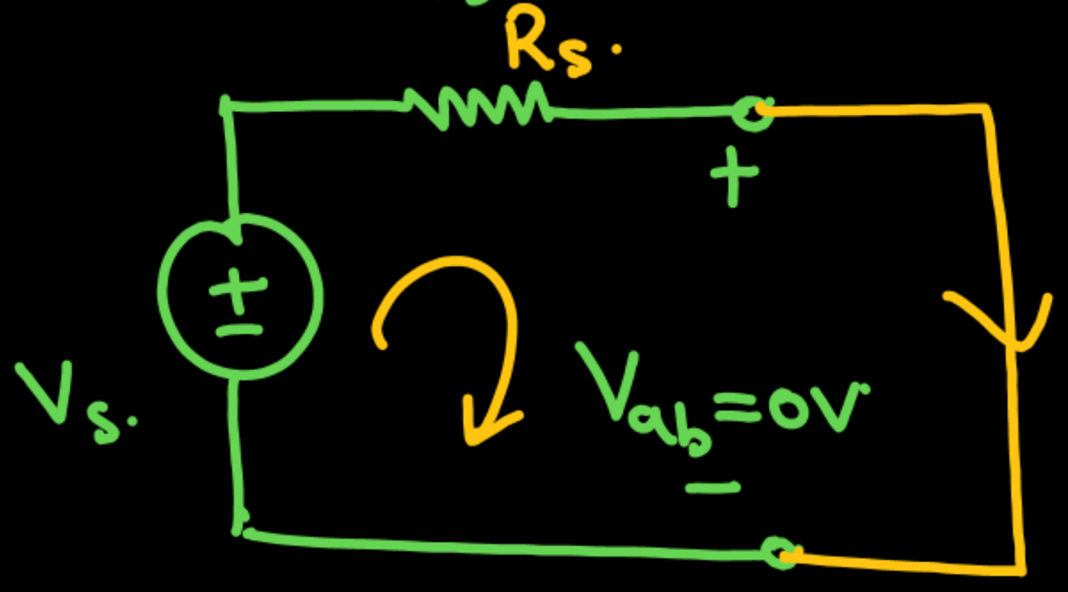
$$\left[\, y = -m x + C \,\right]$$



conclusion:

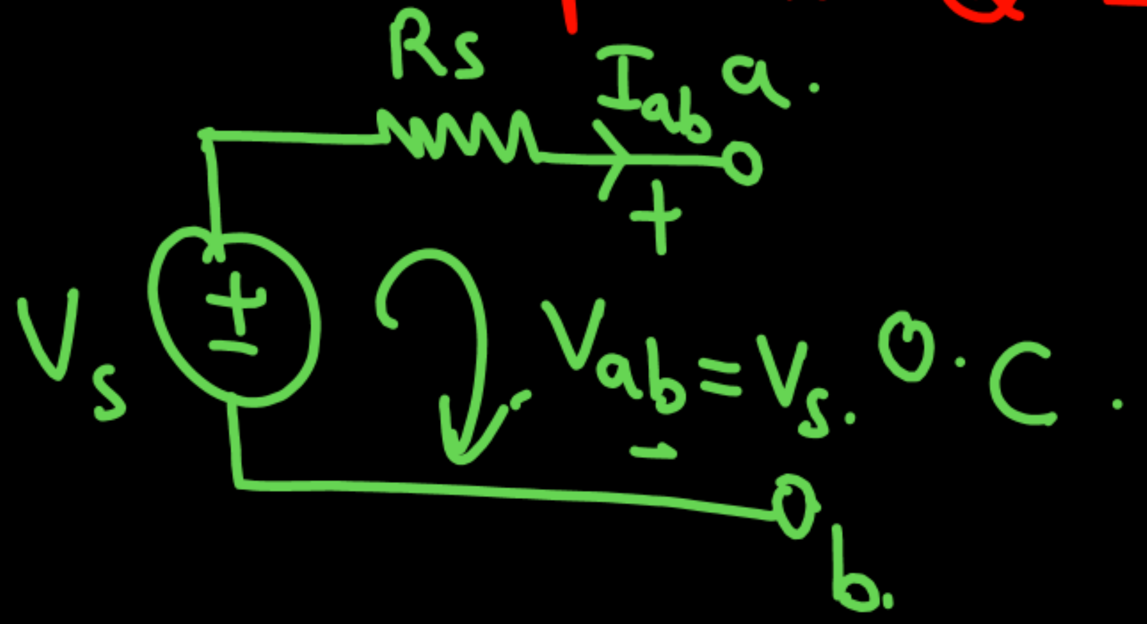
(1) at point 'P' $\rightarrow$

$V_{ab} = 0\,V$ & $I_{ab} = \frac{V_s}{R_s} = I_{sc} = I_N =$ Norton current



$I_{ab} = \frac{V_s}{R_s} =$ Short circuit current

(2) at point 'Q' $\rightarrow$

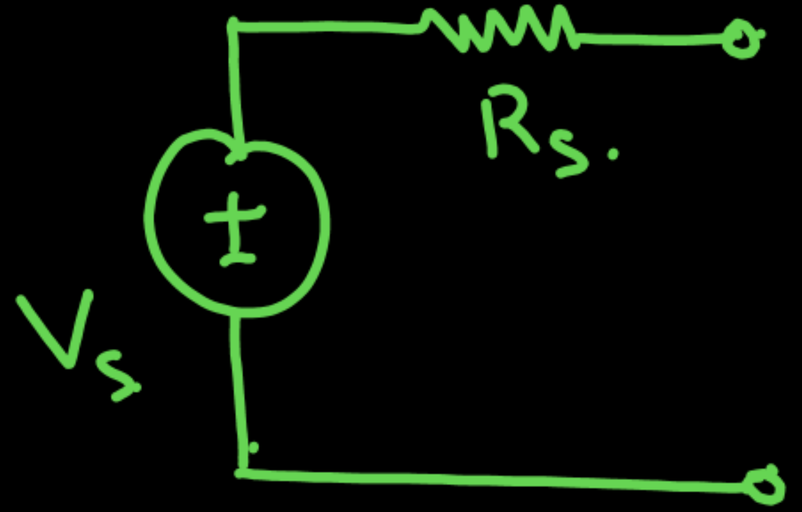


$V_{ab} = V_s$, $I_{ab} = 0\,A \rightarrow$ open circuit

$V_{ab} = V_s = V_{oc} =$ open circuit voltage

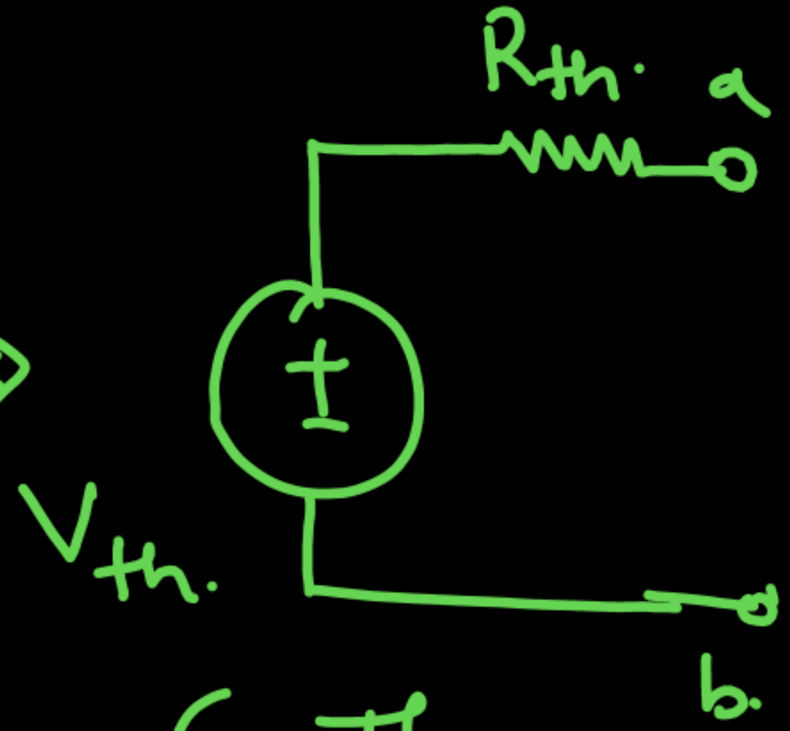
$= V_{th} =$ Thevenin voltage.

Hence, a Practical voltage Source is equivalent of Thevenin model.



(PVS)

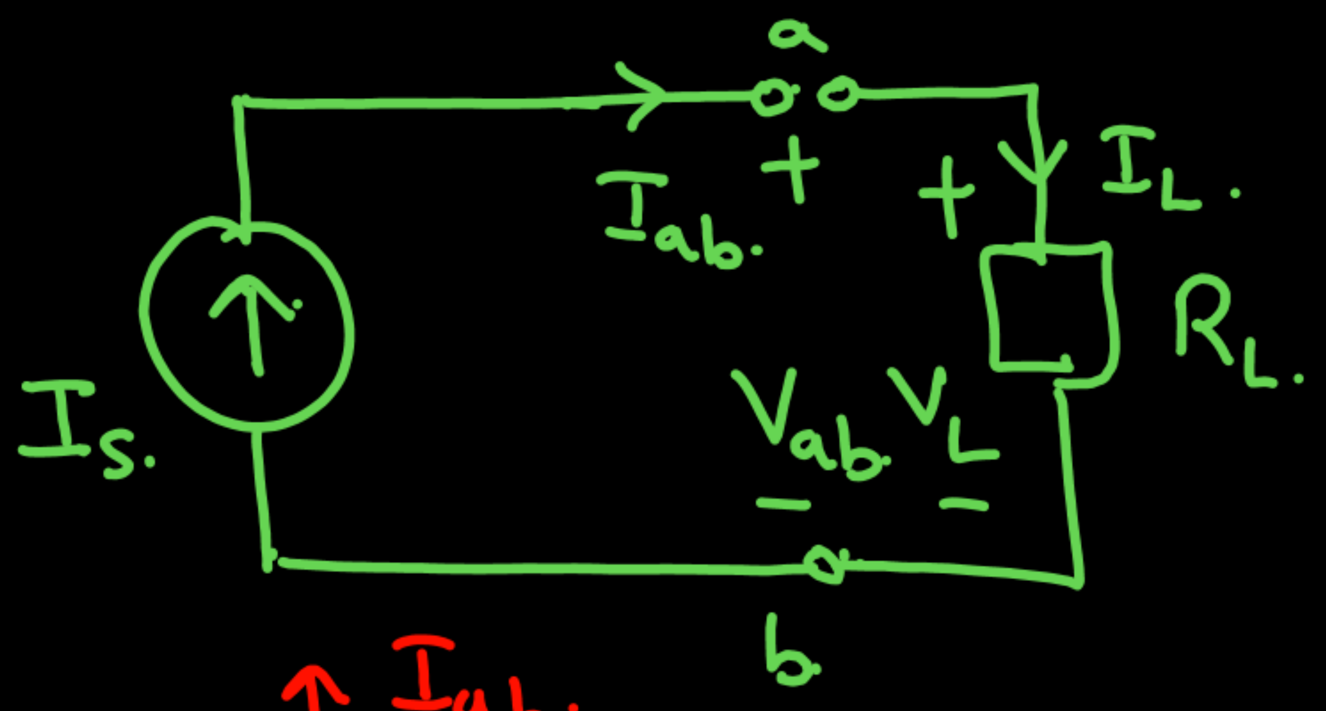
$\Rightarrow$

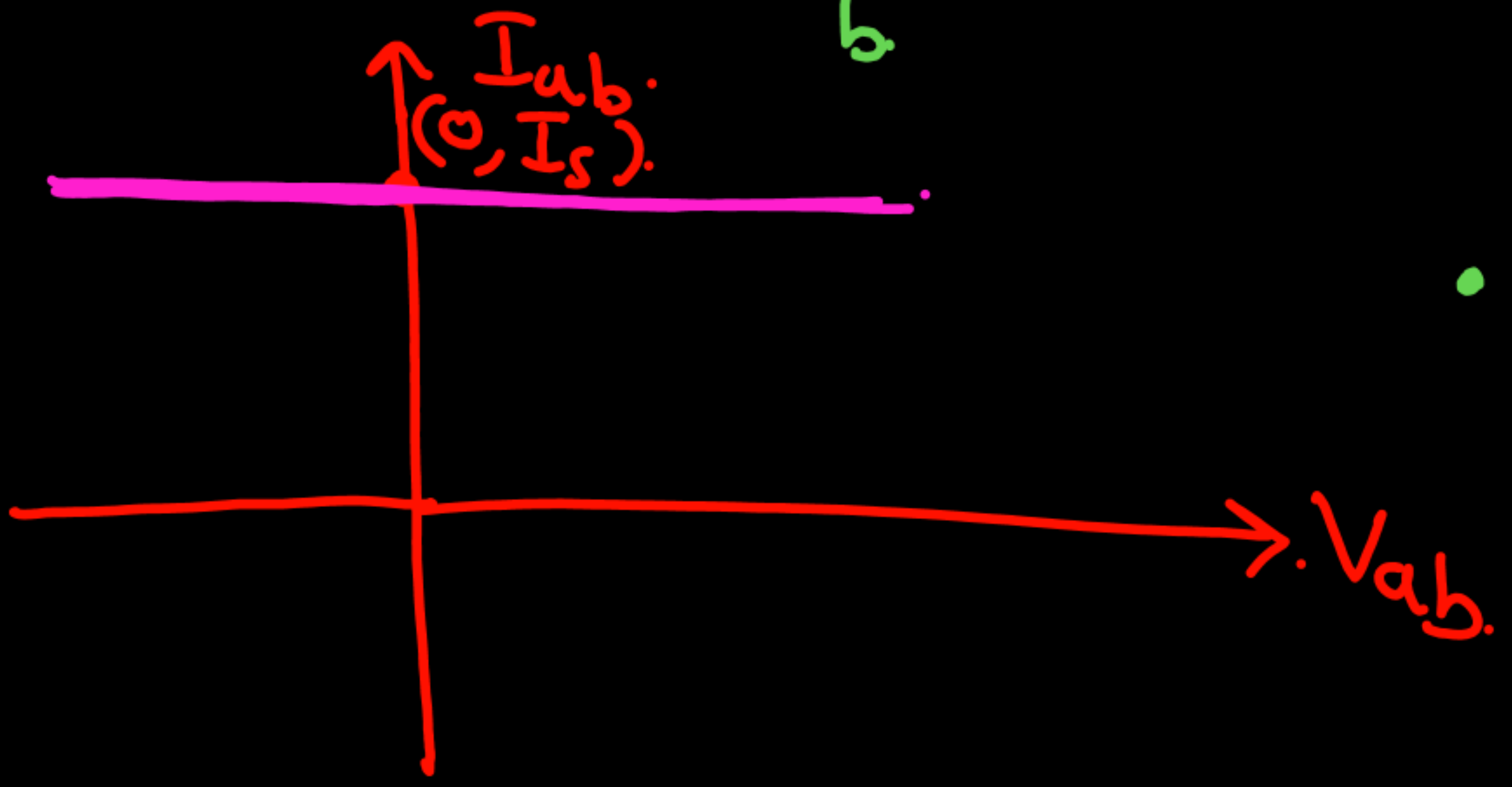


(Thevenin Model)

(b) Current Source:

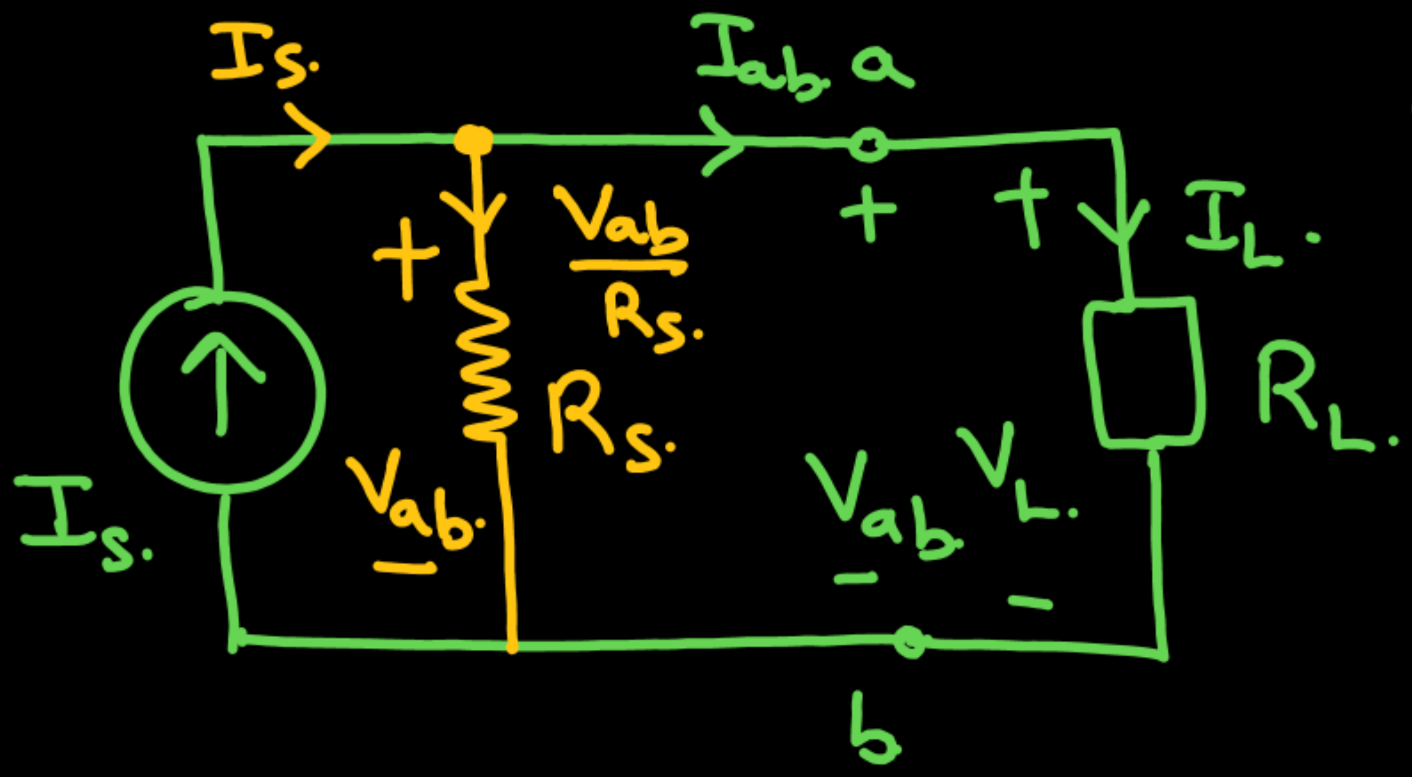
(1) Ideal current Source:





- $I_{ab} = I_s \rightarrow$ Always (fixed).
  - $\rightarrow$ Independent of Load.
- $V_{ab} \rightarrow$ can be any value.
  - $(\oplus, 0, \ominus)$.
  - $\rightarrow$ It depends upon the load.
- I_{ab} Vs V_{ab} curve (I-V curve).

(2) Practical current Source:



$I_{ab} \longrightarrow$ can be any value.
$V_{ab} \longrightarrow$ can be any value.
$\longrightarrow$ Depends upon load.

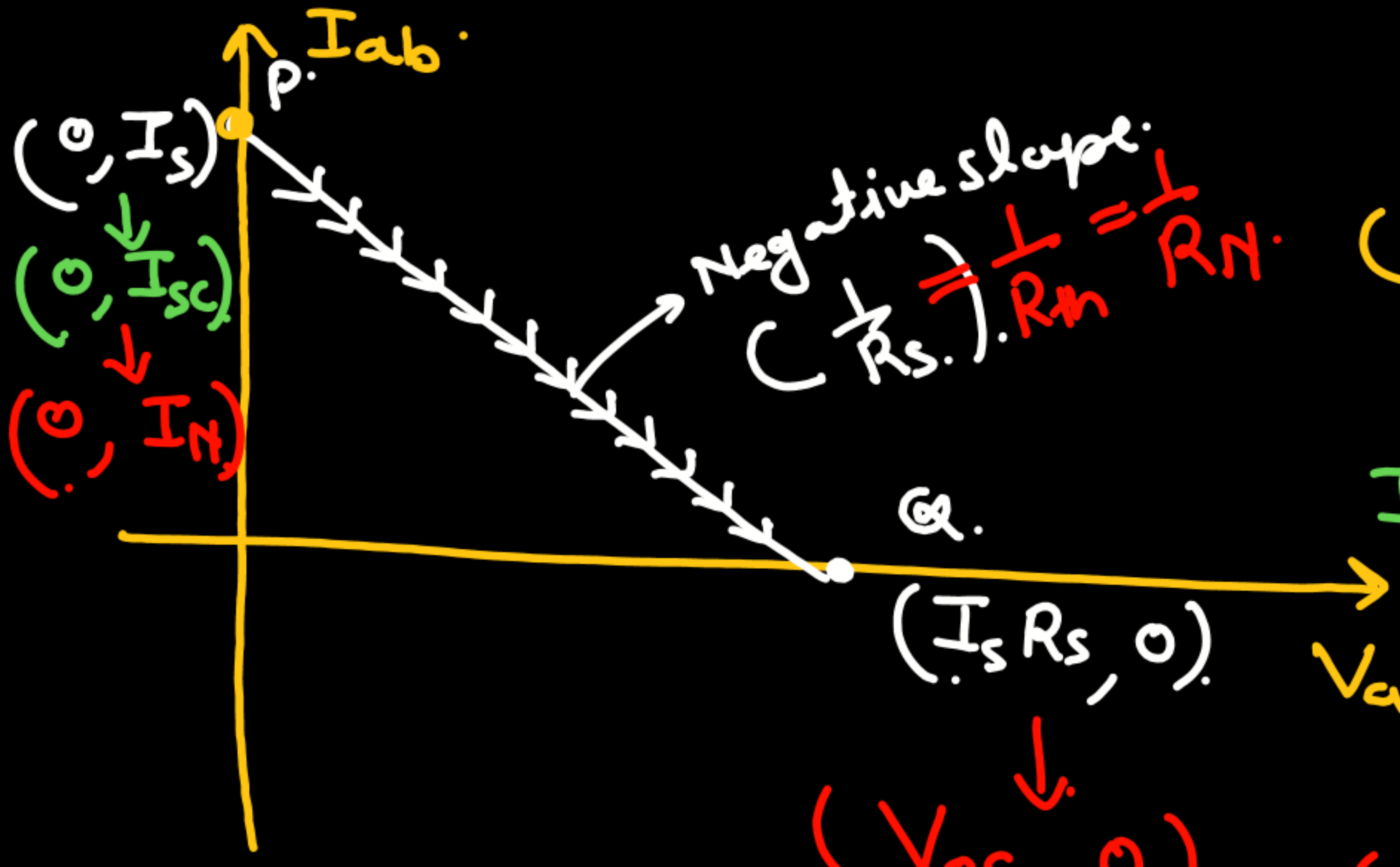
- $I_s = \frac{V_{ab}}{R_s} + I_{ab}$.

$$I_{ab} = I_s - \frac{V_{ab}}{R_s}.$$

$$\left[I_{ab} = -\frac{1}{R_s} \cdot V_{ab} + I_s \right].$$

$$[y = -mx + c].$$

- I_{ab} V_s V_{ab} curve (I V_s V)



$(V_{oc}, 0)$

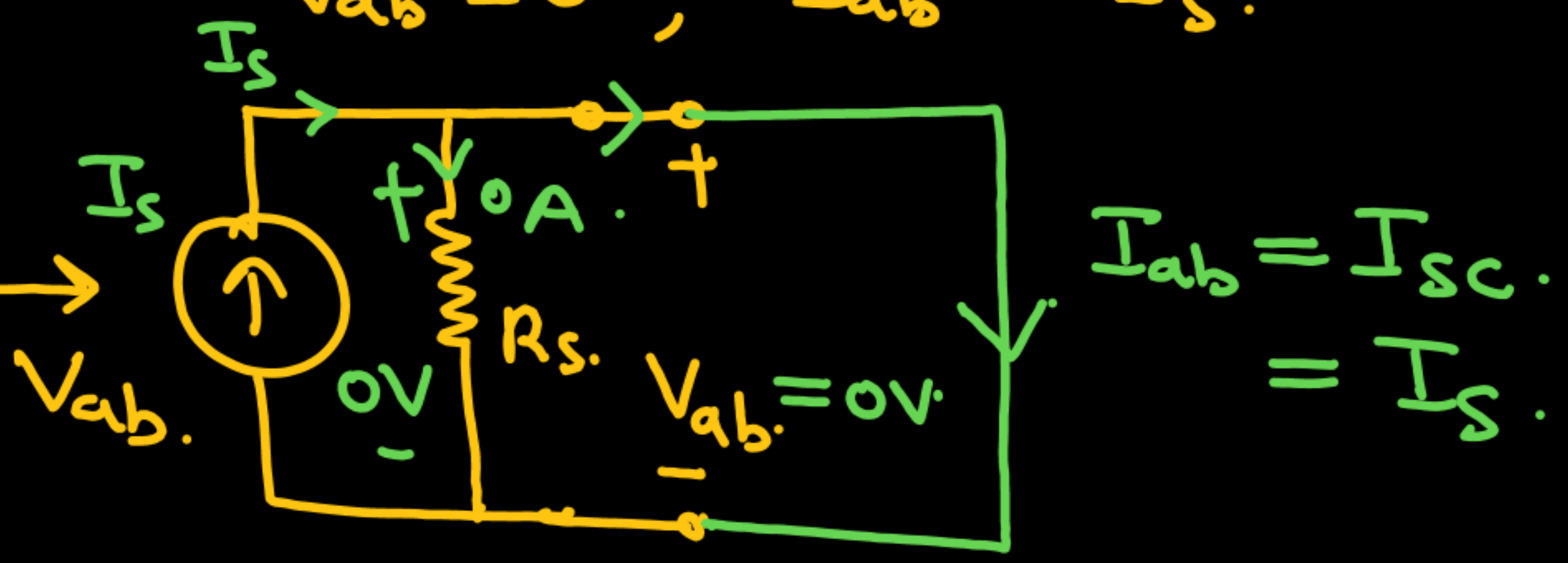
$\downarrow$

$(V_{th}, 0)$

conclusion:

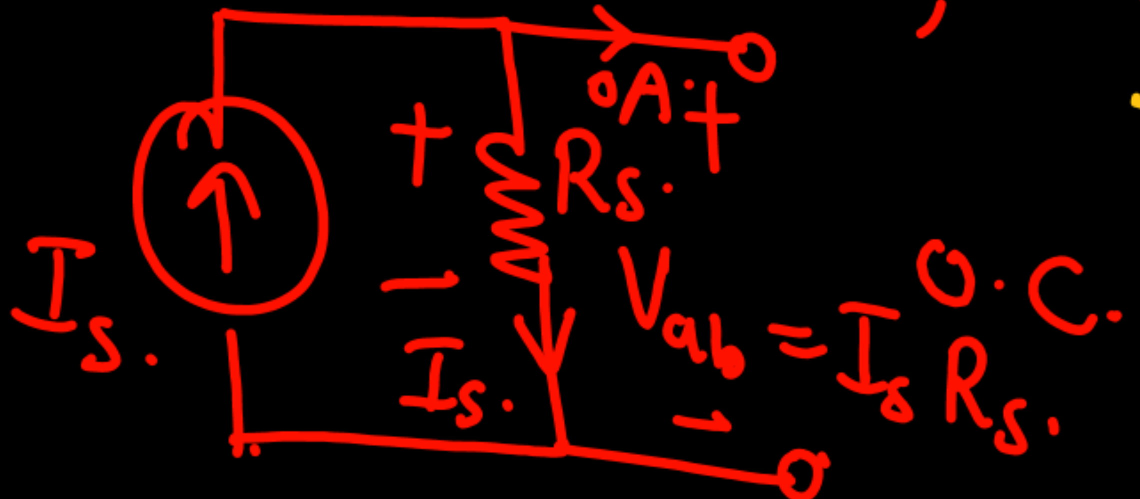
(1) At point 'P' $\rightarrow$

$V_{ab} = 0\,V, \quad I_{ab} = I_s$

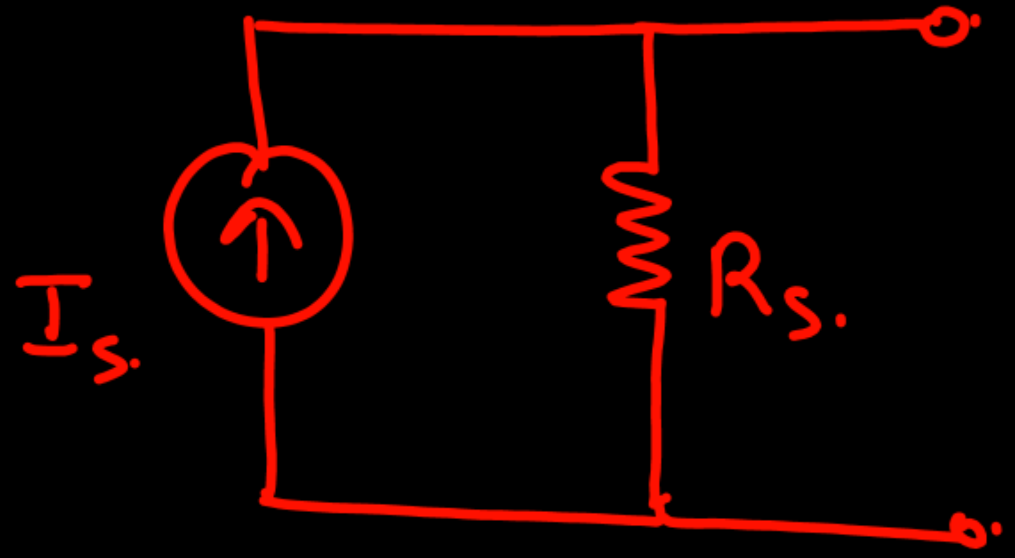


(2) At point 'Q' $\rightarrow$

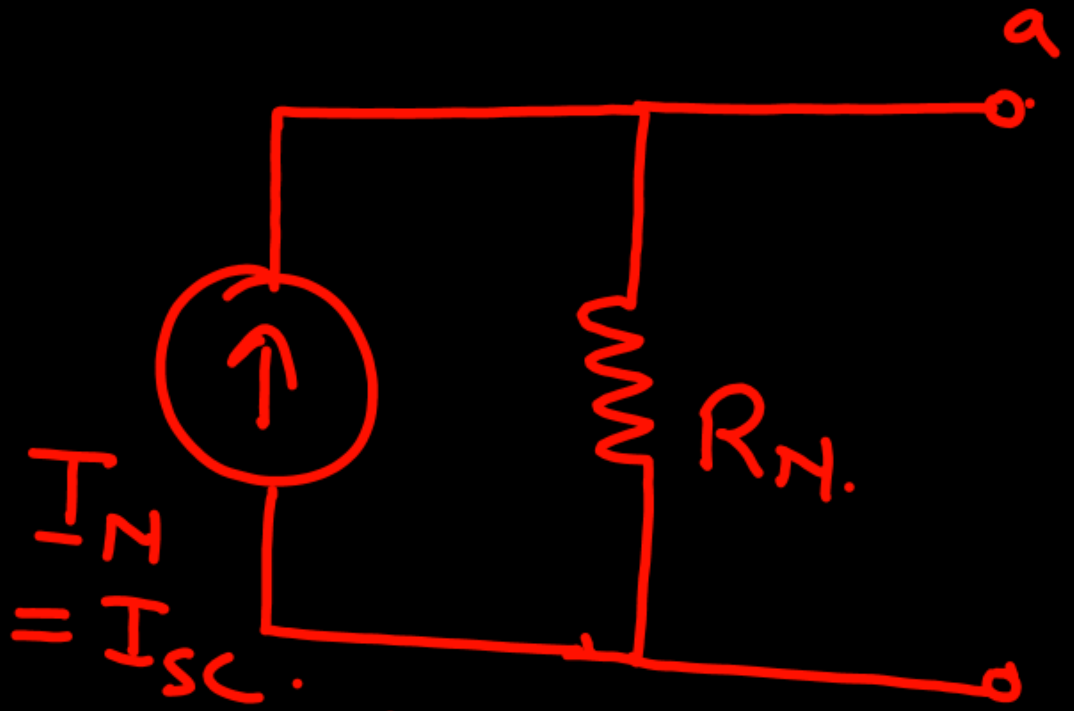
$V_{ab} = I_s \cdot R_s, \quad I_{ab} = 0\,A$



- Hence a Practical current Source is equivalent of Norton Model.



(PCS)



(Norton Model).

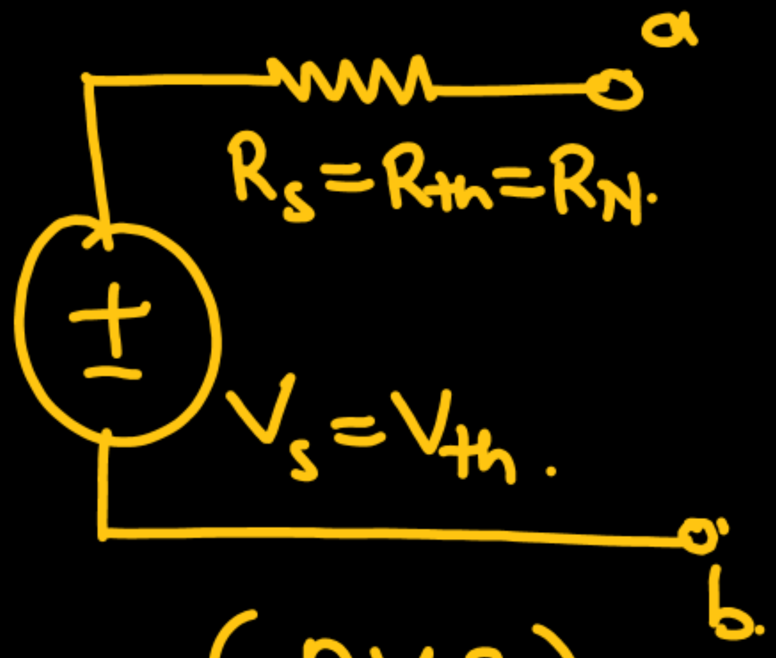
- Hence from PVS & PCS modelling, we can say.

$$\left[I_{SC} = I_s = I_N = \frac{V_{th}}{R_{th}} = \frac{V_s}{R_s} \right] \rightarrow (P)$$

• $\left[V_{oc} = V_{th} = V_s = I_s R_s = I_{sc} \cdot R_{th} = I_N \cdot R_N \right]$ $\hookrightarrow$ Q.

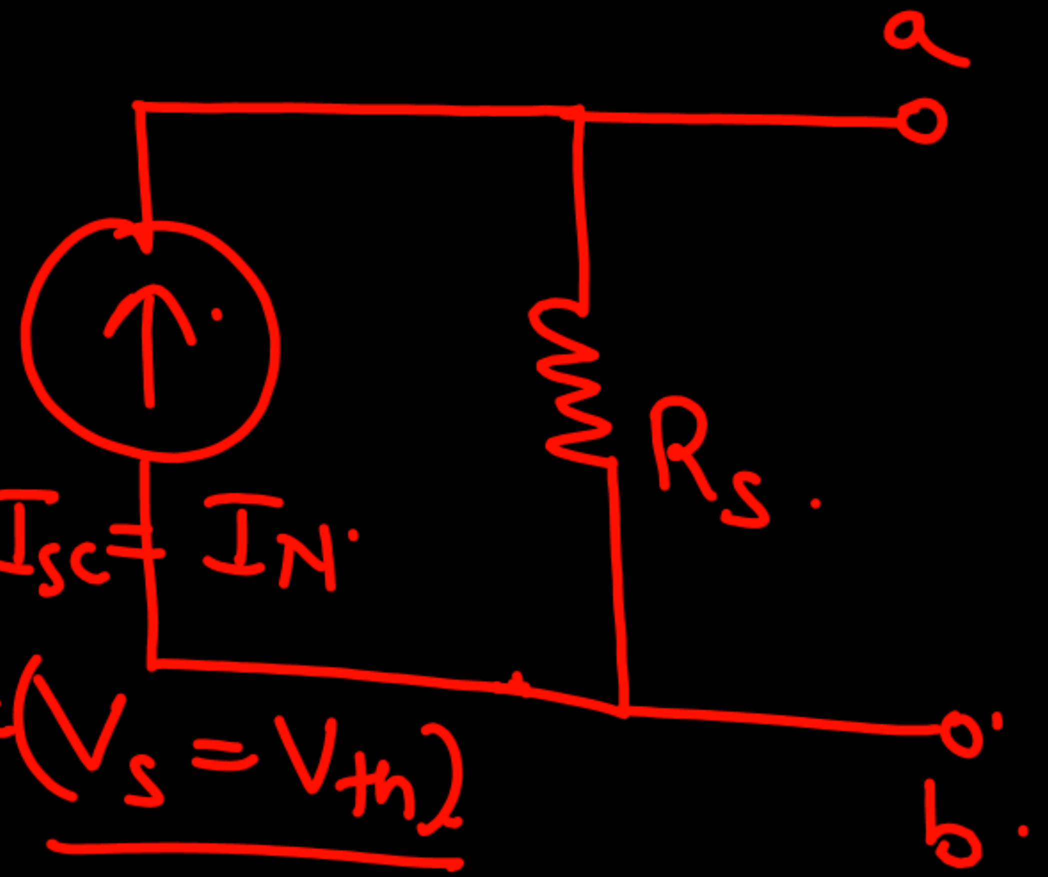
Hence,

<u>case-I</u> if we have PVS.



(PVS)

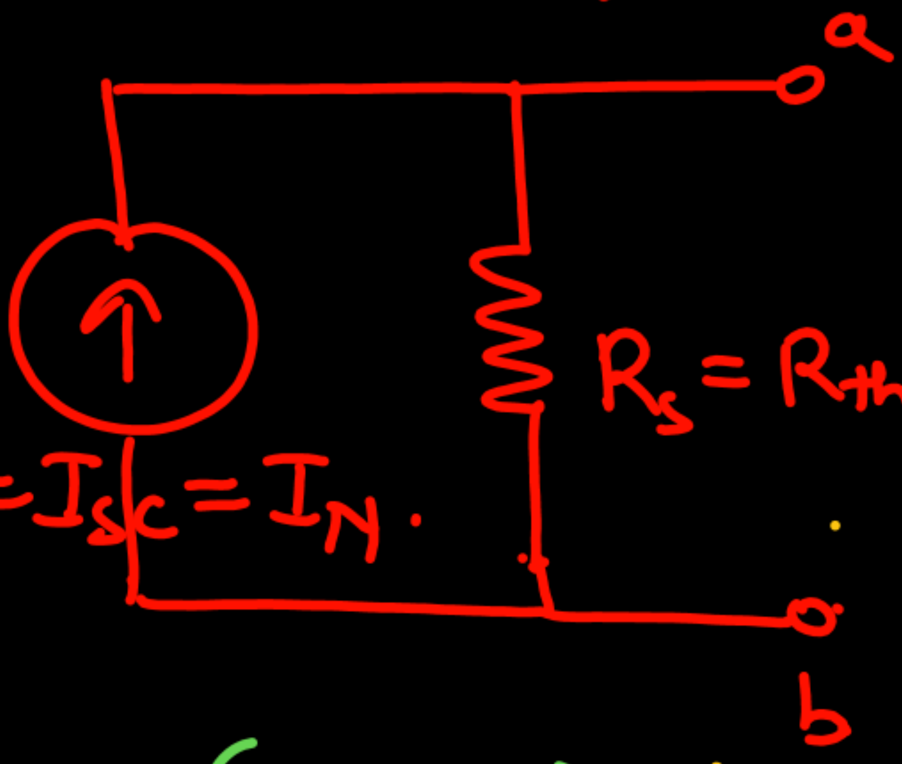
$\Longrightarrow$



$I_s = I_{sc} = I_N = \dfrac{(V_s = V_{th})}{R_s = R_{th}}$

$\rightarrow$ (Source transformation).

Case-II if we have PCS:

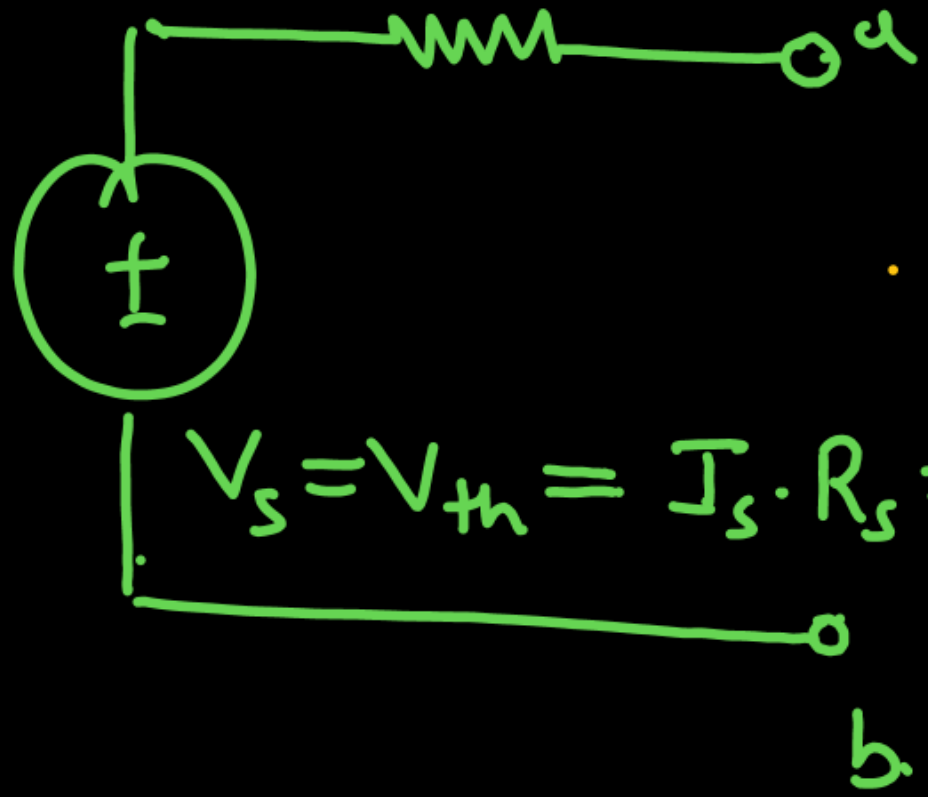


$R_s = R_{th} = R_N$.

$I_s = I_{sc} = I_N$.

(PCS) $\Rightarrow$

$R_s = R_{th} = R_N$.



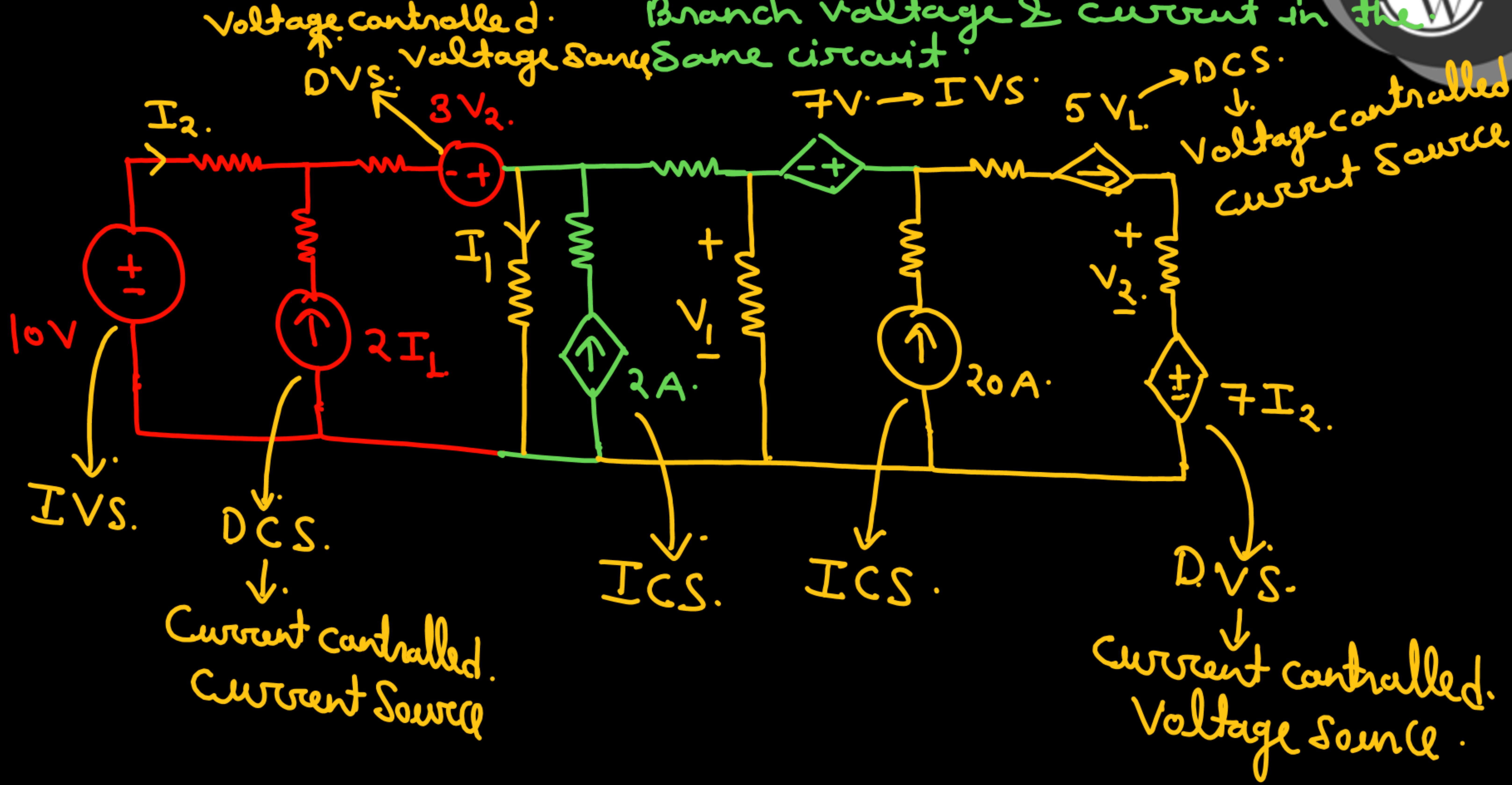
$V_s = V_{th} = I_s \cdot R_s = I_N \cdot R_N$.

$= I_{sc} \cdot R_{th}$.

(Source transformation).

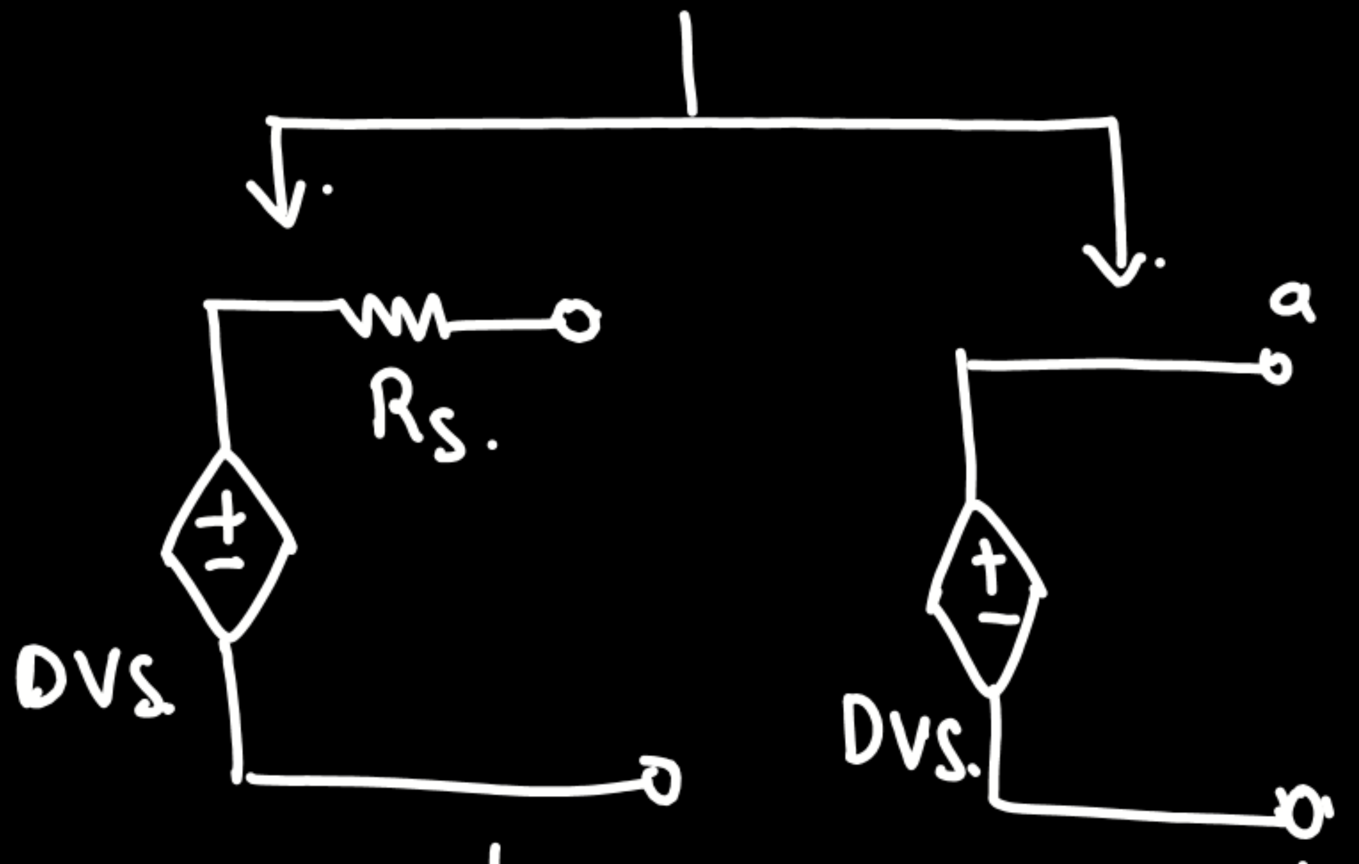
(2) Dependent Sources:

The Source which depends upon other Branch voltage & current in the Same circuit.



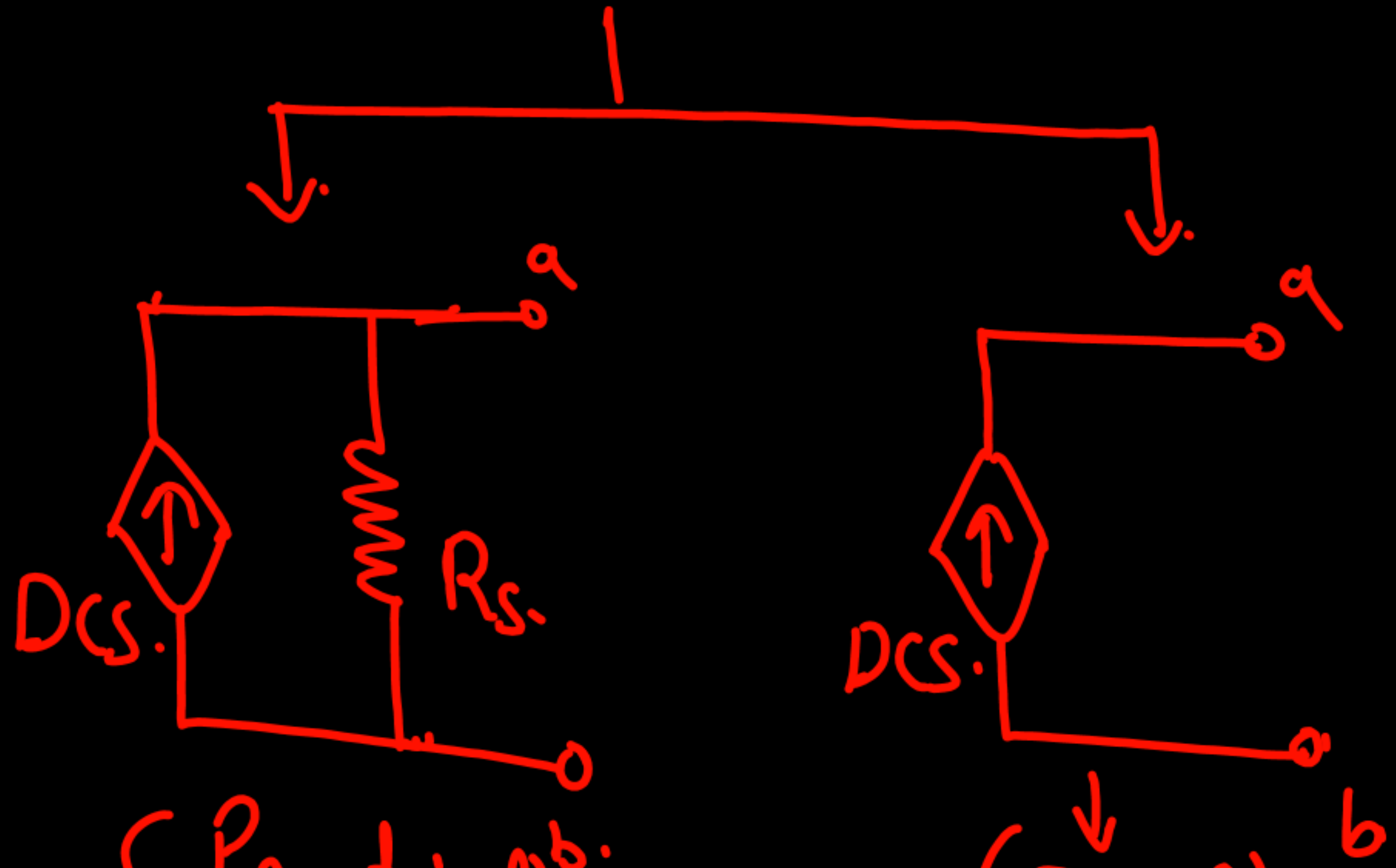
- DCS
  - VCCS.
  - CCCS.
- DVS
  - VCVS.
  - CCVS.

DVS.



(Practical) (Ideal)

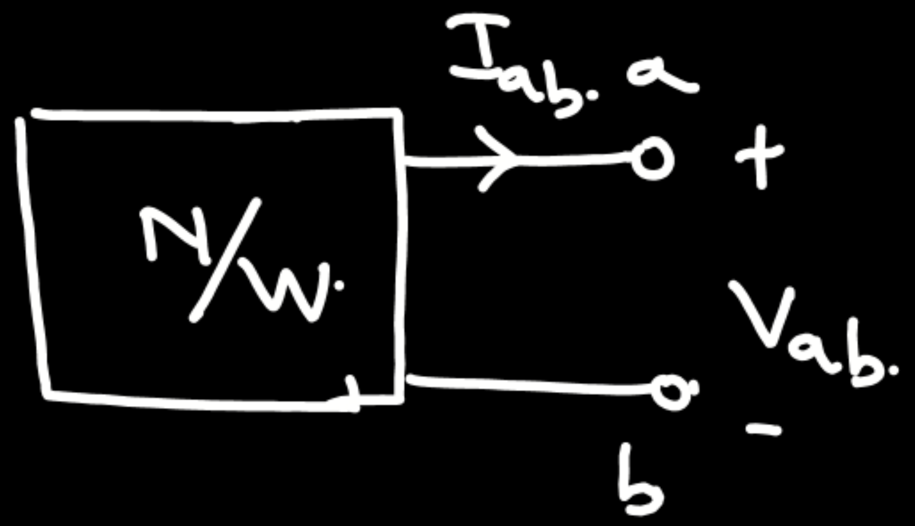
DCS.



(Practical) (Ideal)

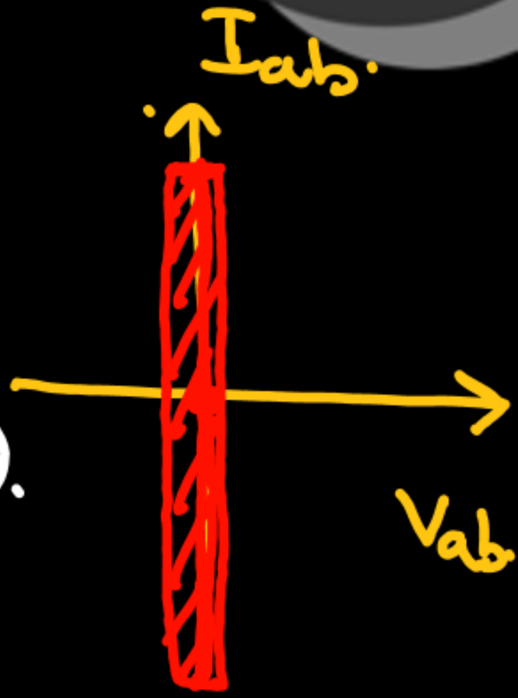
Note: (Always Remember).

(1) Short ckt condition:

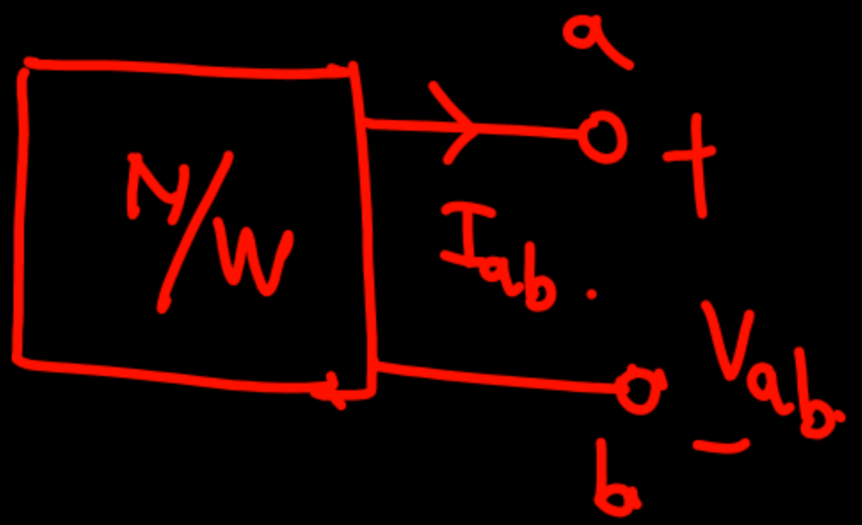


$V_{ab} = 0V$ (Always).

$I_{ab} \Rightarrow$ anything $(0, +, -)$.

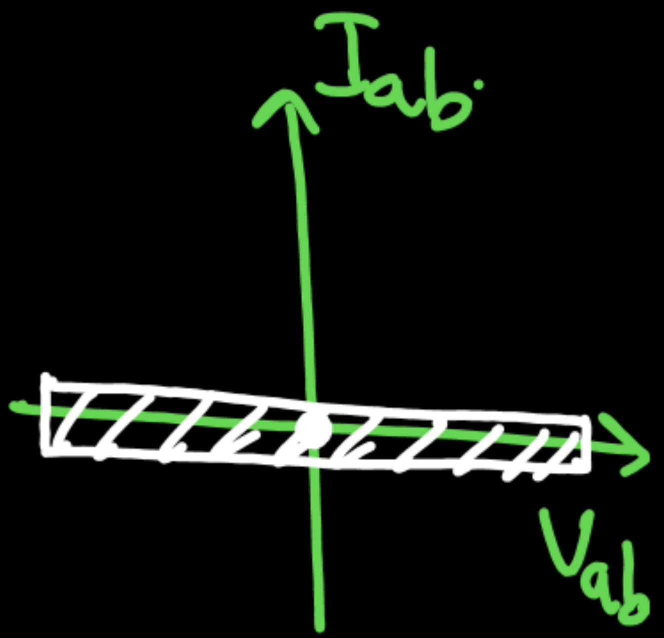


(2) open-circuit condition:



$I_{ab} = 0\,A$ (Always).

$V_{ab} \Rightarrow$ Anything $(0, +, -)$.



(3) if in any Question, at 'ab' terminal.

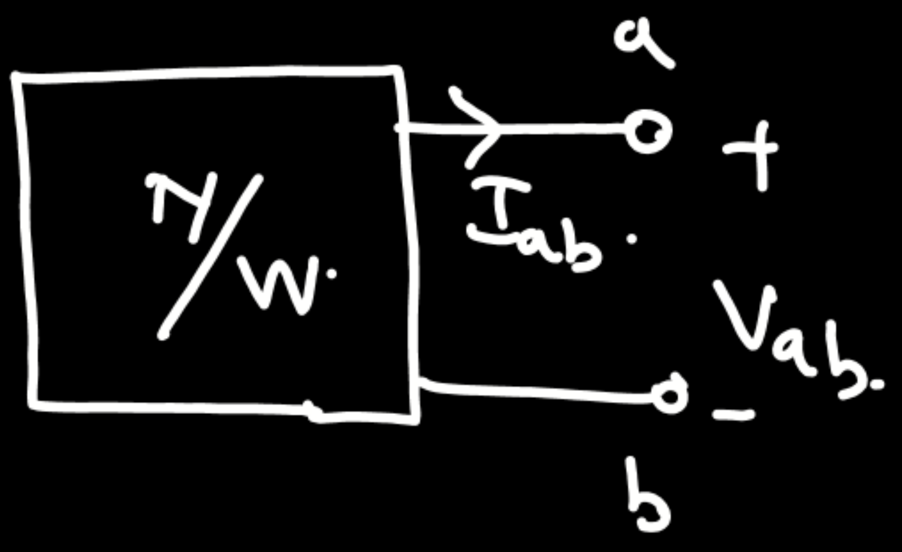
$$\left[\underbrace{V_{ab} = 0V \;\; \& \;\; I_{ab} = 0A}\right]$$

↓

You have your choice.

↓

(You can short or You can open)

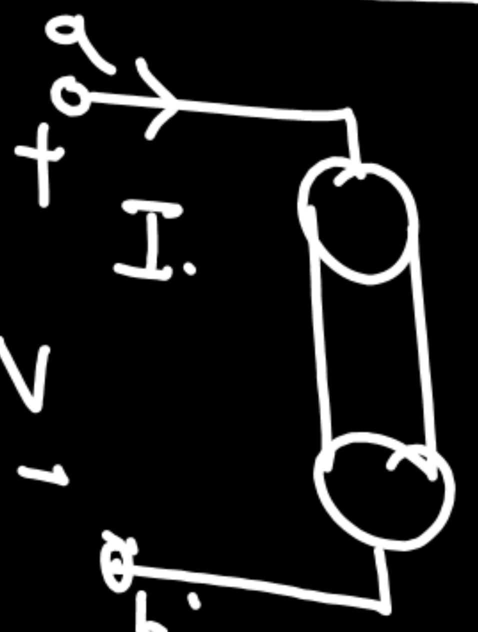


(4) ohm's law:

$V \propto I$ or $I \propto V$

$[V = RI]$ or $[I = G \cdot V]$

$\left(G = \frac{1}{R} = \mho, \; R \Rightarrow \Omega\right)$



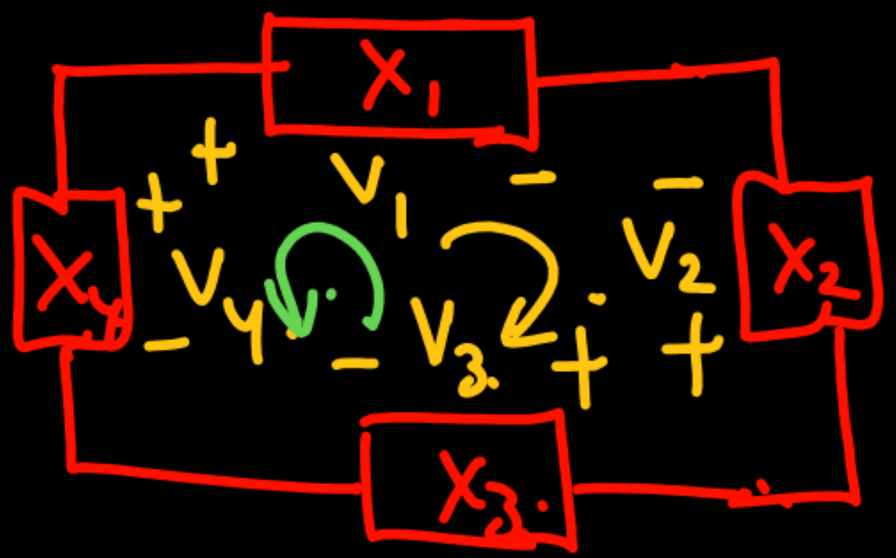
Topic-05 (KVL & KCL).

Note: This is the best Possible Numerical Solving technique.

KVL → [Kirchhoff's voltage law]

- In any loop or in any closed Path.

$$\left[\sum V_{loop} = 0\right]$$



- In a loop,

$$\sum V_{loop} = 0\,V.$$

- $$\left[\sum V_{rise} = \sum V_{drop}\right]$$

$$\left\{\begin{array}{l} \overset{-\qquad +}{\longrightarrow} \;\longrightarrow\; \text{voltage rise.} \\ \overset{+\qquad -}{\longrightarrow} \;\longrightarrow\; \text{voltage drop.} \end{array}\right\}$$

Step-01. choose one.
Direction.
clockwise or.
Anticlockwise.

Case-I clockwise.

$$\underbrace{V_1 + V_3}_{V_{drop}} = \underbrace{V_2 + V_4}_{V_{rise}} \checkmark$$

$$V_1 + V_3 = V_2 + V_4 \checkmark$$

$$\left[V_1 + V_3 - V_4 - V_2 = 0\right] ✓$$

<u>case-II</u> Anticlockwise.

$$\underbrace{V_1 + V_3}_{V_{rise}} = \underbrace{V_2 + V_4}_{V_{drop}} ✓$$

$$\left[V_1 + V_3 - V_2 - V_4 = 0\right] ✓$$

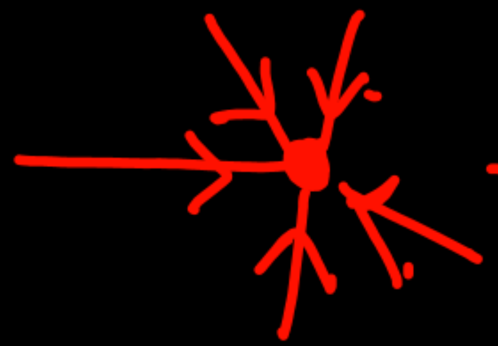
KCL → (Kirschaff's current law).

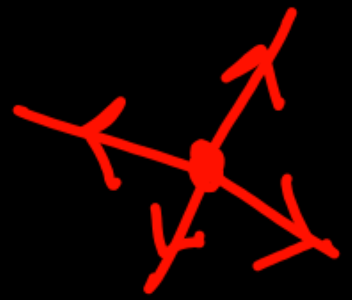
- At any node,

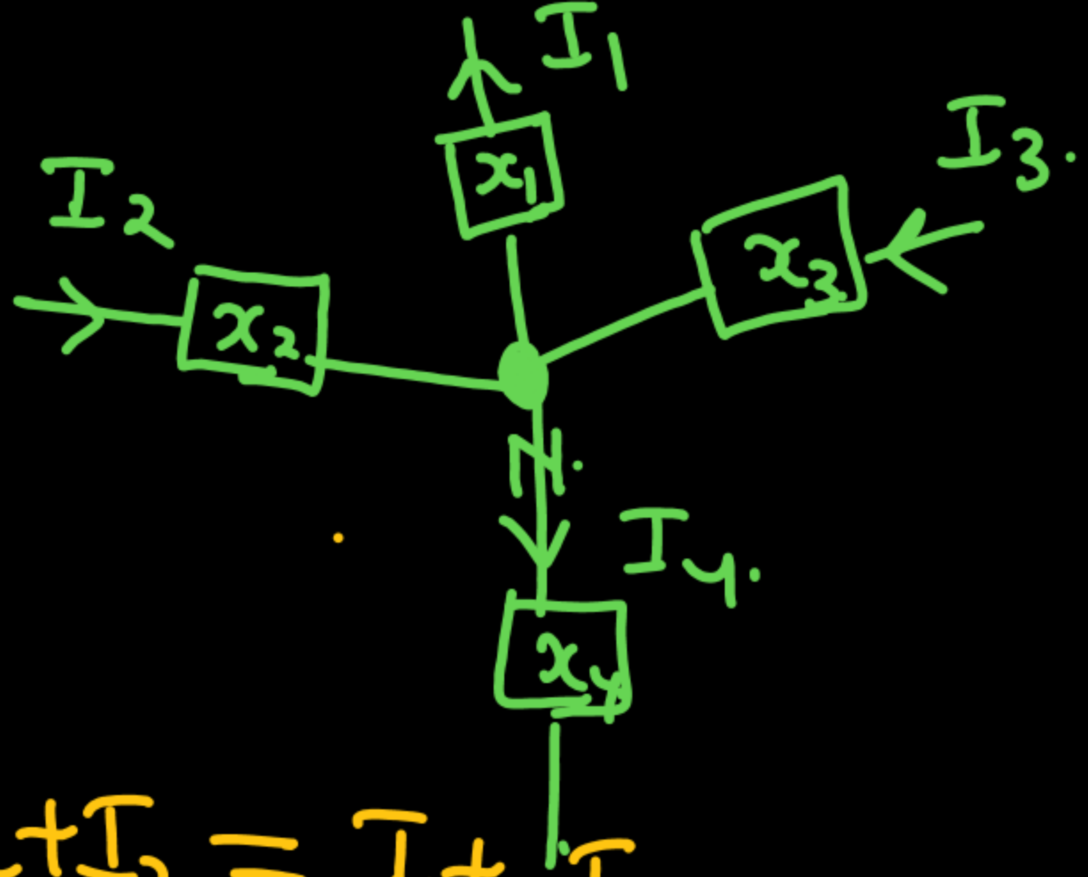
$$\left[\sum I_{node} = 0\right]$$

$$\Downarrow$$

$$\left[\sum I_{incoming} = \sum I_{outgoing}\right]$$


→ incoming current.


→ Outgoing current.



- $I_2 + I_3 = I_1 + I_4$.

$$\left[I_1 + I_4 - I_2 - I_3 = 0\right]$$

(How to Solve Numericals of chapter-01).

Step-01.

Thank you

GW Soldiers !