Basic Electrical Engg. :→

1.) Circuit Element:

2.) Branch

3.) Network V.S Circuit.

Network
↓
→ Interconnection of circuit element
→ need not to be closed

Circuit
↳ closed network

→ Every circuit is a network but vice versa is not true

4.) Lumped network (n/t) V.S Distributed n/t

Lumped
↓
electrical elements can be separate physical

Distributed
↓
network in which elements can neither be electrically or physically separated

5.) Charge: 1.6×10^{-19} C

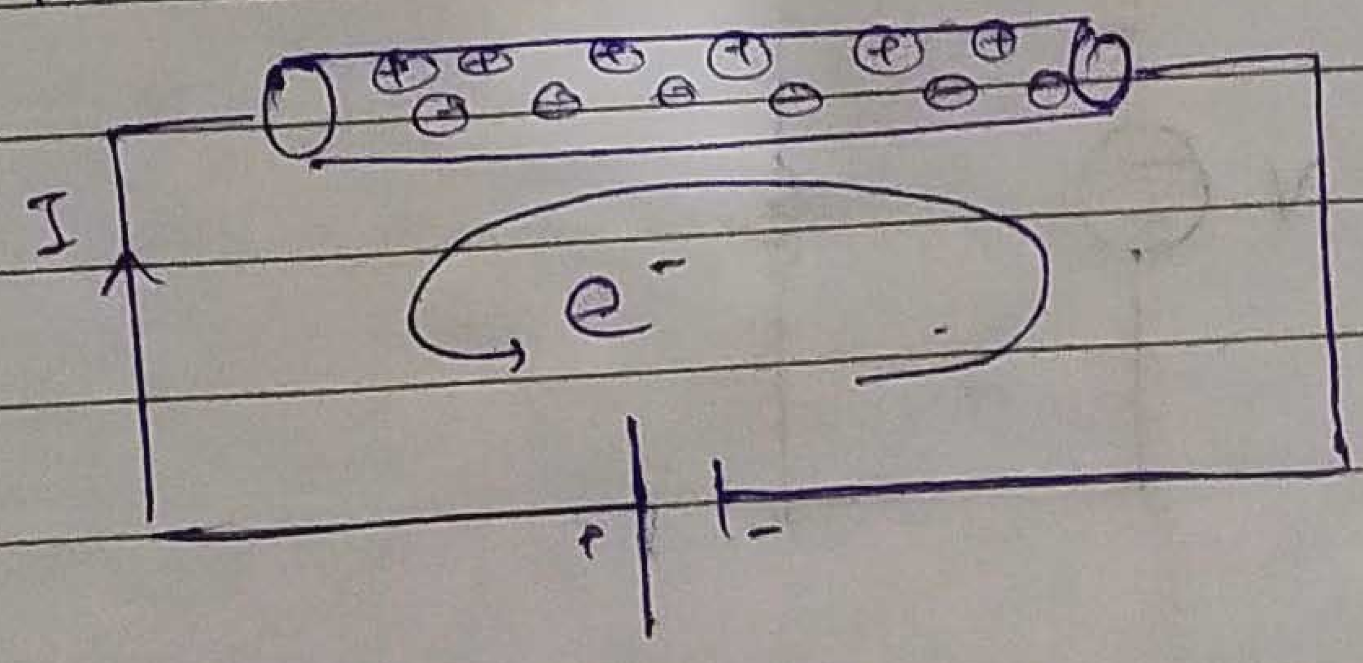
Charge in motion is known as current

6.) Current: $C = \frac{dq}{dt}$ or $I = \frac{dq}{dt}$

rate of change of charge is current

Q = Coulomb
t = sec
I = Ampere = C/s

I_e



7) <u>Voltage:</u> $\frac{dw}{dq}$ → work done per unit charge

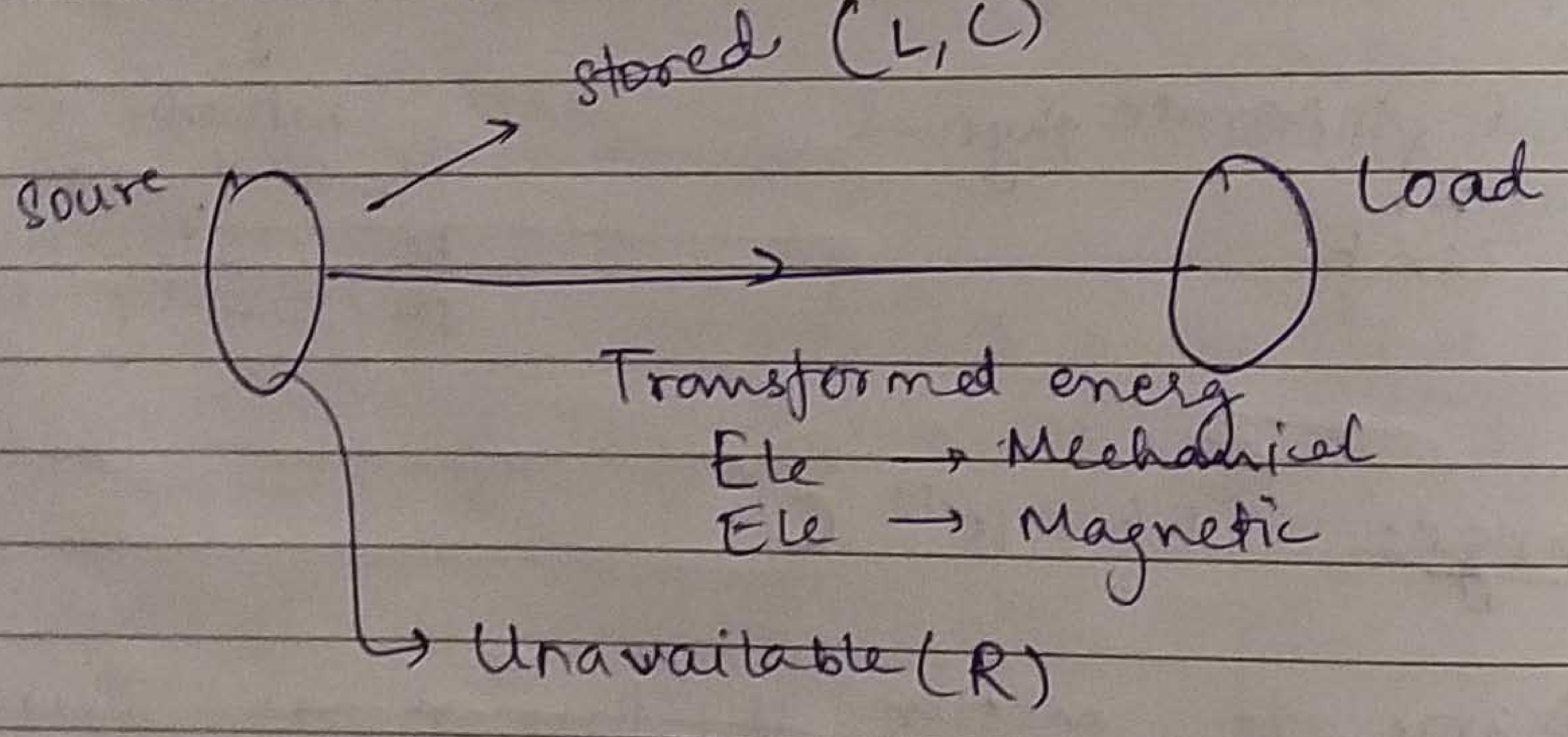
8) <u>Power:</u> $V \cdot I$

$= \frac{dw}{dq} \cdot \frac{dq}{dt}$

$\Rightarrow \frac{dw}{dt}$ → J (Joules), s

Volts ⟶ Amp ⇒ Watts

9) Energy = $\int_0^\infty \frac{dw}{dt}\, dt$ = Work done

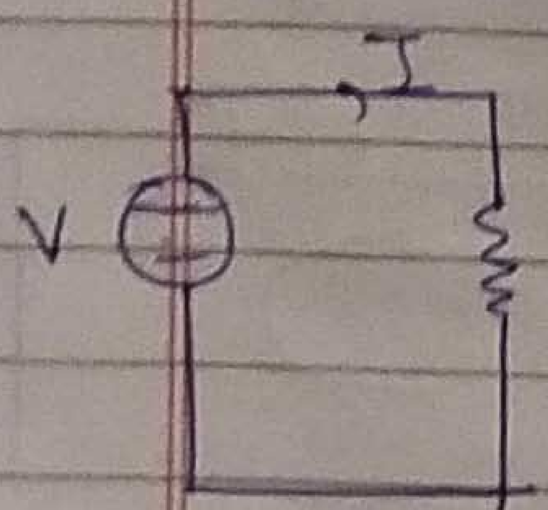


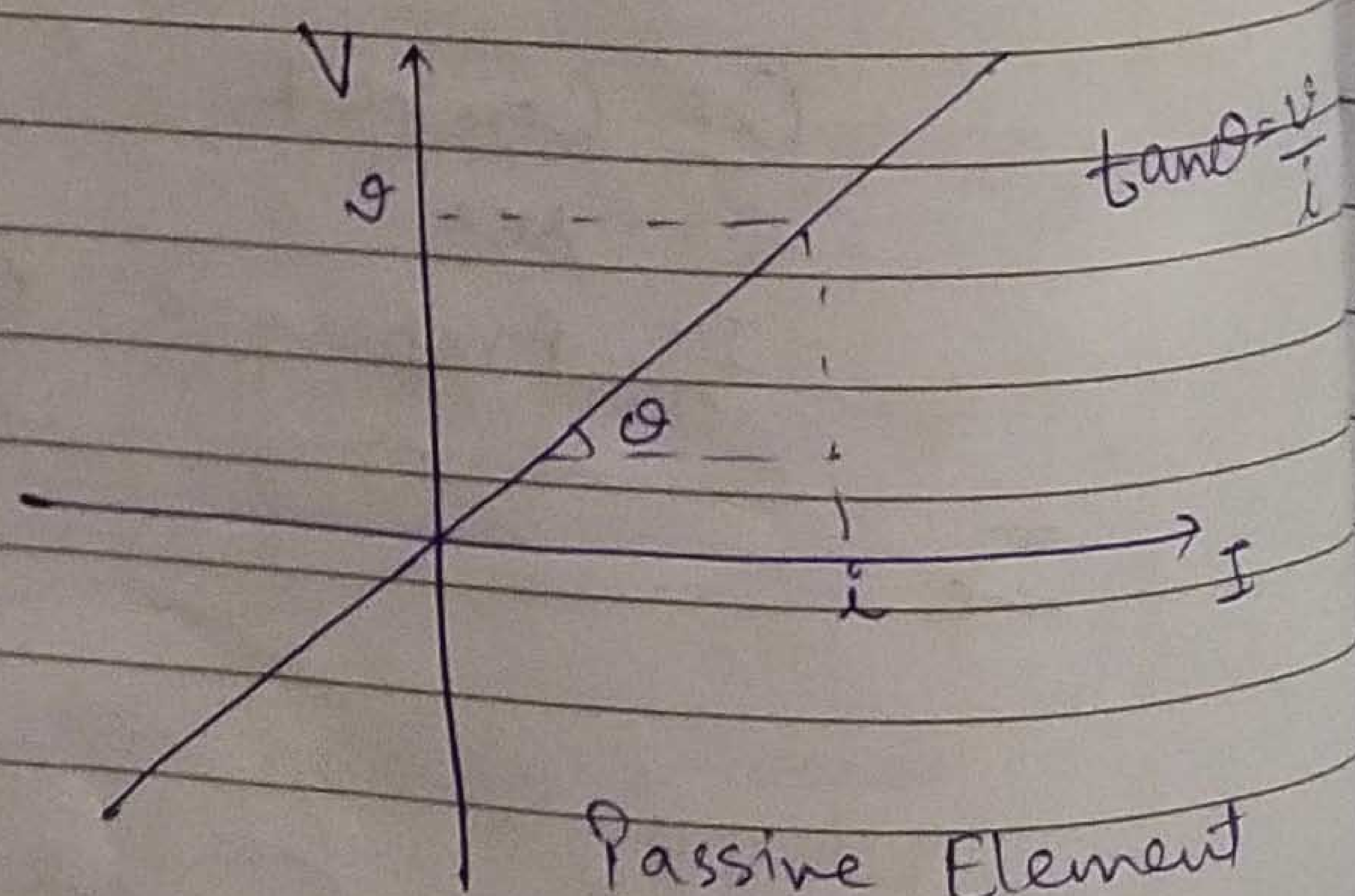
Classification of Elements :-

1) Active Elements (Transistors, Amplifier)

2) Passive Elements (R, L, C)

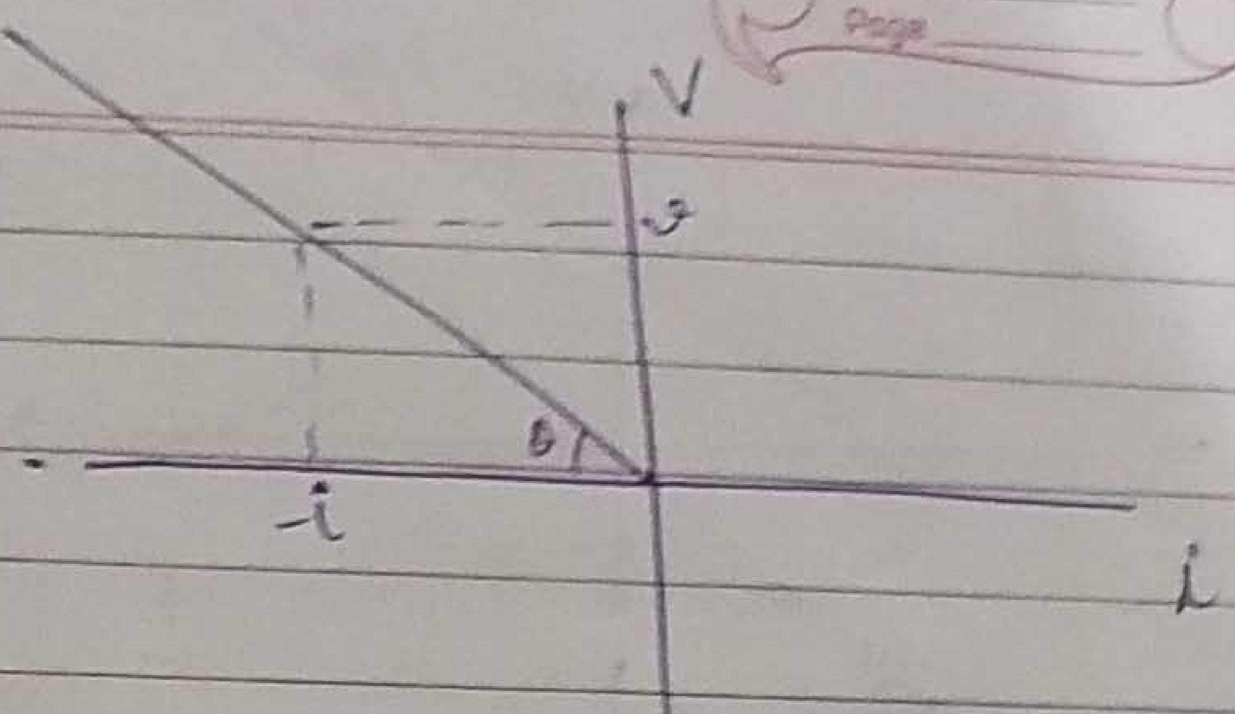
V-I characteristic:



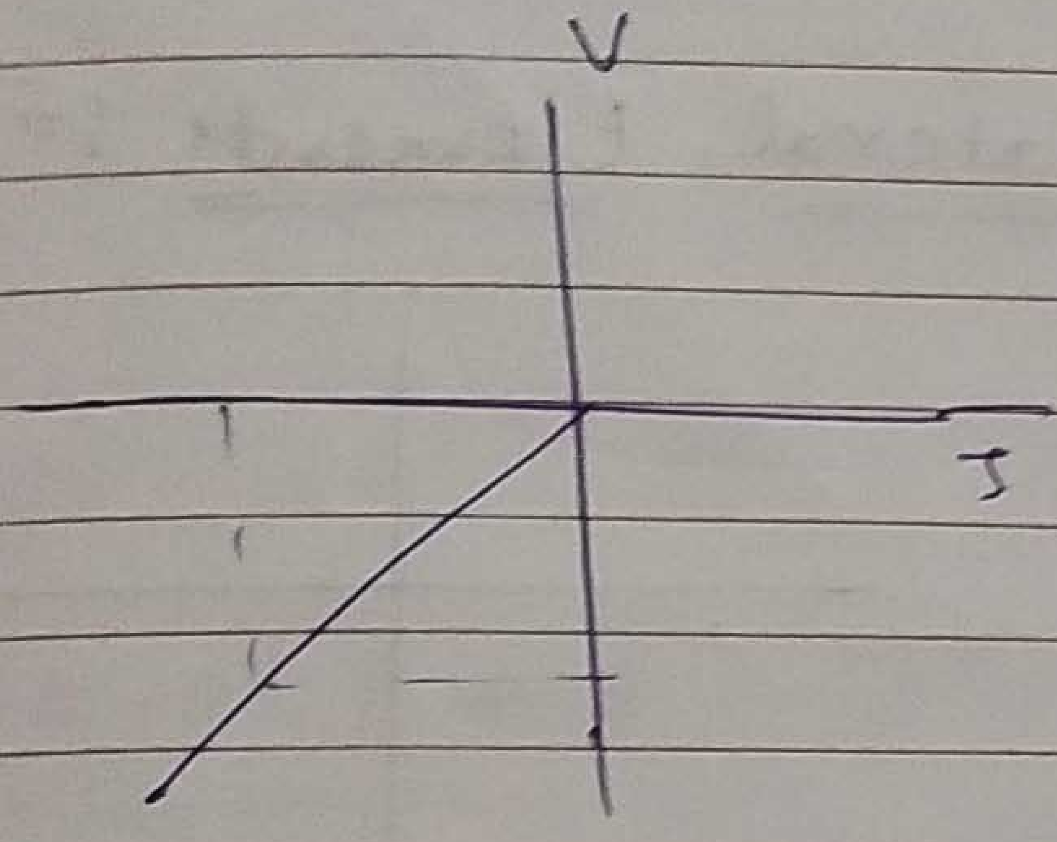


Passive Element

$\tan\theta = \frac{v}{-i}$

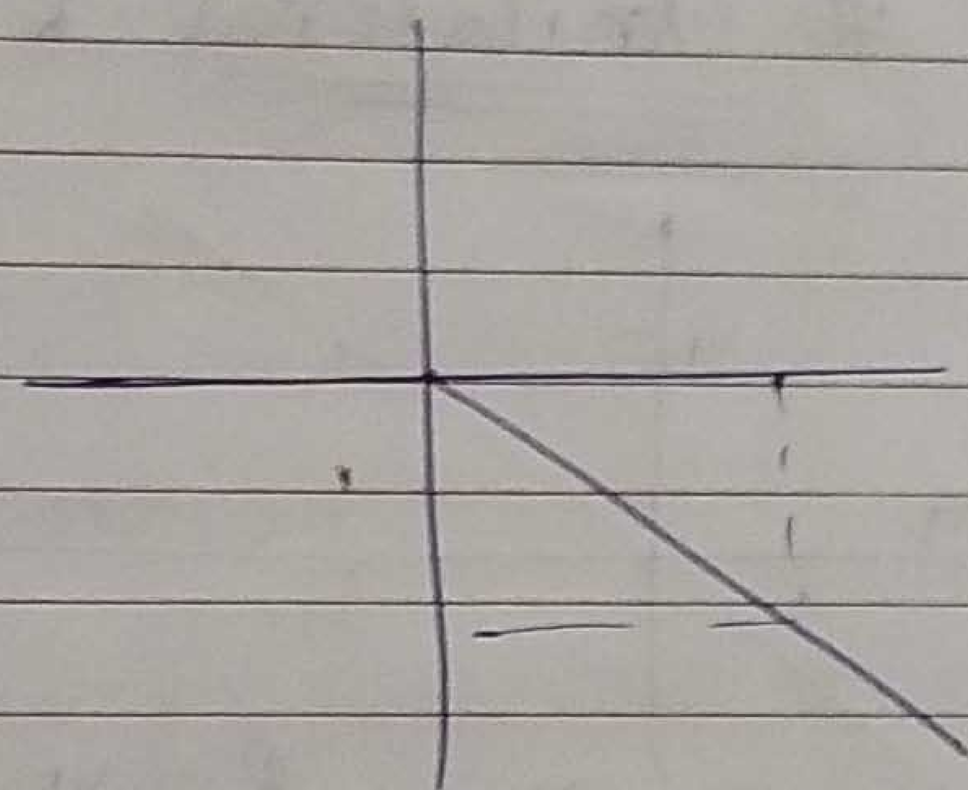


active



slope = +ve

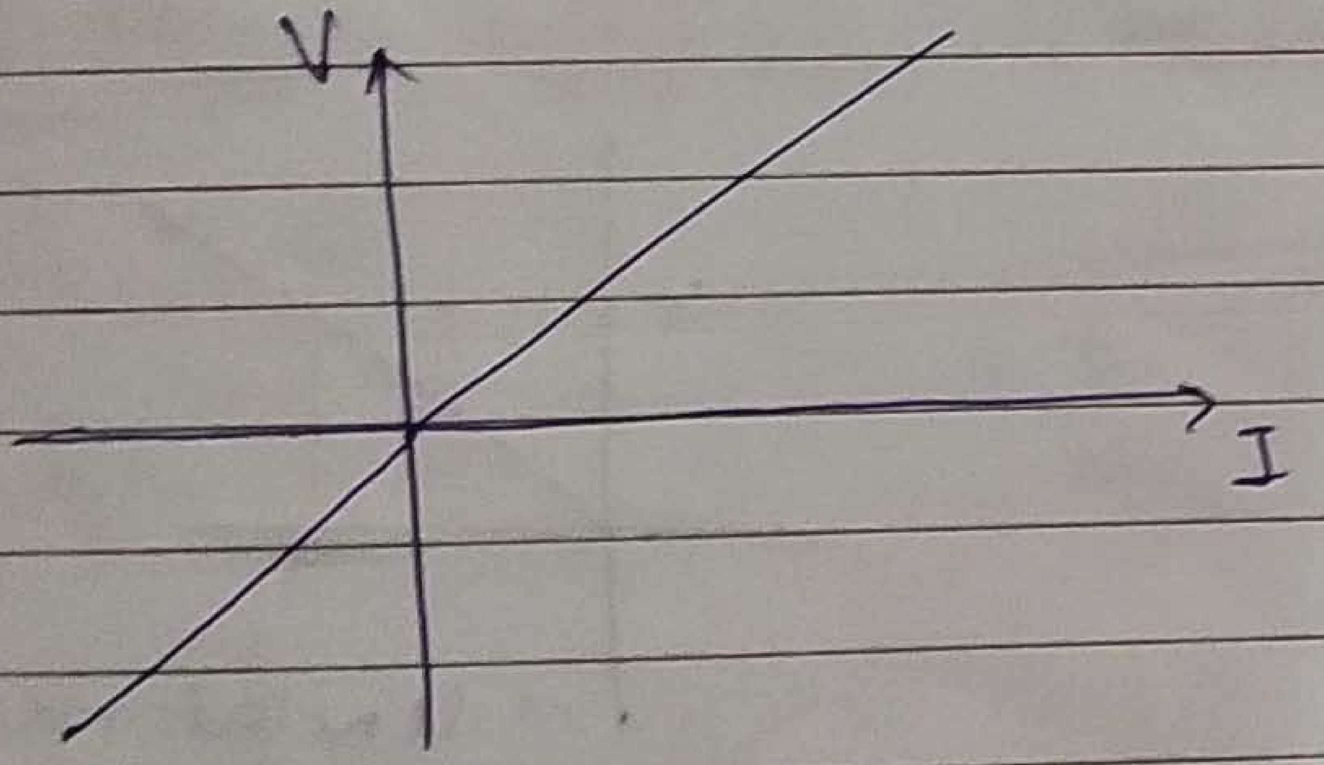
Passive



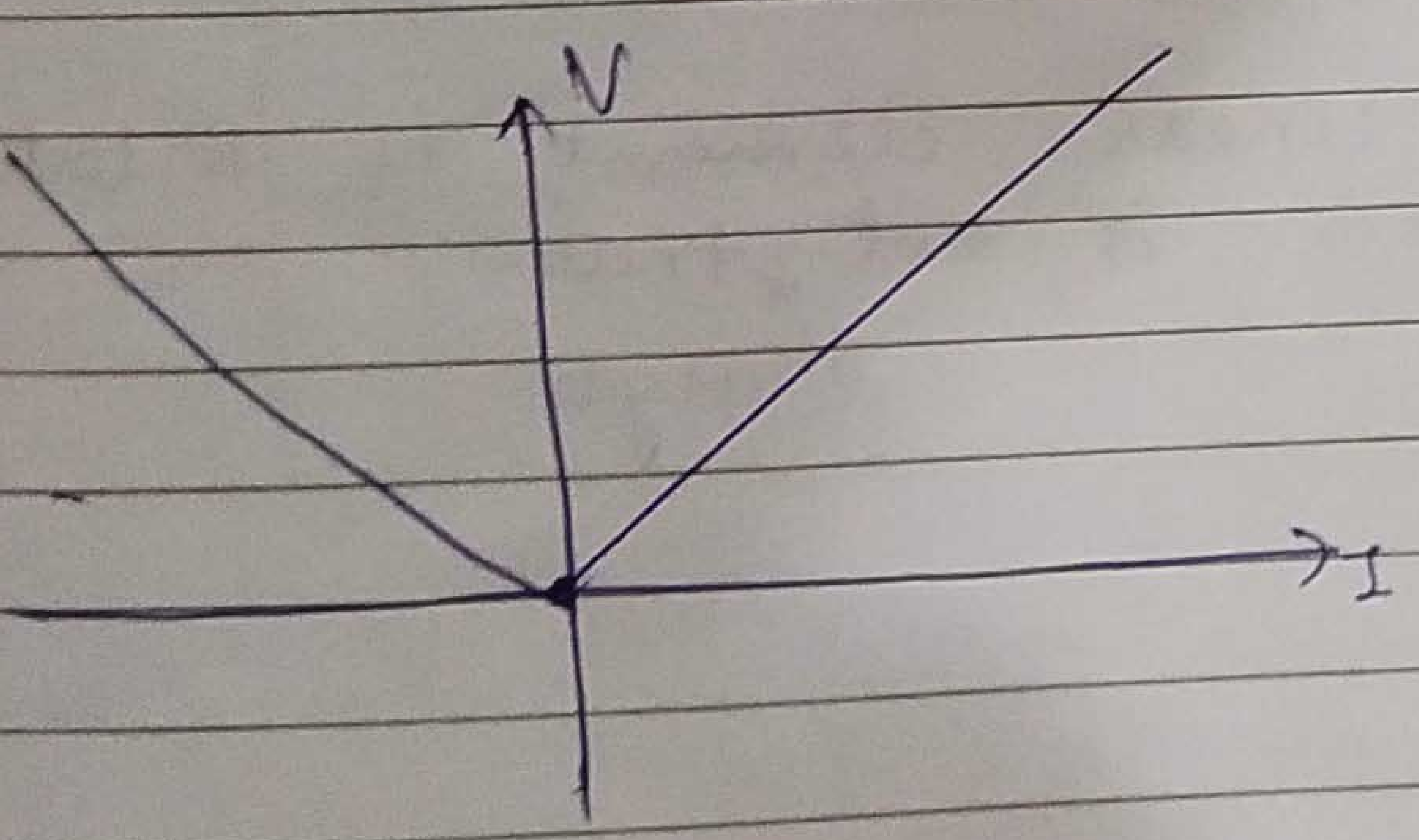
slope = -ve

Active

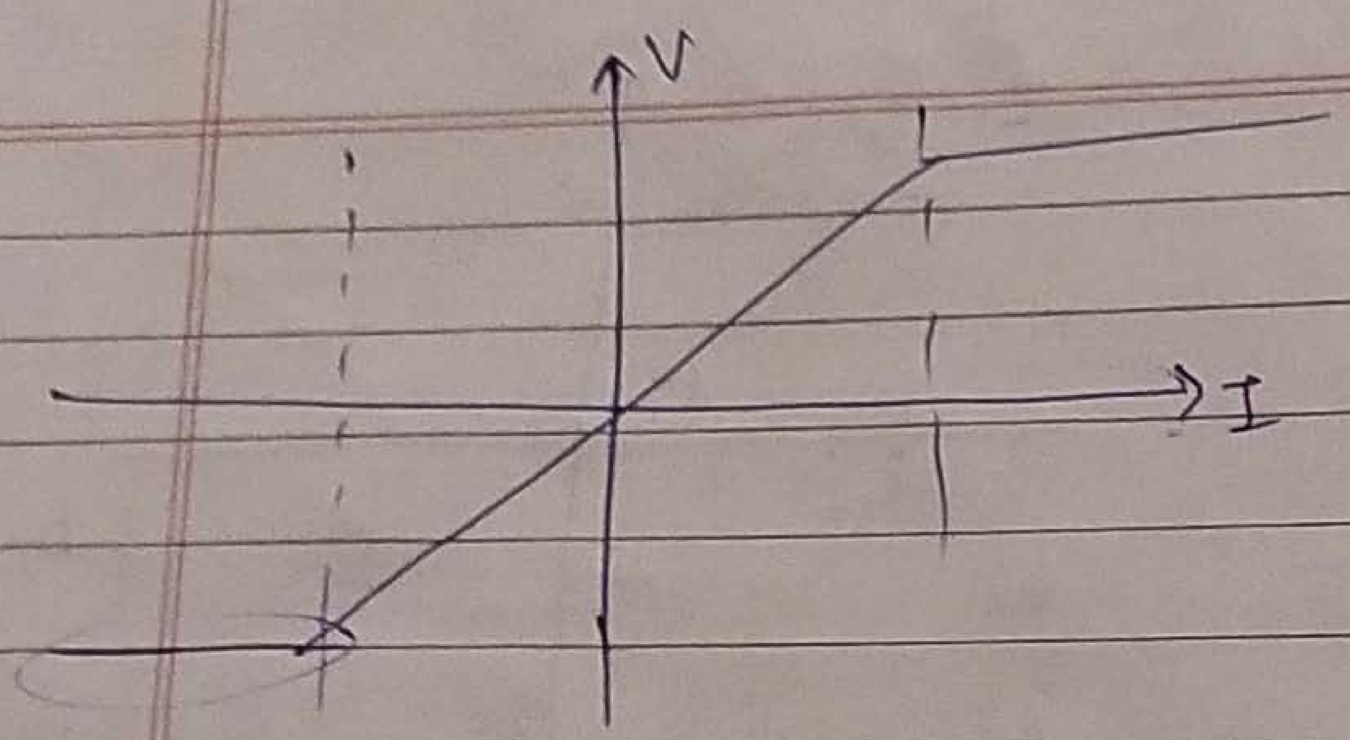
Linear & Non-Linear Elements:→



Linear Element

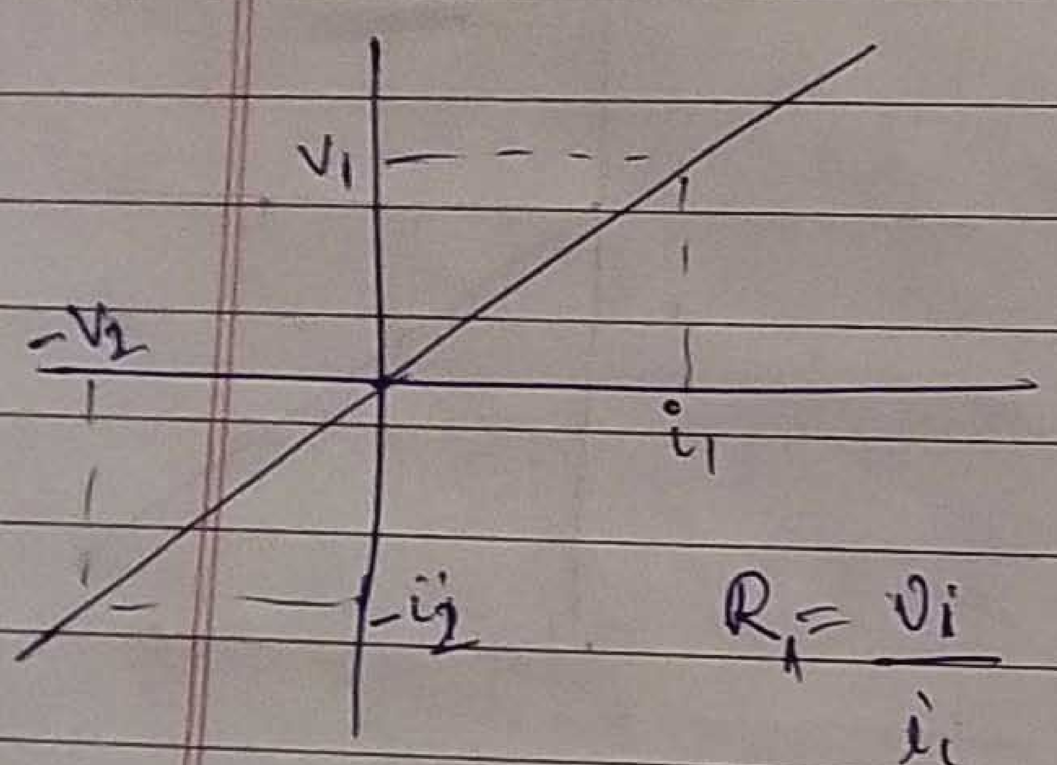


Non-linear Element



Non- Linear

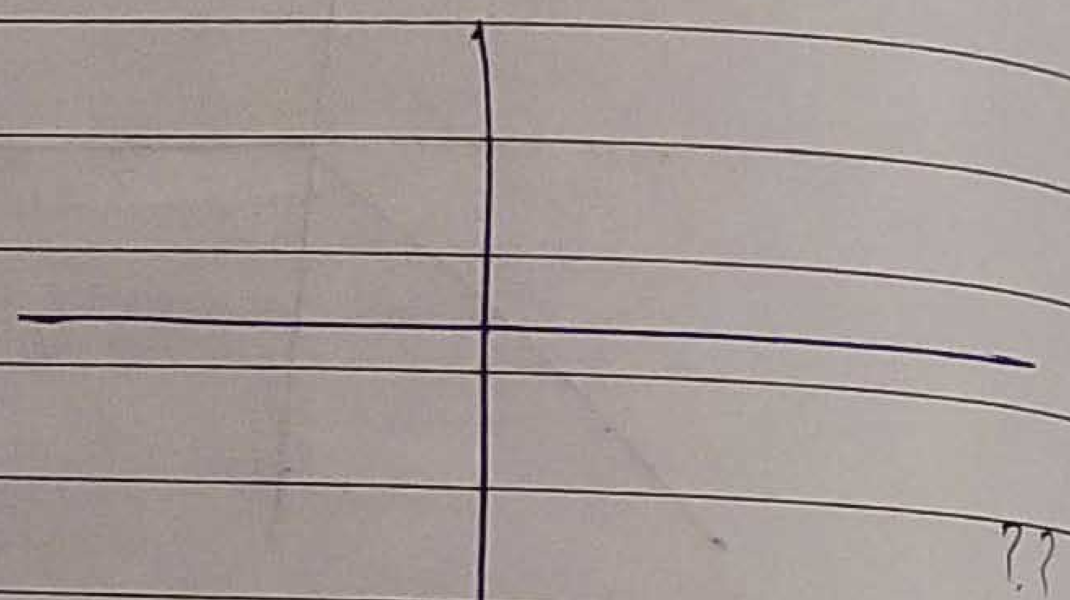
Unilateral & Bilateral Elements :-



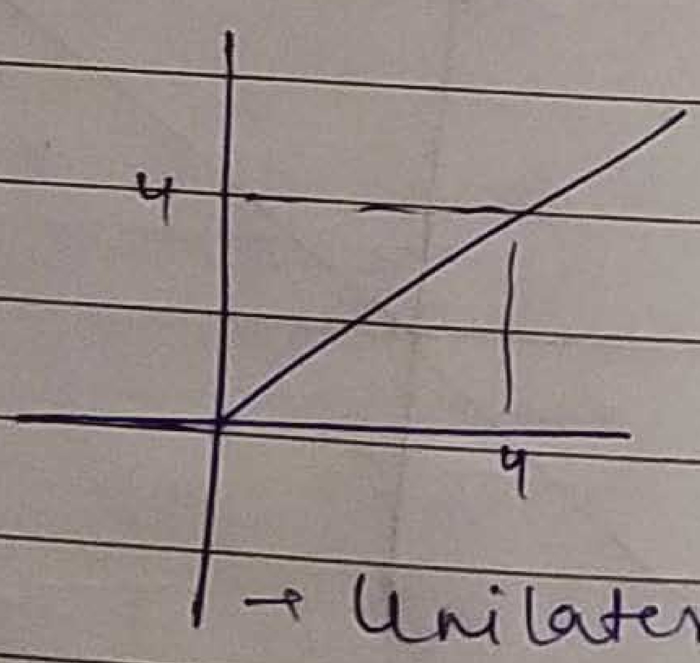
$R_1 = \frac{v_1}{i_1}$

$R_2 = \frac{v_2}{i_2}$

Bilateral Ele
(Resistor)



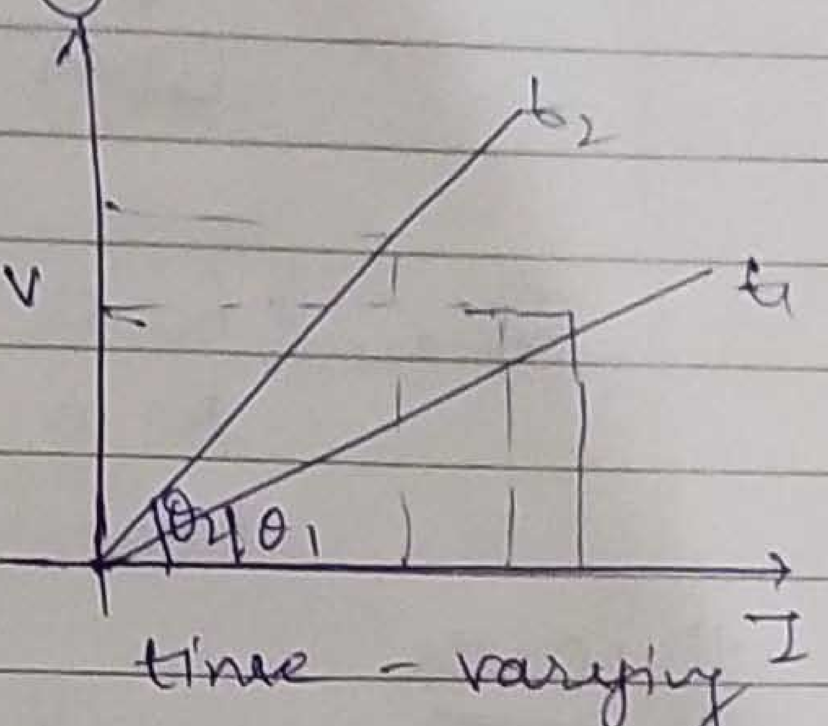
→ (diode)
Unilateral



→ Unilateral

Imp ⊛ Every ~~Resisa~~ Linear element is Bilateral but vice-versa is not always true.

Time - Varying and Time - Invarying :-

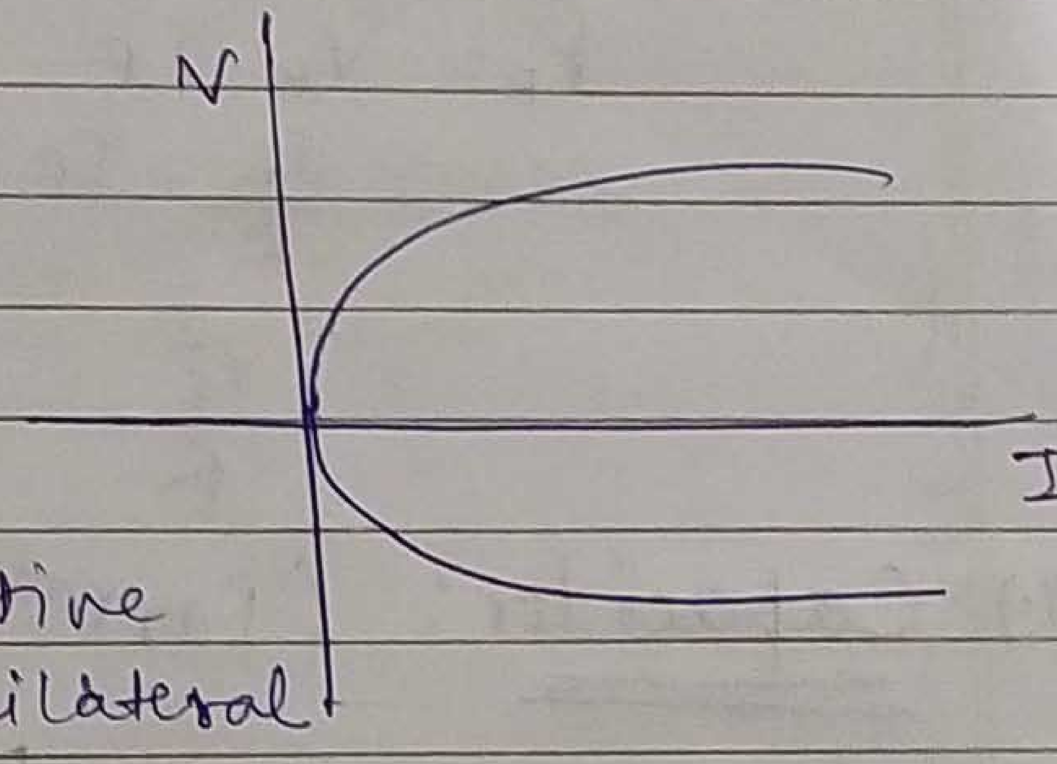


time - varying

Example

(A) $\boxed{A+P = \text{Active}}$.

L or NL → NL
Active or Passive → Active
U or BL → Unilateral



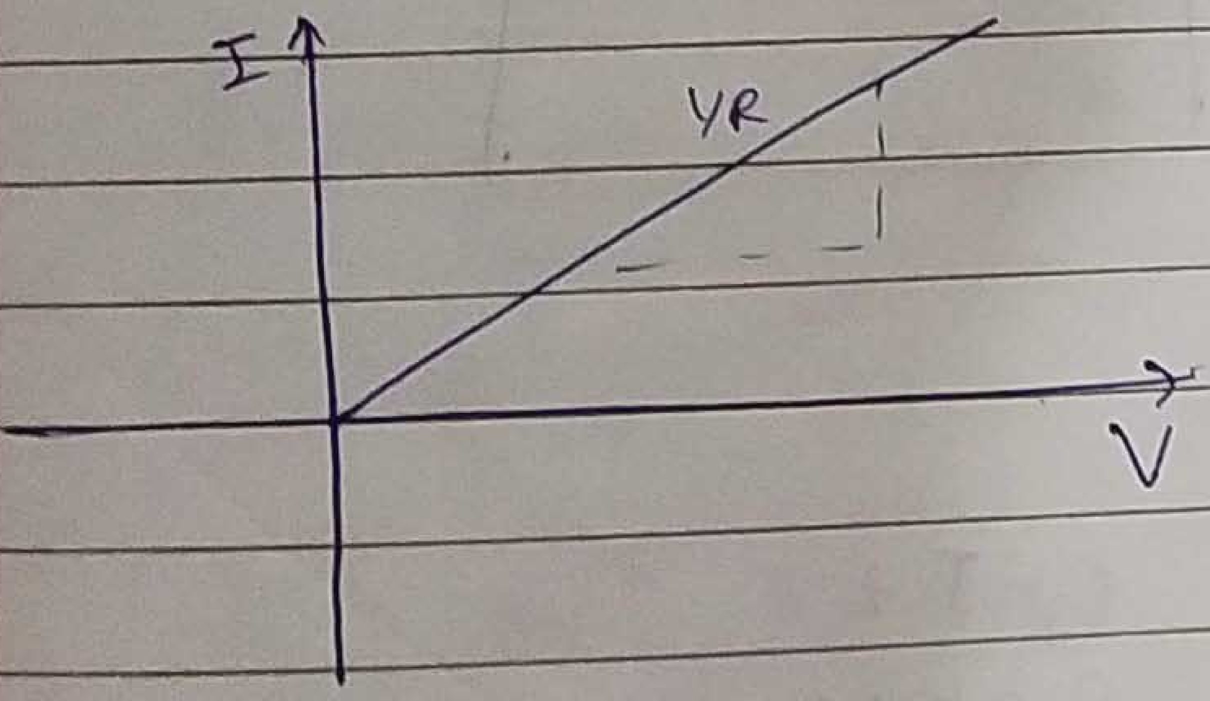
Basic Circuit Elements:

1.) Resistors :

↳ static element

$\boxed{R = \rho \frac{l}{a}}$

→ descipated Element in which energy is lost as heat



Ohm's law

$V \times \frac{1}{R} = I$

$\frac{1}{R} = G$

$R \rightarrow \Omega$
$G \rightarrow$ siemen ℧

$J = \sigma E$ → volt/unit length

A/m^2

conductivity

$(\Omega m)^{-1}$ or $\frac{1}{\Omega m}$

If, $R = 0$ → Short circuit (Current will be max & Voltage ...)

$R = \infty$ → Open circuit. ($I = 0$ & volt = max)

Power:

$V_R, \; I_R$

$$P_R = V_R \cdot I_R$$
$$= \frac{I_R}{R} \cdot I_R = \frac{I_R^2}{R}.$$
$$= \frac{V_R^2}{R}.$$

2.) Capacitor: (farrad)

permittivity

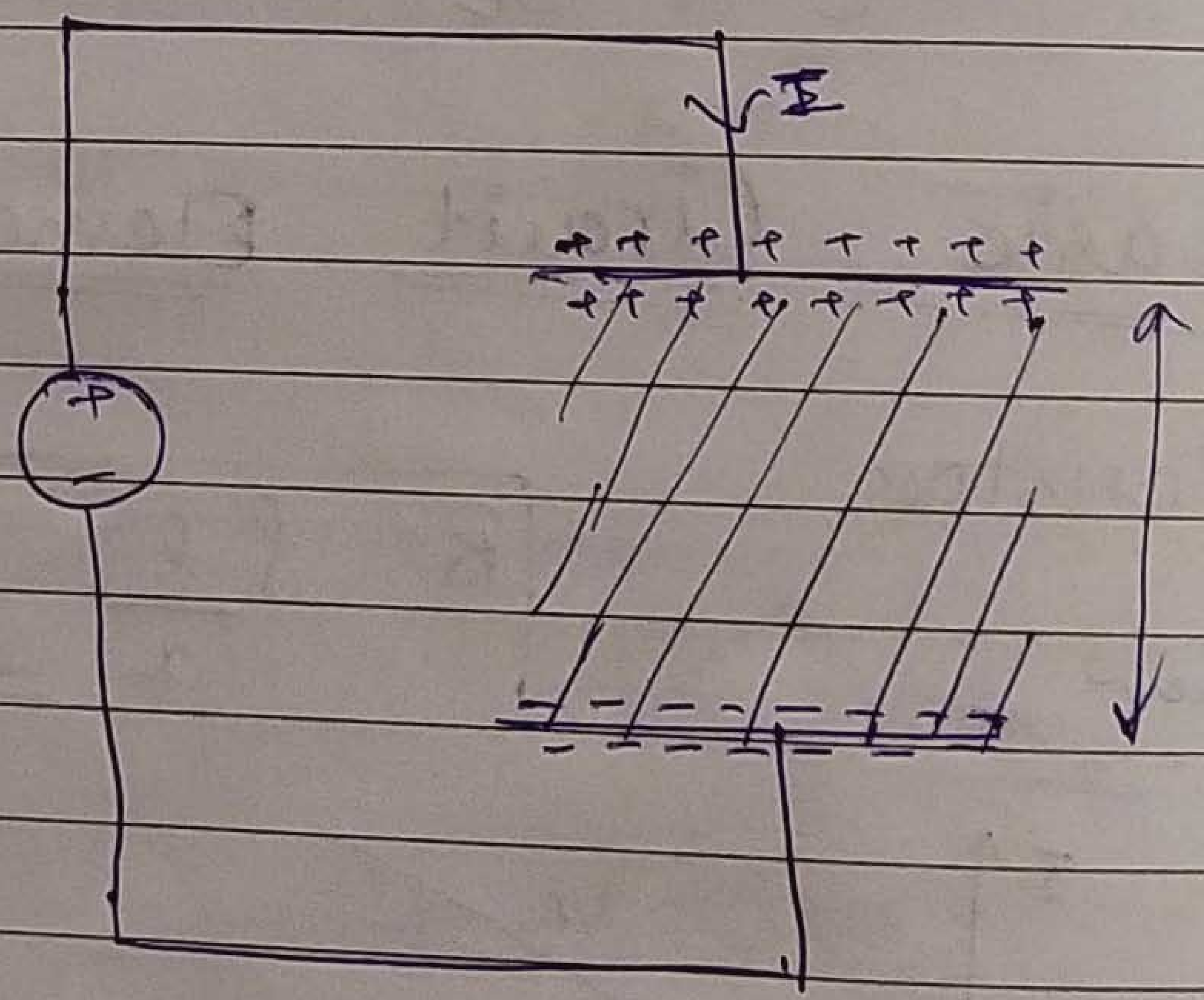
$$C = \frac{\epsilon A}{d}$$

Area of metal plate

d → distance b/w two

$\epsilon_0 \; \epsilon_r$

→ dynamic elements



Steady State:

$Q = It$

$Q = CV$

$$i = C\frac{dV}{dt} \Rightarrow \int i\,dt = C\int dV$$

$$\frac{1}{C}\int_{-\infty}^{t} i\,dt = \int_{V_0}^{V_t} dV$$

$$\boxed{\frac{1}{C}\int_{-\infty}^{t} i\,dt = (V_t - V_0)}$$

Classmate
Date
Page

Power, $P = Vi$

$= V.C.\frac{dV}{dt}$

$\int P.dt = \int CV.dV$

$\boxed{E = \frac{CV^2}{2}}$ → Energy of a capacitor.

3) **Inductors:** → (Henry) → μH, mH
→ dynamic compo

$\text{emf } (e) = N\frac{d\phi}{dt}$ — ①

$e = L\frac{di}{dt}$ — ②

flux

$N\phi = Li$

$\boxed{\frac{N\phi}{i} = L}$ → Inductance

$\phi = \frac{Ni}{\frac{l}{\mu A}} = \frac{Ni\mu A}{l}$

$L = \frac{N}{i} \cdot \frac{Ni\mu A}{l}$

$\boxed{L = \frac{N^2 \mu A}{l}}$

In Magnetic Circuits

$\phi = \text{mmf}$ (magnetic motive force)

$\phi = \frac{\text{mmf}}{\text{Magnetic reluctance}}$

$\phi = \frac{\text{mmf}}{l/a}$

$$V = L \frac{di}{dt}$$

$$\frac{1}{L} \int V\,dt = \int_{i_0}^{i_t} di$$

$$\boxed{\frac{1}{L} \int V \cdot dt = (i_t - i_0)}$$

→ Non-linear element

→ In case if initial current is zero then only it is linear element.

$$P = V \cdot i$$

$$= \cancel{v \cdot \frac{1}{L} \int v \cdot dt}$$

$$= L \cdot \frac{di}{dt} \cdot i$$

$$\int_{0} P \, dt = L \int i \, di$$

$$E = \frac{L \cdot i^2}{2}$$

$$\boxed{E = \frac{1}{2} L i^2}$$ → Energy stored in Inductor

CLASSIFICATION OF SOURCES :→

Independent
- Practical
- Ideal

Dependent
- Practical
- Ideal

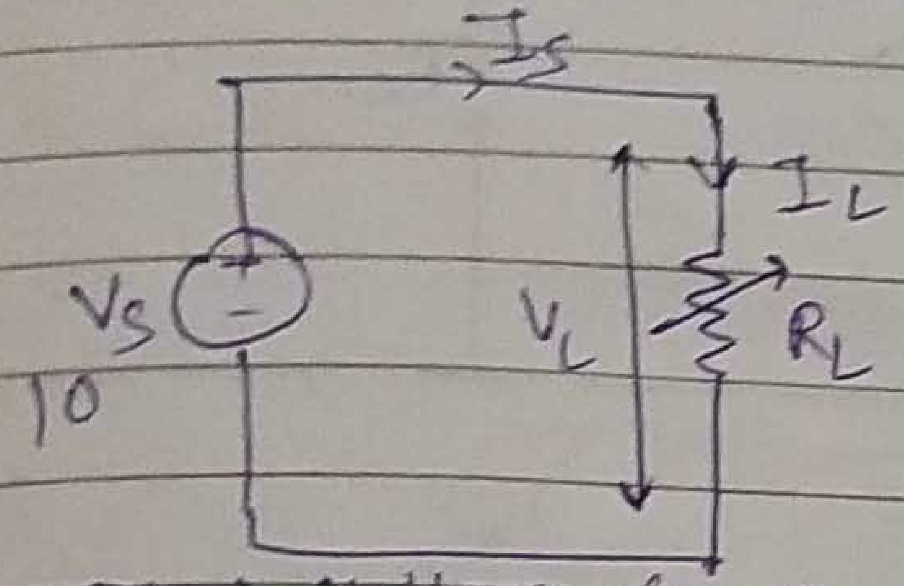
→ Voltage Controlled Volt source

→ Current controlled Volt source

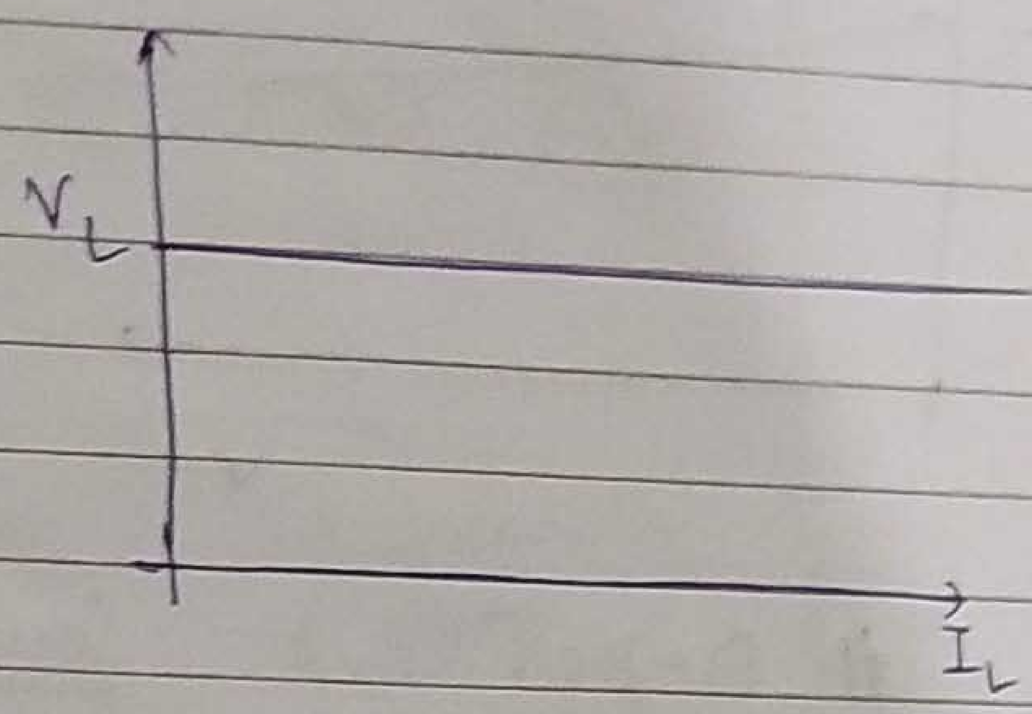
→ Voltage controlled Current source

→ Current controlled Current source

Independent Voltage Sources:→



Ideal Voltage Source

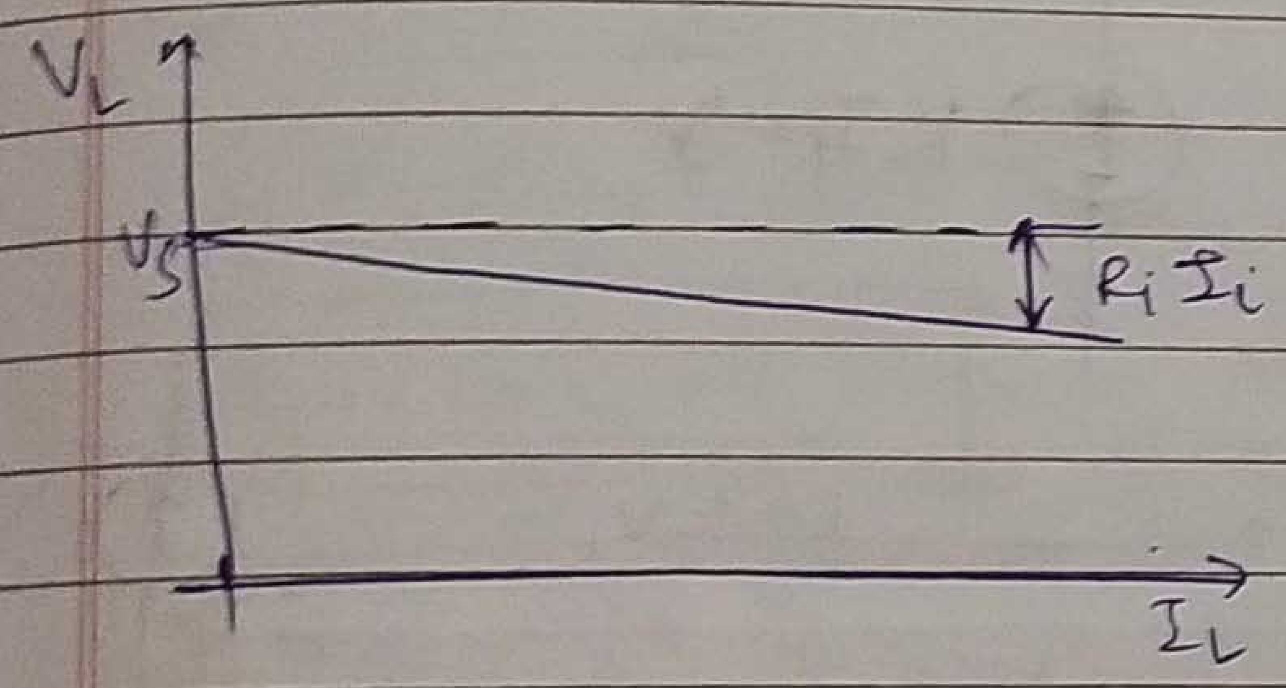


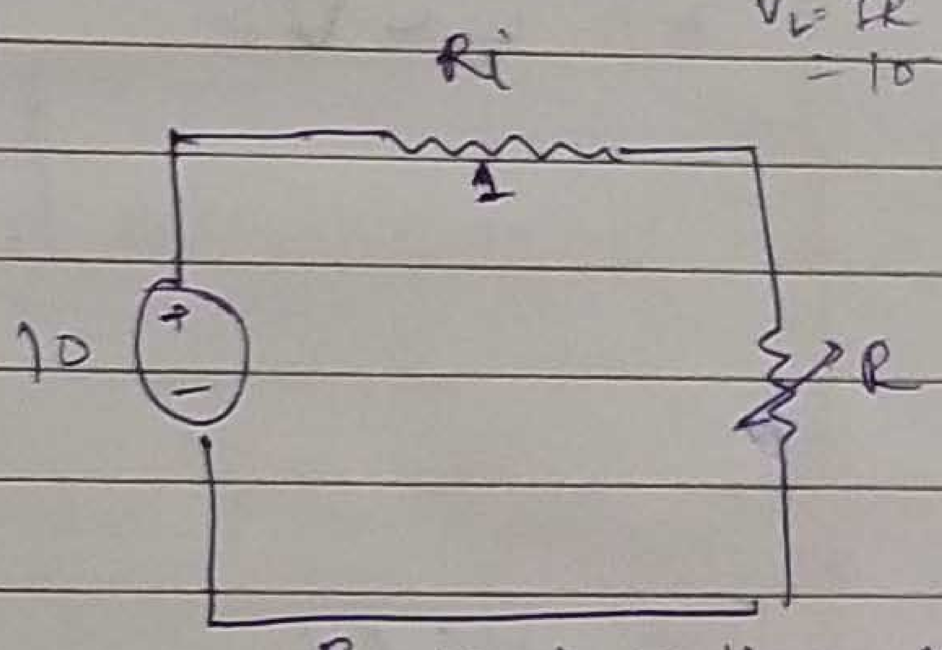
R_L	I_L	V_L
1	10	10
2	5	10

$V = IR$

$I = \frac{V}{R}$

$V_L = IR$
$= 10$





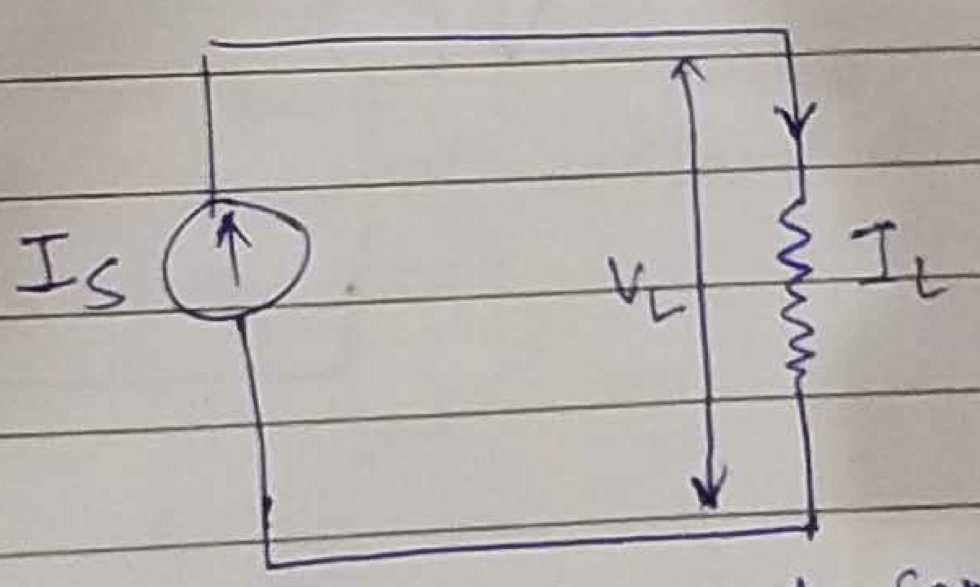
Practical Voltage Source

$V_L = V_S - R_i I_L$

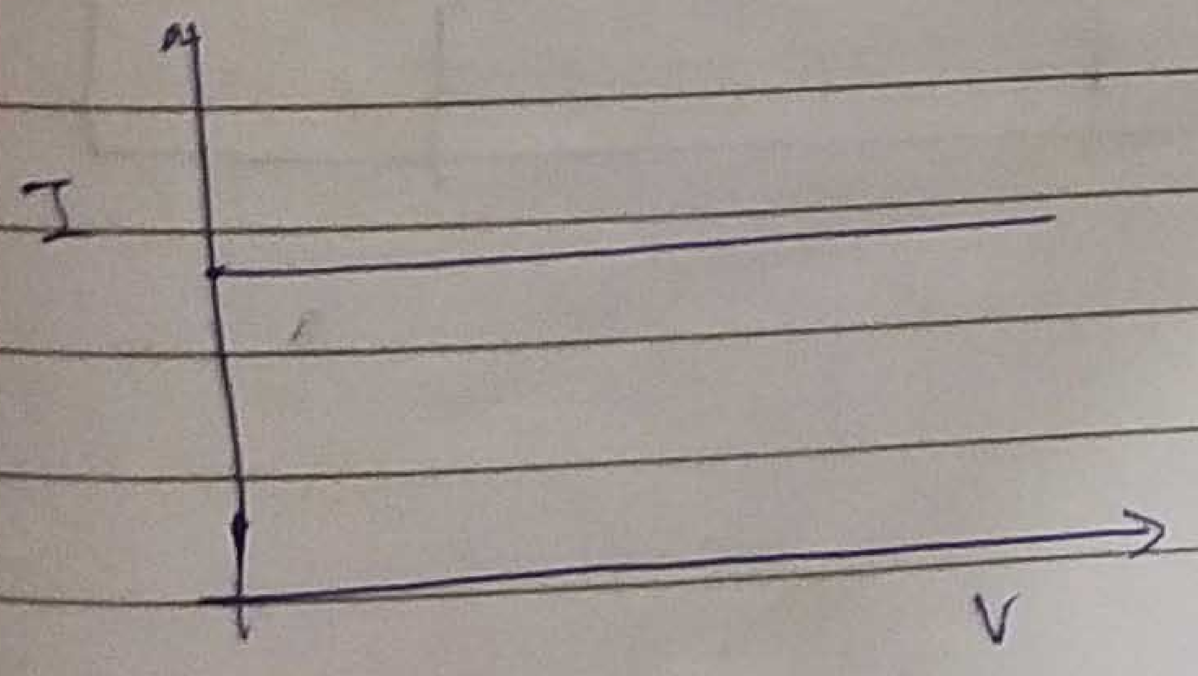
$\cancel{V_R = I_L R_L}$ $V_L = V_S - I_L R_L$

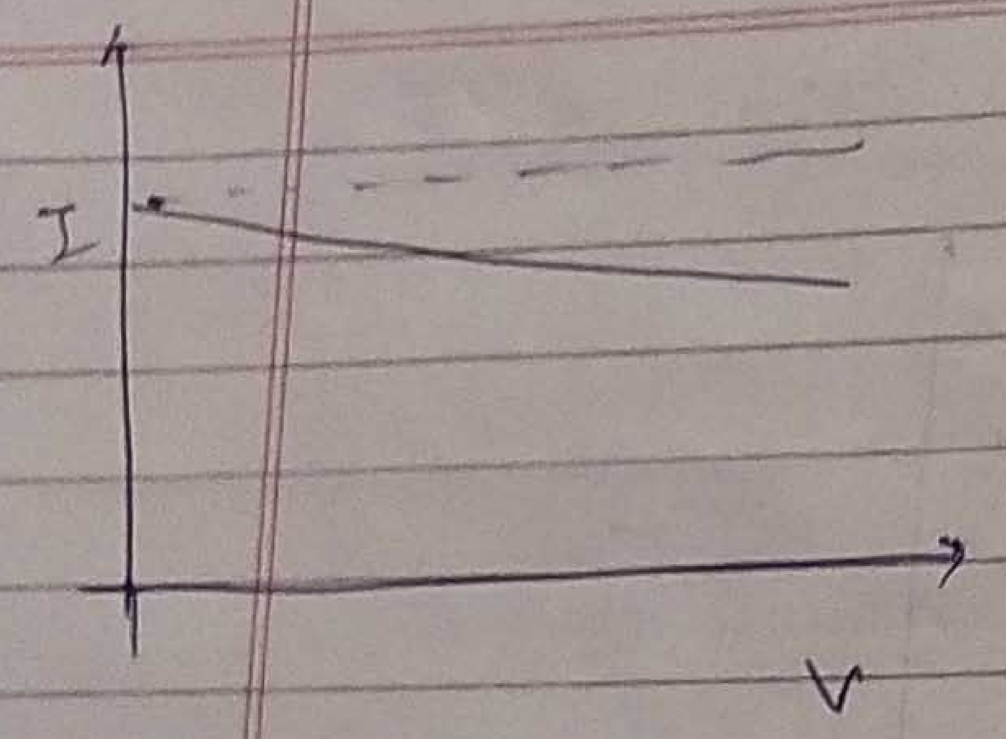
$$\frac{10}{R_i + R_L} = I_L$$

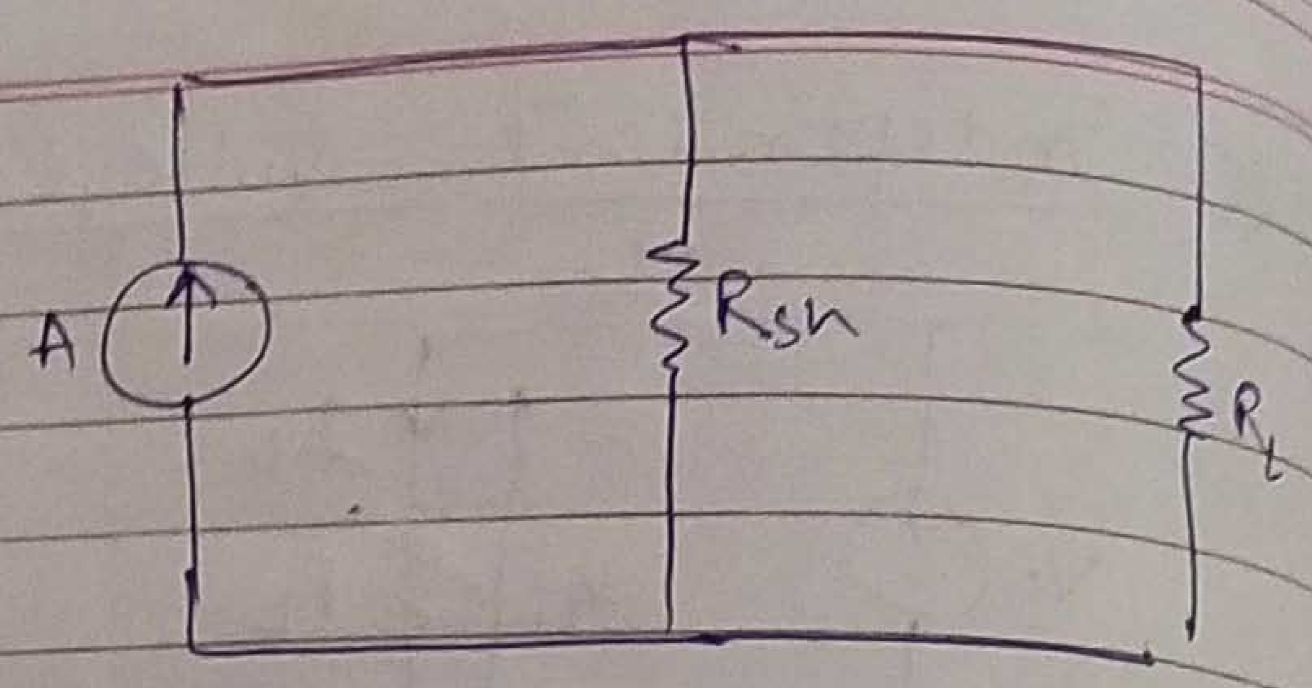
Current Sources:→



Ideal Current Source

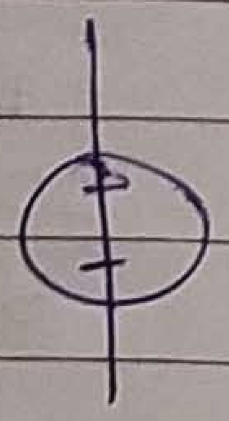






Dependent Sources:

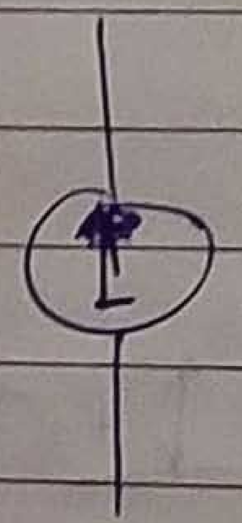
1.) VCVS →



$kV_1 = V$

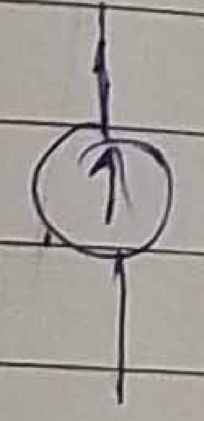
2.) CC~~V~~S

↳



$KI_1 = V$

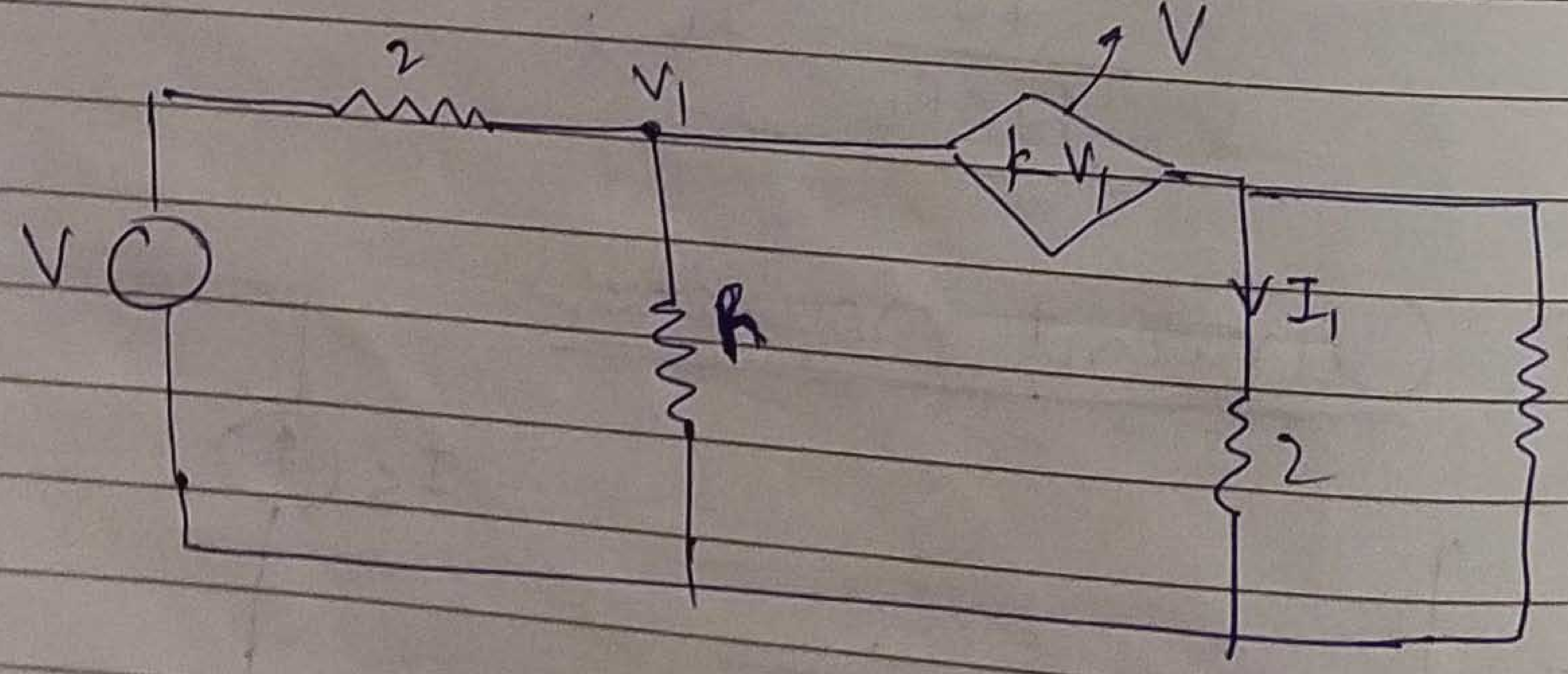
3.) VCCS → $I = kV_1$



4.) CCCS

↳ $I = kI_1$

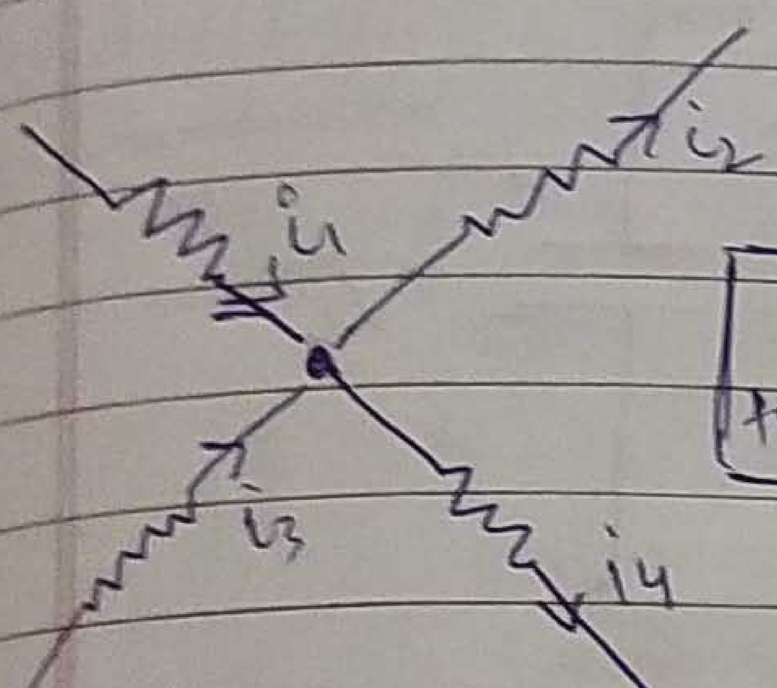
Example:



Kirchoff's Laws:→

1.) KCL

↓



$$\boxed{\sum_{\text{for all } k} i_k = 0}$$

⇓

$$-i_1 - i_3 + i_4 + i_2 = 0$$

$$\boxed{i_1 + i_3 = i_4 + i_2}$$

$$\boxed{\sum i_{\text{incoming}} = \sum i_{\text{outgoing}}}$$

Also, $i = \frac{dq}{dt}$

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

$$\Rightarrow \boxed{q_1 + q_3 = q_2 + q_4}$$

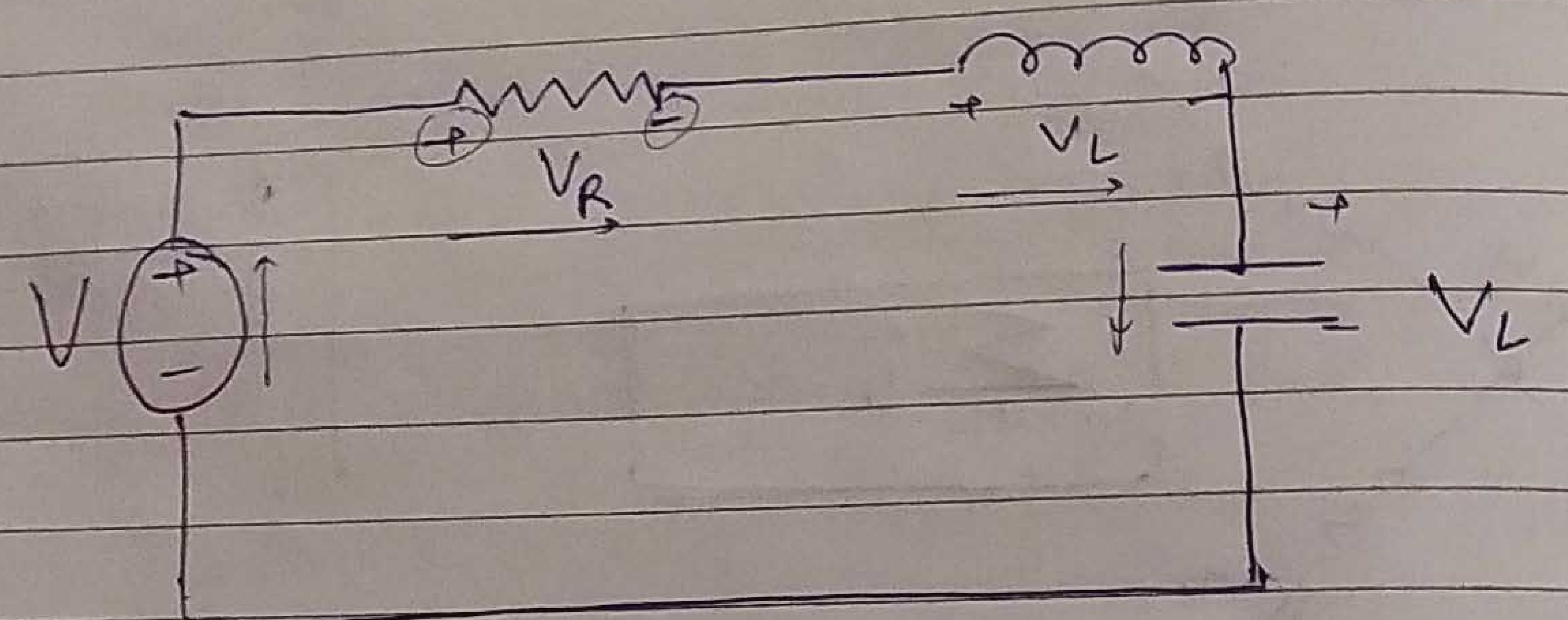
→ Thus, it follows law of conservation of charge.

2.) KVL

Incoming → −ve
Outgoing → +ve

2) **KVL** :→ Sum of voltage in a loop is zero

$$\Rightarrow \boxed{\sum_{\text{for all } k} V_k = 0} \rightarrow \text{in a loop}$$



Sign convention
- to + → +ve
+ to - → -ve

$$V - V_R - V_L - V_C = 0$$

$$\boxed{V = V_R + V_L + V_C}$$

$$\boxed{\Sigma \text{ Voltage rise} = \Sigma \text{ Voltage drops}}$$

Also, $V = \frac{dw}{dq}$

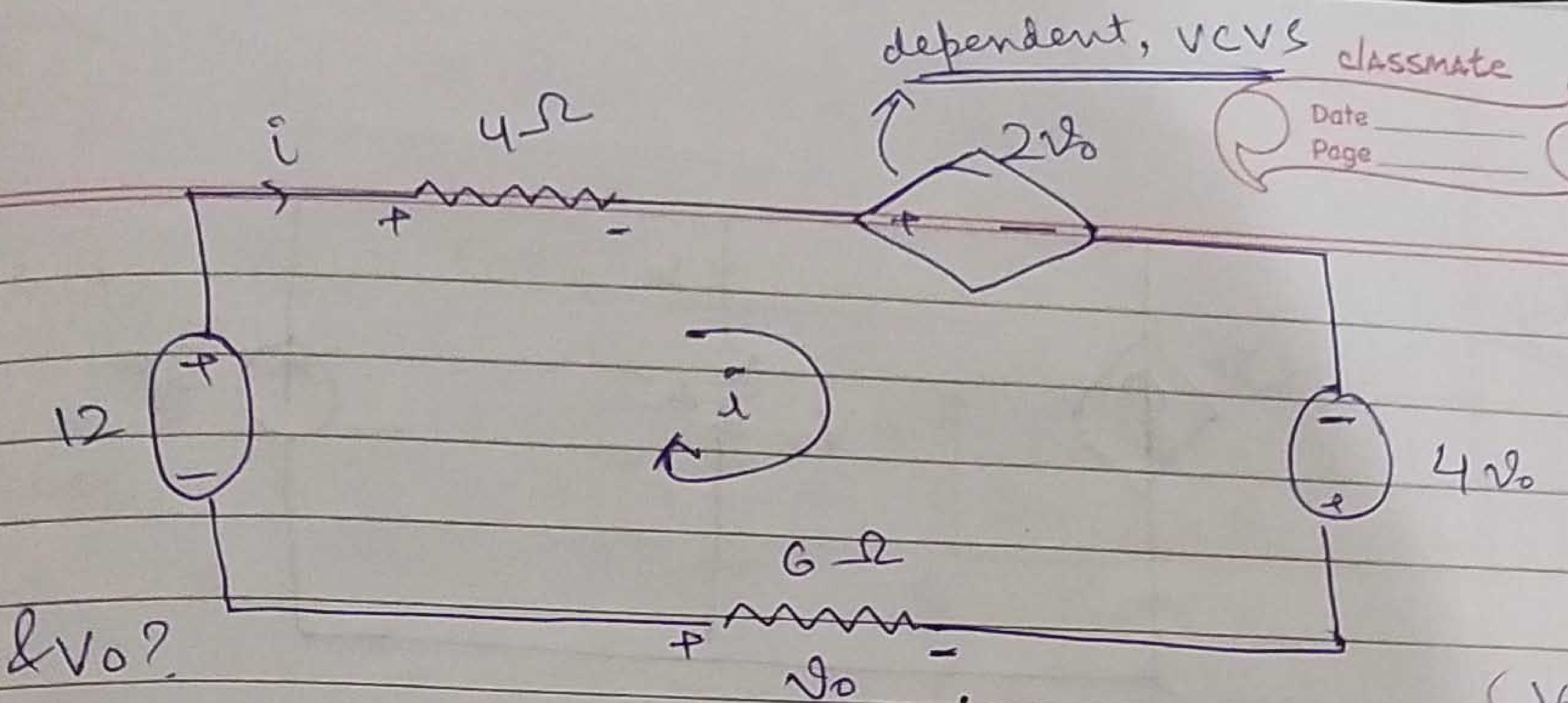
$$\therefore \frac{dW}{dq} = \frac{dW_R}{dq} + \frac{dW_L}{dq} + \frac{dW_C}{dq}$$

$$\Rightarrow \boxed{W = W_R + W_L + W_C}$$

⇒ KVL follows law of conservation of energy

→ applicable to lumped Networks.

Example:



Find i & V_o?

$\boxed{-6i = v_o}$

$(V = iR)$

Applying KVL:

$\cancel{12 + 4i - 2v_o + 4v_o + 6i = 0}$

$12 - 4i - 2v_o + 4v_o + v_o = 0$

$16 - 4i = v_o = 0$

$16 + 4i + 6i = 0$

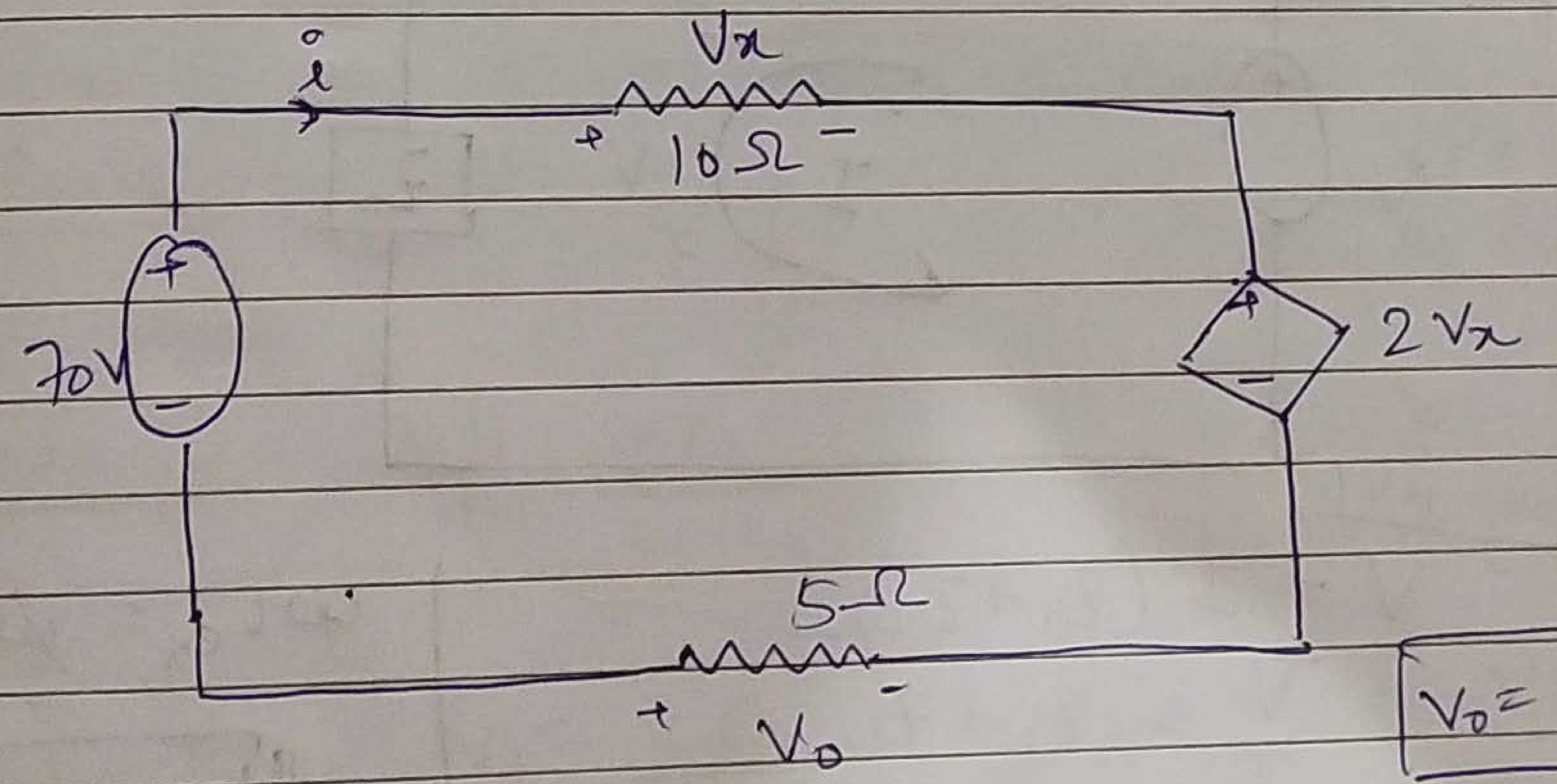
$16 + 2i = 0$

$-\frac{16}{2} = i$

$\boxed{i = -8A}$

$\boxed{v_o = 48V}$

Example.



Find V_o & V_x?

$\boxed{V_o = -5i}$

$V_x = -10i$

$70 - V_x - 2V_x + v_o = 0$

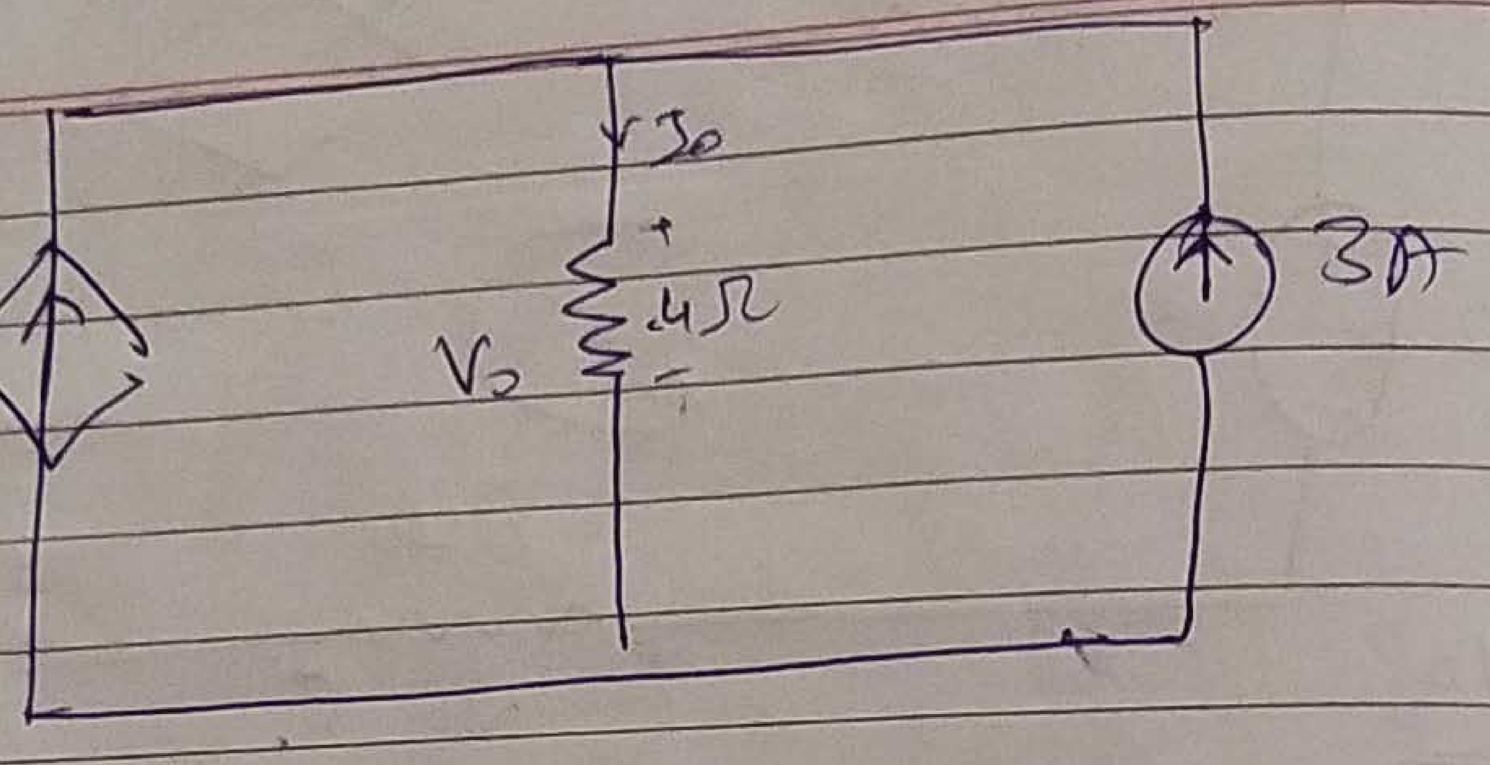
$70 - 3V_x - 5i = 0$

$70 + 30i - 5i = 0$

$70 + 25i = 0$

$i = -\frac{\cancel{70}\ 14}{\cancel{25}\ 5}$

Q:-



Find V_o & I_o?

Sol: $0.5I_o + 3 = I_o$

$3 = 0.5I_o$

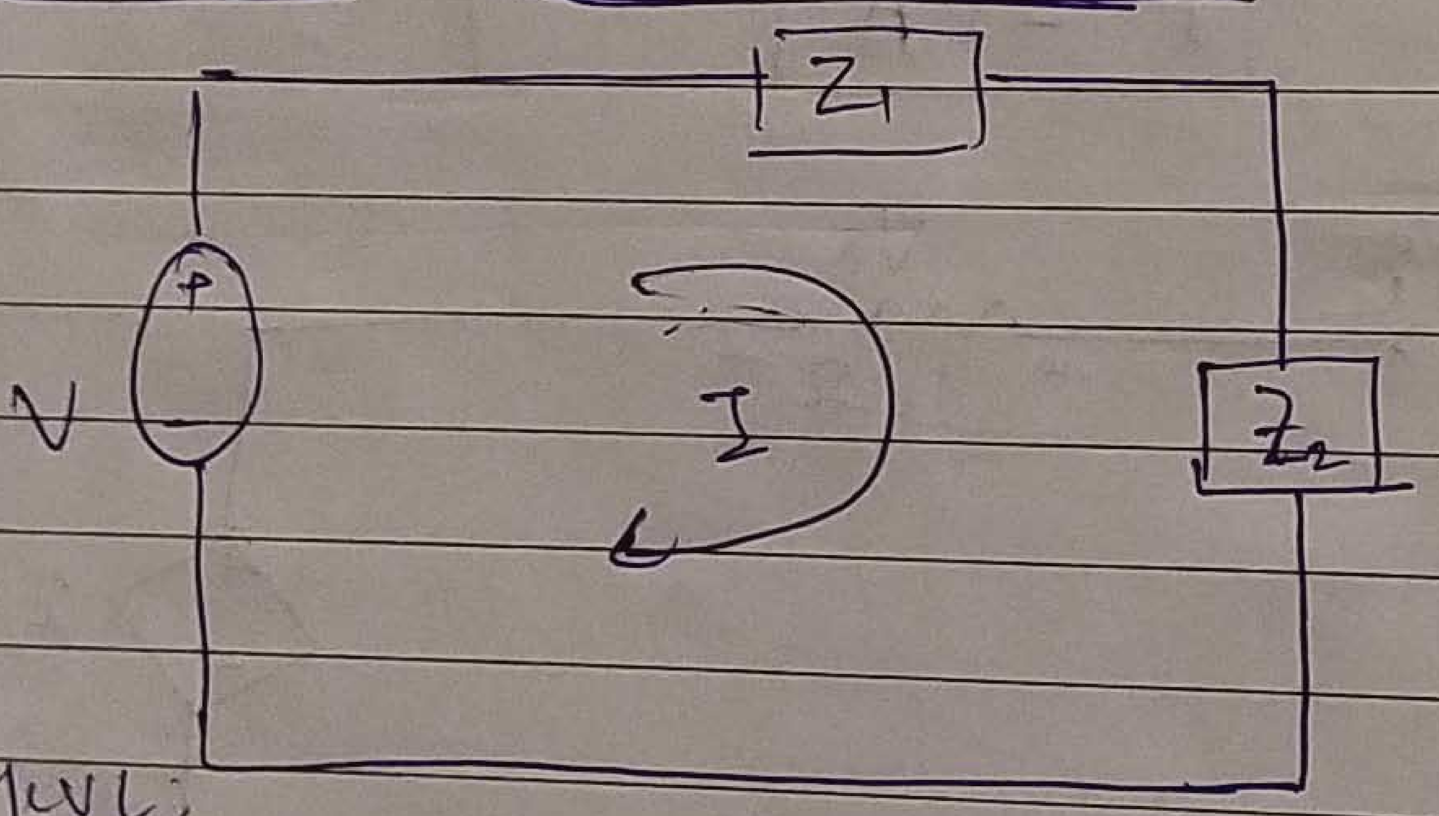
$3/0.5 = I_o$

$I_o = 6$

$V_o = 4I_o$

$\boxed{V_o = 24\,V}$

SERIES CONNECTION :→



Applying KVL,

$V = I(Z_1 + Z_2)$

$\frac{V}{I} = Z_1 + Z_2$

$\boxed{Z_{eq} = Z_1 + Z_2}$

$\boxed{R_{eq} = R_1 + R_2}$

$X_{Leq} = \omega L_1 + \omega L_2$

$\boxed{X_{Leq} = \omega(L_1 + L_2)}$

$\cancel{\omega} L_{eq} = \cancel{\omega}(L_1 + L_2)$

$\boxed{L_{eq} = L_1 + L_2}$

$X_{C_{eq}} = X_{C_1} + X_{C_2}$

$\frac{1}{\omega C_{eq}} = \frac{1}{\omega C_1} + \frac{1}{\omega C_2}$ $\Rightarrow$ $\boxed{\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2}}$

$\Rightarrow$

$Q = CV$

$\frac{Q}{C} = V$

$V = V_1 + V_2$

$\frac{Q}{C_{eq}} = \frac{Q}{C_1} + \frac{Q}{C_2}$

(#) $\boxed{I = \frac{V}{Z_1 + Z_2}}$

$\therefore$ $V_1 = I Z_1$ $\Rightarrow$ $\boxed{V_1 = \frac{V}{(Z_1 + Z_2)} \cdot Z_1}$

$V_2 = I Z_2$ $\Rightarrow$ $\boxed{V_2 = \frac{V}{(Z_1 + Z_2)} \cdot Z_2}$

Voltage division Rule

for Resistor: $V_1 = \frac{V R_1}{R_1 + R_2}$, $V_2 = \frac{V R_2}{R_1 + R_2}$

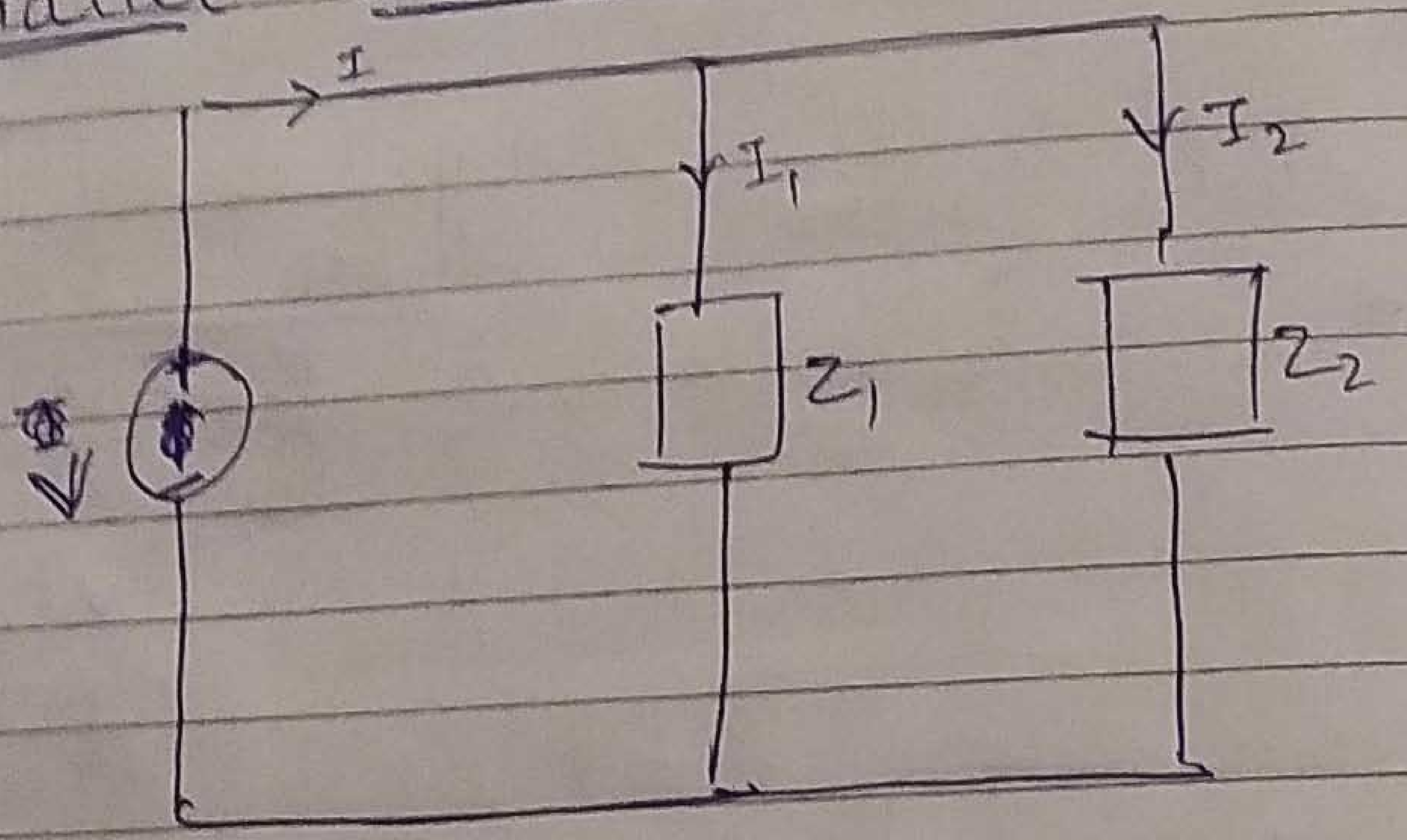
for Inductor: $V_1 = \frac{V L_1}{L_1 + L_2}$, $V_2 = \frac{V L_2}{L_1 + L_2}$

for Capacitor: $\boxed{V_1 = \frac{V C_2}{C_1 + C_2}}$, $\boxed{V_2 = \frac{V C_1}{C_1 + C_2}}$

Inverse Relation.

#. $\boxed{G_{eq} = G_1 + G_2}$

Parallel Connection :-



KCL: $\boxed{I = I_1 + I_2}$

$$\frac{V}{Z_{eq}} = \frac{V}{Z_1} + \frac{V}{Z_2}$$

$$\boxed{\frac{1}{Z_{eq}} = \frac{1}{Z_1} + \frac{1}{Z_2}}$$

$V = IR$

$I = \frac{V}{R_{eq}}$

for R;

$$\boxed{\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}}$$

for L;

$$\boxed{\frac{1}{L_{eq}} = \frac{1}{L_1} + \frac{1}{L_2}}$$

for C;

$$\boxed{C_{eq} = C_1 + C_2}$$

$$I_1 = \frac{V}{Z_{\cancel{eq}1}}$$

$$I_1 = \frac{I Z_{eq}}{Z_1}$$

$$\frac{1}{Z} = \frac{Z_1 + Z_2}{Z_1 Z_2}$$

$$Z_{eq} = \frac{Z_1 Z_2}{Z_1 + Z_2}$$

$$\boxed{I_1 = I \cdot \left(\frac{Z_2}{Z_1 + Z_2}\right)}$$

$$\boxed{I_2 = I \cdot \left(\frac{Z_1}{Z_1 + Z_2}\right)}$$

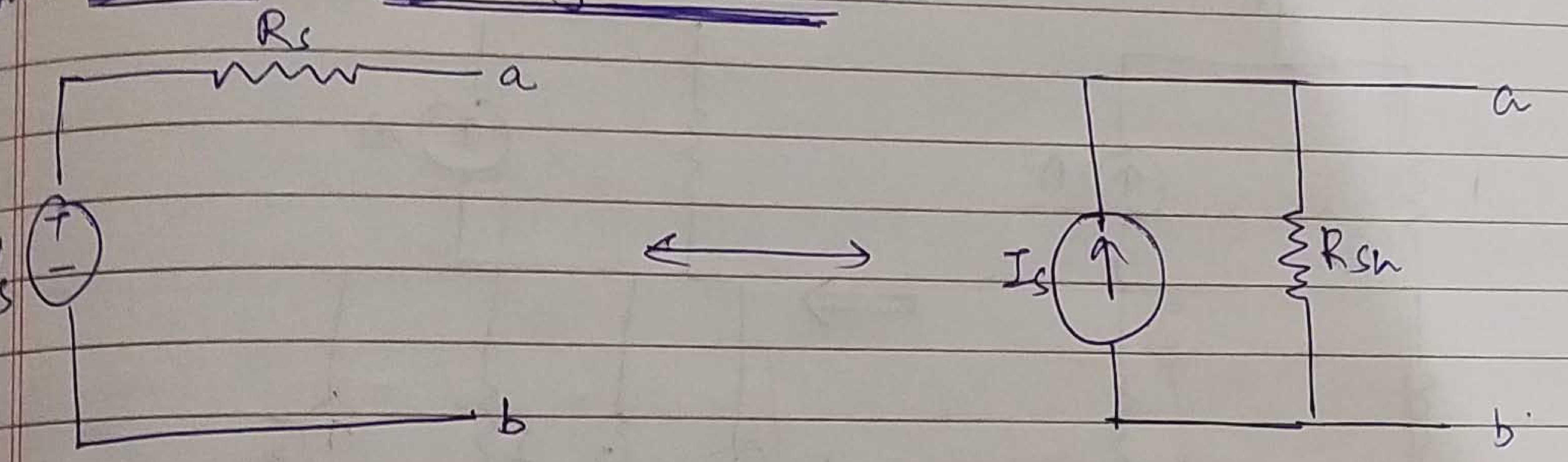
$\Rightarrow$ Current division Rule

If $Z = R$: $\boxed{I_1 = \frac{I \cdot R_2}{R_1 + R_2}}$, $\boxed{I_2 = \frac{I \cdot R_1}{R_1 + R_2}}$

If $Z = L$; $\boxed{I_1 = I \cdot \frac{L_2}{L_1 + L_2}}$, $\boxed{I_2 = I \cdot \frac{L_1}{L_1 + L_2}}$

If $Z = C$; $\boxed{I_1 = I \cdot \frac{C_1}{C_1 + C_2}}$, $\boxed{I_2 = I \cdot \frac{C_2}{C_1 + C_2}}$

Source Transformation :→



$\boxed{I_s = \frac{V_s}{R_{sh}}}$ & $\boxed{R_{sh} = R_s}$

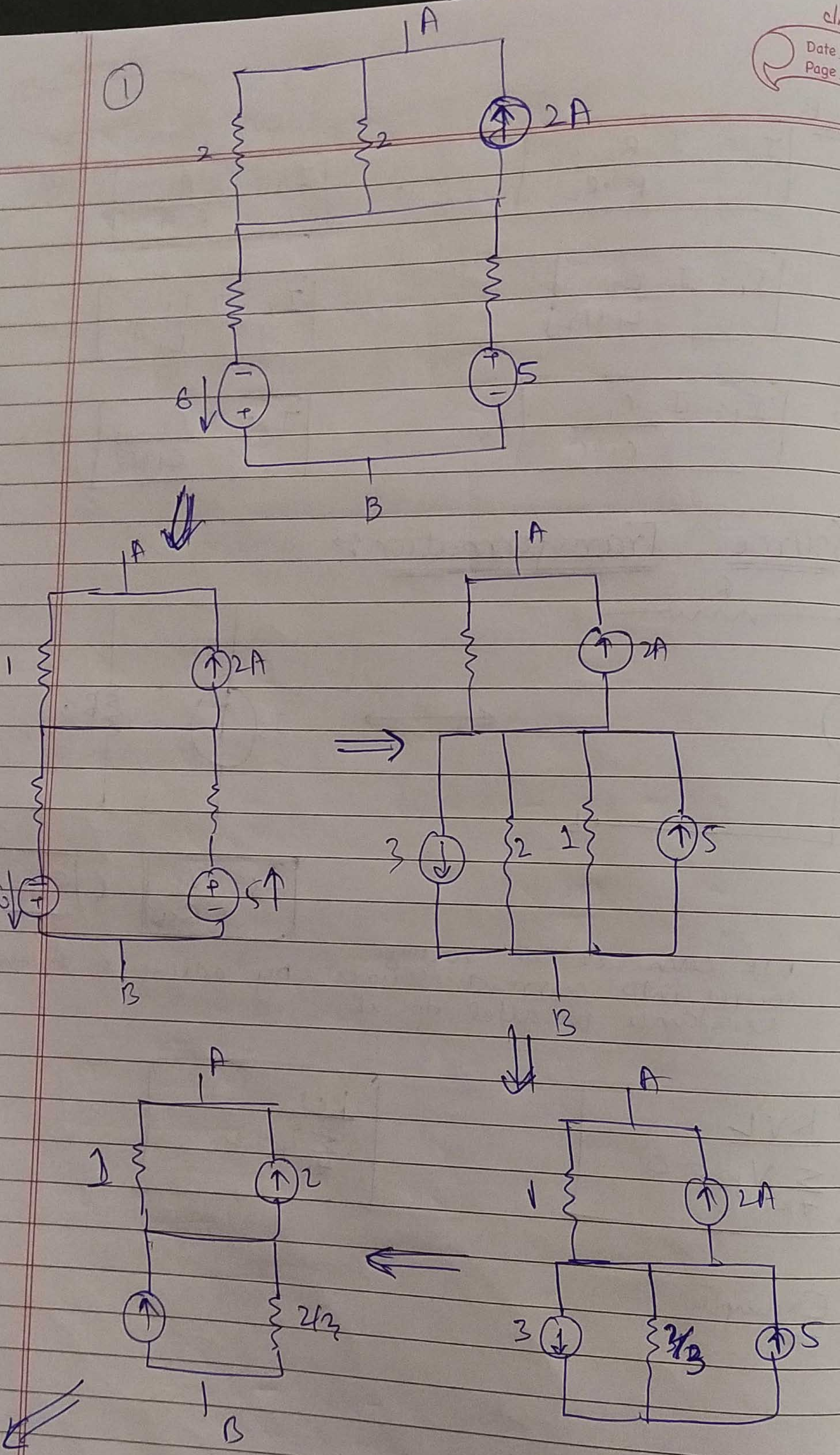
we can convert voltage source into current source by adding a shunt resistance parallel to it.

$\boxed{\begin{array}{l}\text{KVL} \\ \sum_{\forall k} V_k = 0\end{array}}$

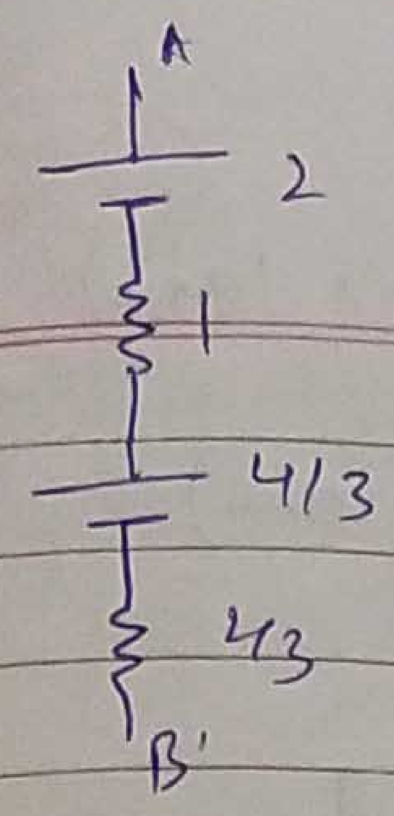
$\boxed{\begin{array}{l}\text{kcl} \\ \sum_{\forall k} i_k = 0\end{array}}$

Example

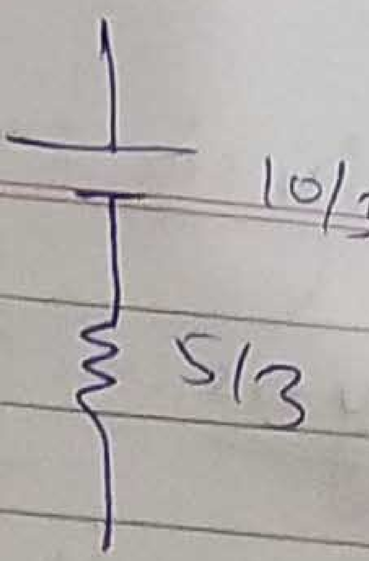
1



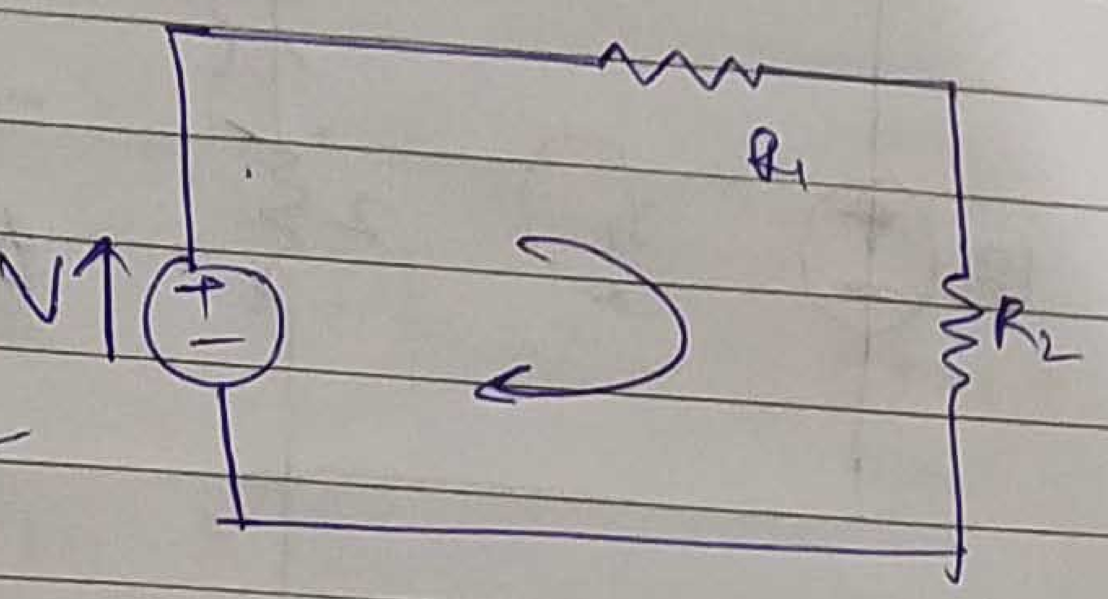
PTO

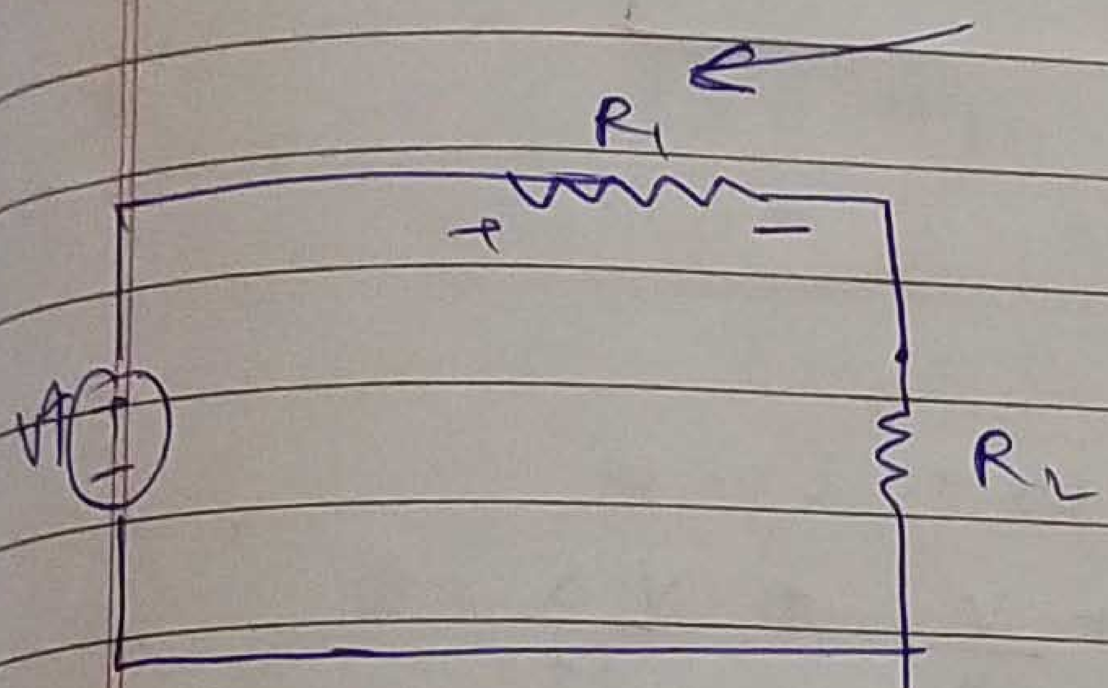


⇒



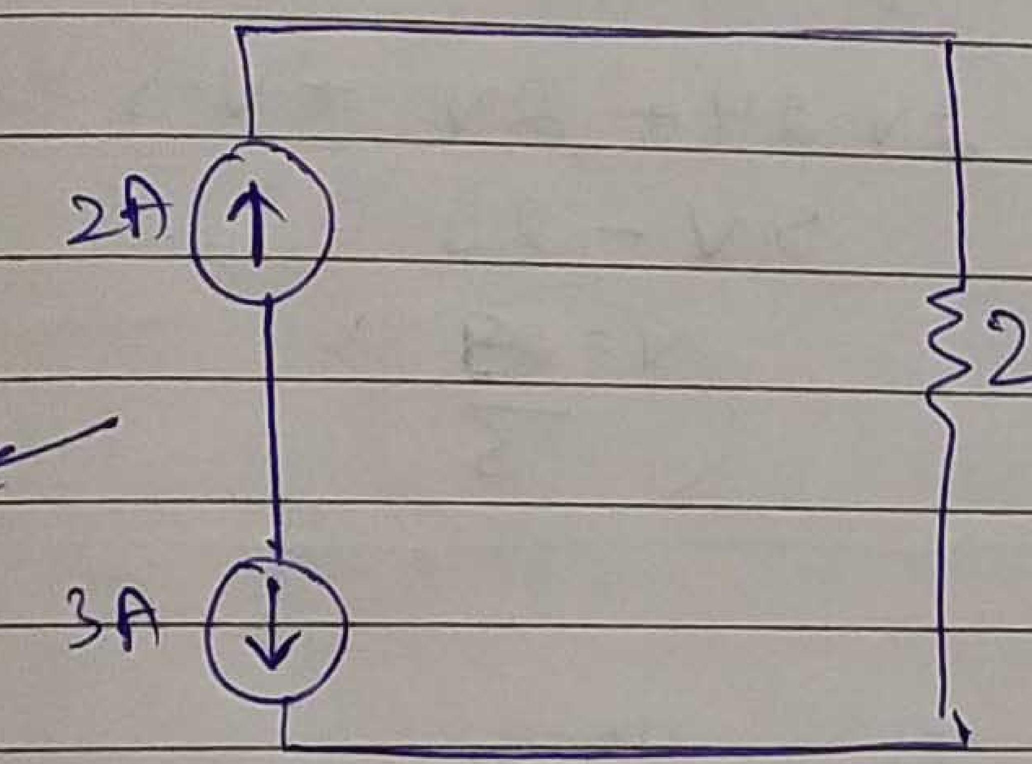
Concept:





Questions!

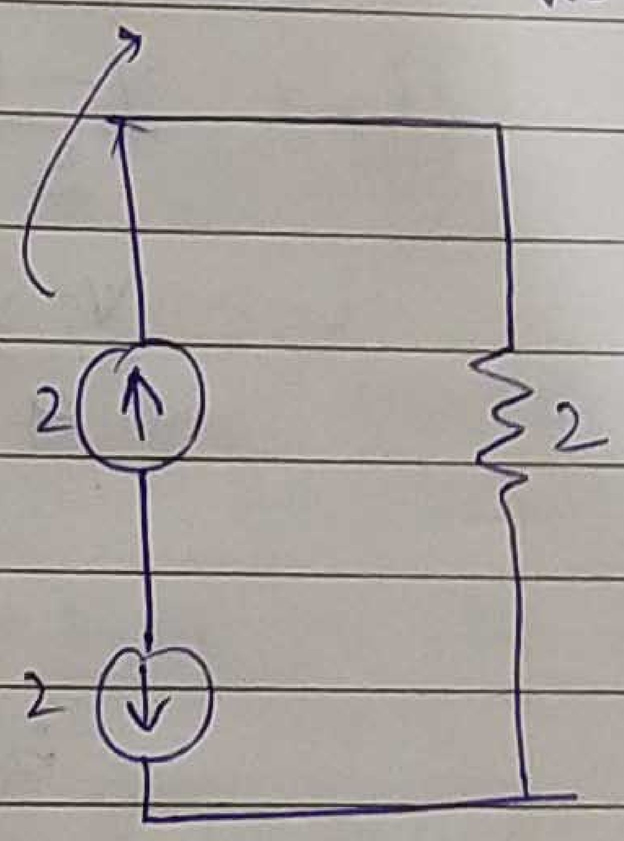
1.)



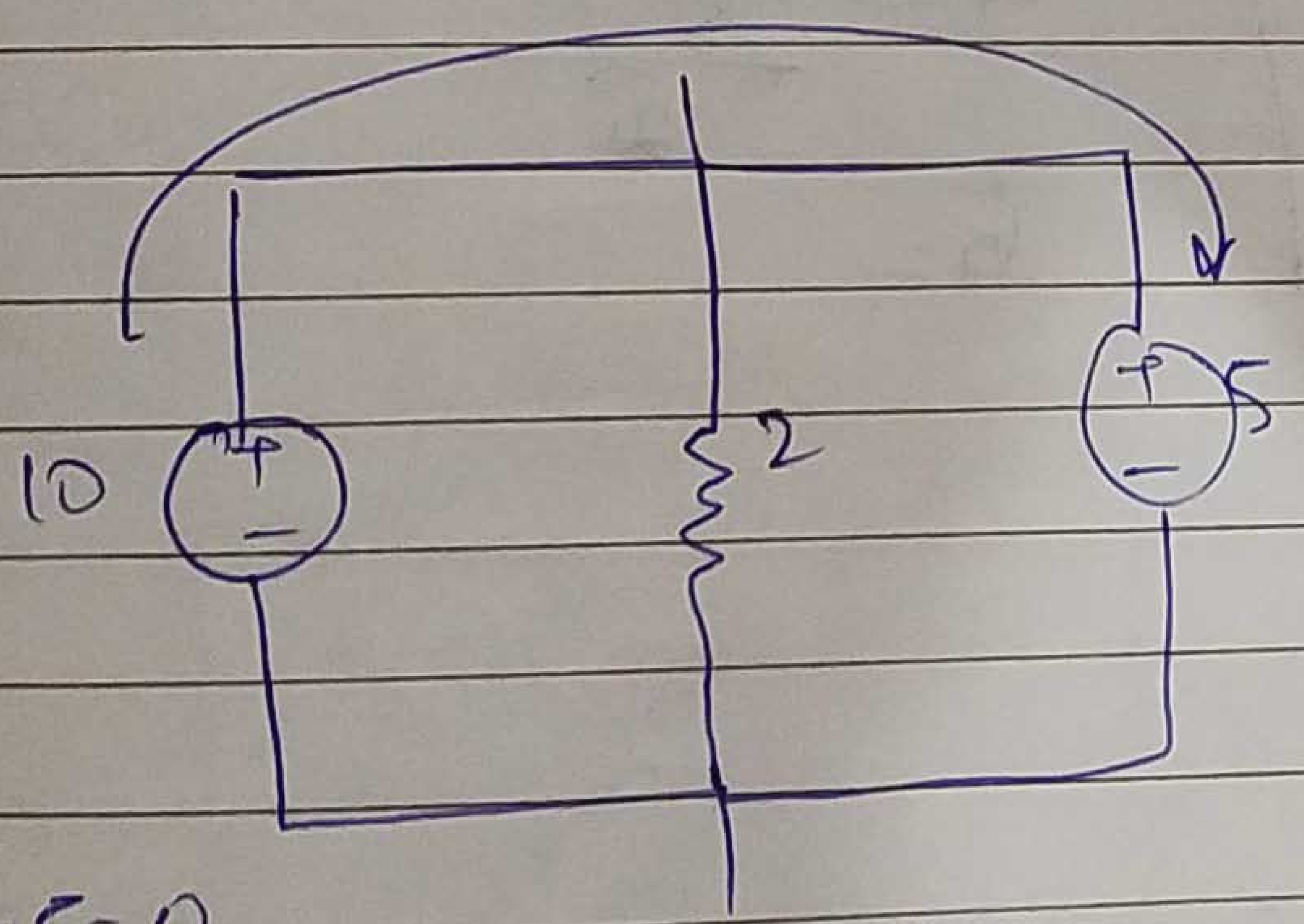
KCL
$2+3\neq 0$
Not possible

(2.)

$2+2\neq 0$ KCL violated

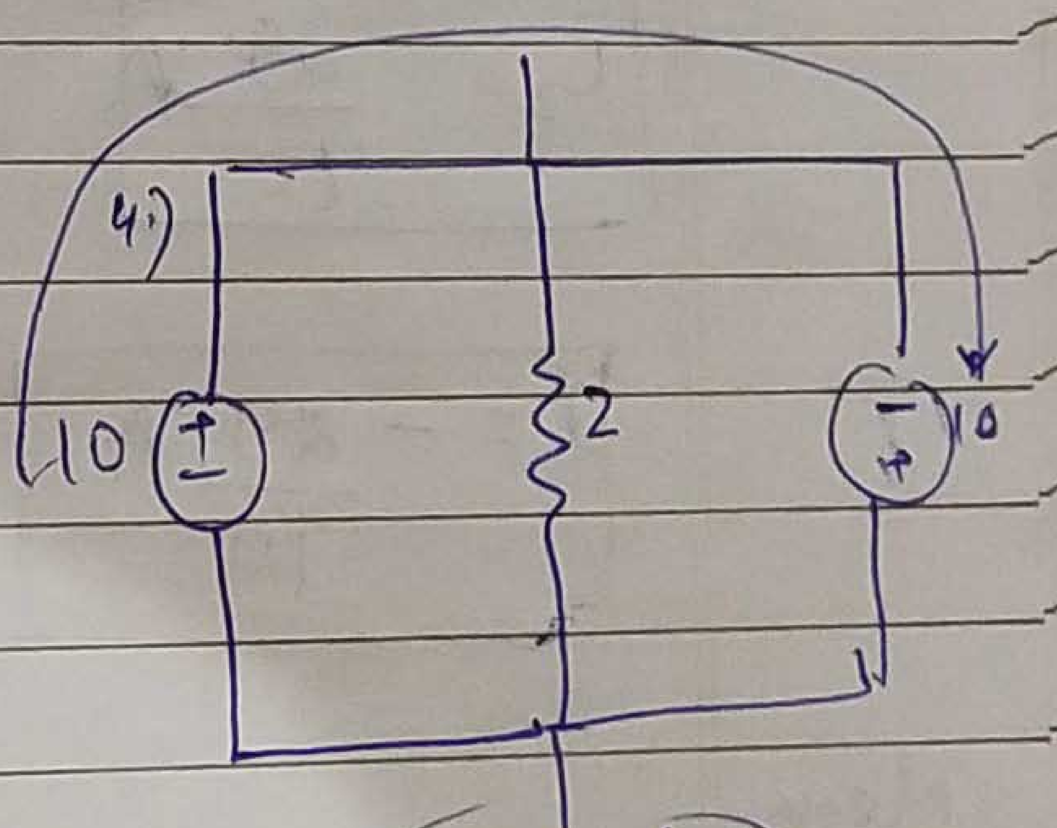


3.)



$10-5\neq 0$
↓
KVL violated

4.)

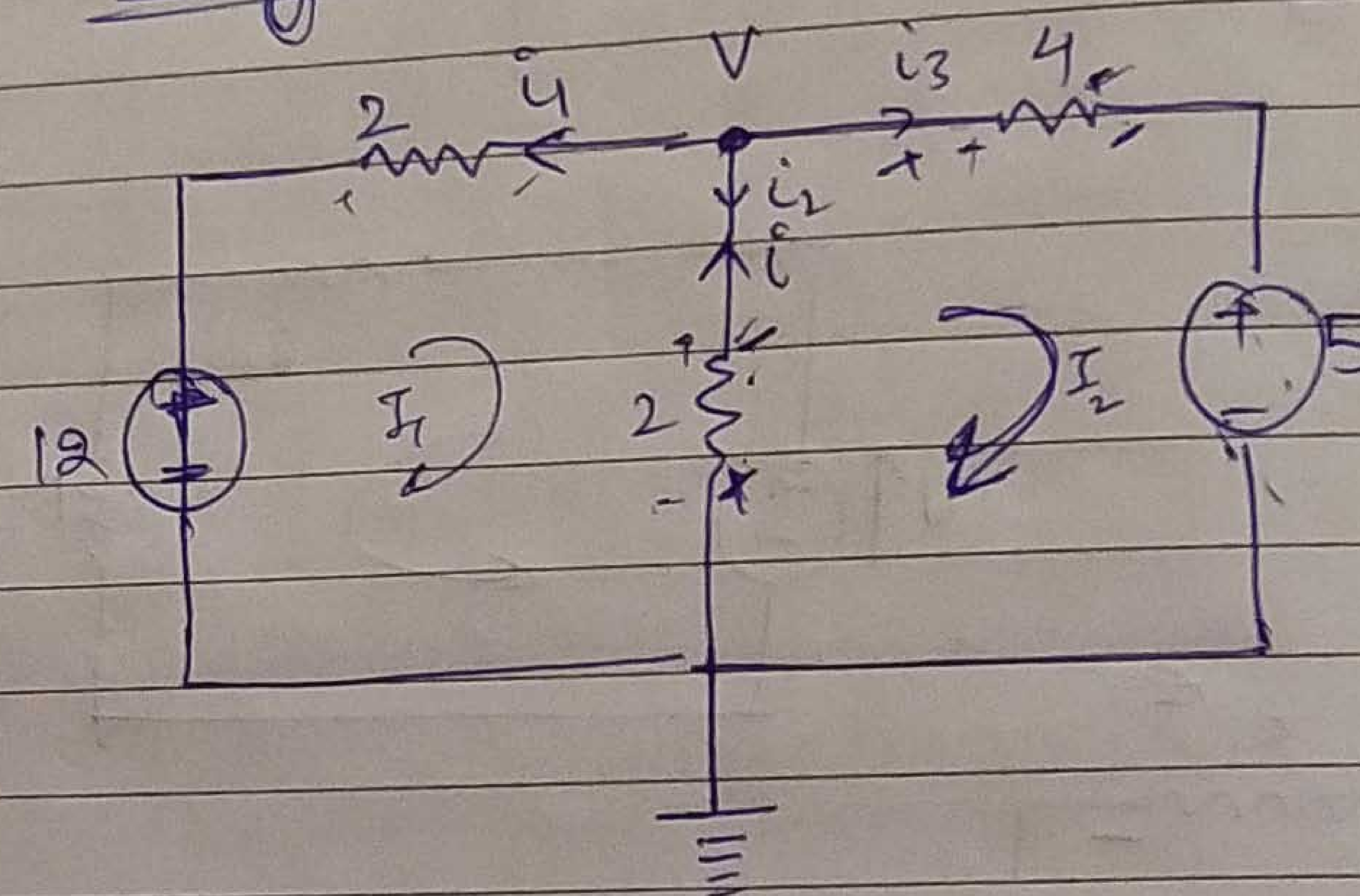


$10+10\neq 0$
KVL violated

Nodal Analysis :→ (KCL + ohm's law)

Mesh Analysis :→ (KVL + ohm's law).

e.g.:-



Nodal Analysis: $i_1 = \frac{V-12}{2}$

$i_2 = \frac{V-0}{2}$

$i_3 = \frac{V-5}{4}$

$i_1 + i_2 + i_3 = 0$

$\frac{V-12}{2} + \frac{V}{2} + \frac{V-5}{4} = 0$

$2V - 24 + 2V + V - 5 = 0$

$5V - 29 = 0$

$V = \frac{29}{5}$ V

~~$i_1 + i_3 = i_2$~~

$\boxed{i_2 = \frac{29}{10}\ A}$

$\cancel{i_1} = \frac{\cancel{\frac{29}{5}} - 12}{\cancel{2}}$

$i_1 =$

$\boxed{i = -\frac{29}{10}\ A}$

Mesh Analysis:

$12 - 2I_1 - 2(I_1 - I_2) = 0$

$12 - 2I_1 - 2I_1 + 2I_2 = 0$

$\boxed{12 - 4I_1 + 2I_2 = 0}$

$-4i_2 - 5 - 2(i_2$

~~$-5 + 2(I_2 - I_1) + 4I_2 = 0$~~

~~$-5 + 2I_2 - 2I_1 + 4I_2 = 0$~~

~~$-5 - 2I_1 + 6I_2 = 0$~~

$4i_2 + 5 + 2(i_2 - i_1) = 0$

$6i_2 - 2i_1 + 5 = 0$

$12 = 4I_1 - 2I_2$ | $-5 = -2I_1 + 6I_2$

$$\begin{aligned} 12 &= 4I_1 - 2I_2 \\ -10 &= -4I_1 + 12I_2 \\ \hline 2 &= 10 I_2 \end{aligned}$$

$$\boxed{I_2 = \frac{1}{5}\ A}$$

$12 + \frac{2}{5} = 4I_1$

$4I_1 = \frac{62}{5}$

$$\boxed{I_1 = \frac{31}{10}\ A}$$

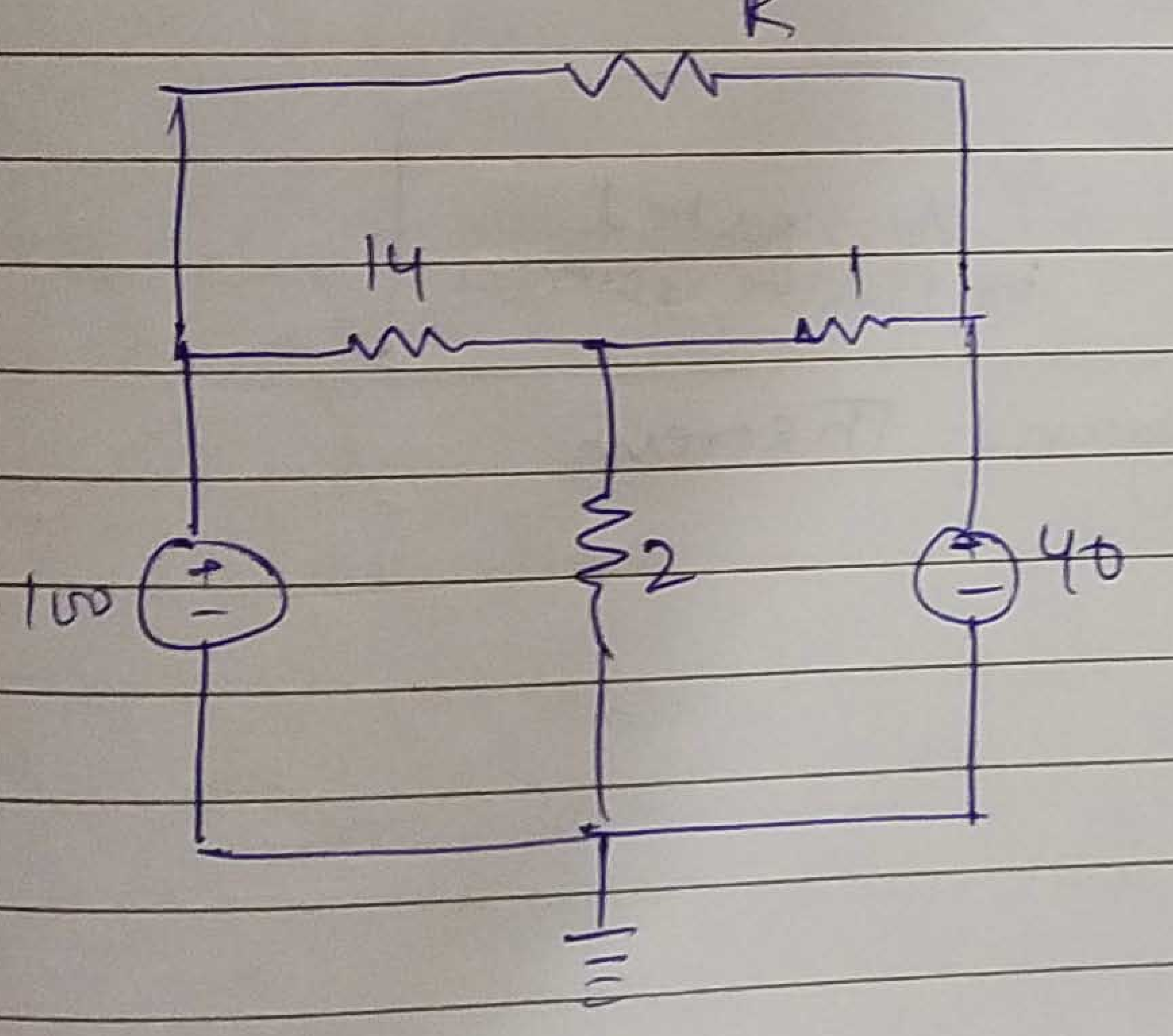
$\frac{31}{\cancel{62}}$

$I = I_2 - I_1$

$= \frac{1}{5} - \frac{31}{10}$

$$\boxed{I = -\frac{29}{10}\ A}$$

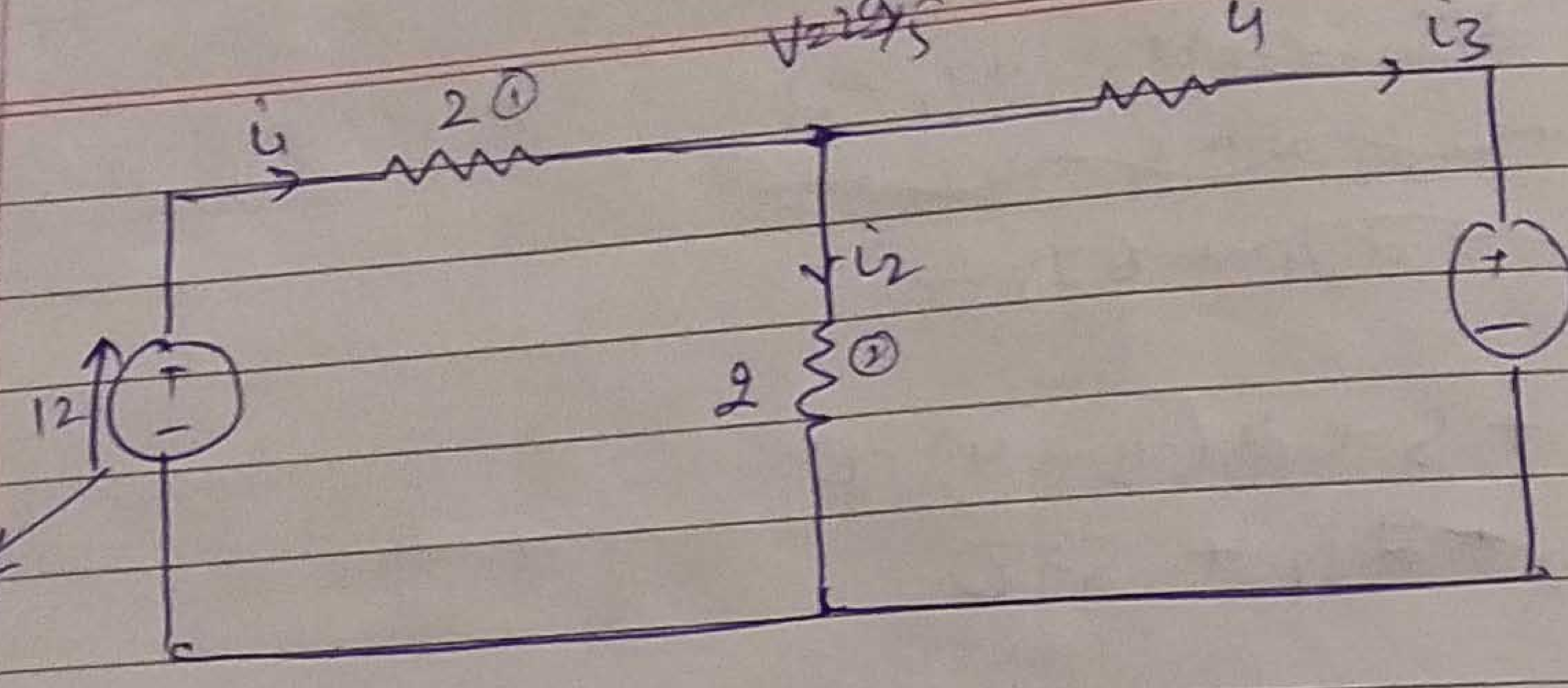
Ques:



$R = ?$

Ques:-

$P = 12 \times 3.1 = 37.2\,W$



$i_1 = \frac{12 - 5.8}{2} = 3.1$

$i_2 = \frac{5.8 - 0}{2} = 2.9$

$i_3 = \frac{5.8 - 5}{4} = 0.2$

① $P_{2\Omega} = i_1^2 R$
$= (3.1)^2 \cdot 2$
$= 19.22\,W$

② $P_{2\Omega} = 2.9^2 \times 2$
$= 16.82\,W$

$P_{4\Omega} = 0.2^2 \times 4$
$= 0.16\,W$

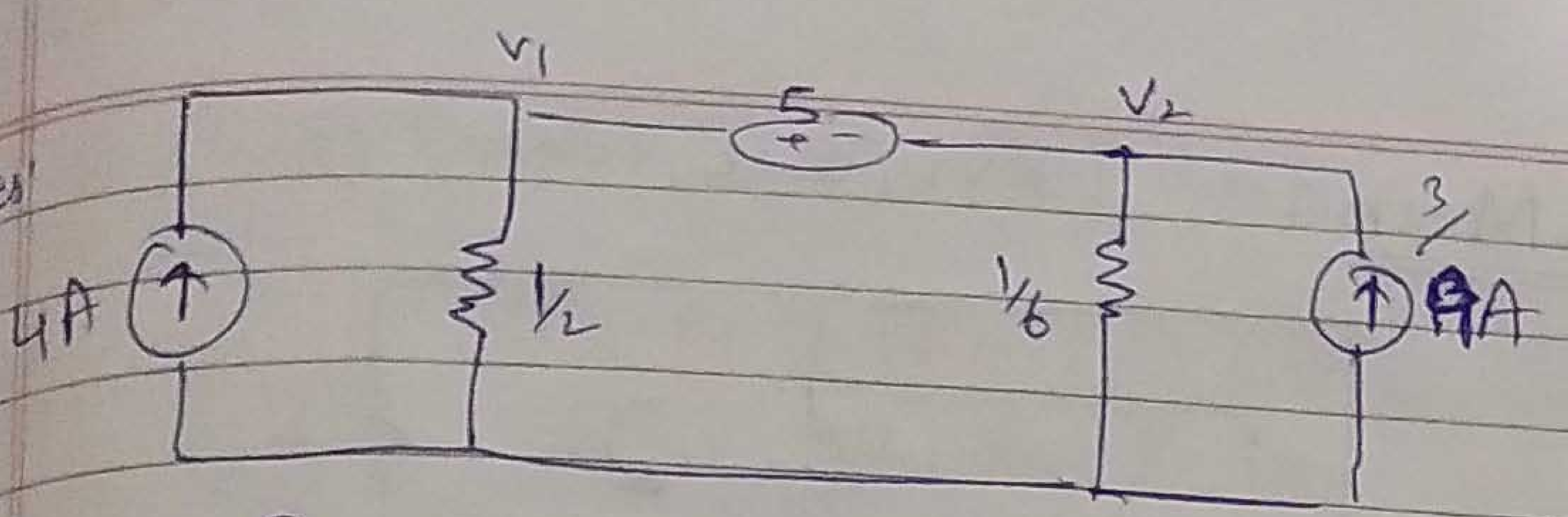
$P_{5V} = 5 \times 0.2 = 1$

$\boxed{P_T = 37.2\,W}$

$\boxed{P \text{ delivered by active source} = P \text{ dissipated by passive sources}}$

↳ Tellegan's Theorem

Ques



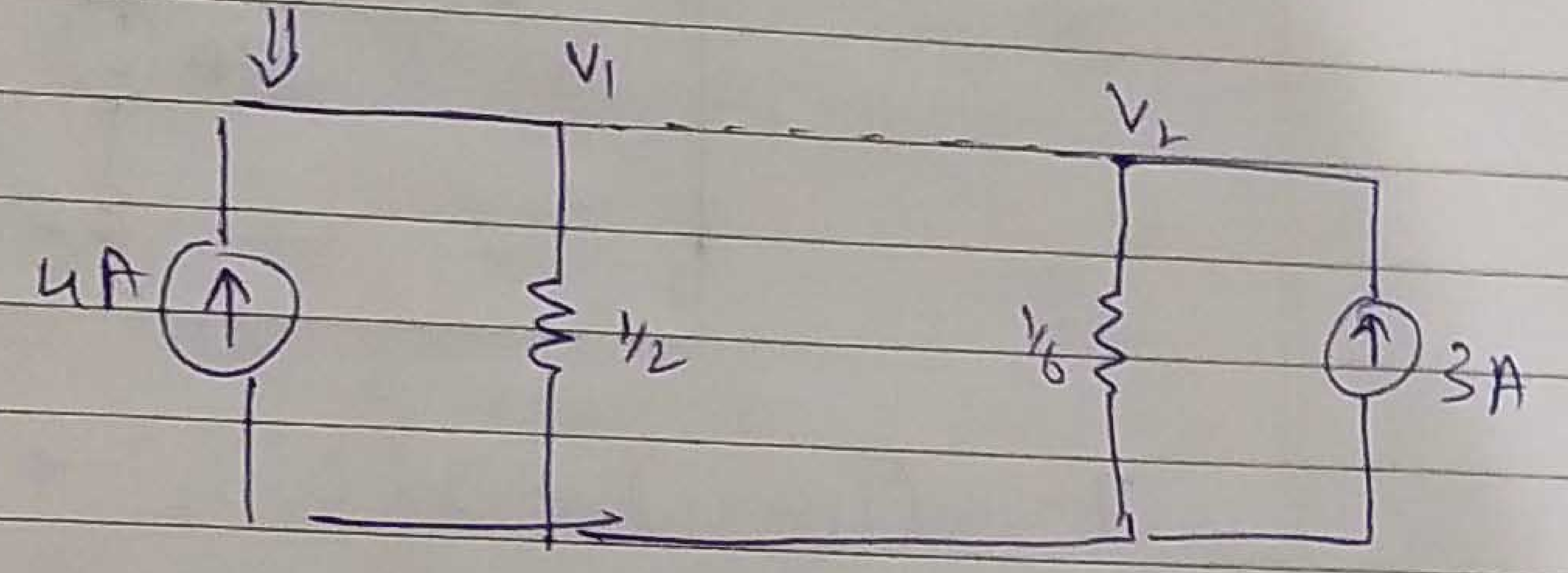
KVL, KCL & ohm's law

↑

↳ (Super node)

Find V_1 & V_2 = ?

⇓



$V_1 - 5 = V_2$

$\boxed{V_1 - V_2 = 5\ V}$

$4 = \frac{V_1}{1/2} + \frac{V_2}{1/6} - 3$

$\boxed{7 = 2V_1 + 6V_2}$

$6V_1 - 6V_2 = 30$

$2V_1 + 6V_2 = 7$

$8V_1 = 37$

$\boxed{V_1 = \frac{37}{8}\ V}$

$V_2 = \frac{37}{8} - 5$

$\boxed{V_2 = \frac{-3}{8}\ V}$

$13 = 2V_1 + 6V_2$

$30 = 6V_1 - 6V_2$

$43 = 8V_1$

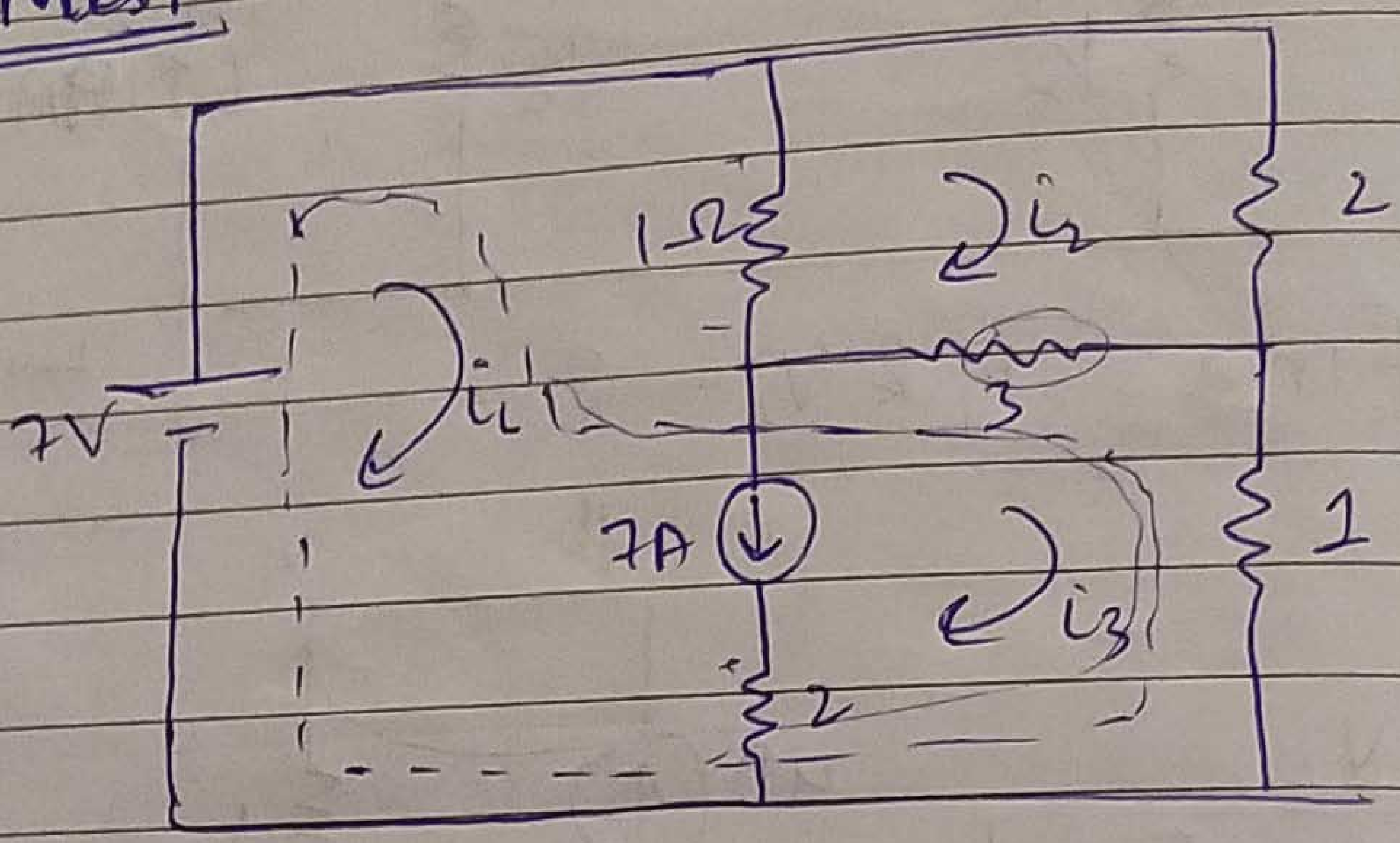
$\boxed{V_1 = \frac{43}{8}\ V}$

$V_2 = \frac{43}{8} - 5$

$\boxed{V_2 = \frac{3}{8}\ V}$

7/11/2019

SuperMesh :→ (KVL, KCL, ohm's law)

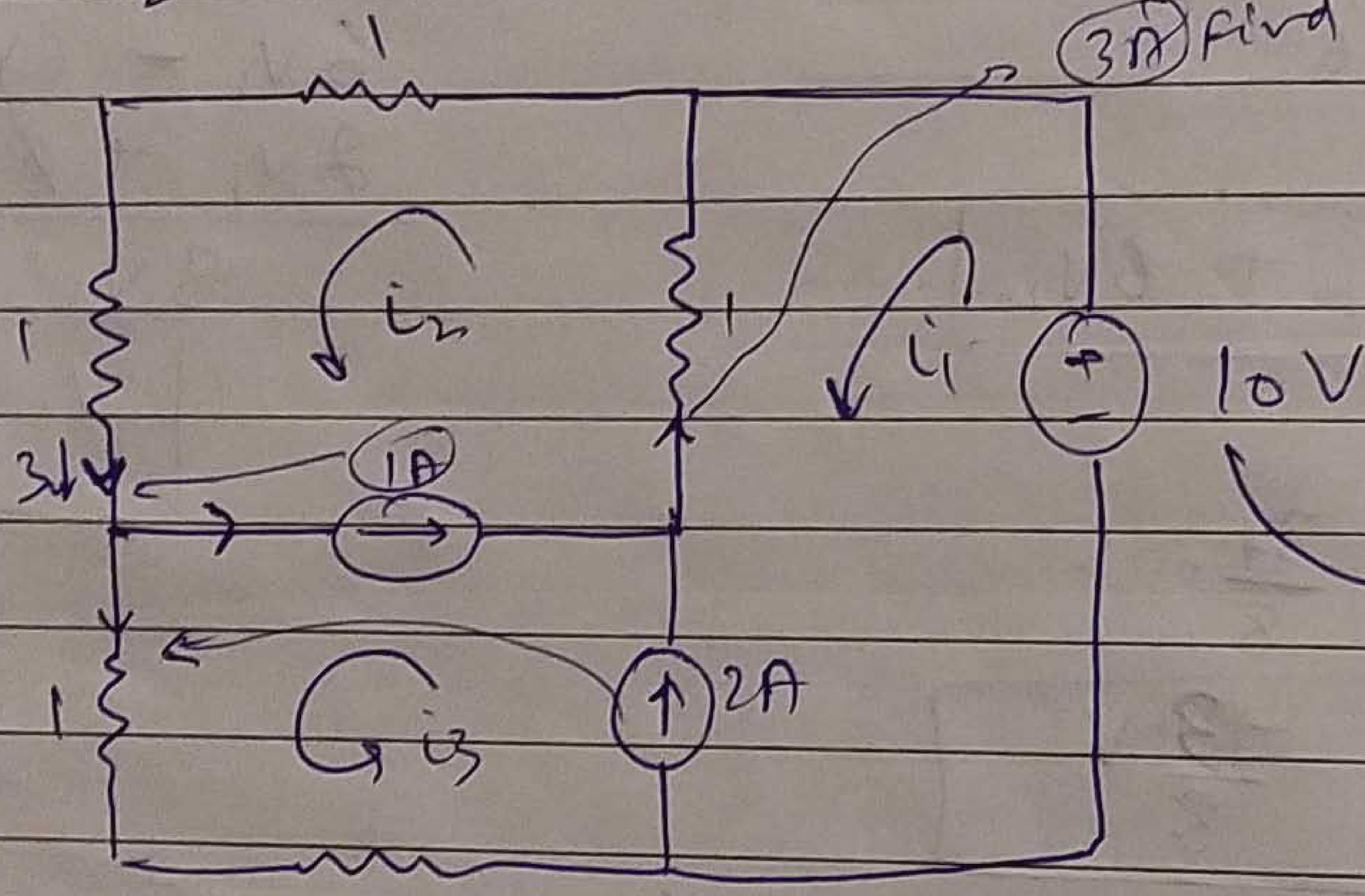


$$7 = (i_1 - i_2) + 3(i_3 - i_2) + i_3$$

$\boxed{i_1 - i_3 = 7A}$

$$2i_2 + 3(i_2 - i_3) + (i_2 - i_1) = 0$$

Eg:-



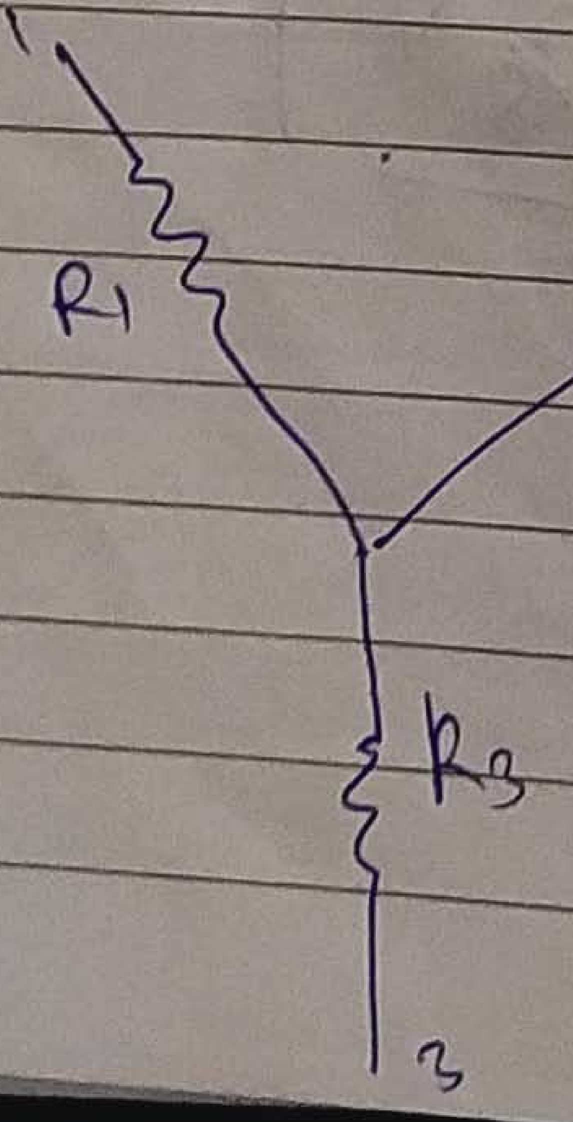
Find Power?

Wye - Delta or

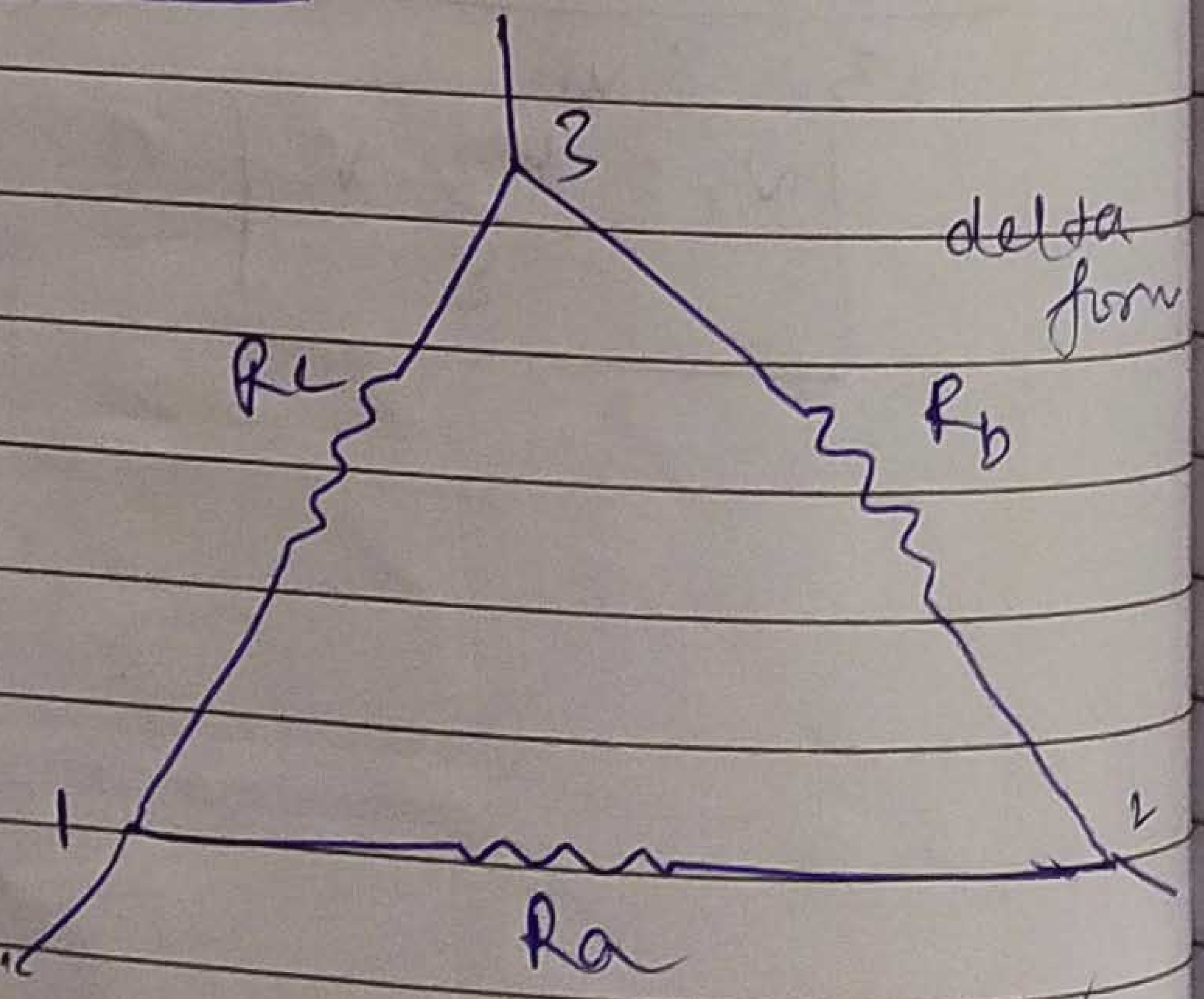
Star - Delta Connection:

T connection

star form



delta form



Δ/π connection

$$R_{12}(Y) = R_1 + R_2 \Rightarrow (R_c + R_b) \parallel R_a$$

$$R_1 + R_2 = \frac{(R_c + R_b)\,R_a}{R_a + R_b + R_c} \quad —\ (1)$$

$$R_{23}(Y) = R_2 + R_3 \Rightarrow \frac{(R_a + R_c)\cdot R_b}{R_a + R_b + R_c} \quad —\ (2)$$

$$R_{31}(Y) = R_3 + R_1 \Rightarrow \frac{(R_a + R_b)\,R_c}{R_a + R_b + R_c} \quad —\ (3)$$

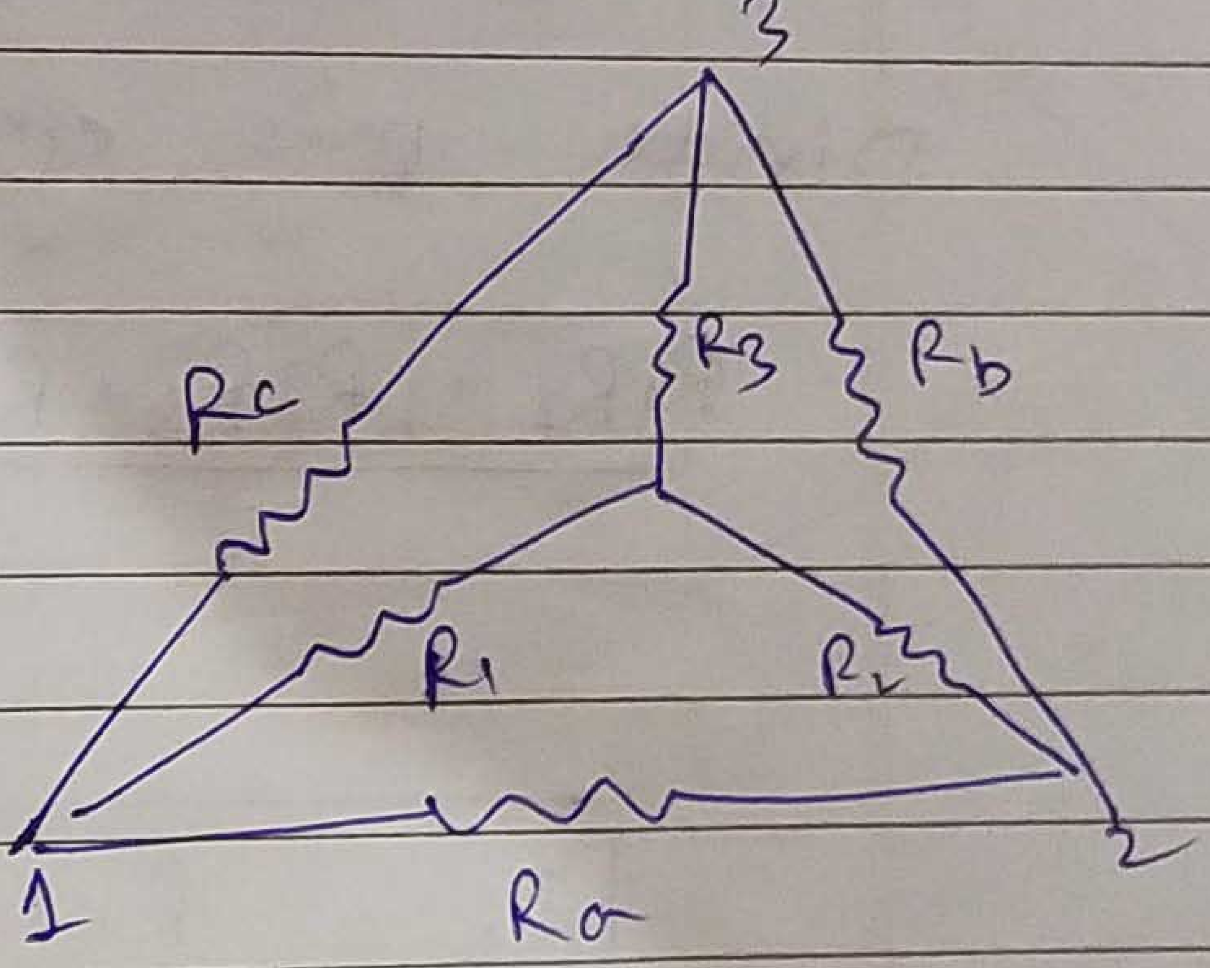
Subtract (2) from (1);

$$R_1 - R_3 = \frac{R_aR_c + \cancel{R_aR_b}}{R_a + R_b + R_c} - \frac{\cancel{R_aR_b} - R_bR_c}{R_a + R_b + R_c}$$

$$\boxed{R_1 - R_3 = \frac{R_aR_c - R_bR_c}{R_a + R_b + R_c}} \quad —\ (4)$$

Add (3) & (4);

$$\cancel{2}R_1 = \frac{\cancel{2}R_aR_c}{R_a + R_b + R_c}$$



$$\boxed{R_1 = \frac{R_aR_c}{R_a + R_b + R_c}}$$

$$\boxed{R_2 = \frac{R_aR_b}{R_a + R_b + R_c}}$$

$$\boxed{R_3 = \frac{R_bR_c}{R_a + R_b + R_c}}$$

Now Star to Delta;

$$R_1 R_2 = \frac{Ra^2 \, Rb Rc}{(Ra + Rb + Rc)^2} \quad — (a)$$

$$R_2 R_3 = \frac{Rb^2 \, Ra Rc}{(Ra + Rb + Rc)^2} \quad — (b)$$

$$R_1 R_3 = \frac{Rc^2 \, Ra Rb}{(Ra + Rb + Rc)^2} \quad — (c)$$

Add (a), (b) & (c);

$$R_1 R_2 + R_2 R_3 + R_3 R_1 = \frac{Ra^2 Rb Rc + Rb^2 Ra Rc + Rc^2 Ra Rb}{(Ra + Rb + Rc)^2}$$

$$= \frac{(Ra Rb Rc)\cancel{(Ra + Rb + Rc)}}{(Ra + Rb + Rc)^{\cancel{2}}}$$

$$\boxed{R_1 R_2 + R_2 R_3 + R_3 R_1 \Rightarrow \frac{Ra Rb Rc}{(Ra + Rb + Rc)}}$$

Divide this eqn. by R_1

$$\frac{R_1 R_2 + R_2 R_3 + R_3 R_1}{R_1} = \frac{\frac{\cancel{Ra} Rb \cancel{Rc}}{\cancel{(Ra + Rb + Rc)}}}{\frac{\cancel{Ra} \cancel{Rc}}{\cancel{(Ra + Rb + Rc)}}}$$

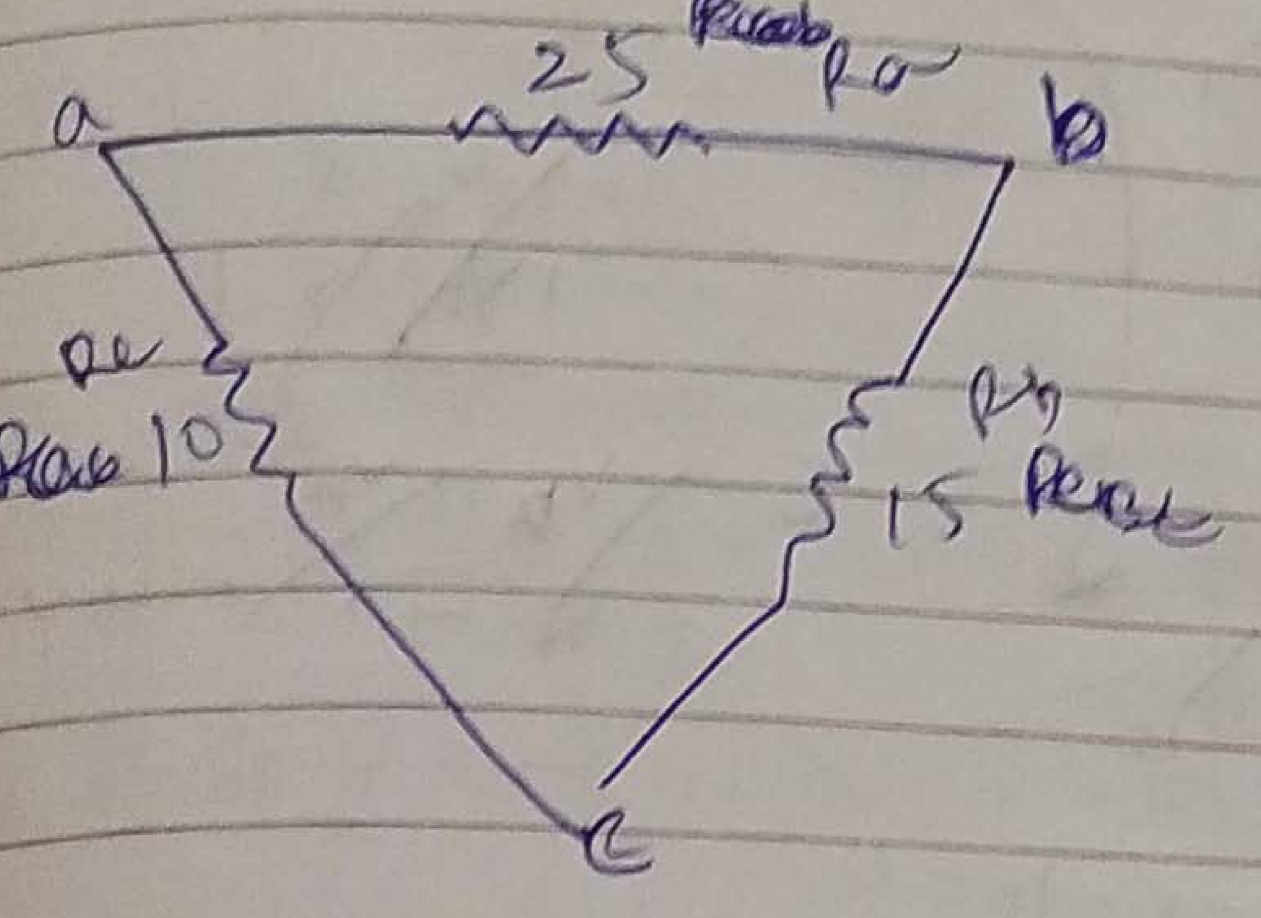
$$\boxed{Rb = \frac{R_1 R_2 + R_2 R_3 + R_3 R_1}{R_1}}$$

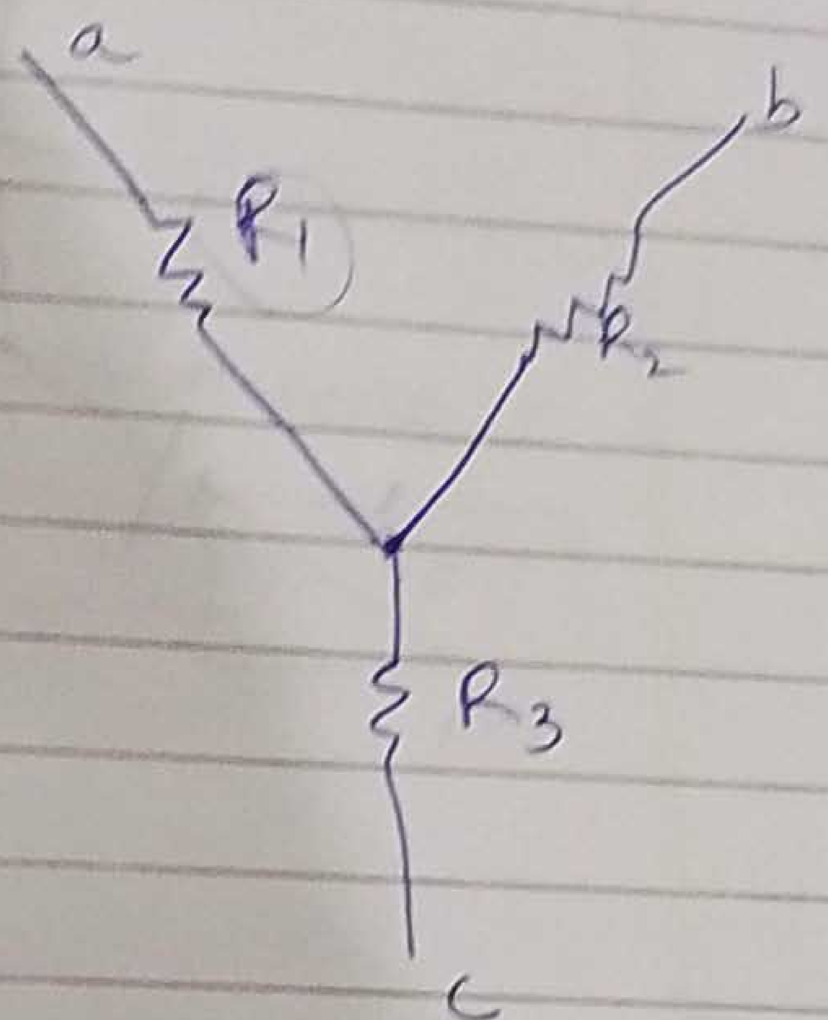
$$\boxed{Rc = \frac{R_1 R_2 + R_2 R_3 + R_3 R_1}{R_2}}$$

$$\boxed{R_a = \frac{R_1R_2 + R_1R_3 + R_3R_1}{R_3}}$$

* $\boxed{R_a, R_b \& R_c \text{ eliminate} \; R_1, R_2, R_3}$

Ques



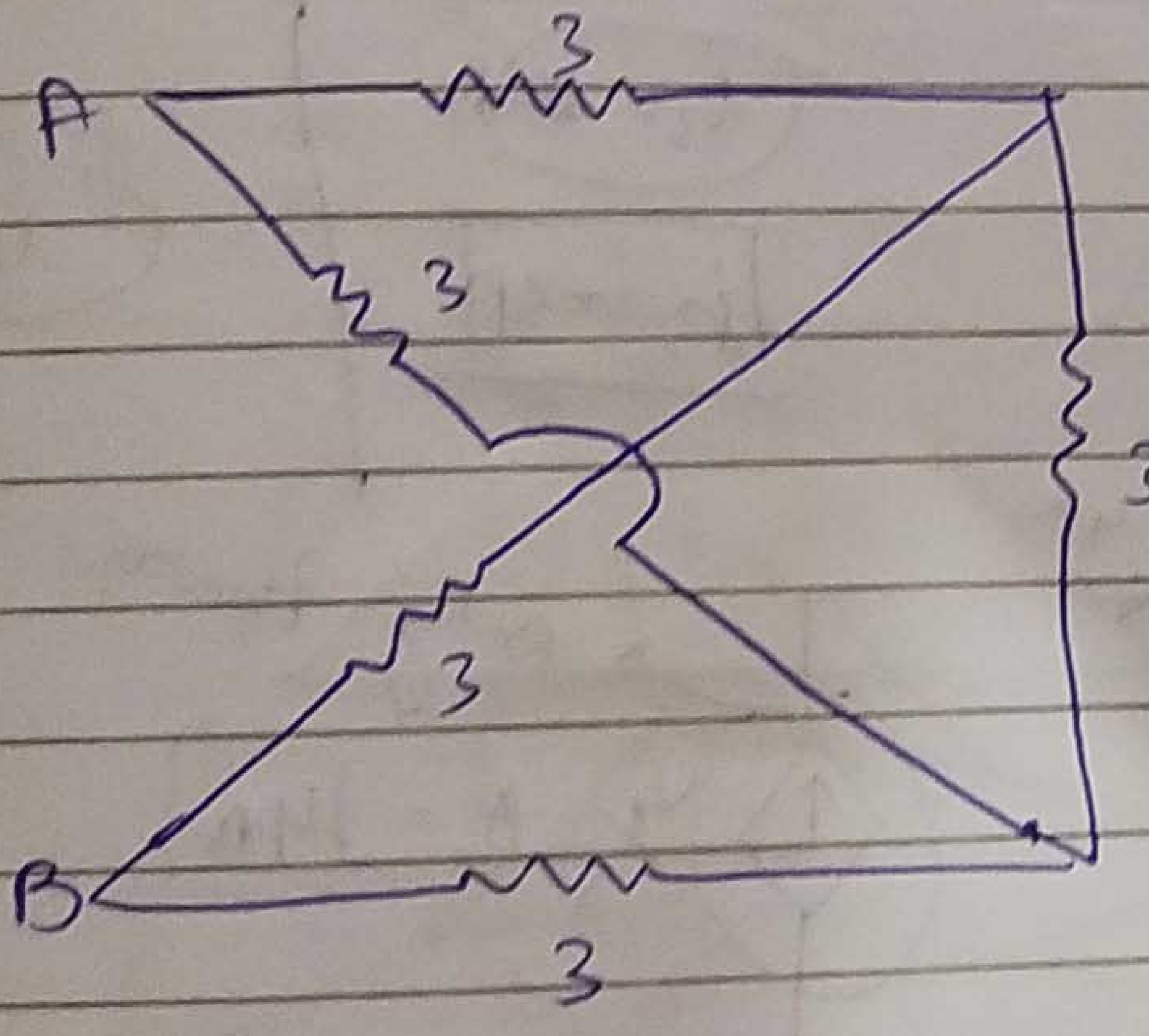


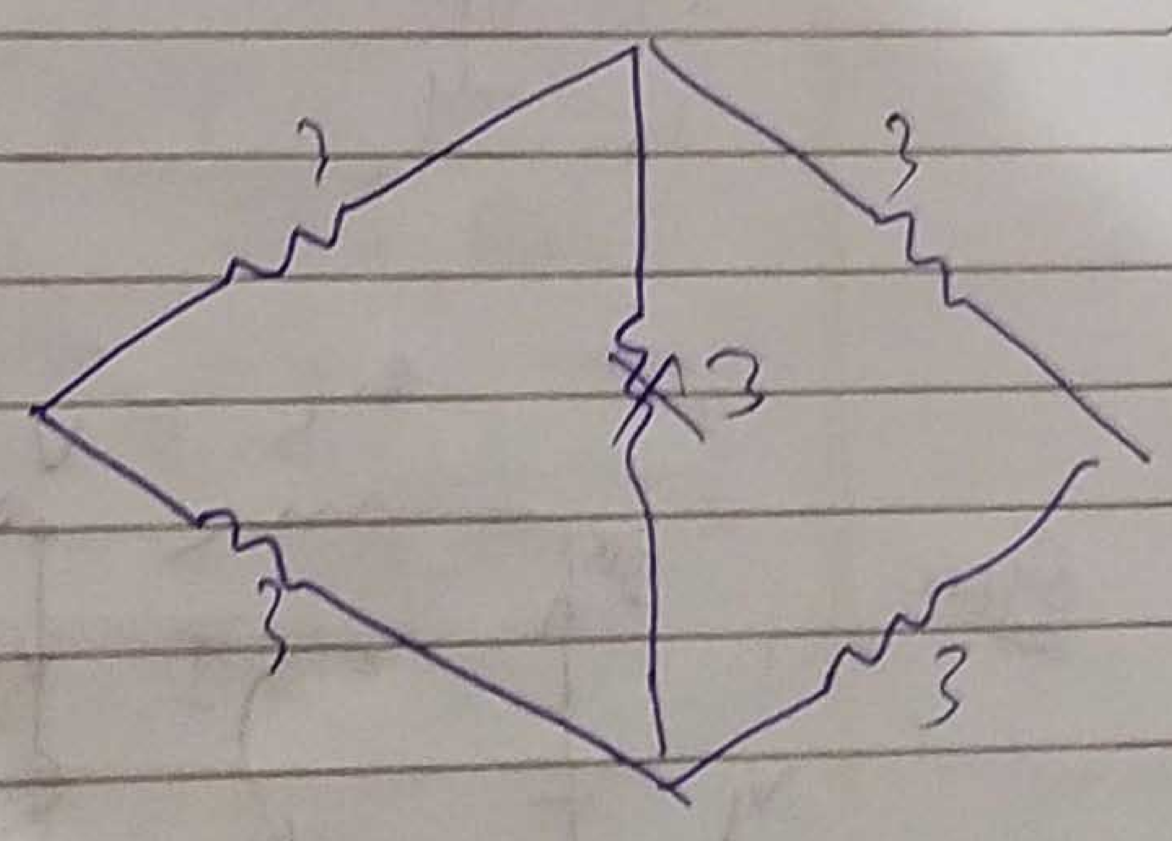
$$R_1 = \frac{10 \times 25}{50} = 5$$

$$R_2 = \frac{15 \times 25}{50_2} = \frac{\cancel{45}}{\cancel{8}} \rightarrow \frac{15}{2}$$

$$R_3 = \frac{10 \times 25}{50}$$

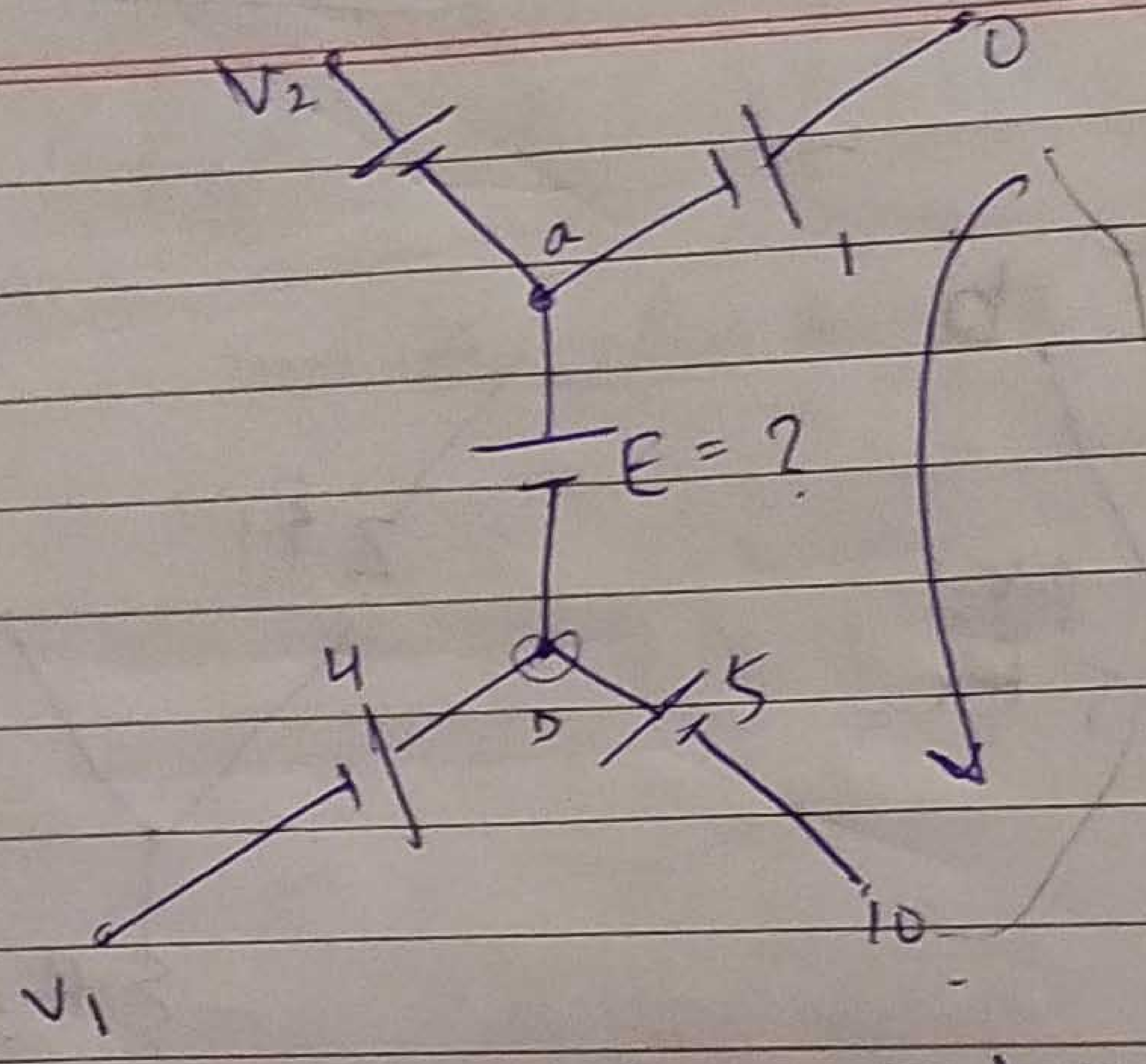
Ques





$$\frac{\cancel{36}\,3}{\cancel{12}} \qquad \frac{6 \times 6}{12}$$

Ques:-



$V_A - 0 = 1$

$\boxed{V_A = 1}$

$10 - V_B = 5$

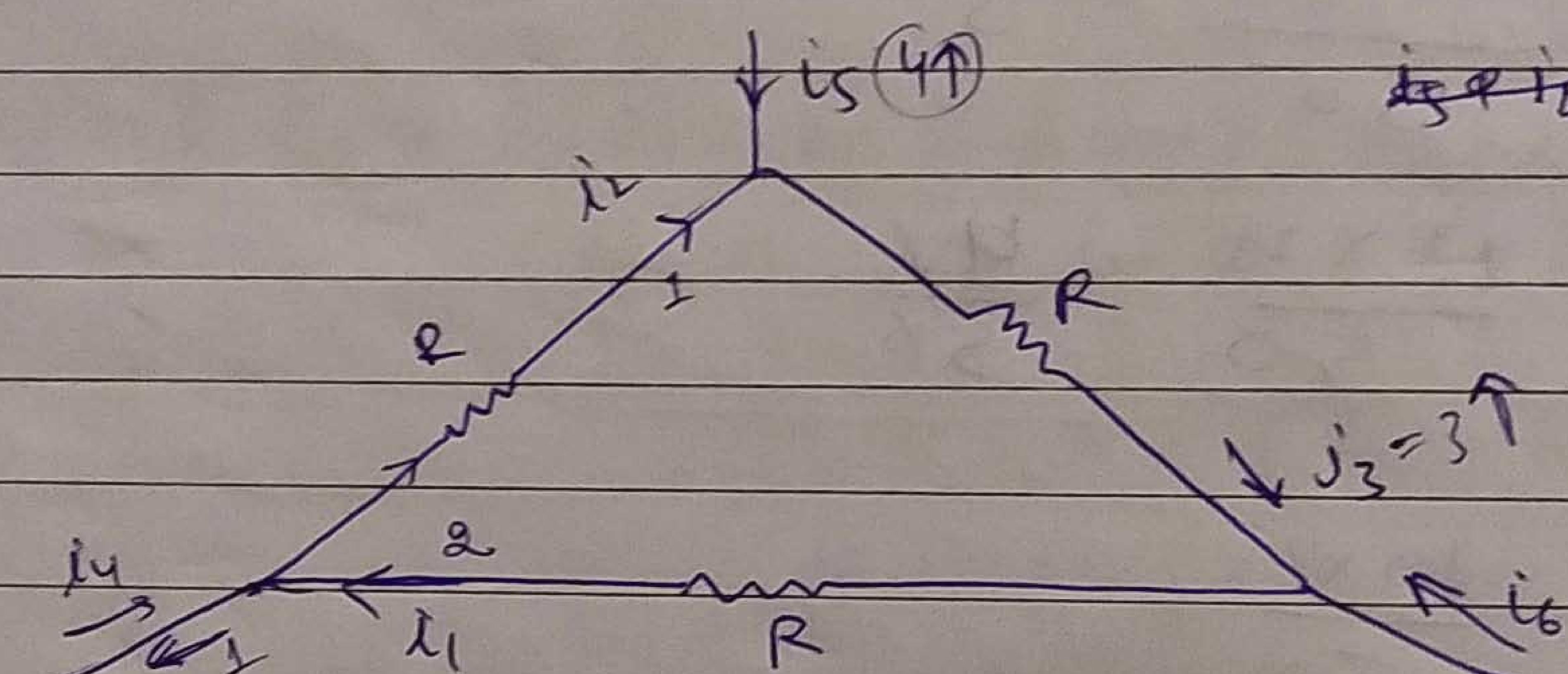
$\boxed{V_B = 5}$

$\cancel{E = V_B - V_A = 5 - 1 = 4V}$

$-1 - E - 5 - 10 = 0$

$\boxed{E = -16\,V}$

Ques:-



$i_1 = 2A$

$i_4 = -1A$

$i_5 = -4$

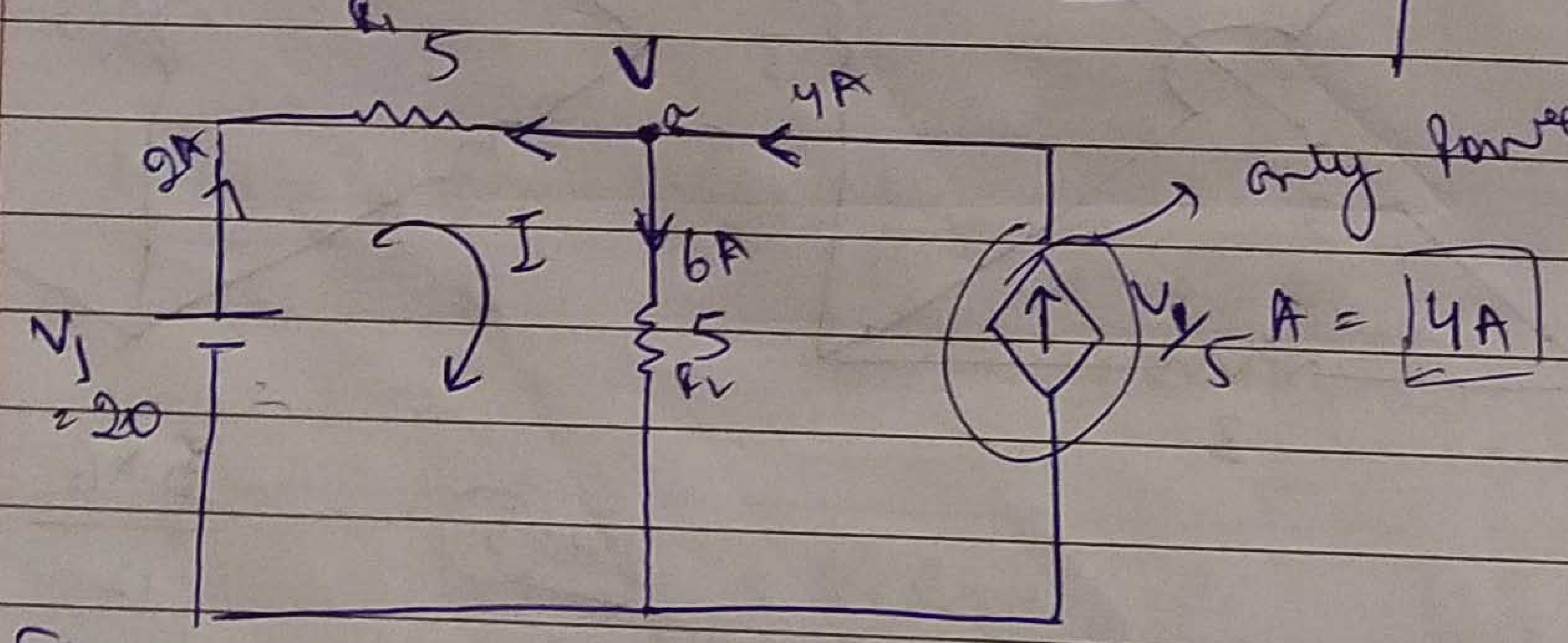
i_2 & i_6?

$i_2 = 2A$

$\boxed{i_3 = -3A}$

$i_6 = 5A$

Ques:-



only power

$\frac{V}{5}A = \boxed{4A}$

Find power delivered / absorbed by independent & dependent sources?

$R_{eq} = 10\,\Omega$

$I_{net} = \frac{V_1}{R_{eq}} = \frac{20}{10} = 2A$

$P_{R_1} = I^2 V_1$

$= IRI = I^2R = (2)^2 \cdot 5 = 20\,W$

$P_{R_2} = I^2R = (6)^2 5 = 36\times5 = 180\,W$

$P_{V_1} = VI = 20\times2 = 40\,W$

or

KCL at a;

$\frac{V}{5} + \frac{V-V_1}{5} = \frac{V_1}{5}$

$\frac{V}{5} + V = \frac{2V_1}{5}$

$\frac{6V}{5} = \frac{2V_1}{5}$

$V = \frac{V_1}{3} = \frac{20}{3} = 6.67\,V.$

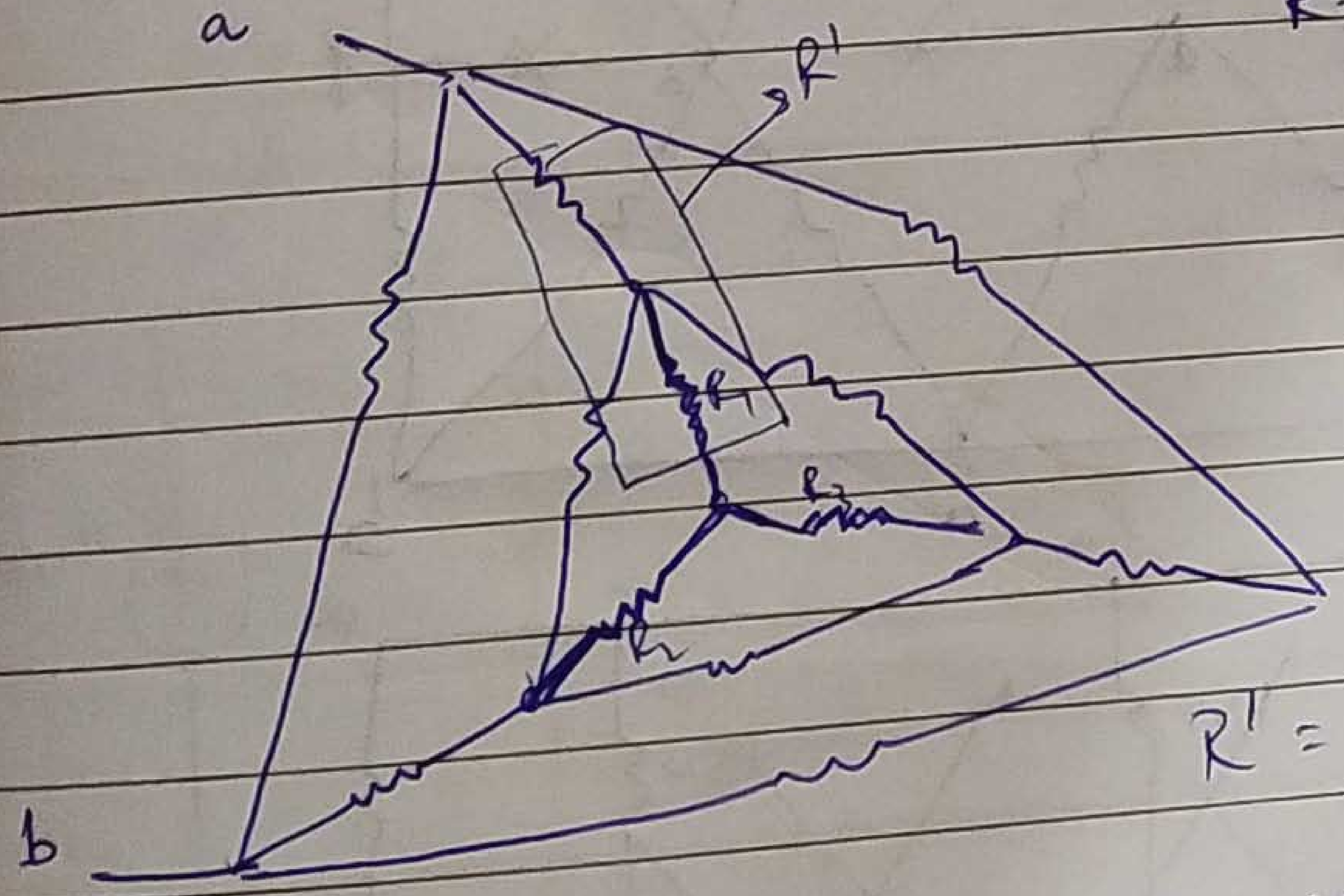
$\frac{V}{5} + \frac{V-V_1}{5} = \frac{V_1}{5}$

$\frac{2V}{5} = \frac{2V_1}{5}$

$V = V_1$

$\boxed{V_1 = 20V}$

Ques



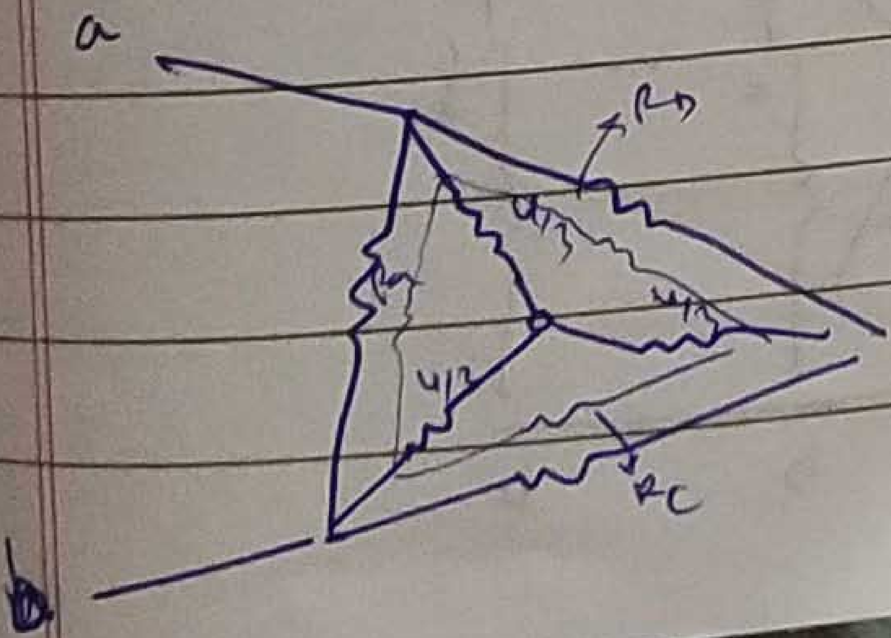
$R = 1\,\Omega$

Find Rab?

$R_1 = \frac{1\times1}{3} = \frac{1}{3}$

$R_2 = 1/3$ $R_3 = 1/3$

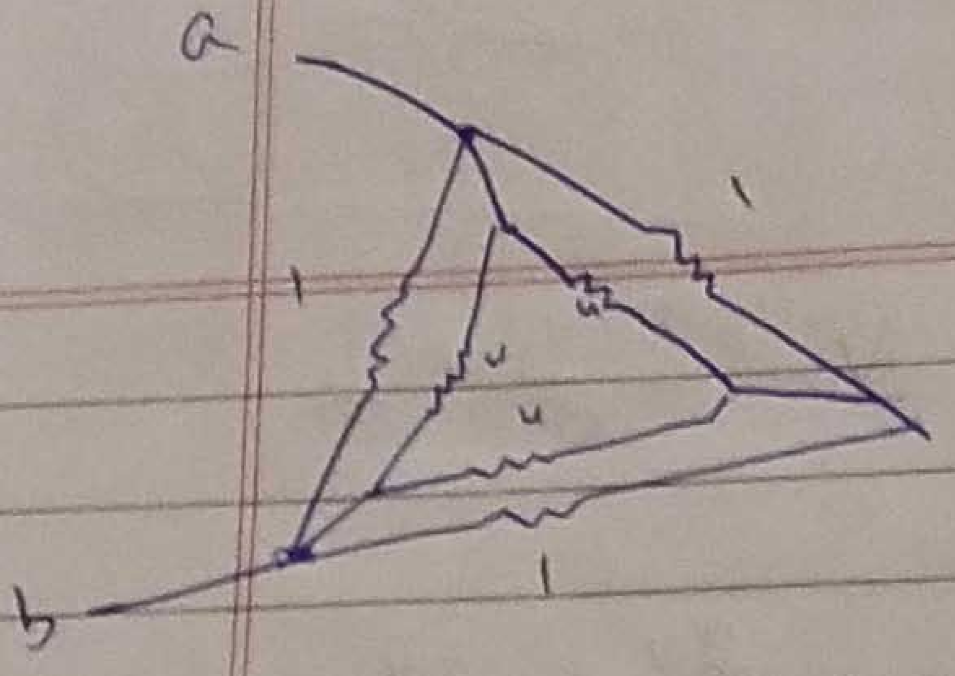
$R' = 1 + \frac{1}{3} = \frac{4}{3}\,\Omega$



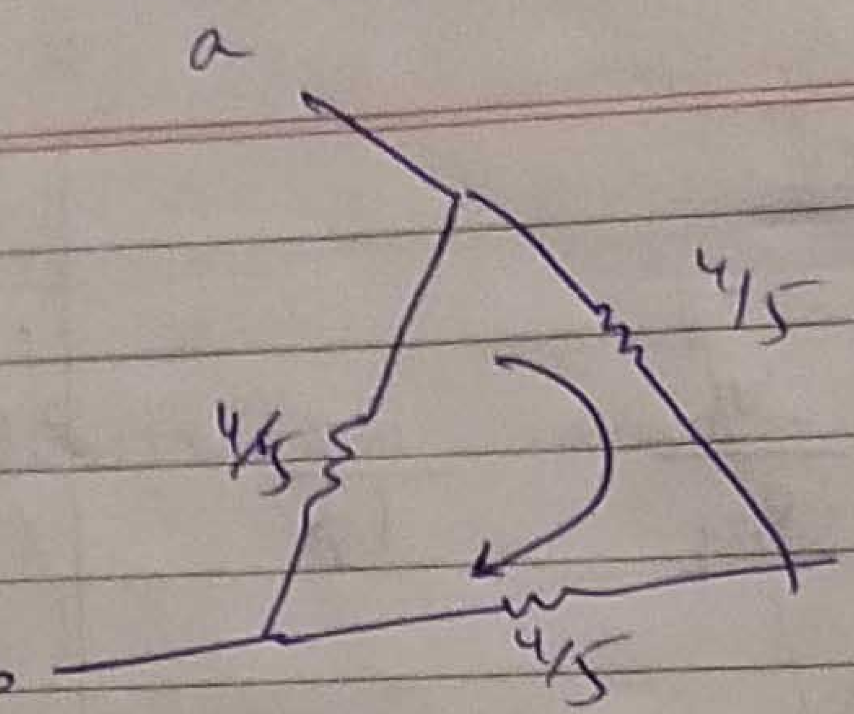
$R_a = \frac{(\frac{4}{3}\times\frac{4}{3})3}{4/3} = \frac{\frac{16}{9}\times3}{4/3} = 4$

$R_b = 4$ $R_c = 4$

$\frac{1\times 4}{5} = \frac{4}{5}\Omega$

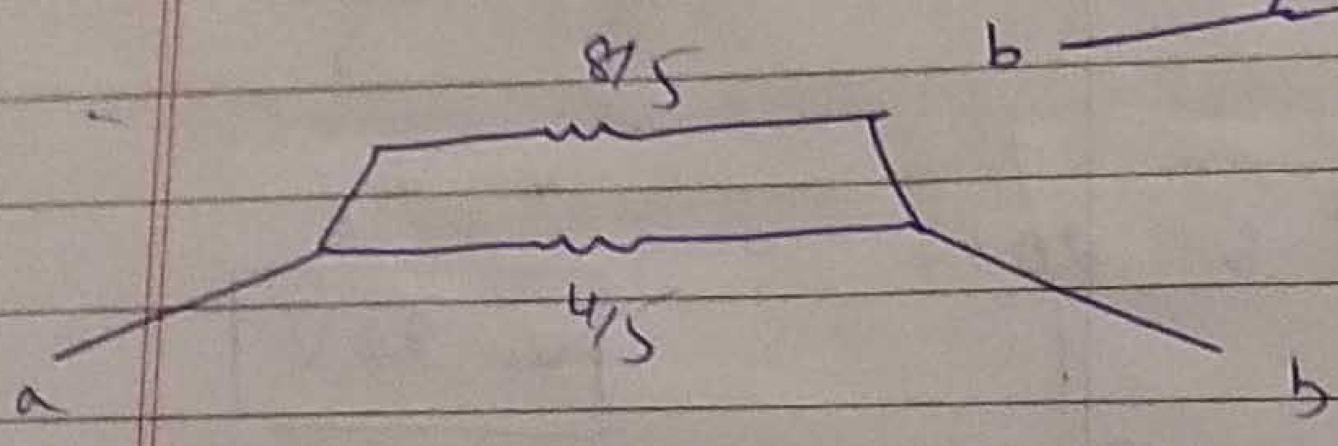


$\Rightarrow$



$\frac{4}{5}+\frac{4}{5}$

$\frac{8}{5}$



$\Rightarrow \dfrac{\frac{8}{5}\times\frac{4}{5}}{\frac{8}{5}+\frac{4}{5}}$

$\Rightarrow \dfrac{\frac{32}{25}}{\frac{12}{5}}$

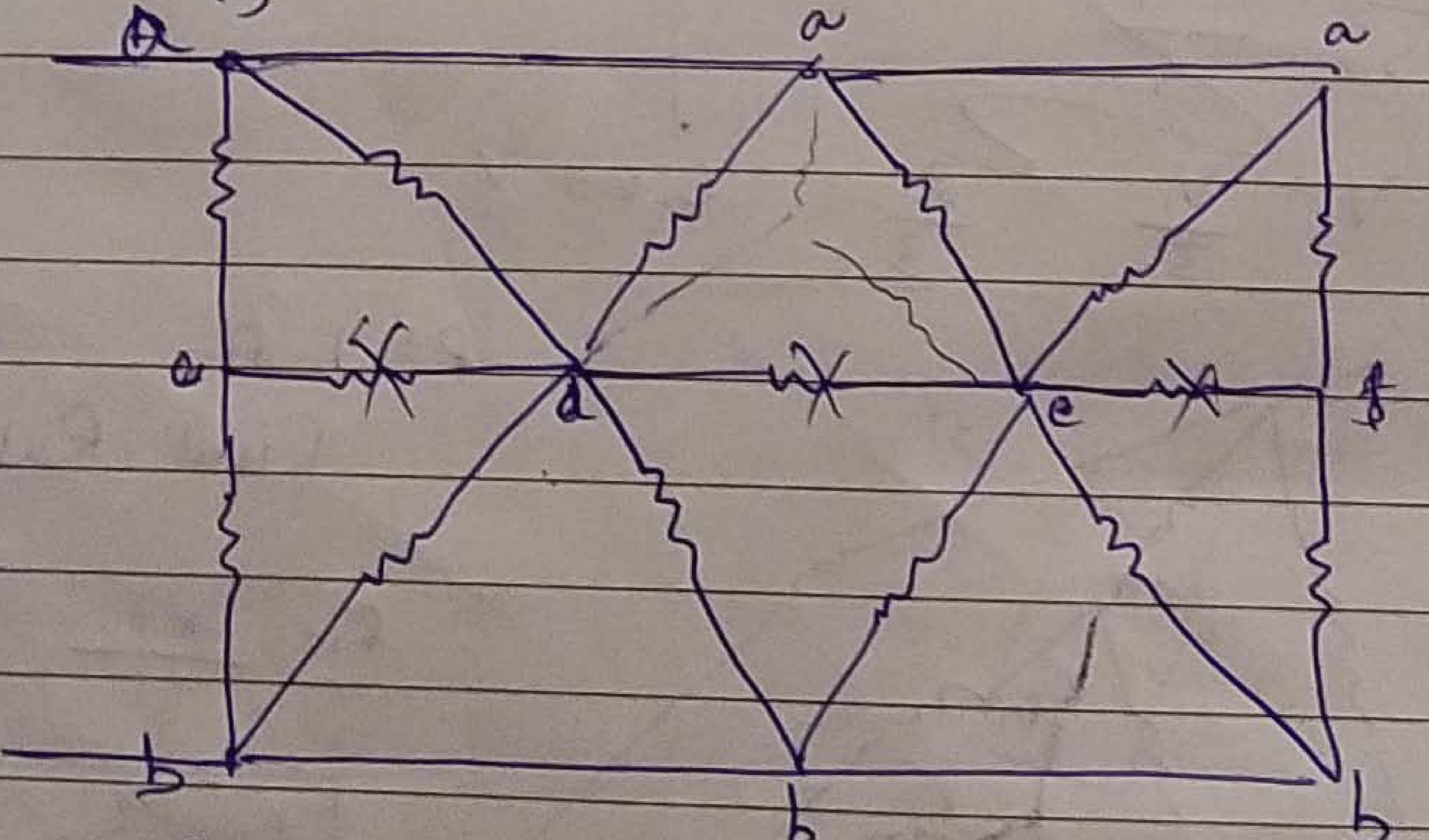
$\Rightarrow \frac{32}{5}\times 12$

$\dfrac{\frac{32}{25}}{\frac{12}{5}}$

$\Rightarrow \frac{32}{25}\times\frac{5}{12}$

$\Rightarrow \frac{8}{15}\Omega$

Ques:-
$R = 300\Omega$
$R_{ab} = ?$



$\frac{150\times 100}{250}$