Electrical Engineering

Electronics and Communication Engineering

Instrumentation Engineering

Network Theory

Lecture No. 05

Basics of Network Theory

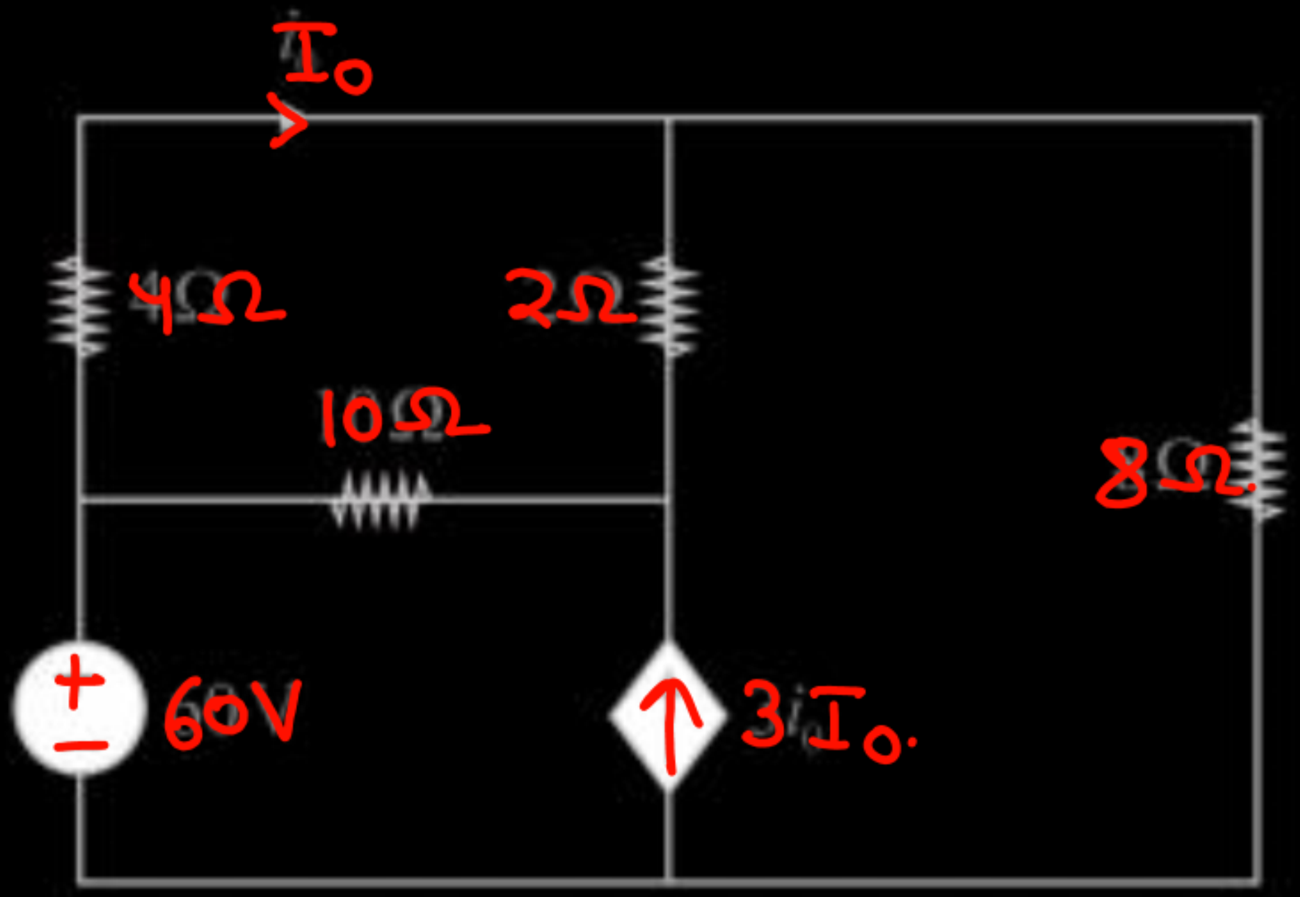
By- Pankaj Shukla sir

1. Question Discussion.
2.
3.
4.
5.
6.

1. Question Discussion.
2. Series & Parallel operation.
3.
4.
5.
6.

Question

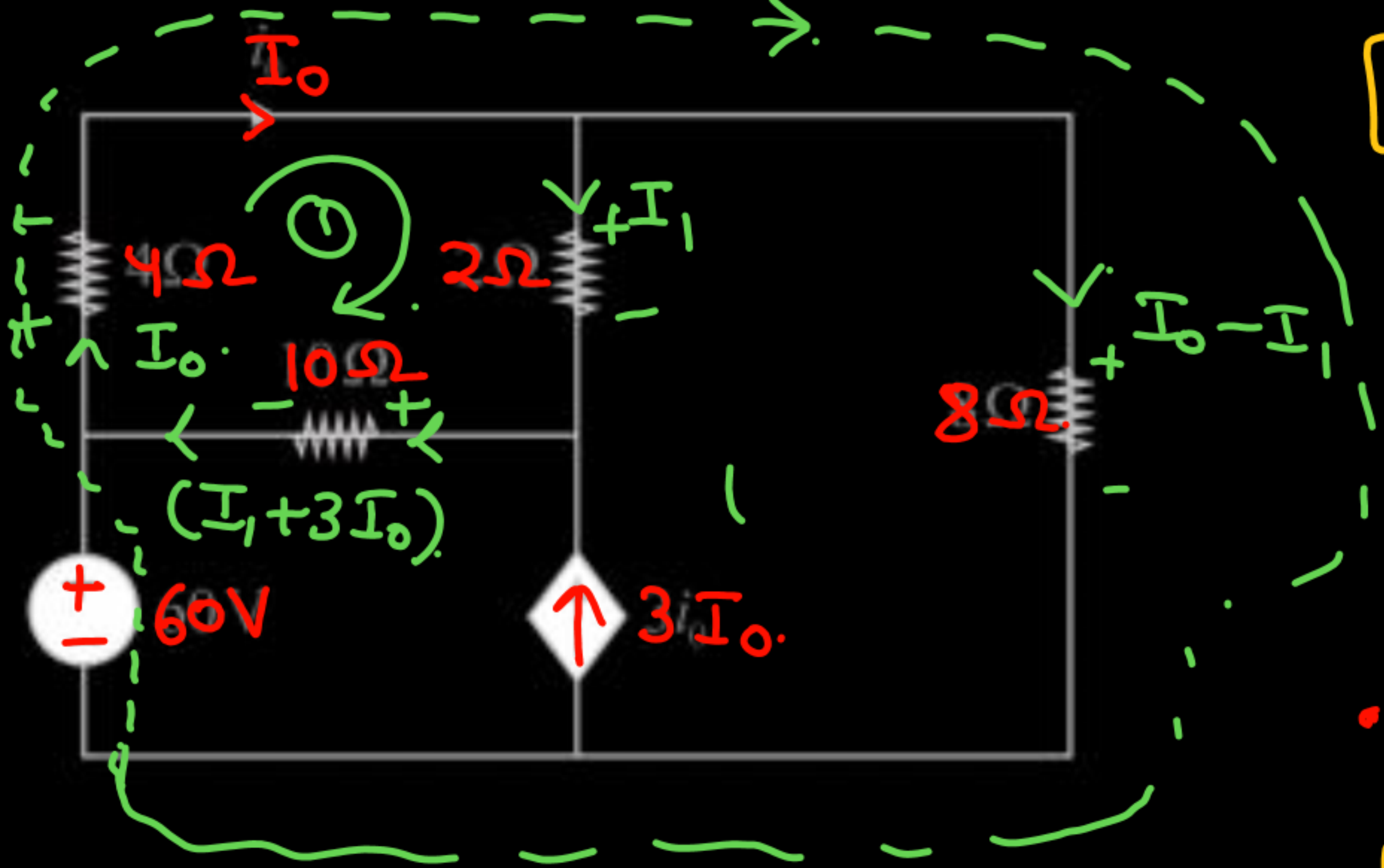
The value of I_o ________ A.



• Inspection Method - 01.

Question

The value of I_o ________ A.



KVL-01.

$$4\times(I_0)+2\times I_1+10\times(I_1+3I_0)=0$$

$$[34I_0+12I_1=0] \quad \text{—— (1)}$$

KVL-02.

$$60=4I_0+8\times(I_0-I_1)$$

$$12I_0-8I_1=60 \quad \text{—— (2)}$$

$$8\times[34I_0+12I_1=0]$$

$$12\times[12I_0-8I_1=60]$$

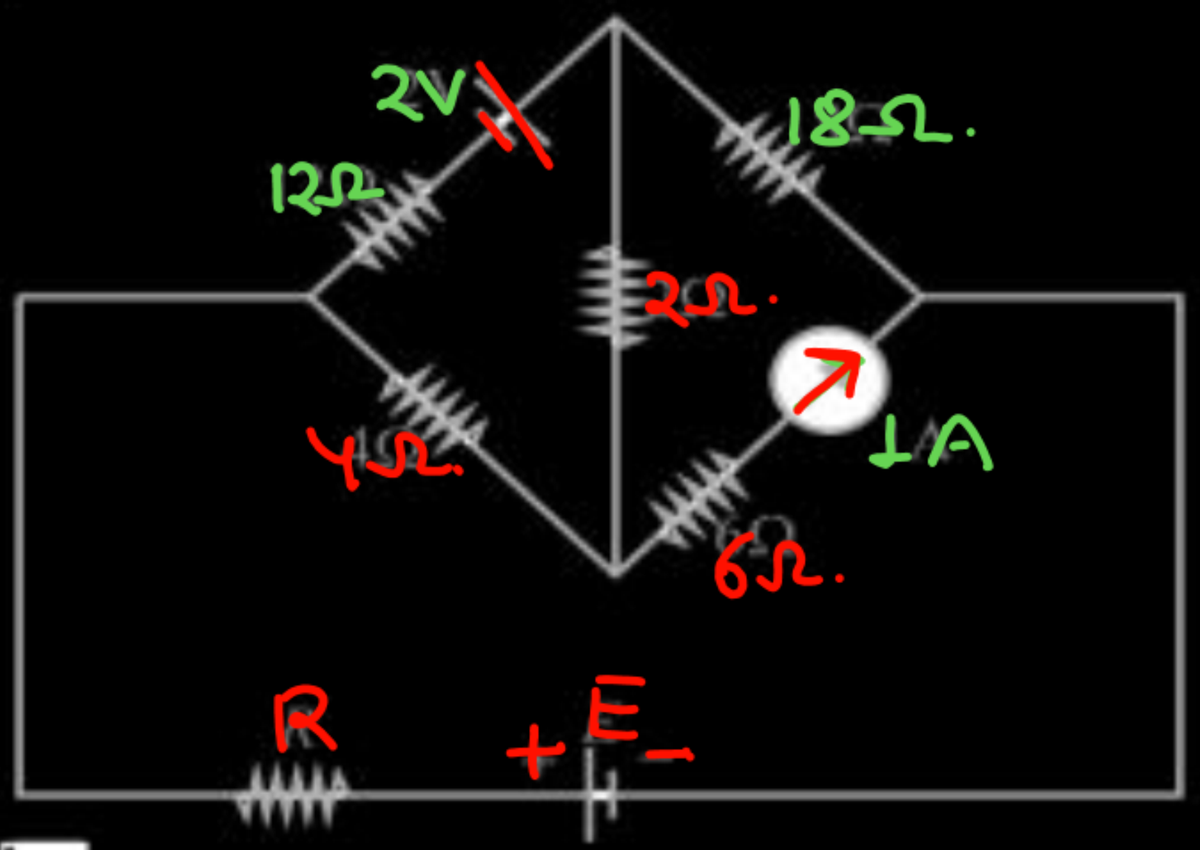
$$I_0(34\times8+12\times12)=0+60\times12$$

$$\left[I_0=\frac{60\times12}{416}=1.7307\ \text{A}\right]$$

Question

6 In the circuit shown in figure, if the current through the 2 ohm resistor is zero, the power delivered by current source of 1A is

- Inspection. Method - 01 .



(A) 3 W

(B) -3W

(C) 6 W

(D) -8W

Question

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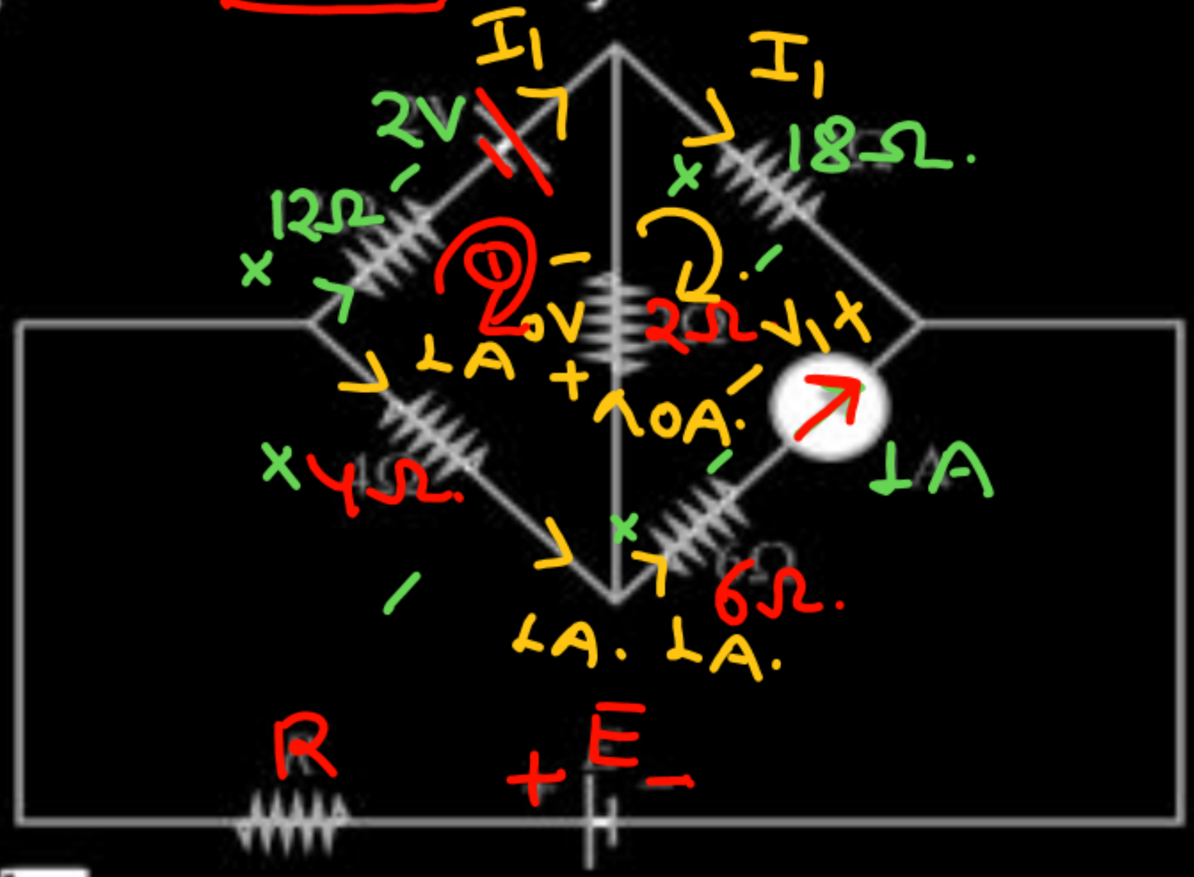


(a) 3 W

(b) -3W

(c) 6 W

(d) -8W

• Inspection. Method - 01 !

KVL →

$4\times 1 + 2 = 12 I_1$

$12 I_1 = 6$

$[I_1 = \frac{1}{2} A] = 0.5 A$

KVL →

$V_1 + 18 I_1 = 6\times 1$

$V_1 = 6 - 18 I_1 = 6 - 18\times 0.5 = (-3 \text{ volt})$

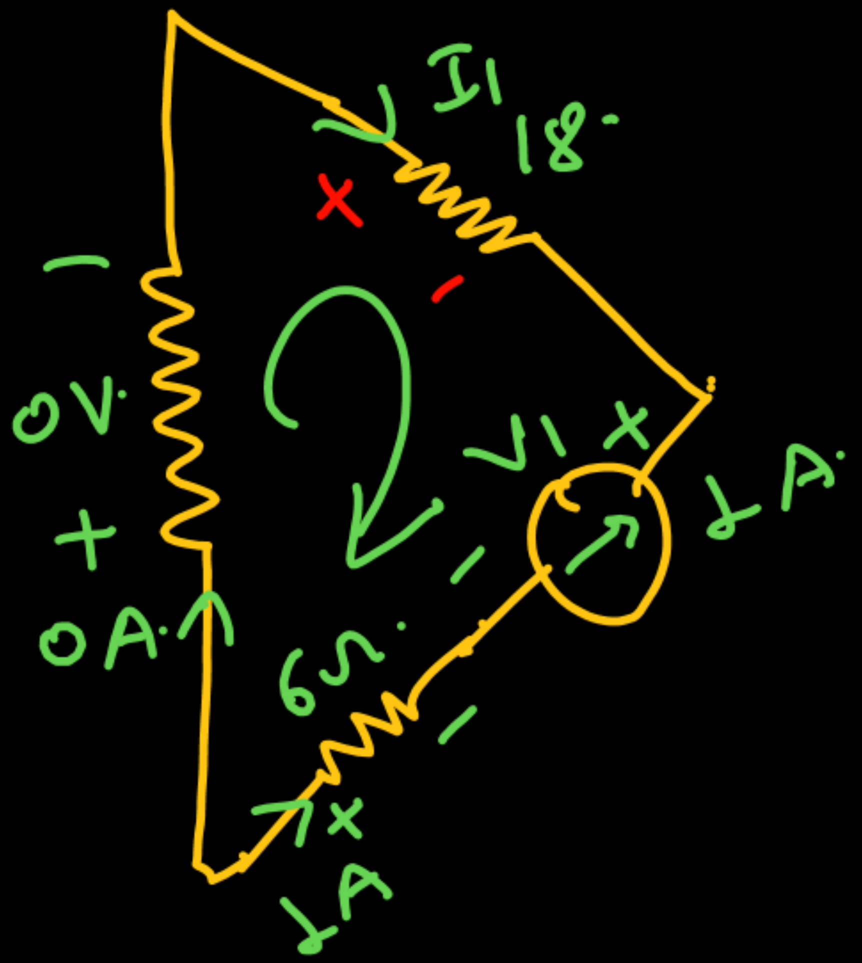
$P_{1A} = V_1 \times 1$

$= (-3)\times 1$

$= -3W$ (D)

or

$+3W$ (A)



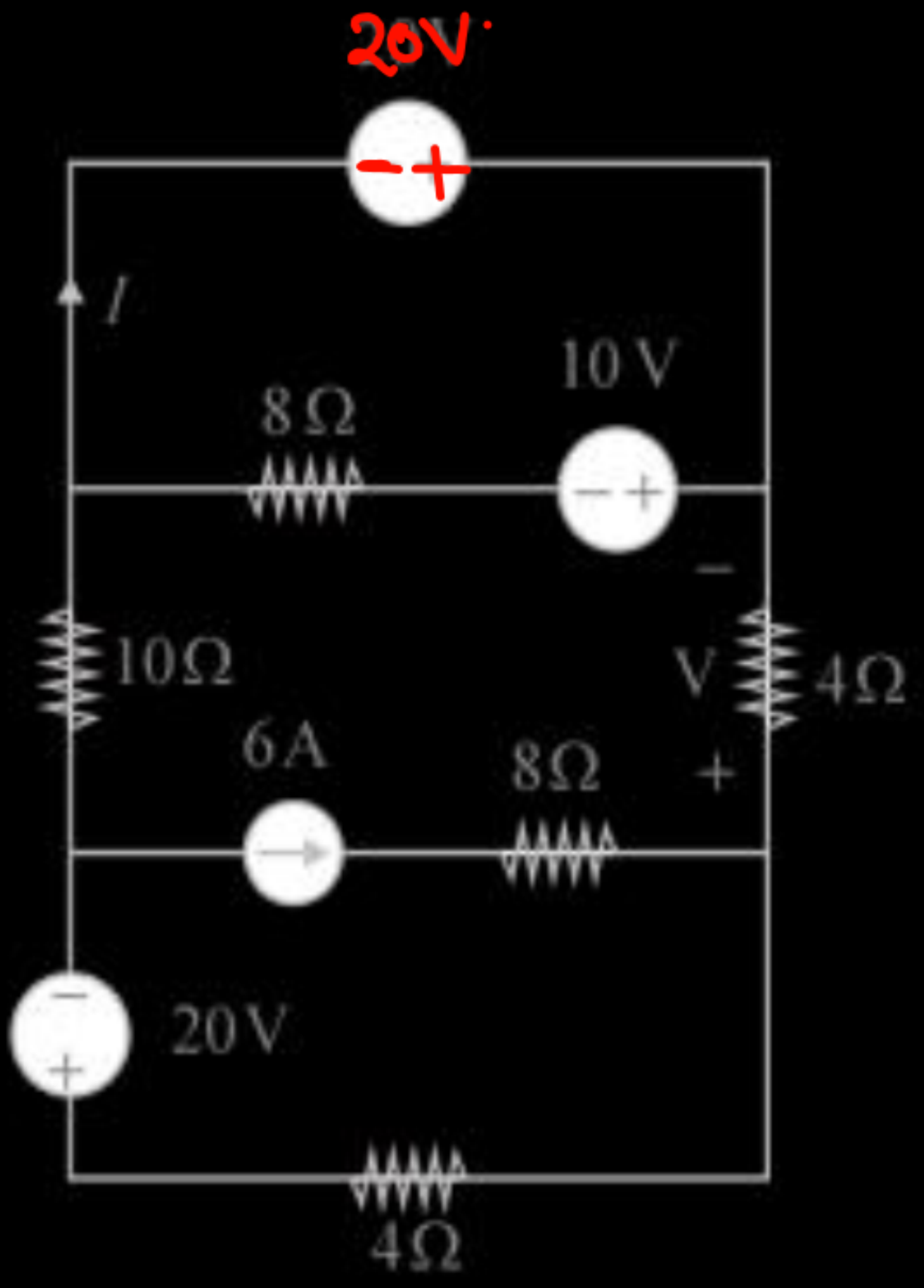
$$6 \times 1 = V_1 + 18 I_1$$

$$\boxed{V_1 = 6 - 18 I_1}$$

Question

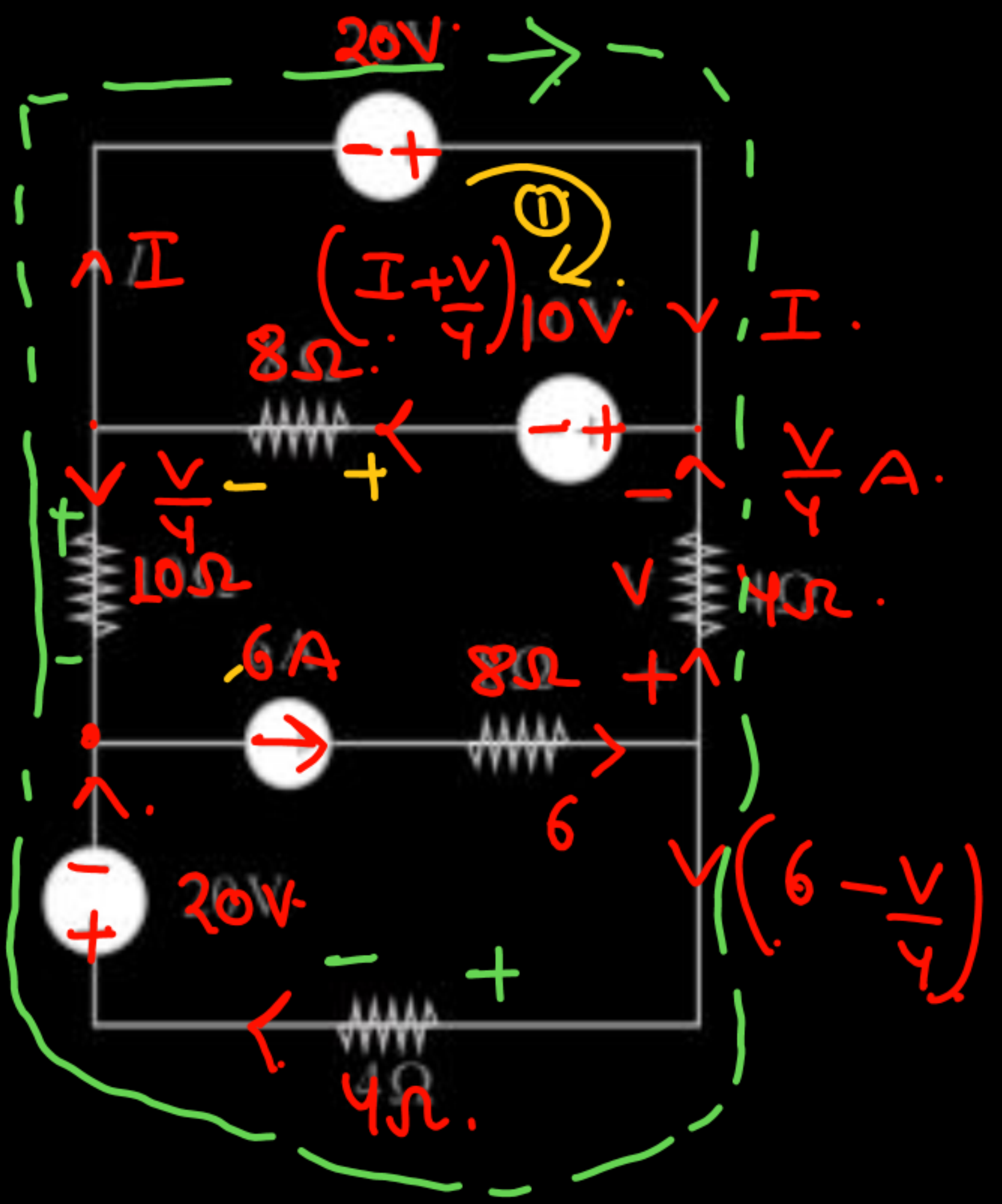
The circuit is shown below find the value of V & I. • (Inspection method).

• Two equation.



Question

The circuit is shown below find the value of V & I. • (Inspection method).



• Two equation.

• KVL-01.

$$20 = 10 + 8 \times \left(I + \frac{V}{4}\right)$$

$$8I + 2V = 10$$

$$[4I + V = 5] \text{ — } (1)$$

KVL-02.

$$20 + V + \frac{V}{4} \times 10 = 4 \times \left(6 - \frac{V}{4}\right) + 20$$

$$V\left(1 + \frac{10}{4} + 1\right) = 24$$

$$\left[V = \frac{24}{4.5} = 5.33 \text{ volt}\right]$$

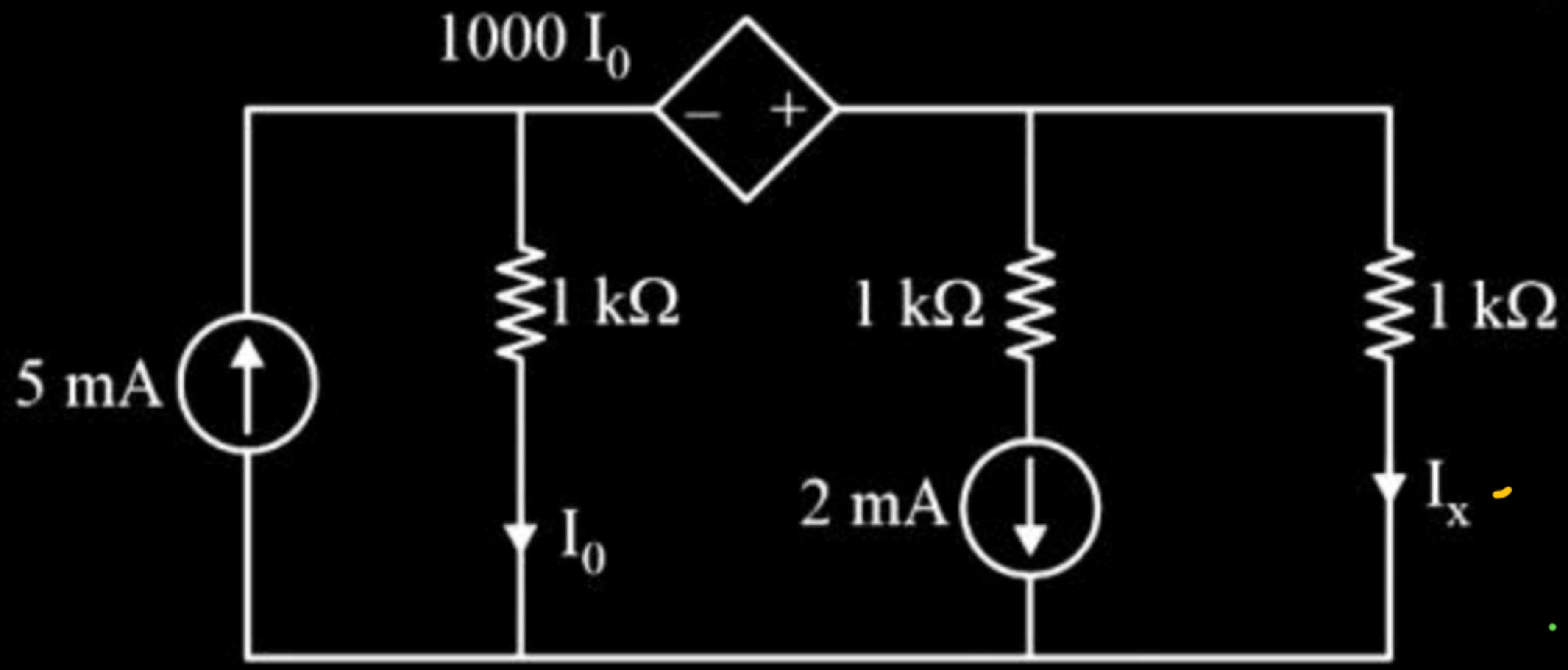
$$\left[I = \frac{5 - V}{4} = \frac{5 - 5.33}{4} = -0.0833 \text{ A}\right]$$

(NAT)

Inspection method

#Q. In the given circuit, the current Ix (in mA) is ______.

[GATE-2024-1M]

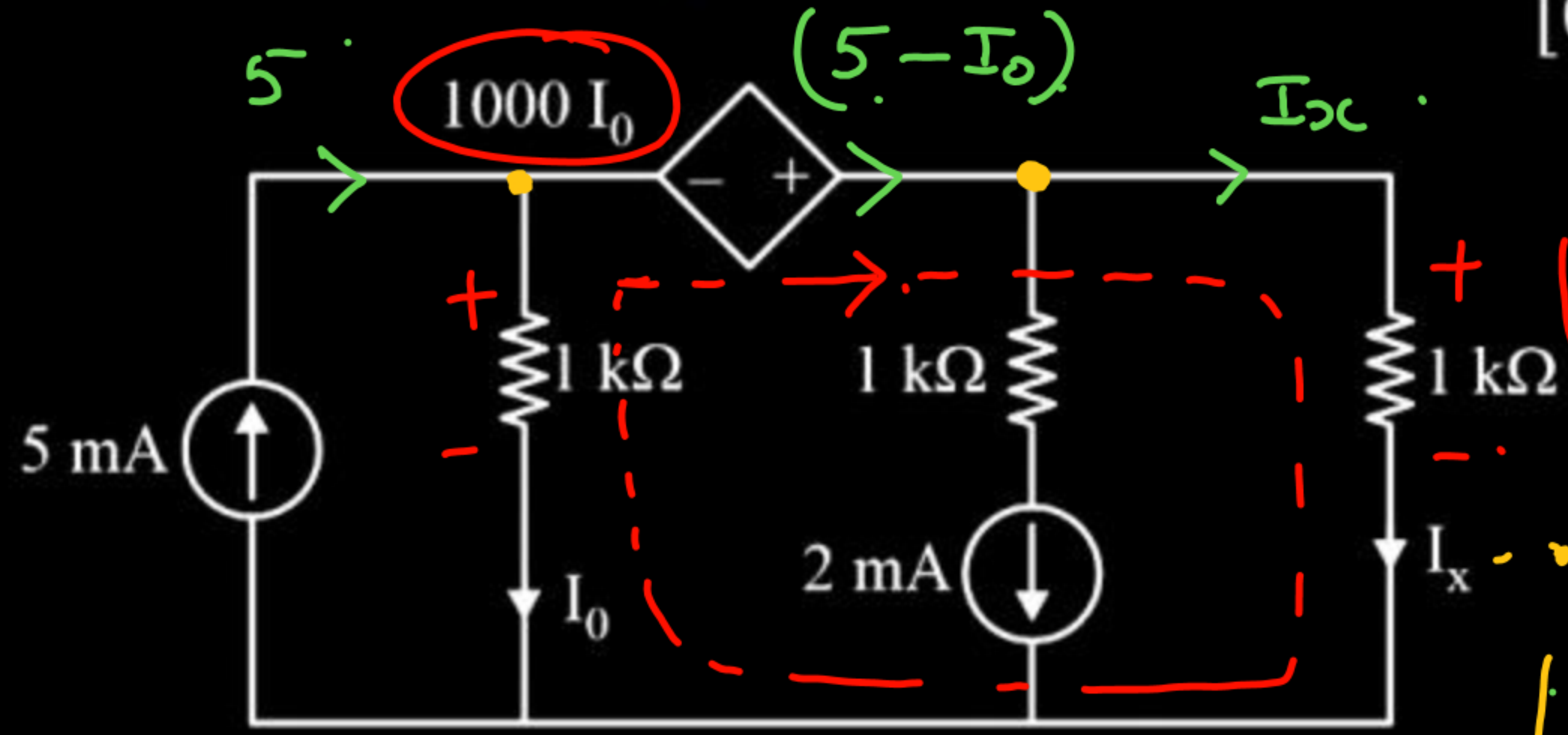


(NAT)

Inspection method

#Q. In the given circuit, the current Ix (in mA) is ______.

[GATE-2024-1M]



$[2I_0 - I_x = 0]$ — (1)

$5 - I_0 = I_x + 2$

$[I_x + I_0 = 3\text{ mA}]$

$1 \times 10^3 \times I_0 + 1000\, I_0 = 1000 \times I_x$

$I_0 + I_0 = I_x\,, \quad 2I_0 = I_x$

$$2I_0 - I_x = 0$$

$$2 \times [I_0 + I_x = 3 \times 10^{-3}]$$

$$I_x(-1-2) = 0 - 6 \times 10^{-3}$$

$$[I_x = 2\ mA]$$

$$2I_0 = I_x$$

$$\left[I_0 = \frac{I_x}{2} = 1\ mA\right]$$

Note: ① if in a circuit, we have.

$R \rightarrow k\Omega$.

$I \rightarrow mA$.

Independent Sources → Voltage Source → Volt. / Current Source → mA.

Then no need to convert milli into A or Ω. Apply Directly.

② if the circuit contains:

$R \rightarrow k\Omega$, $I \rightarrow mA$,

Independent Sources → Voltage → volt. / current → mA.

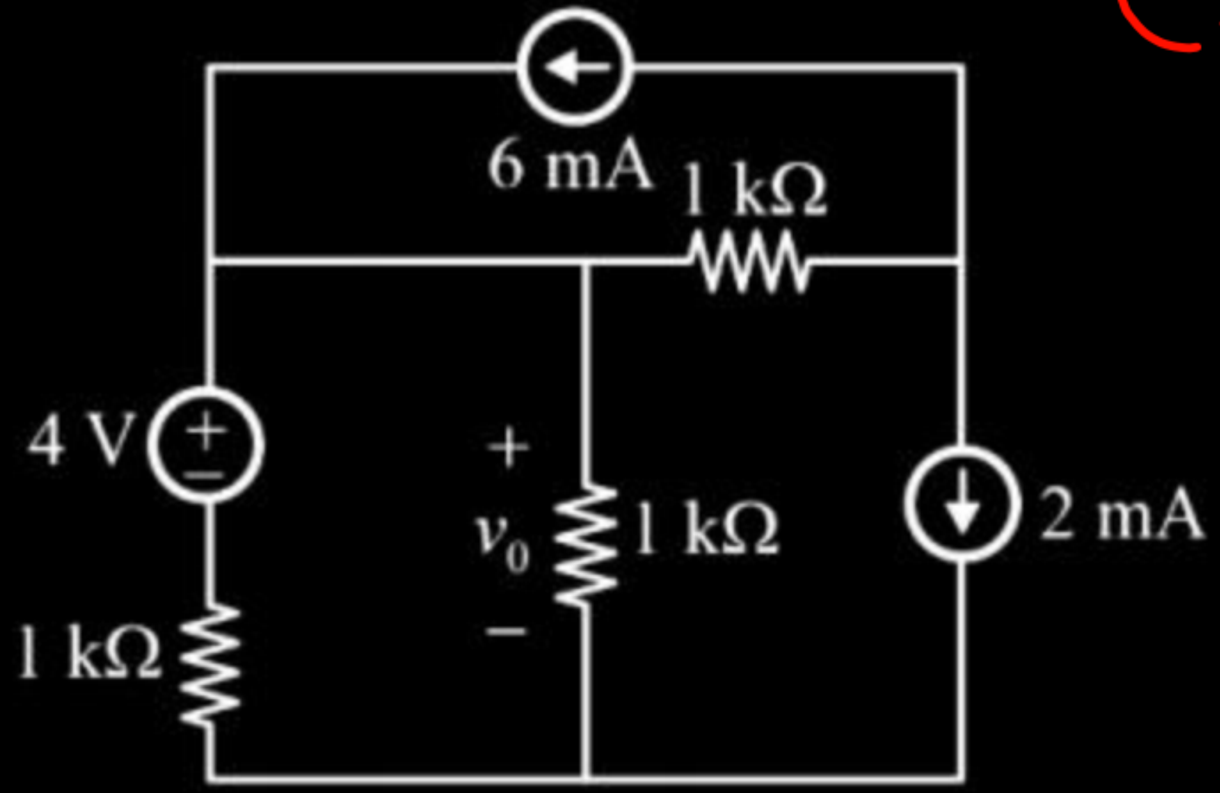
Dependent Source → Voltage. / current Source. } unit is not Mentioned.

Then convert milli $\longrightarrow$ (A).
or. (Ω)

(NAT)

Find $V_0 \rightarrow$.
(Inspection method).

#Q. Consider the circuit shown in the figure.



The value of v_0 (rounded off to one decimal places) is ________ V.

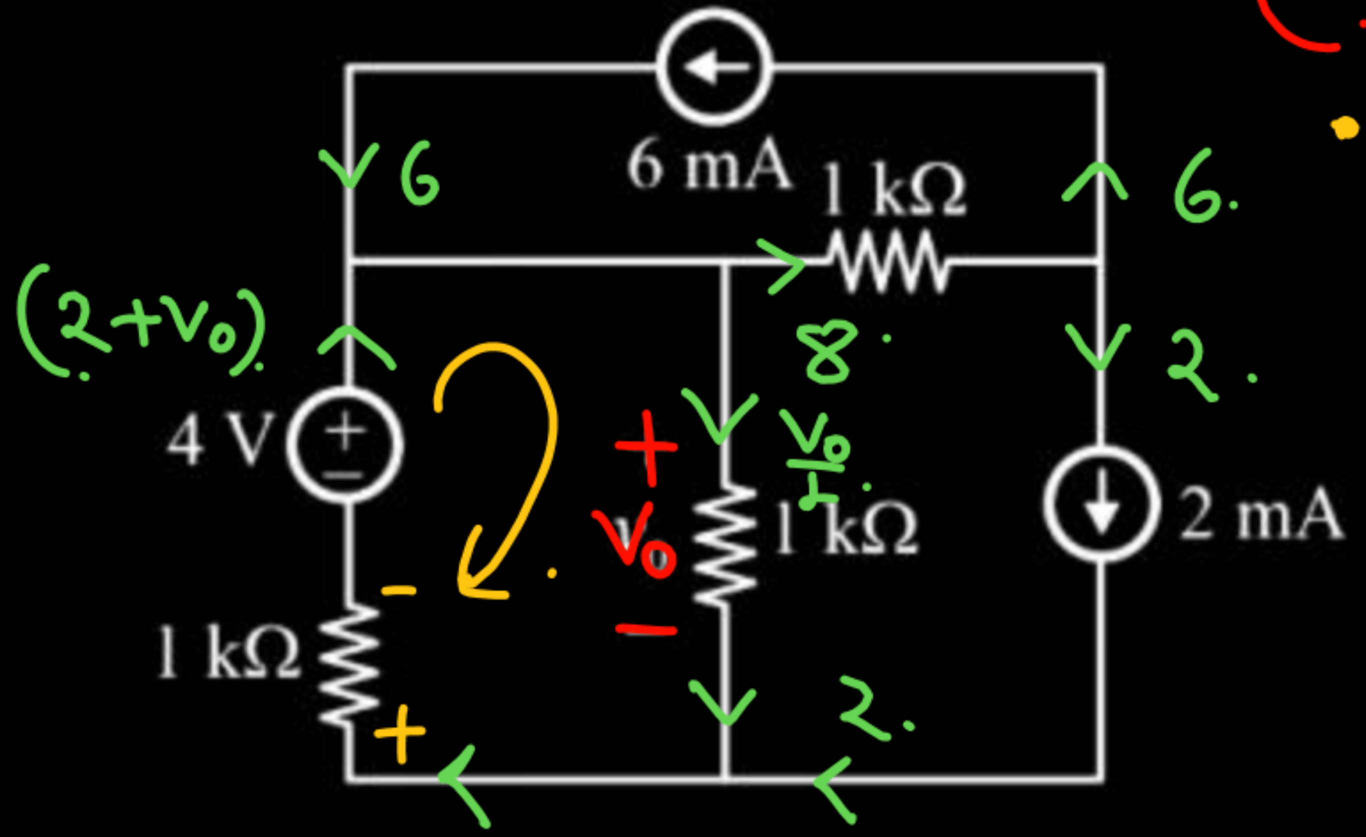
[GATE-2021-1M]

(NAT)

#Q. Consider the circuit shown in the figure.

Find $V_0 \rightarrow$

(Inspection method)



- $4 = V_0 + 1 \times (2 + V_0)$

$4 = V_0 + 2 + V_0$

$2V_0 = 2$

$V_0 = (1 \text{ Volt})$

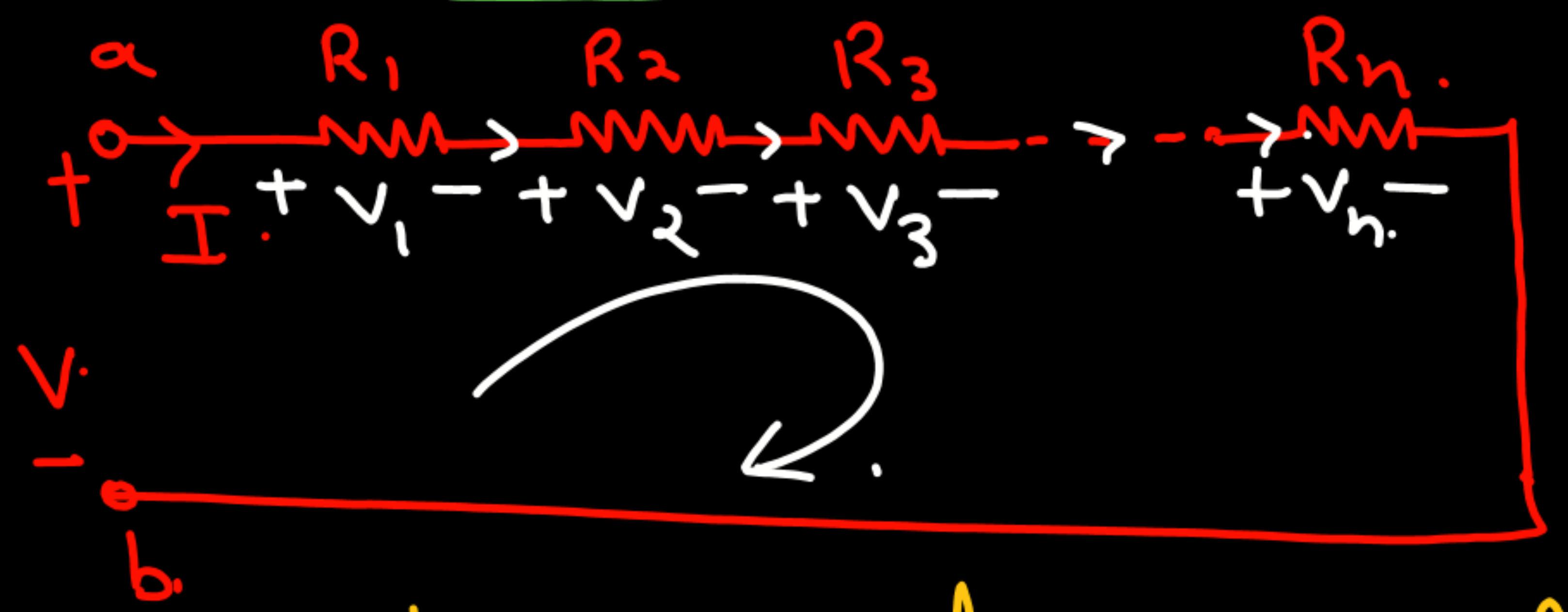
The value of v_0 (rounded off to one decimal places) is ________ V.

[GATE-2021-1M]

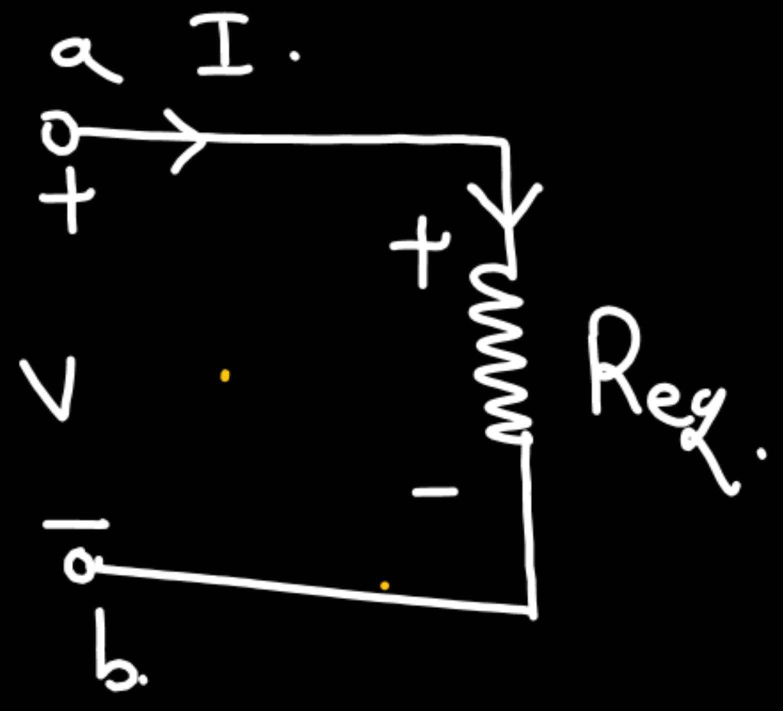
Topic: (Series & Parallel operation)

(1) Series operation:

(a) Resistance:



$\Rightarrow$



- current in each element will always remains same.
- Voltage across each resistor may or may not remain same.

- $V = I \cdot R_{eq}$

$$\left[\frac{V}{I} = R_{eq}\right]$$

- Applying KVL,

$$V = V_1 + V_2 + V_3 + \cdots + V_n.$$

$$V = IR_1 + IR_2 + IR_3 + \cdots + IR_n.$$

$$\left[\frac{V}{I} = R_{eq} = R_1 + R_2 + R_3 + \cdots + R_n\right]$$

- Here, there is a concept known as Voltage Division Rule (VDR) comes into picture that is used to calculate the voltage across each resistance connected in series.

$$V_1 = I \cdot R_1 = V \cdot \left(\frac{R_1}{R_{eq}}\right)$$

$$V_2 = I \cdot R_2 = V \cdot \left(\frac{R_2}{R_{eq}}\right).$$

$$\vdots$$

$$V_n = IR_n = V \cdot \left(\frac{R_n}{R_{eq}}\right).$$

Now, voltage across any resistor (x).

$$\left[V_x = V \times \frac{R_x}{R_{eq}}\right] \longrightarrow \text{(General expression of VDR)}$$

$x = 1, 2, 3, \ldots n.$

- if all resistors are of same value

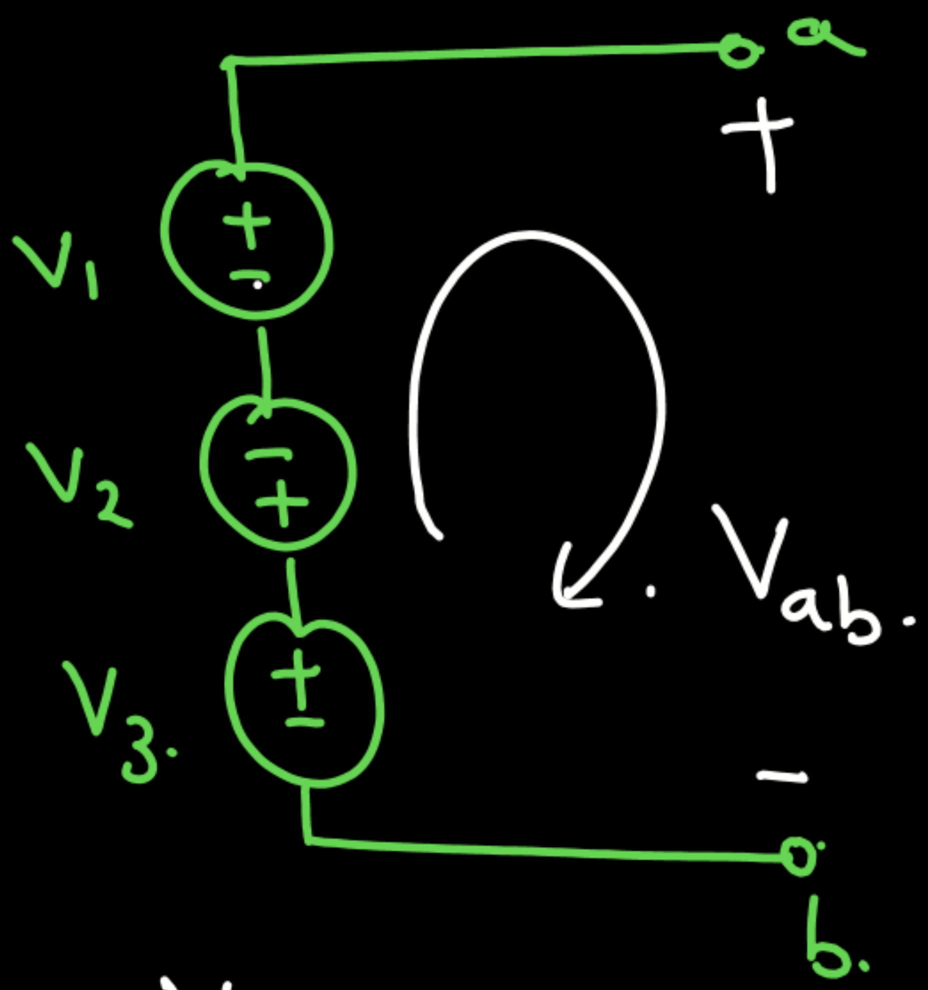
$$[R_1 = R_2 = R_3 = R_4 = \cdots = R_n = R]$$

$$[R_{eq} = [R + R + R + \cdots + R] = nR]$$

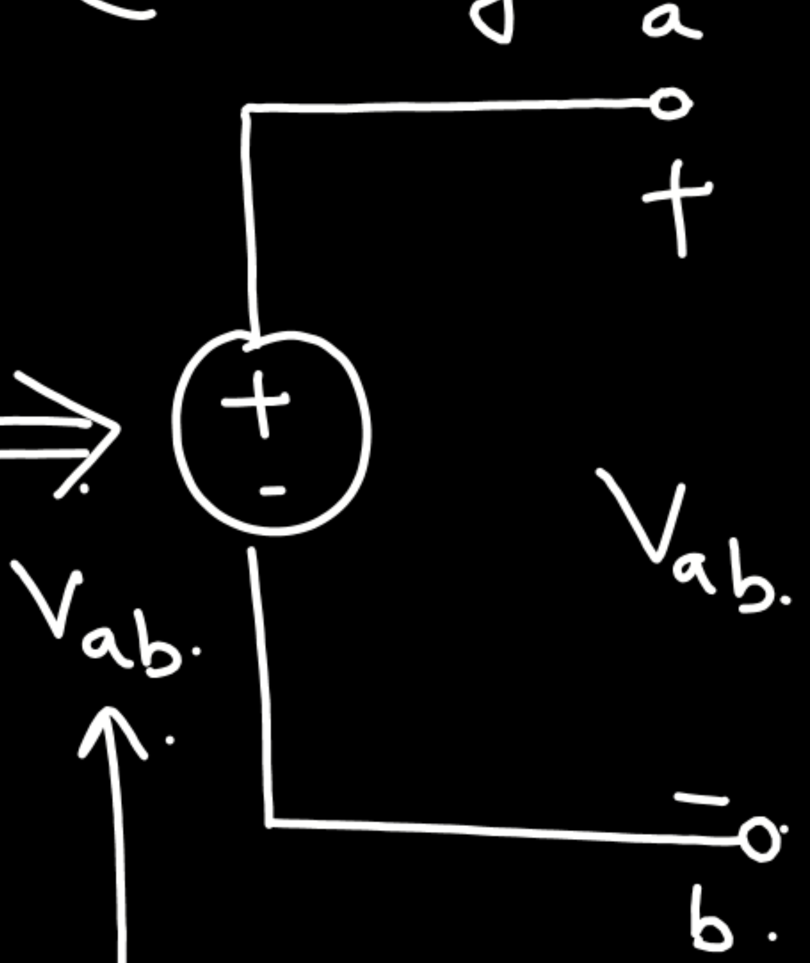
$$\left[V_x = V \times \frac{R}{nR} = \frac{V}{n}\right]$$

(b) Series operation of Voltage Sources:

(1) Ideal Sources. (Simply Apply KVL).



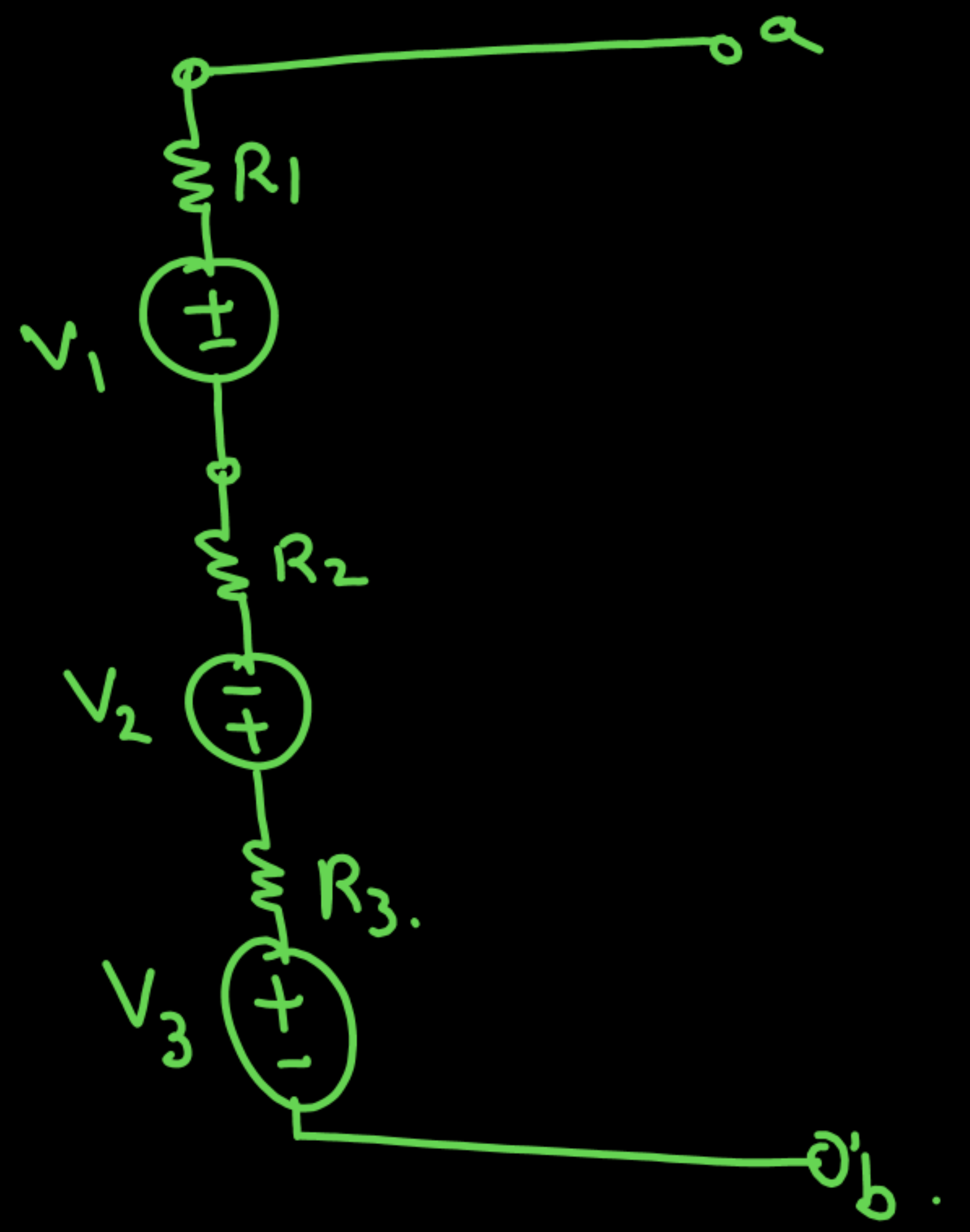
$\Rightarrow$

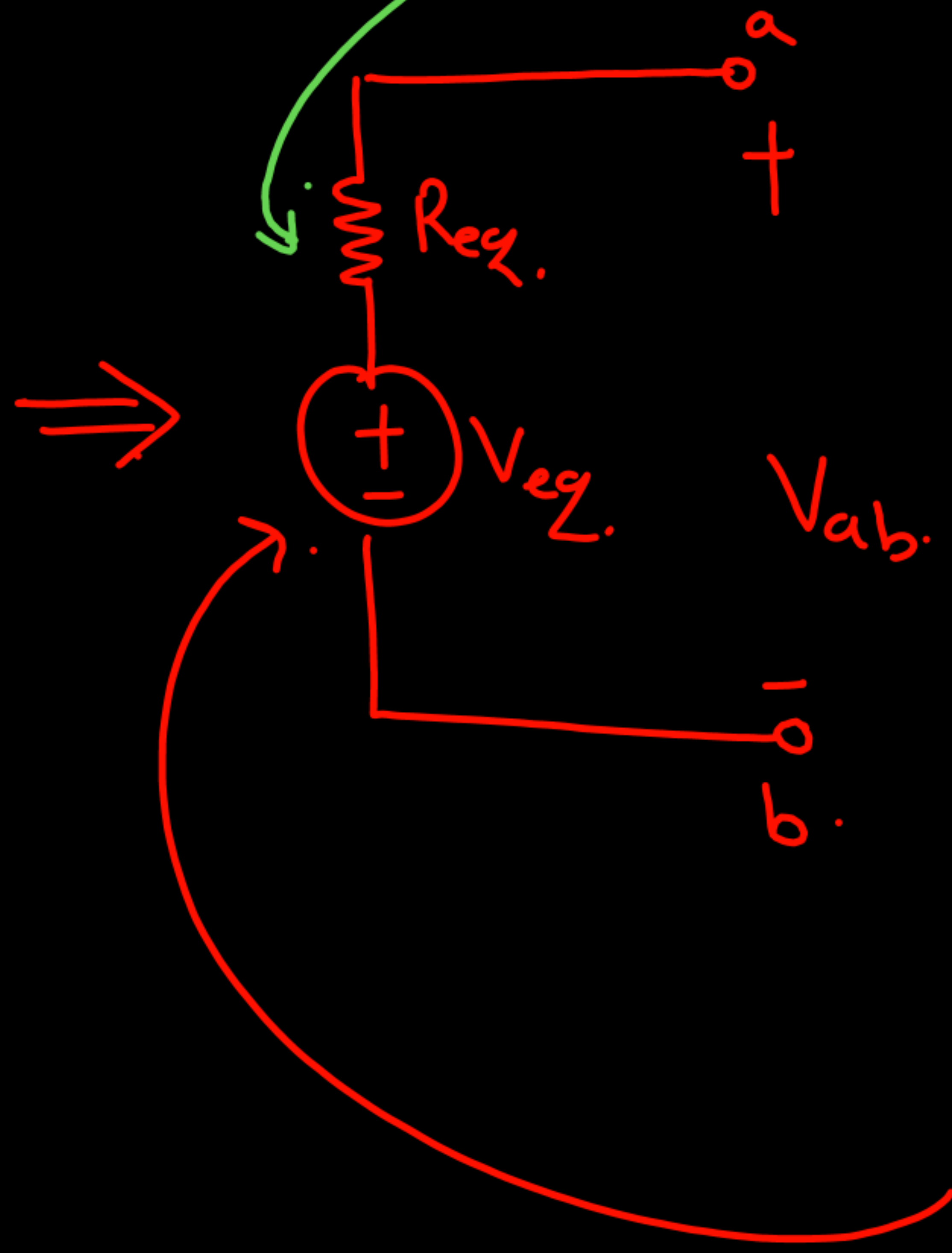


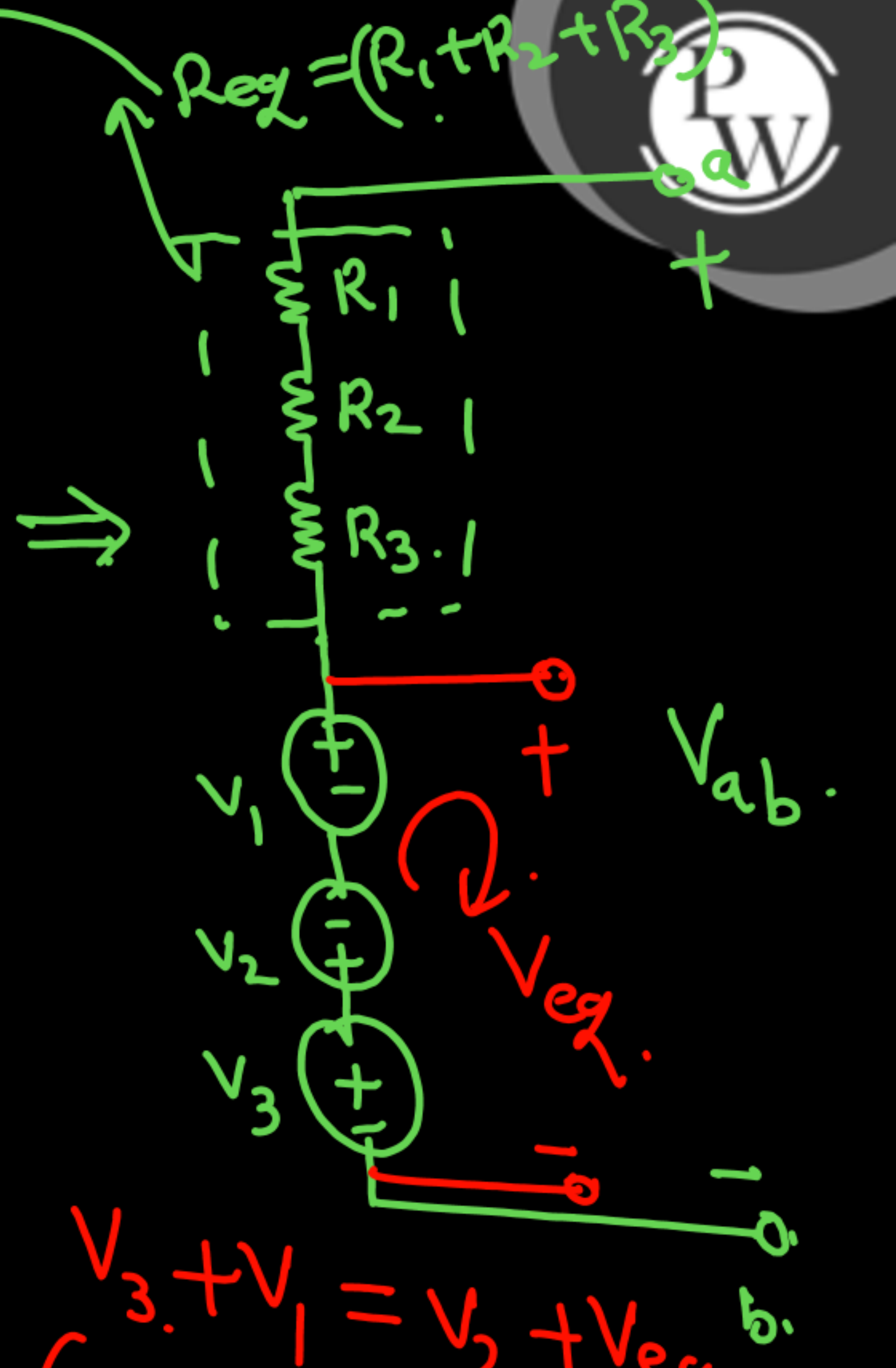
$$V_3 + V_1 = V_2 + V_{ab}$$

$$\left(V_{ab} = V_1 - V_2 + V_3\right)$$

(2) Practical Voltage Source:







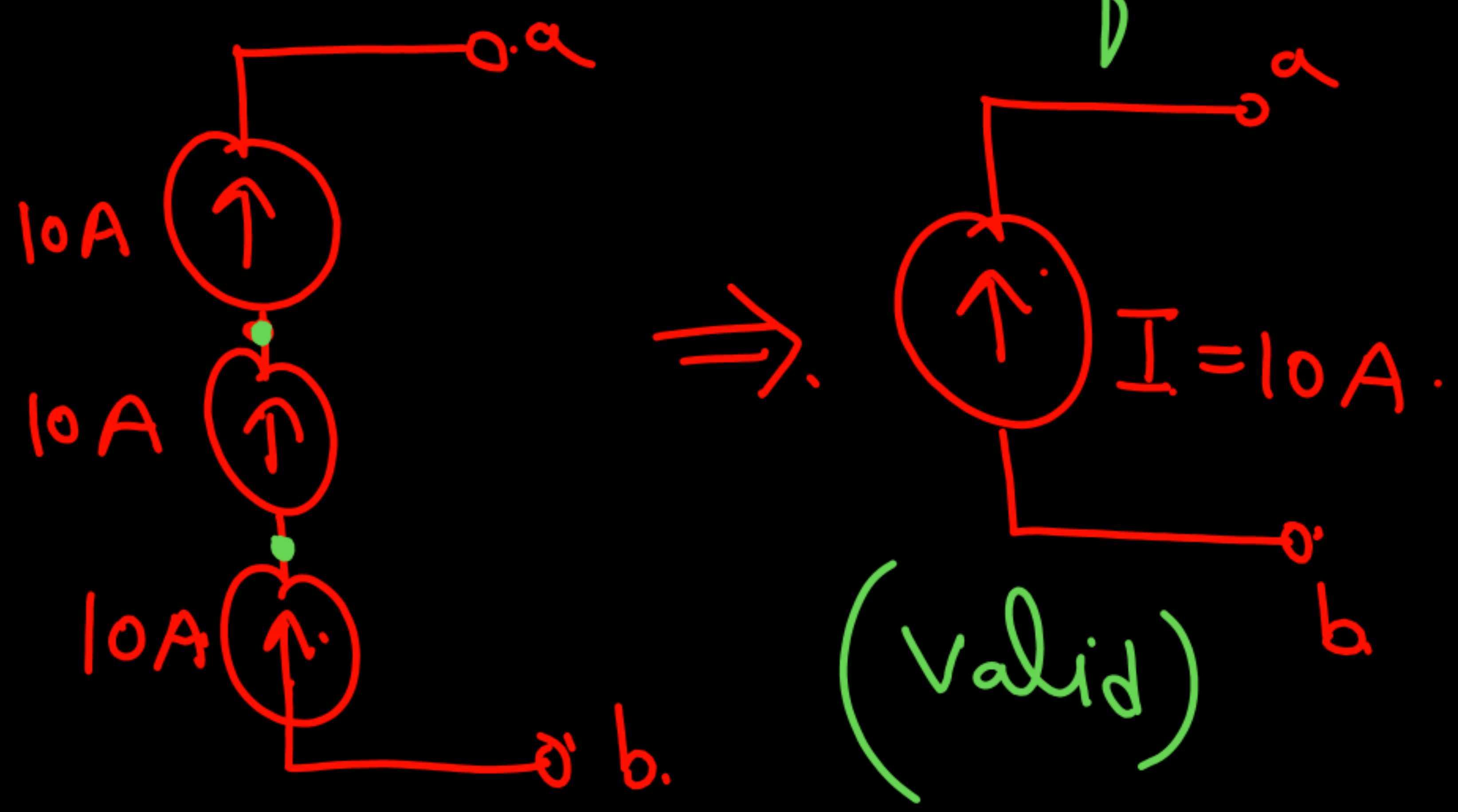
$$V_3 + V_1 = V_2 + V_{eq}.$$

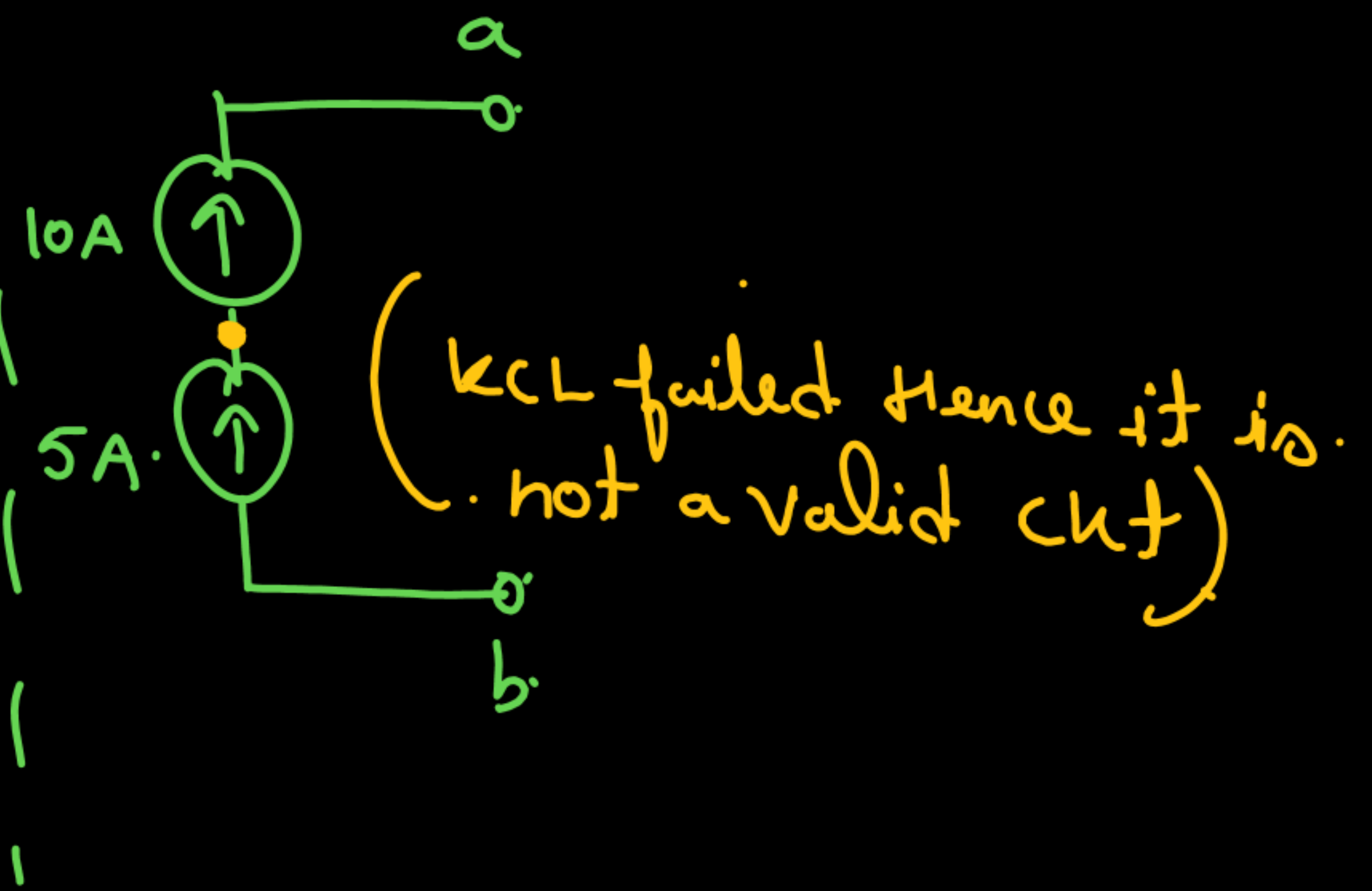
$$\left(V_{eq} = V_1 - V_2 + V_3\right).$$

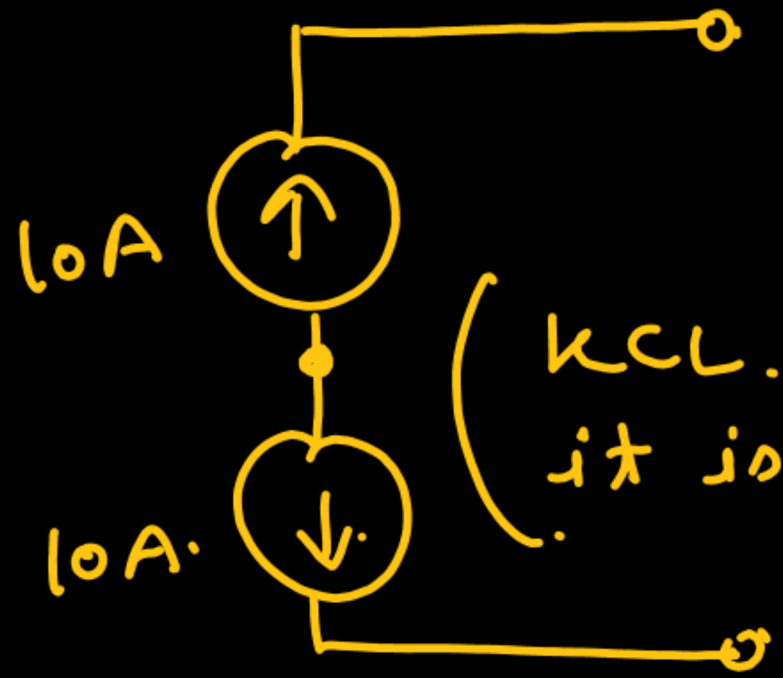
(c) Series operation of current Sources:

(1) Ideal current Sources:

"For Series operation of Ideal current Sources, the magnitude & Direction of all Ideal current Sources Must be same so that KCL will be satisfied."

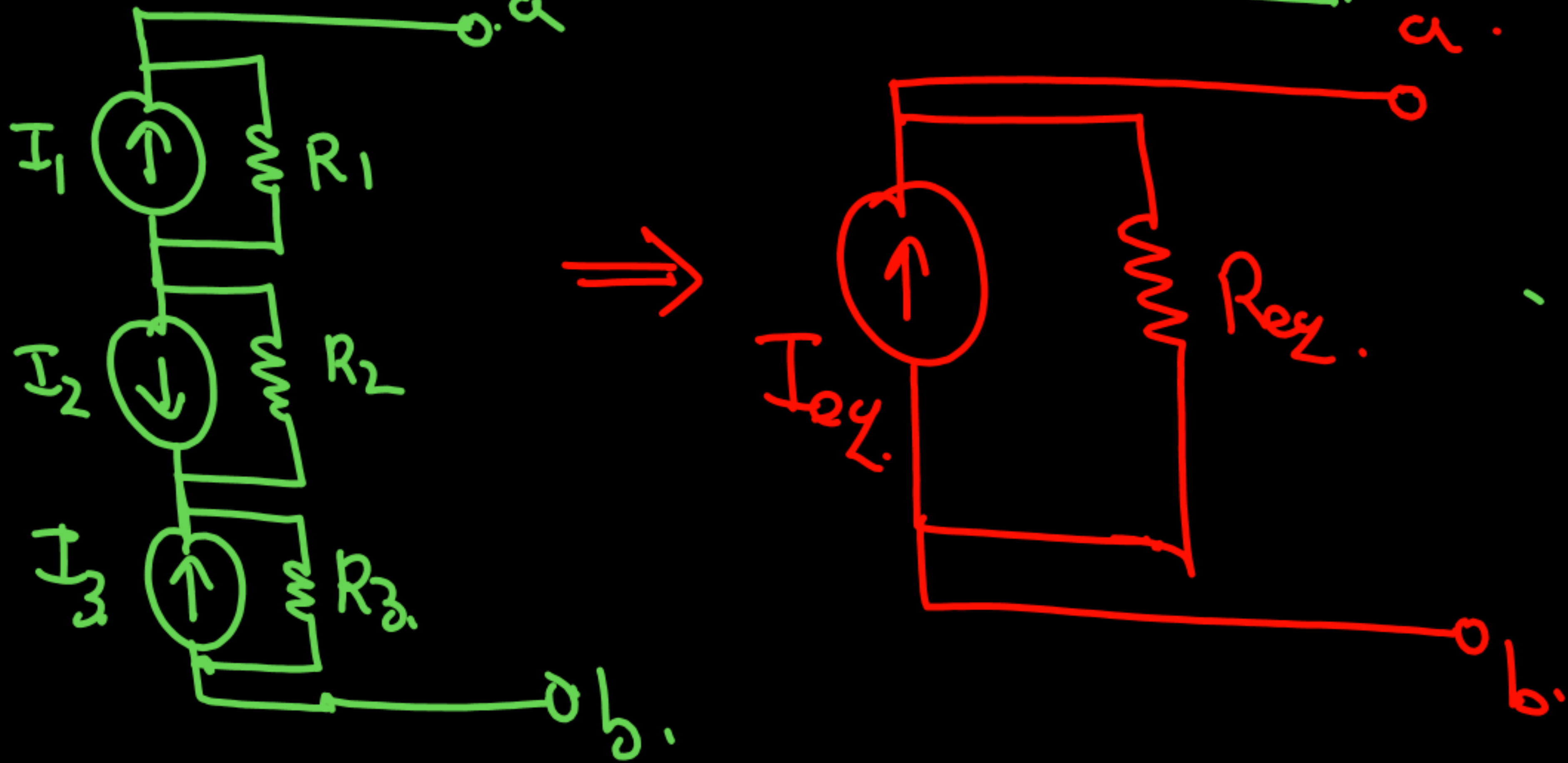






(KCL failed, Hence it is a invalid cut)

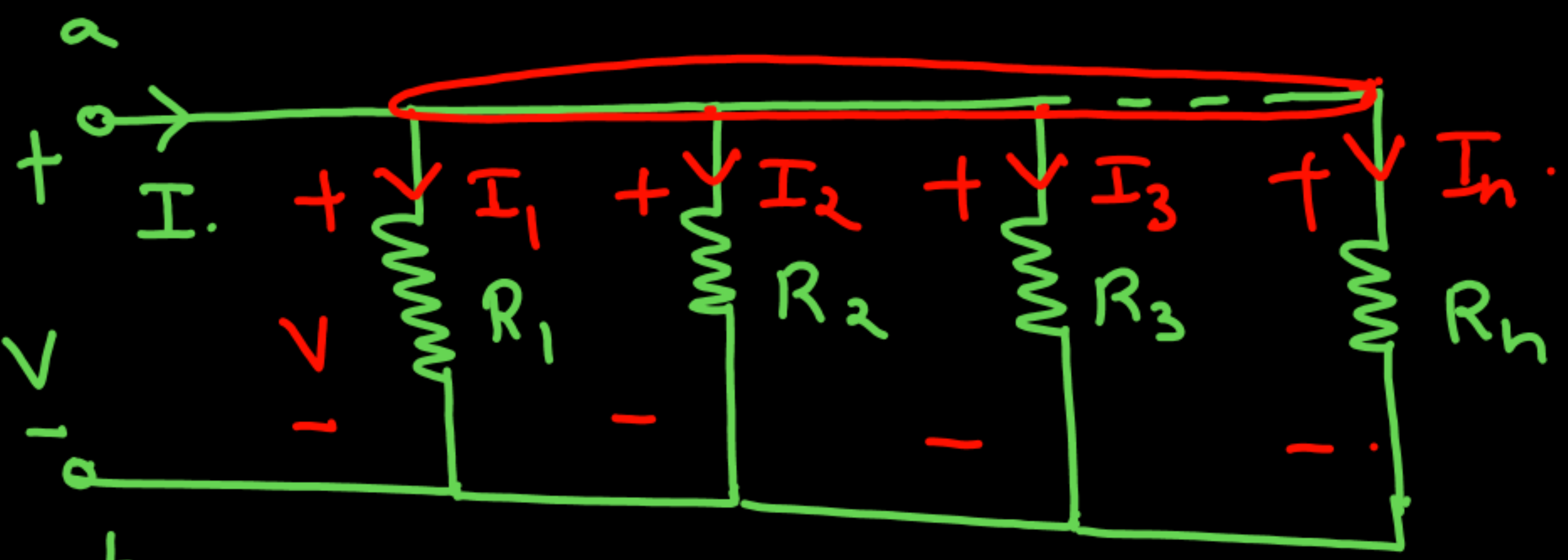
(2) Practical current Sources:



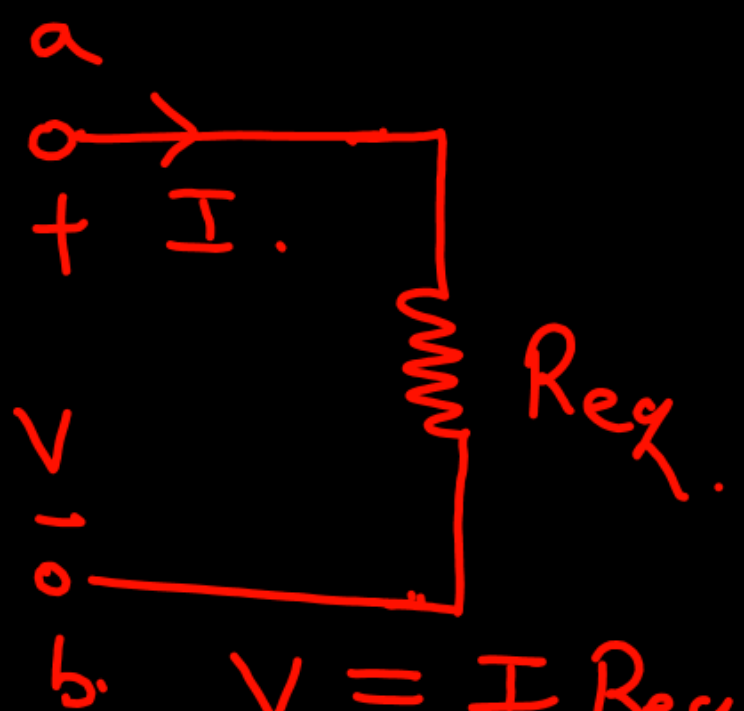
- Here there is no such conditions what we have Discussed in Ideal current case. Any kind of Practical current Source can be Series connected.
- This operation is given by Dual Millman's theorem.

② Parallel operation:

(a) Resistors:



$\Rightarrow$



$V = I R_{eq}$.

$$\left[\frac{1}{R_{eq}} = \frac{I}{V} = G_{eq}\right]$$

- Voltage across each element will remain same always.
- Current in each resistor may or may not remain same.

- Applying KCL,

$$I = I_1 + I_2 + I_3 + \cdots + I_n.$$

$$I = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3} + \cdots + \frac{V}{R_n}.$$

$$\left[\frac{I}{V} = \frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots + \frac{1}{R_n}\right] \longrightarrow$$ in terms of Resistors (Ω).

$$\left[G_{eq} = G_1 + G_2 + G_3 + \cdots + G_n\right] \longrightarrow$$ in terms of conductance ($\mho$).

- Here a concept comes into picture, known as current Division rule (CDR). that is used to find current in any Parallely connected Resistor.

$$I_1 = \frac{V}{R_1} = I\cdot\left(\frac{R_{eq}}{R_1}\right) = I\cdot\left(\frac{G_1}{G_{eq}}\right)$$

$$I_2 = \frac{V}{R_2} = I\cdot\left(\frac{R_{eq}}{R_2}\right) = I\cdot\left(\frac{G_2}{G_{eq}}\right)$$

$$\vdots$$

$$I_n = \frac{V}{R_n} = I\cdot\left(\frac{R_{eq}}{R_n}\right) = I\cdot\left(\frac{G_n}{G_{eq}}\right)$$

Hence, current in any resistance 'x' connected in Parallel,

$$\left[I_x = I \times \frac{R_{eq}}{R_x} = I \times \frac{G_x}{G_{eq}} \right] \rightarrow \text{General formula of CDR.}$$

$x = 1, 2, 3, \ldots n$

- if all resistors are same value.

$$[R_1 = R_2 = R_3 = \cdots = R_n = R]$$

$$\frac{1}{R_{eq}} = \frac{1}{R} + \frac{1}{R} + \cdots + \frac{1}{R} = \left(\frac{n}{R}\right)$$

$$\left[R_{eq} = \frac{R}{n}\right]$$

- $\left[G_{eq} = G + G + \cdots + G = n \cdot G\right]$

- CDR $\longrightarrow$

$$\left[I_x = I \times \frac{R_{eq}}{R_x} = I \times \frac{R/n}{R} = \frac{I}{n}\right]$$

$$\left[I_x = I \times \frac{G_x}{G_{eq}} = I \times \frac{G}{nG} = \frac{I}{n}\right]$$

(b) Parallel operation of Voltage Sources:

[Sunday → 3 to 5 pm]
↳ [3rd August]

- [4 to 7] → August → (class nahi)
- 7 → onwards → {Sat & Sunday} → (full Practice sheet)

Thank you

GW

Soldiers !