Electrical Engineering

Electronics and Communication Engineering

NETWORK THEORY

Lecture No. 02

BASICS OF NETWORK THEORY

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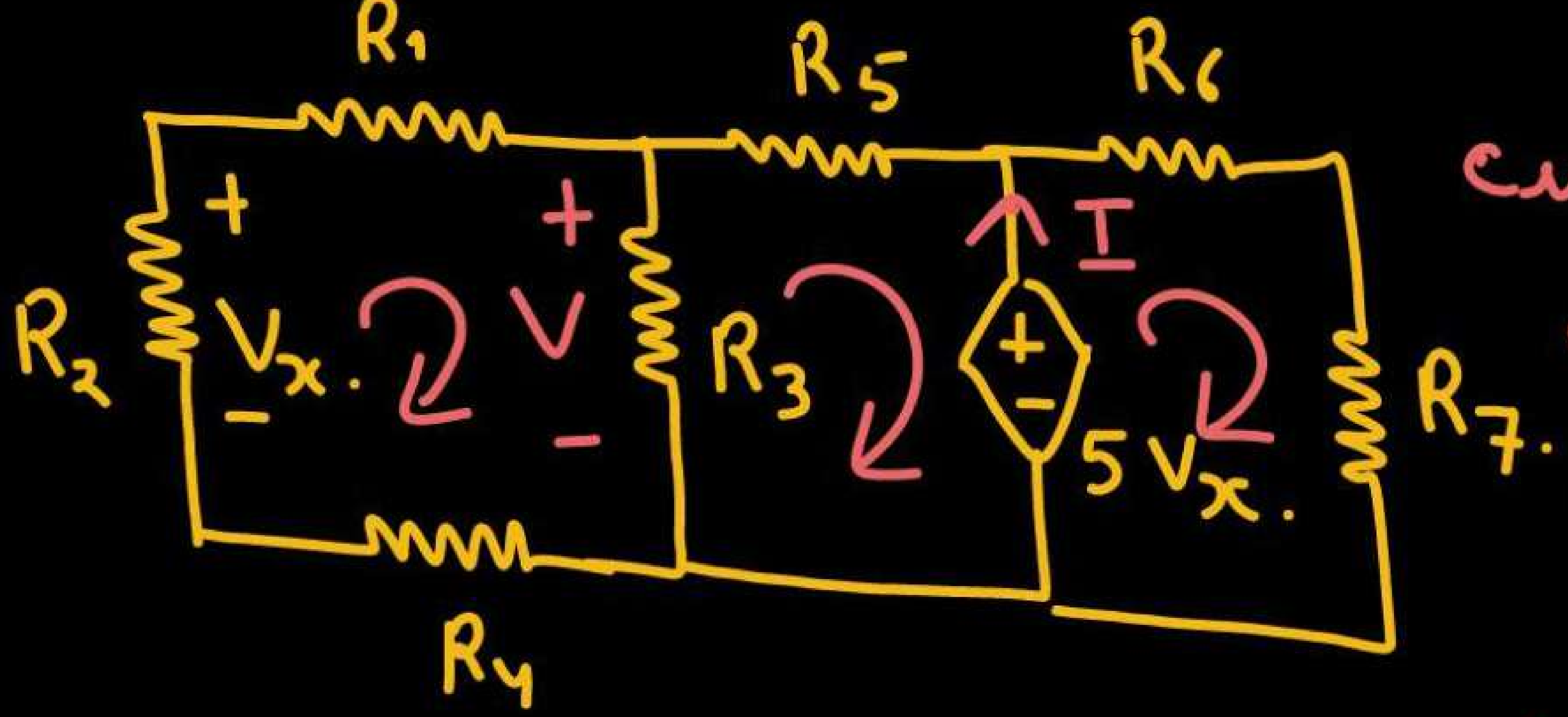
1. Basics
2. KVL & KCL
3. Sources
4.
5.
6.

[• $P_{absorb} = \oplus$ or $\ominus \longrightarrow P_{Actual\,absorb} = \oplus$]

$P_{deliver} = \oplus$ or $\ominus \longrightarrow P_{Actual\,Deliver} = \oplus$

GATE GATE

•



current flow →

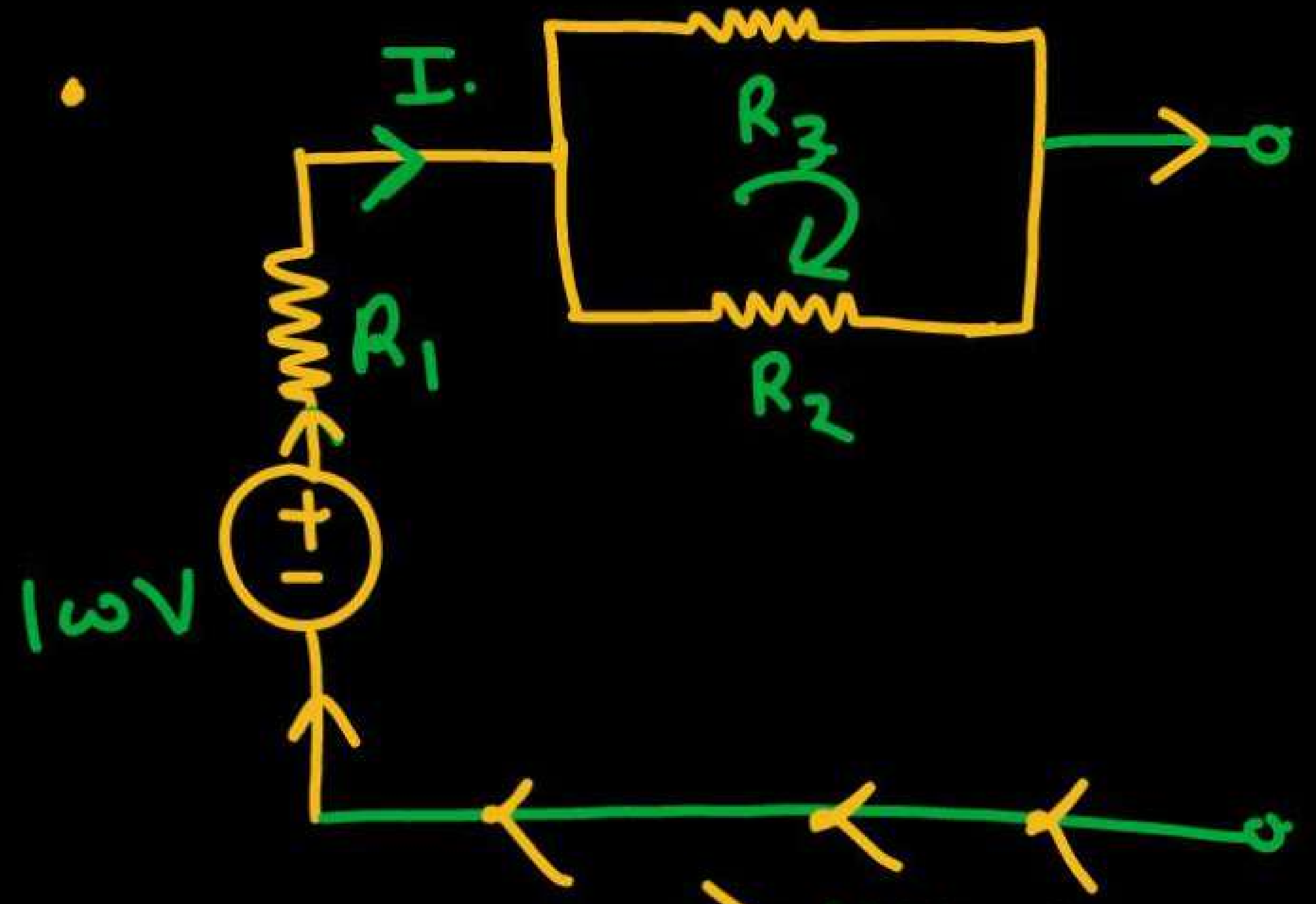
$cod^n\ 1 \rightarrow$ ✗

$cond^n\ 2 \rightarrow$ ✓

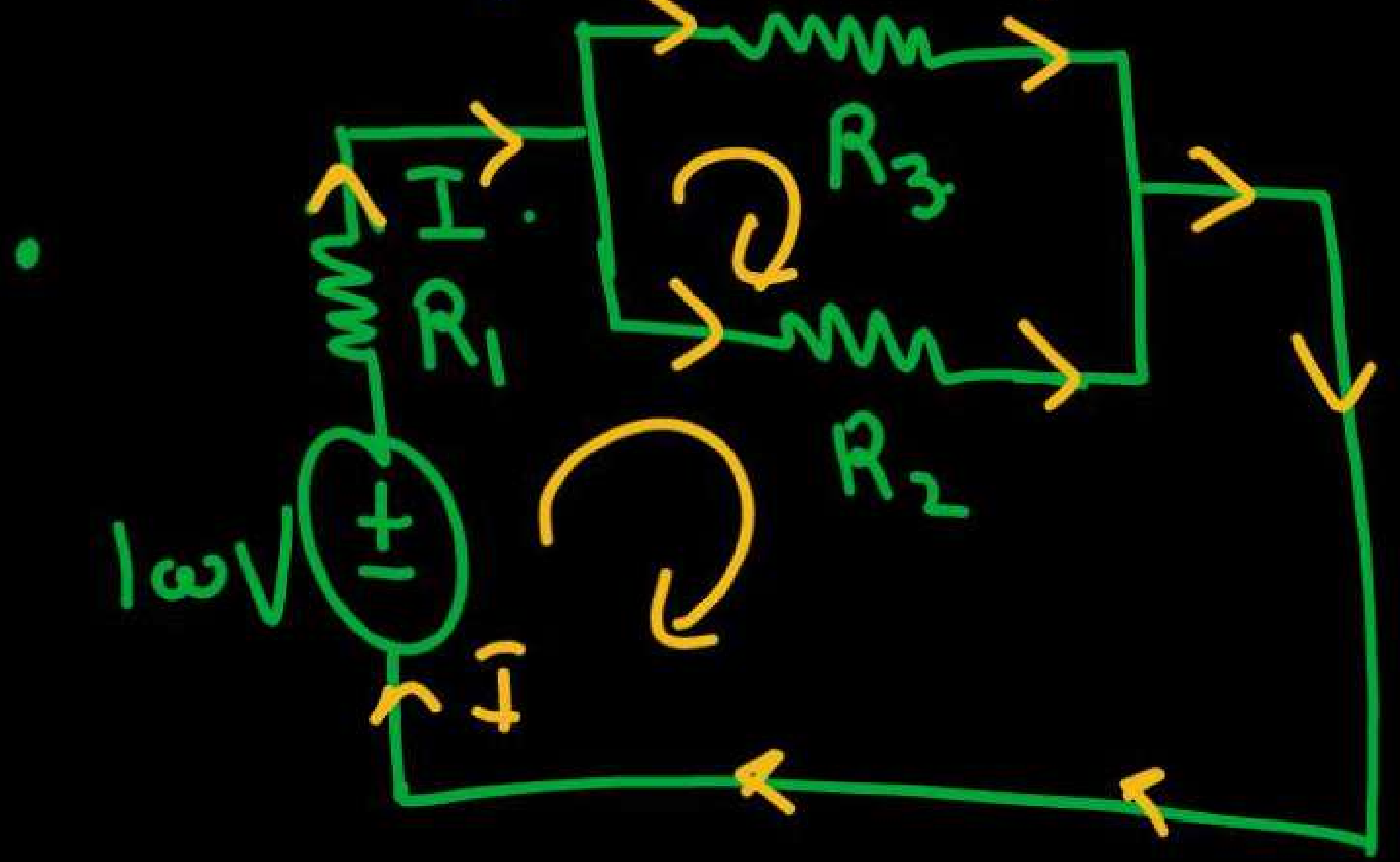
$cond^n\ 3 \rightarrow$ ✓

[current = 0 A]

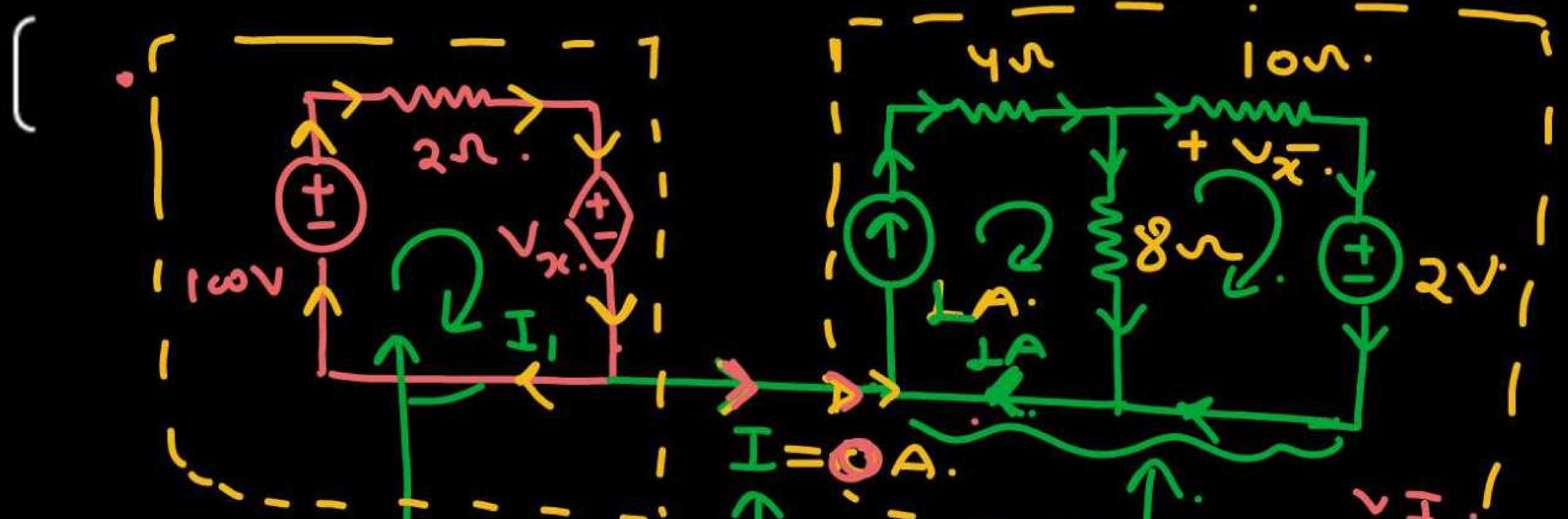
(Dead ~~circuit~~) N/W



cond^n 1 → ✓
cond^n 2 → ✓
cond^n 3 → ✗
$I = 0\,A$.
(Dead circuit).



cond^n 1 → ✓
cond^n 2 → ✓
cond^n 3 → ✓
$(I \neq 0\,A)$ (Active circuit)



N/W A.

↓

Cond^n 1 → ✓

Cond^n 2 → ✓

Cond^n 3 → ✓

$(I \neq 0\,A)$

Cond^n 1 → ✓

Cond^n 2 → ✓

Cond^n 3 → ✗

$I = 0\,A$

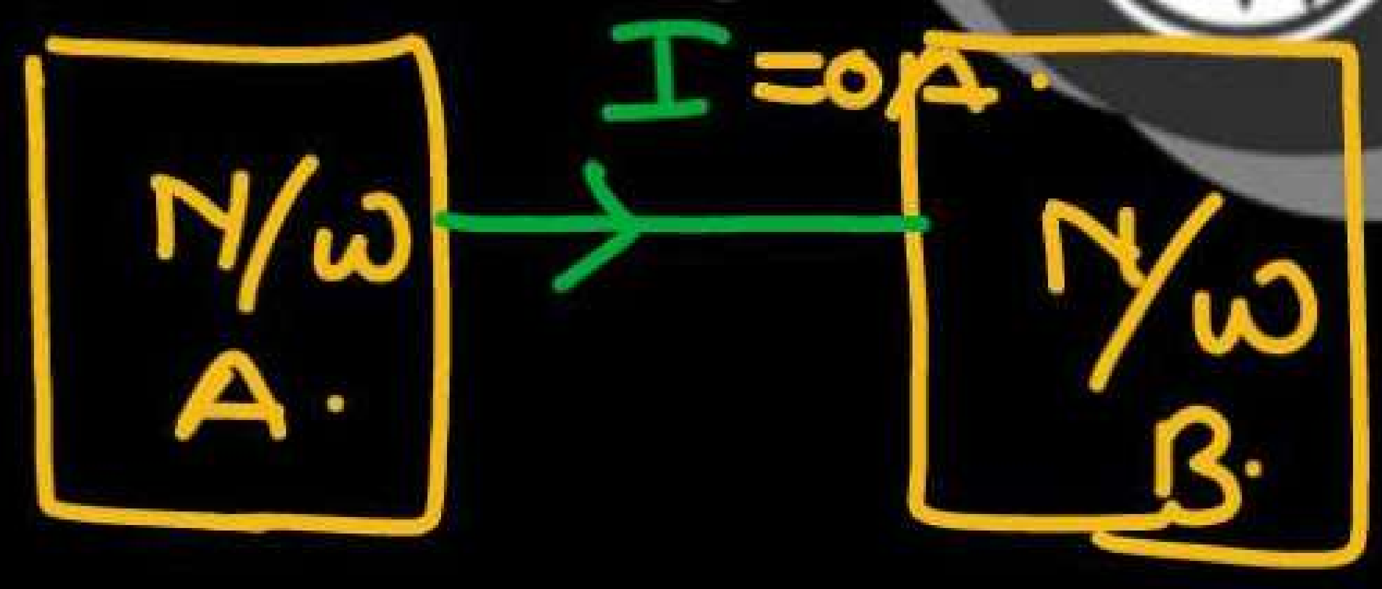
N/W B

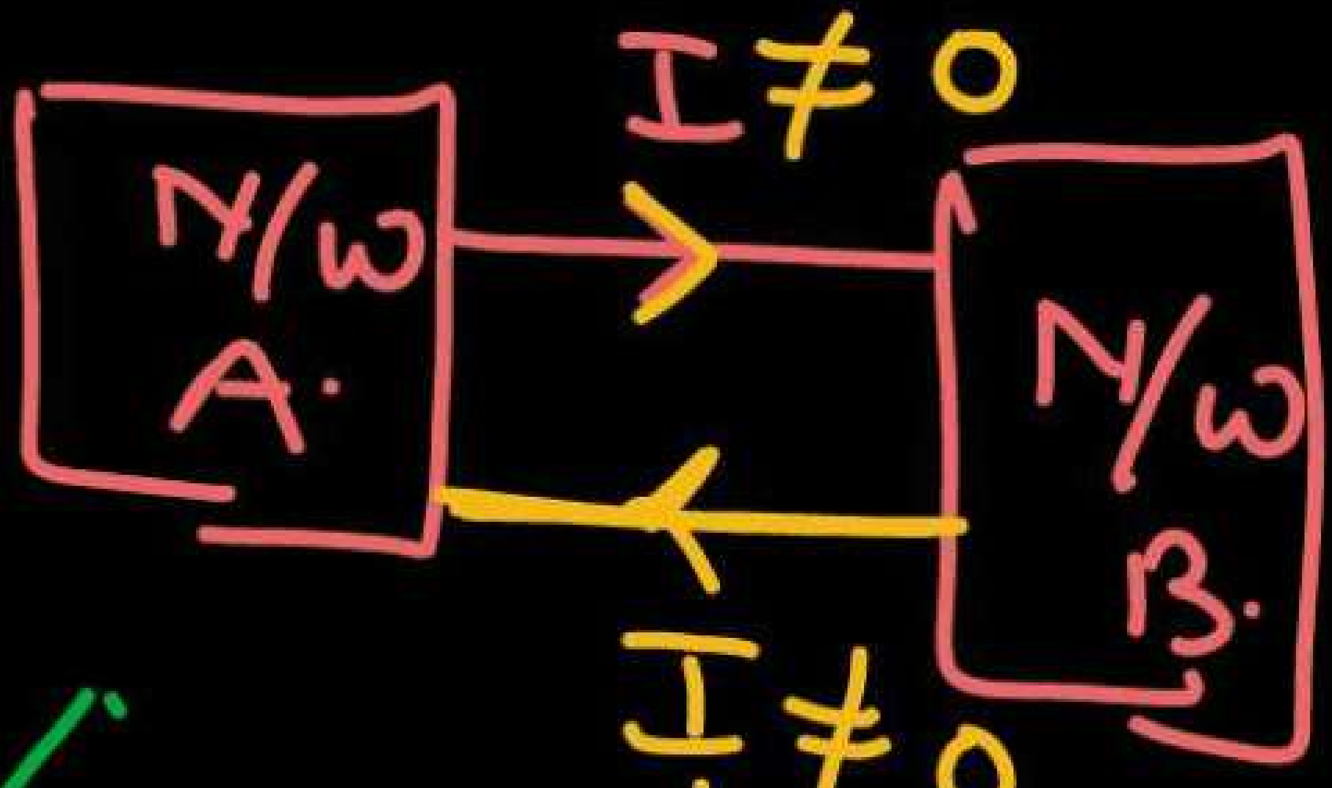
↓

Cond^n 1 → ✓

Cond^n 2 → ✓

Cond^n 3 → ✓





↓

Cond^n → ✓

Cond^n → ✓

Cond^n → ✓

[• Ohm's law, KVL & KCL. → Topic-(03)]

(1) Ohm's law. →

(a) $V \propto I \longrightarrow V = (R) \cdot I$ ✓ $\longrightarrow x = R \cdot y$

Resistance. (Ω)

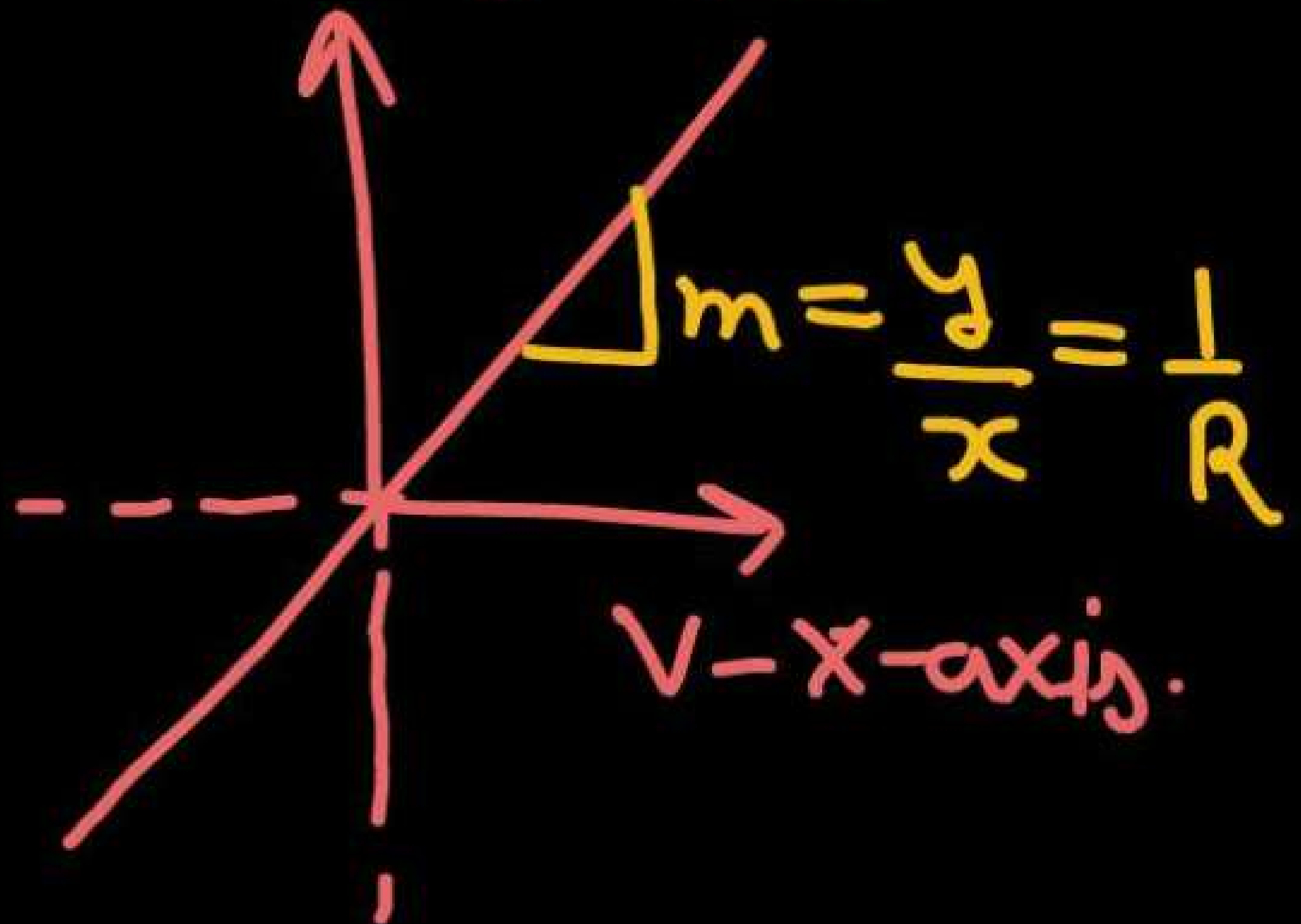
$y = \left(\frac{1}{R}\right) \cdot x.$

or   or

(b) $I \propto V \longrightarrow I = \left(\frac{1}{R}\right) \cdot V = G \cdot V$ ✓

Conductance ($\mho$)

I - Y-axis.

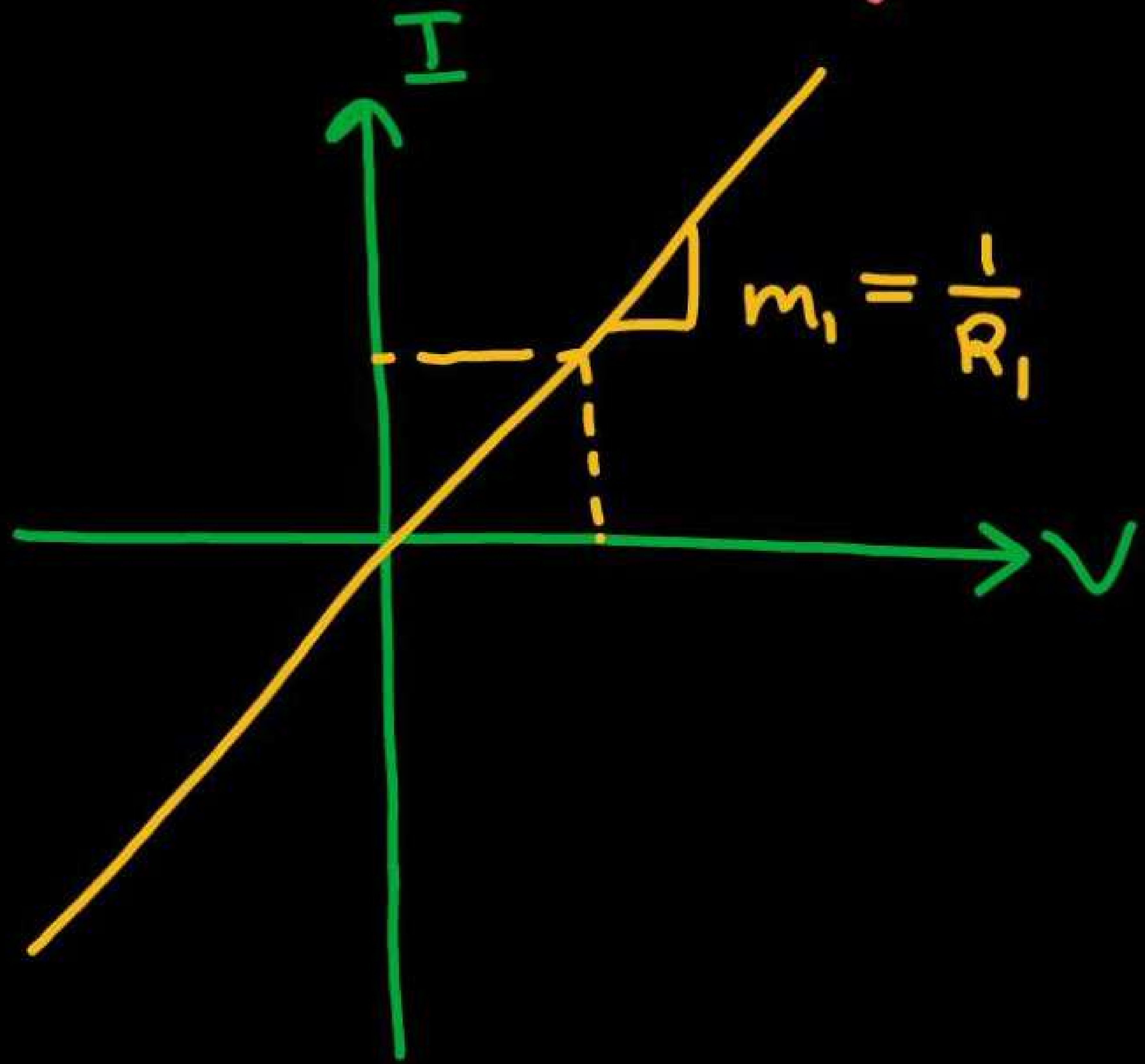


$y = \left(\frac{1}{R}\right) \cdot x.$

$[y = m \cdot x.] \rightarrow$ equation of a straight line. Passing through the origin.

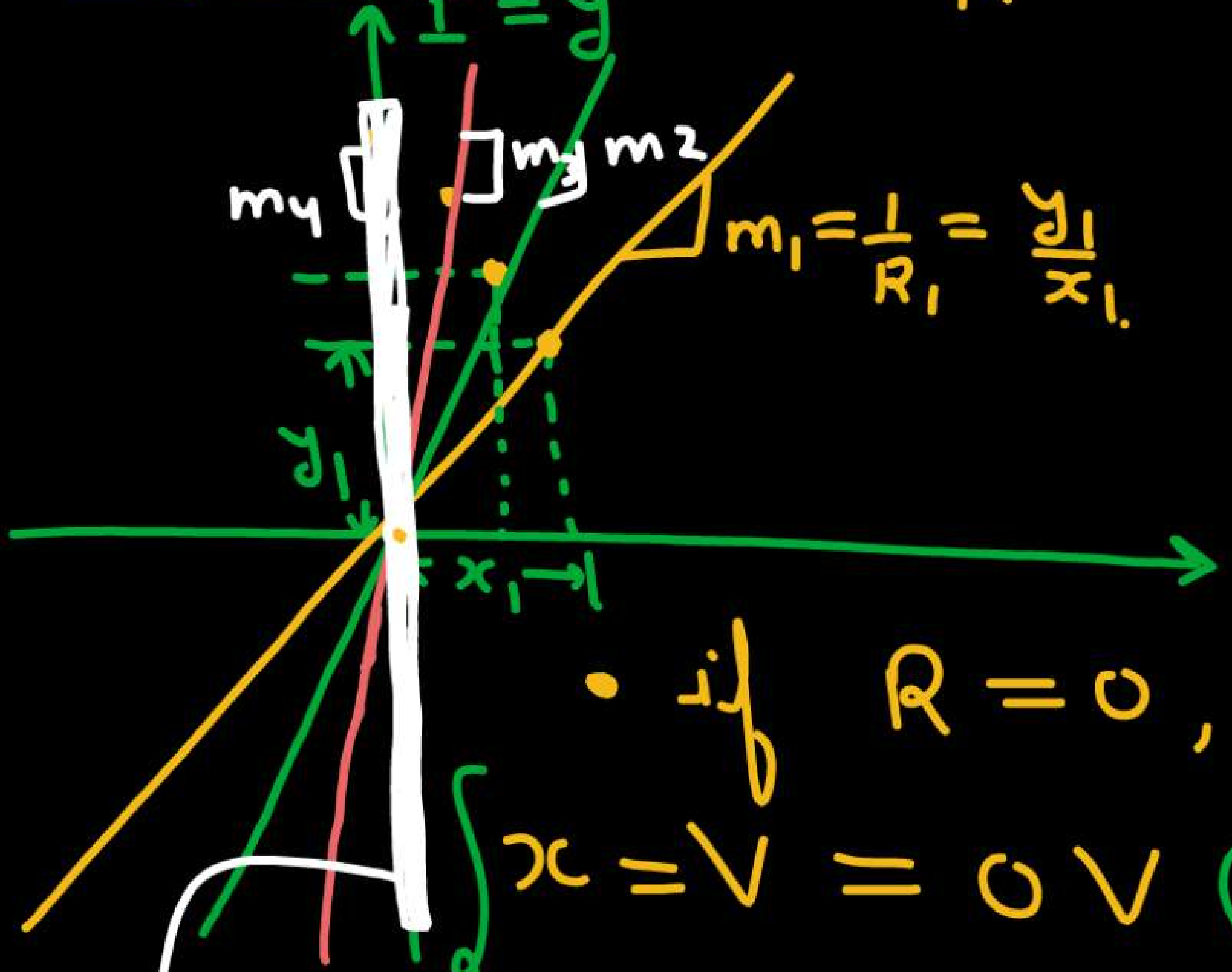
$m = \frac{1}{R} = \left(\frac{y}{x}\right)$

Case-I Now if we increase the slope $\left(m = \frac{1}{R} \Rightarrow \uparrow \uparrow \right)$



$$\uparrow m = \frac{y \uparrow}{x \downarrow}$$

[Case-I Now $m = \frac{1}{R} \uparrow$. $\quad \uparrow m = \frac{y\uparrow}{x\downarrow} = \frac{1}{R\downarrow}$]



$m_1 = \frac{1}{R_1} < m_2 = \frac{1}{R_2} < m_3 = \frac{1}{R_3} < m_4 = \frac{1}{R_4}$

$\frac{1}{R_1} < \frac{1}{R_2} < \frac{1}{R_3} < \frac{1}{R_4}$.

or

$R_1 > R_2 > R_3 > R_4$.

Decrease.

- if $R = 0,\ m = \infty$

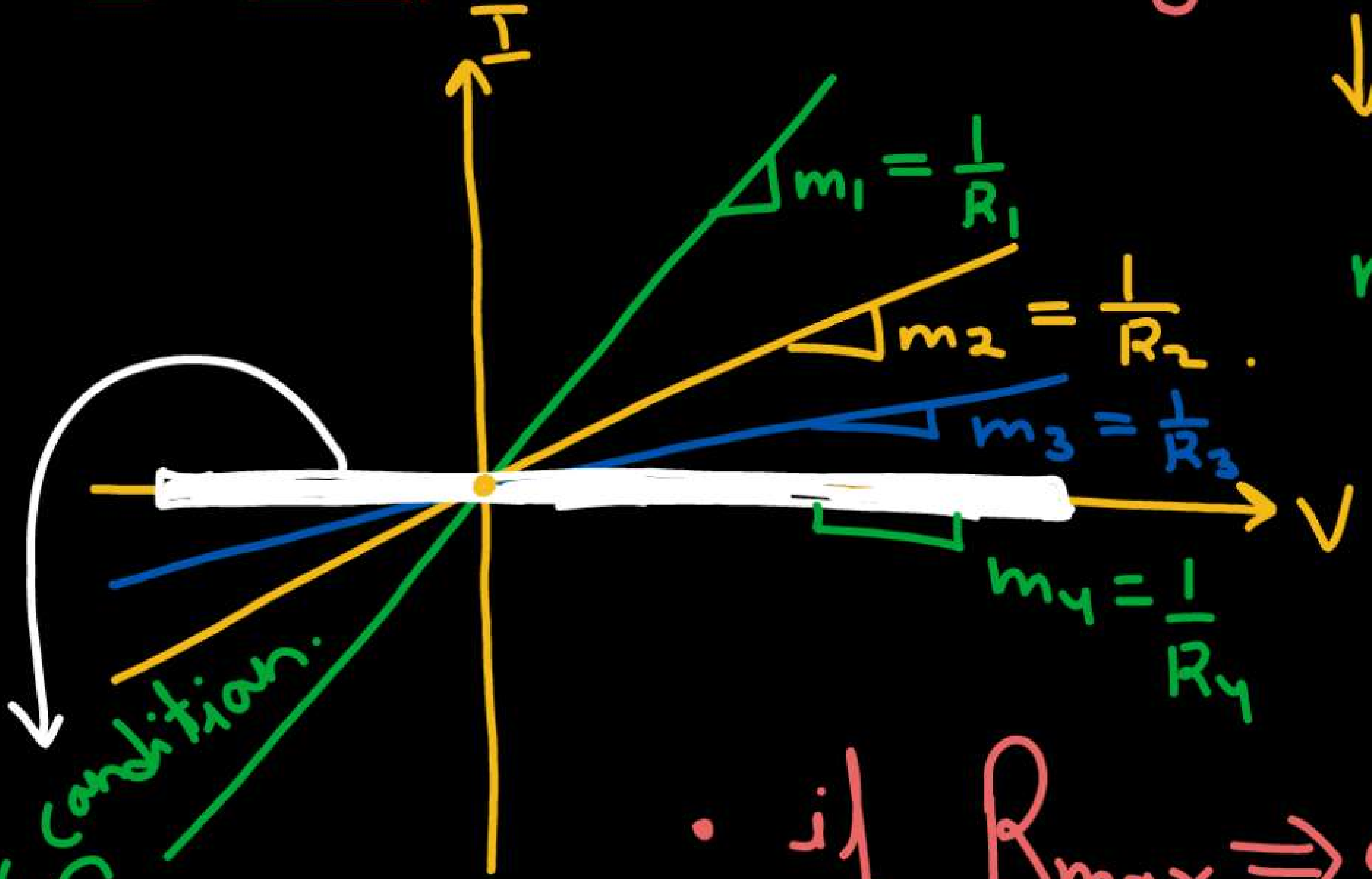
$\begin{cases} x = V = 0\,V \text{ (Always)} \\ y = I = \underbrace{\oplus, 0, \ominus}_{\text{Anything}} \end{cases}$

Short circuit cond^n.

$R_{min} = 0\,\Omega$.

$m = \frac{1}{R \to 0} = \frac{y}{x \to 0} = \to \infty$

[case – II Now decreasing the slope ($m = \frac{1}{R}$ ↓)]



$$\downarrow m = \frac{y\downarrow}{x\uparrow} = \frac{1}{R\uparrow}$$

$$m_1 = \frac{1}{R_1} > m_2 = \frac{1}{R_2} > m_3 = \frac{1}{R_3} > m_4 = \frac{1}{R_4}$$

or

$$\frac{1}{R_1} > \frac{1}{R_2} > \frac{1}{R_3} > \frac{1}{R_4} >$$

or

$$R_1 < R_2 < R_3 < R_4$$

- if $R_{max} \Rightarrow \infty$

$$0 \leftarrow m = \frac{1}{R \to \infty} = \frac{y}{x \to \infty}$$

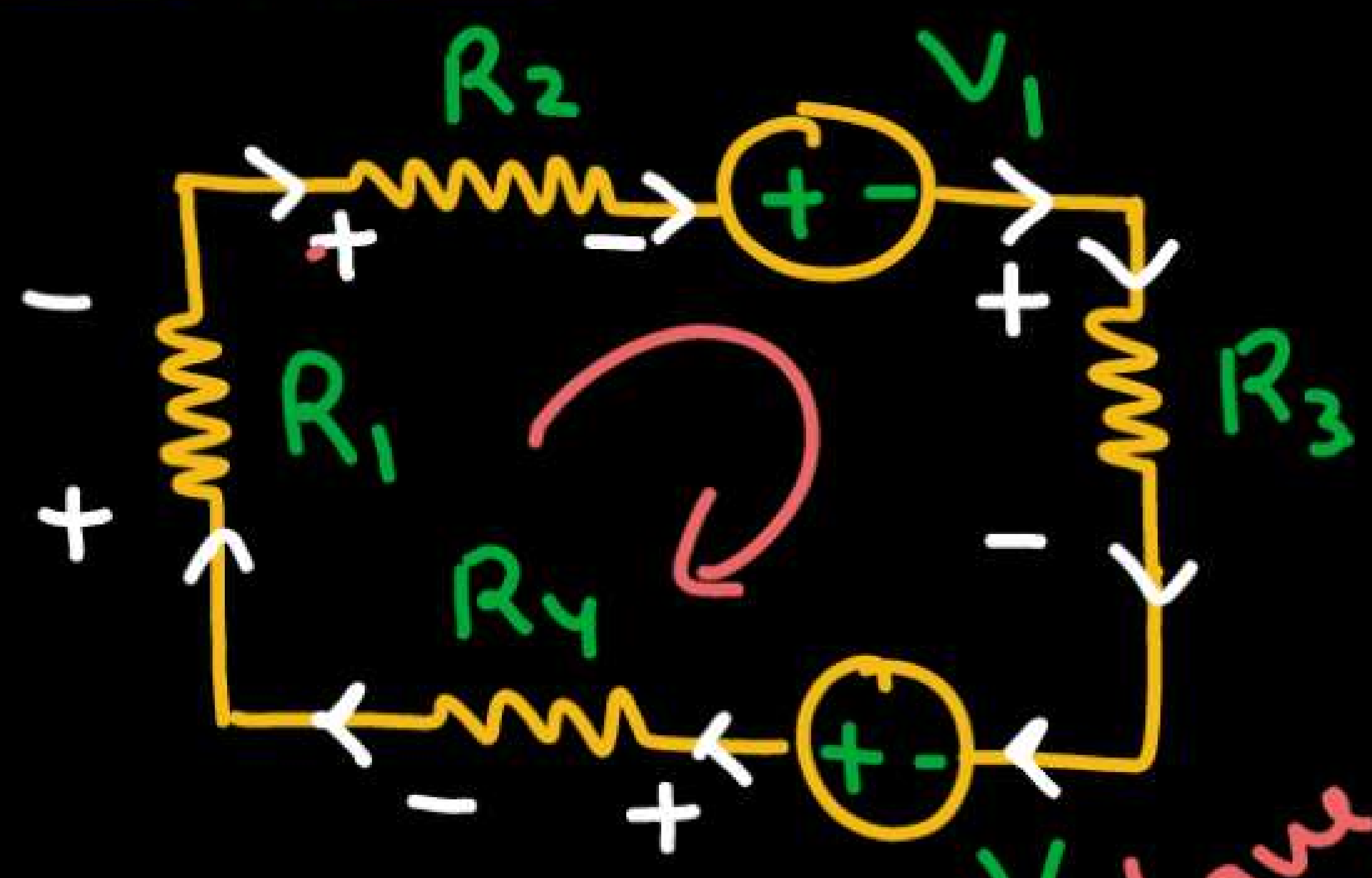
0-condition
- $I = 0\,A$ (Always)
- $V = \oplus, 0, \ominus$ = Anything

[KVL & KCL.

R → Always absorbs energy & dissipate it]

L → It absorbs energy → store energy

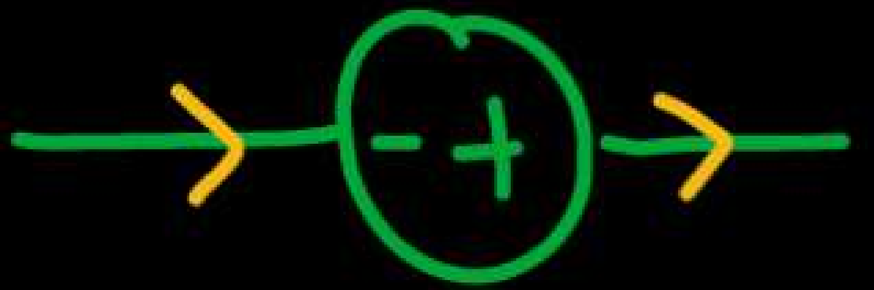
C → It absorbs energy → Store energy

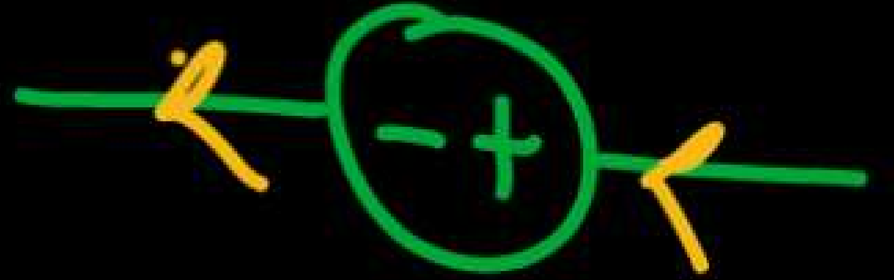


- KVL →

$$\left[\sum V_{loop} = 0\right] \to \text{First Approach.}$$

V2 have to follow


→ V_{rise} ⊕


→ V_{drop} ⊖

→ we have to follow one convention:

$$\left[-V_{R_2} - V_1 - V_{R_3} + V_2 - V_{R_4} - V_{R_1} = 0\right]$$

$$\left[\ \cdot \quad -V_{R_2} - V_1 + V_2 - V_{R_3} - V_{R_4} - V_{R_1} = 0 \ \right]$$

$$V_2 = V_{R_1} + V_{R_2} + V_{R_3} + V_{R_4} + V_1$$

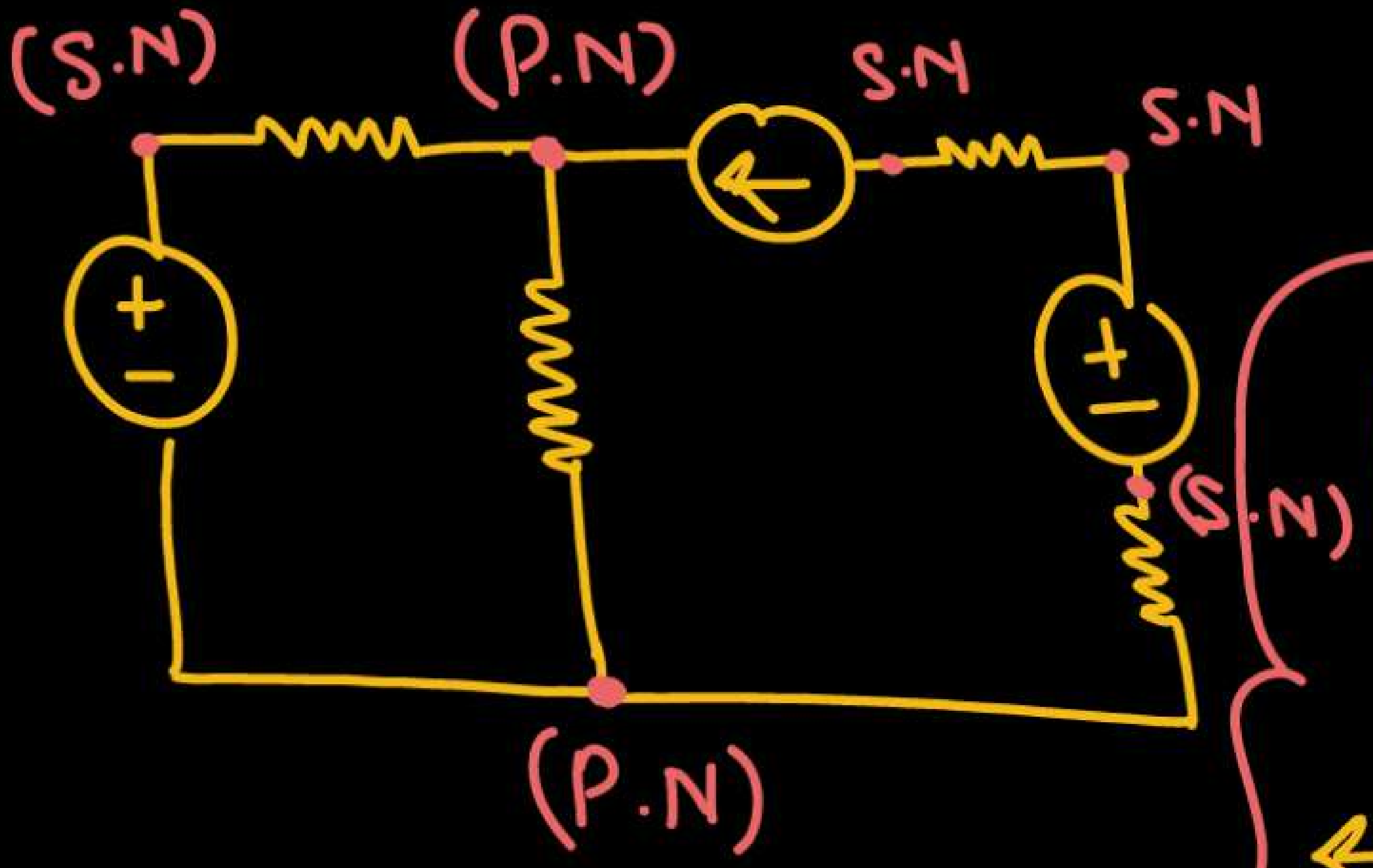
$$\boxed{\sum V_{rise} = \sum V_{drop}.}$$ — 2^{nd} approach

You need not to follow any convention as you have to take V_{rise} & V_{drop} = (+).

[KCL → Applicable on Node.]

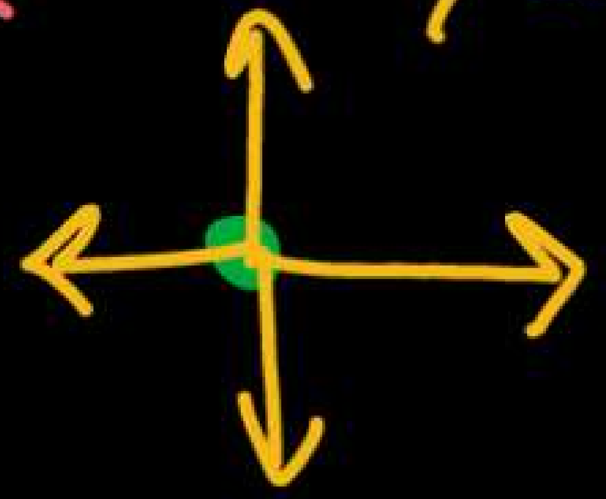
Node → Principle Node (P N) → If more than 2 element connected.

Node → Simple Node (S N) → connection point of two elements only.

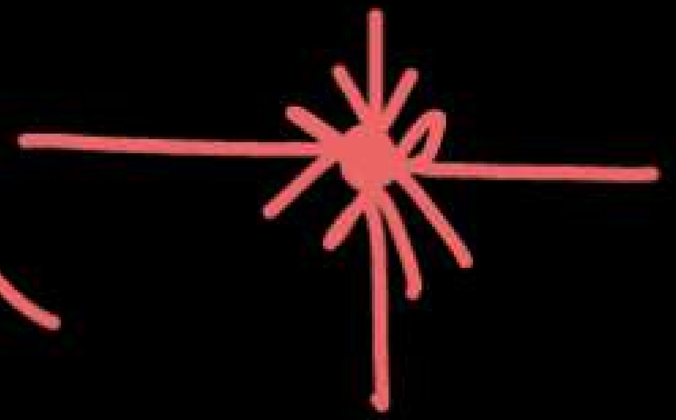


$$\left[\sum I_{node} = 0 \right] \rightarrow 1^{st} \text{ Approach}$$

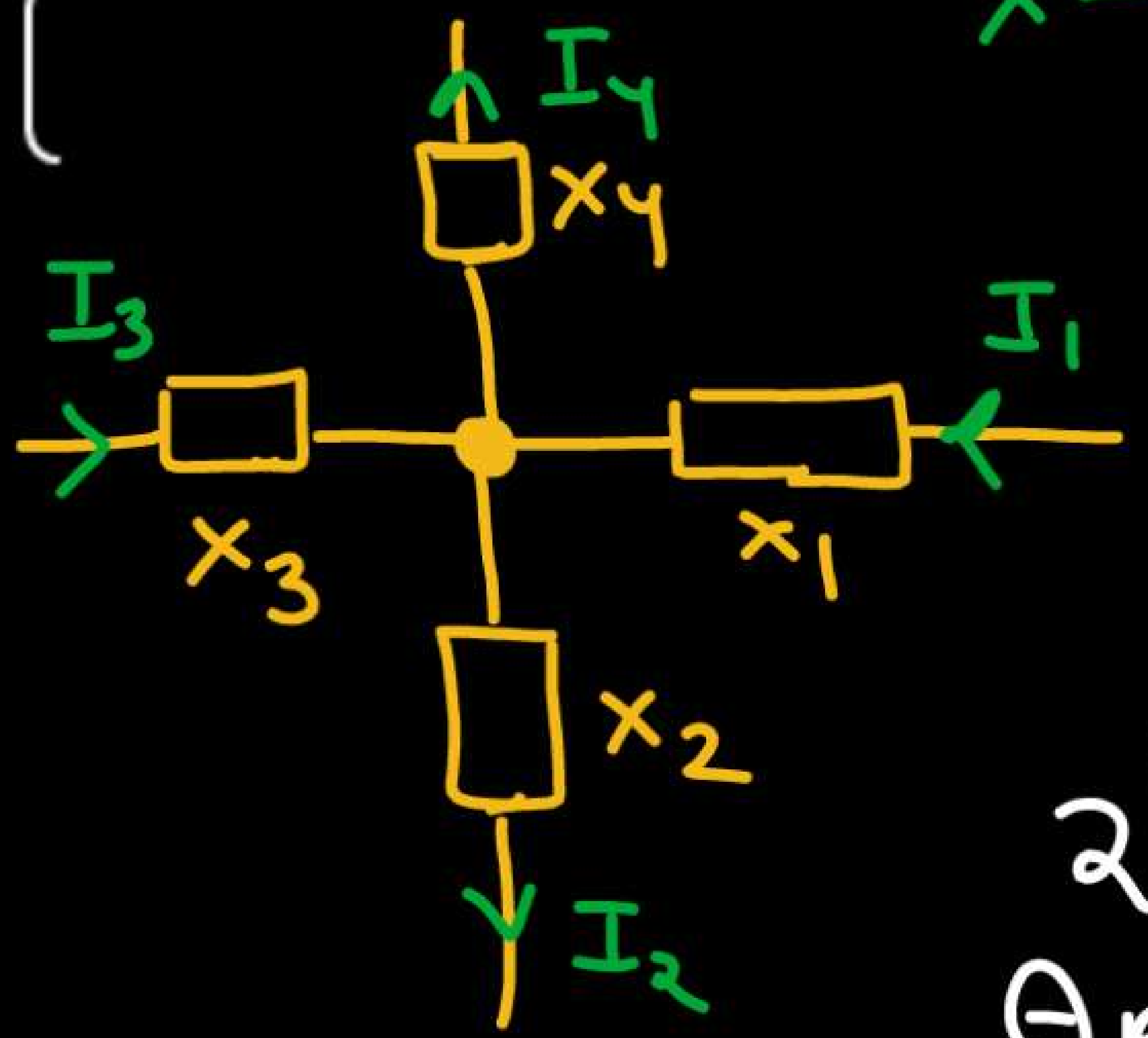
→ You need Some Convention



→ outgoing current → $\oplus$



→ Incoming current → $\ominus$



$x \rightarrow$ Any element

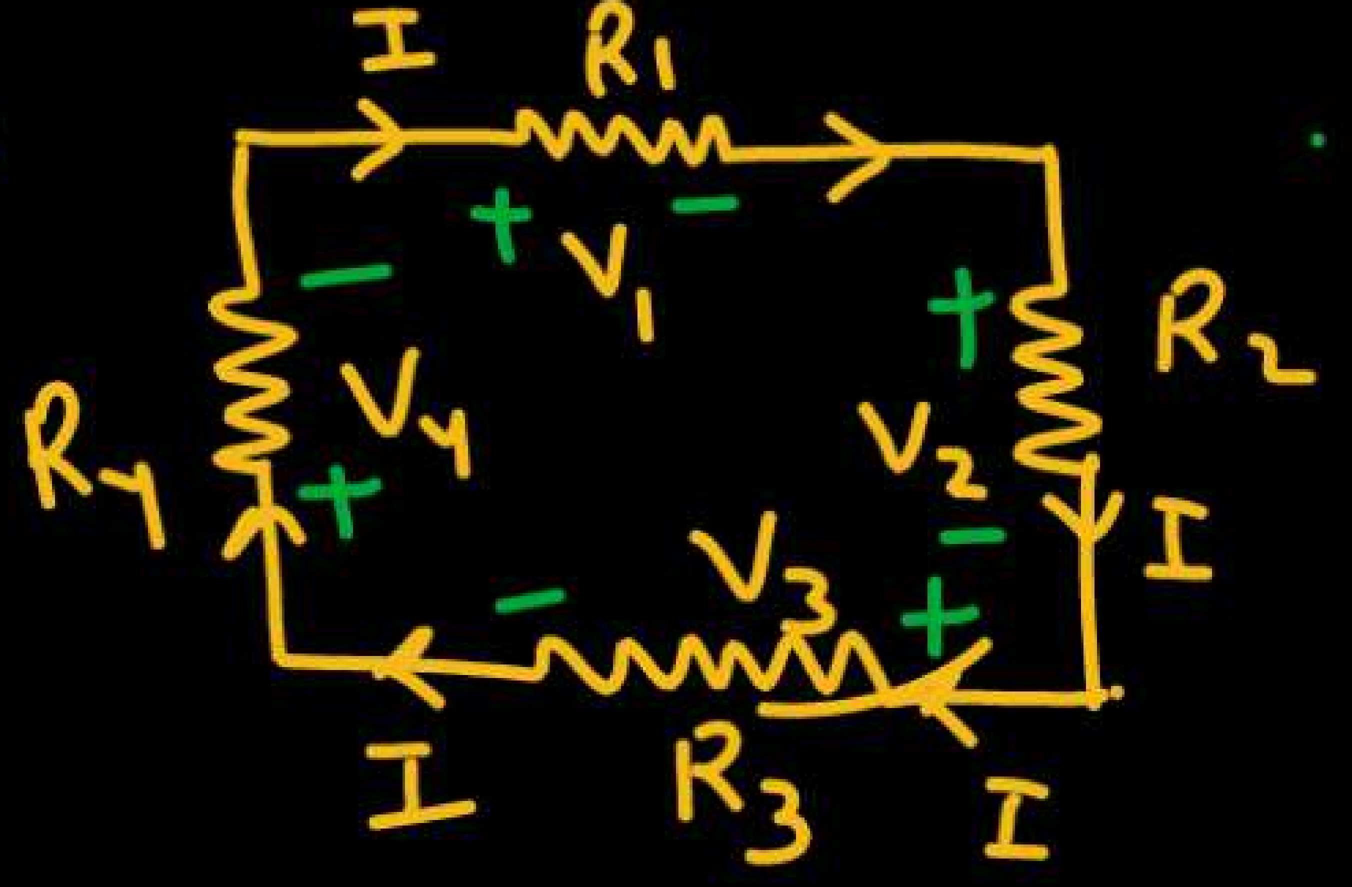
- $[-I_1 + I_4 + I_2 - I_3 = 0]$
- $I_2 + I_4 = I_1 + I_3$

2^{nd} Approach. (Best) $\leftarrow$ $\boxed{\sum I_{outgoing} = \sum I_{incoming}}$

$\hookrightarrow$ You do not need any convention.

Important conclusion :

- KVL & KCL are Independent of Nature of Element.
- For the validity of the circuit
  (1) KVL Must be Satisfied.
  (2) KCL Must be Satisfied.
  (3) Energy Conservation Must be Satisfied.
  (4) Charge conservation Must be Satisfied.

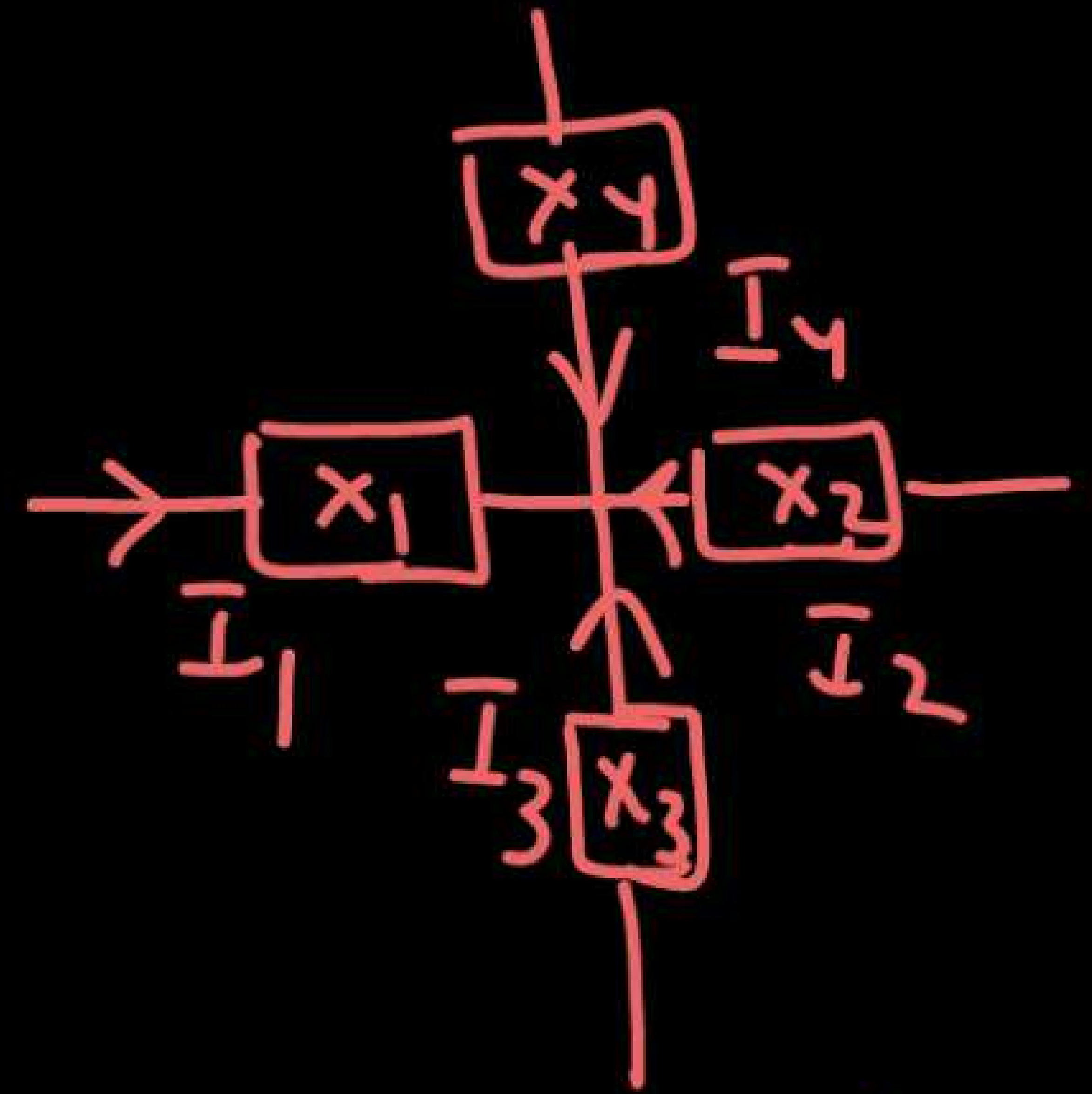


$$V_1 + V_2 + V_3 + V_4 = 0$$

$$\frac{dW_1}{dq} + \frac{dW_2}{dq} + \frac{dW_3}{dq} + \frac{dW_4}{dq} = 0$$

$$\boxed{dW_1 + dW_2 + dW_3 + dW_4 = 0}$$

energy conservation.



$$I_1 + I_2 + I_3 + I_4 = 0$$

$$\frac{dq_1}{dt} + \frac{dq_2}{dt} + \frac{dq_3}{dt} + \frac{dq_4}{dt} = 0$$

Charge conservation. $\leftarrow$ $$[dq_1 + dq_2 + dq_3 + dq_4 = 0]$$

Topic-04 (Energy Sources)

- Independent Sources
  - Voltage Source
  - Current Source
    - Ideal
    - Practical
- Dependent Sources
  - Voltage Source
    - VCVS
    - CCVS
  - Current Source
    - VCCS
    - CCCS

[• $\left[\sum V_{rise} = \sum V_{drop}\right] \rightarrow$ easy.]

$$\left[V_2 = V_1 + V_{R_1} + V_{R_2} + V_{R_3} + V_{R_4}\right]$$

Thank you

GW Soldiers !