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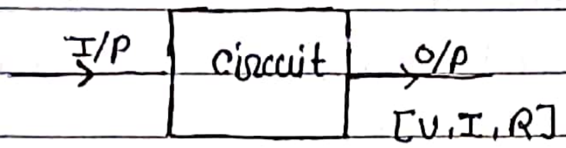
Basic electrical & electronics

Network theory → Anylasis
↓ → Synthesis
Circuit (R, I, L, B, C)

Circuit → It can be made by electrical elements like as (Register, Inductor, capcitor, volatage, current, Power) etc.

* Anylasis

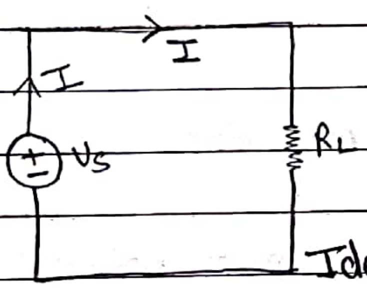


* Synthesis

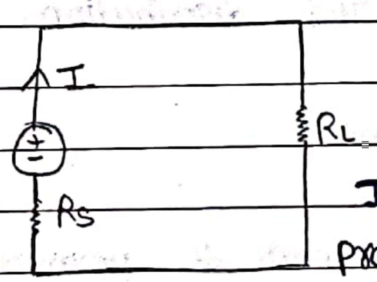
Network → Network may be or may not be their in closet loop but circuit are always in close loop.

Ideal and practical source (V/I)

Ideal and practical voltage source



Ideal voltage



Internal connecte
practical voltage

No internal Registance
Delivers always constant voltage across the load.

It has some voltage drop across the internal Registar
So can not deliverse constan voltage

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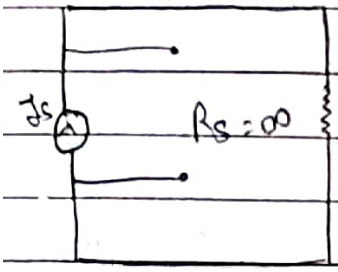
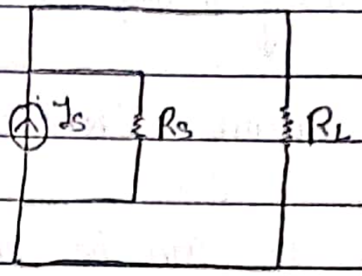
Ideal & Practical current sources :





Ideal current source	Practical current source.
1) It has ∞ registance in parallel across current source Is.	① It has finite registance Rs Connected in parallel to current Source Is.
② It diliverse constant current to load RL.	② It cannot give constant current to load As Practional current goes throw Rs. internal registance.

* classification of network :-

Their are four types of network :

1. linear and non linear network
2. Bilateral and unilatral network
3. active and passive network
4. lumped and distribution network

linear	non linear
for linear network the parameter of the network will not change with repect to temprature, volltage or current no as linear current	for non linear network parameter network will change respect to temp. valltage or current know as non linear current
Ex R, L, C or RLC	Ex . diode, transistor, FET

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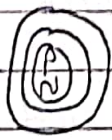
Biletral	Uniletral
For biletral network behaviour remains same when current flows from Both direction.	In uniletral network behaviour depend to direction of current. f.B
	

Active	Passive
for active network it contains elements which deliver power Ex. Voltage source, current source in a network	for passive network is does not contain element which deliver power. Ex. RLC circuit.

lumped	distributed
lumped network work at low frequency	It is work as high frequency and micro frequency.

* Electric charge & electric current

electric charge

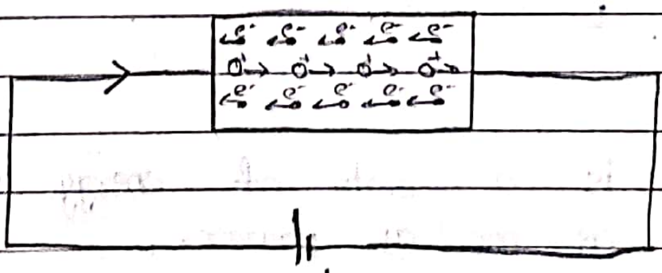


p^+ = +ve = 1.6×10^{-19} C

n . no charge

e^- = −ve = -1.6×10^{-19} C

electric current



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* Electric current is rate of change charge w.r.t time is Known as electric current.

$$\boxed{I = \frac{dQ}{dt}} \quad \because Q = \text{charge}$$

$$\int dQ = \int I \cdot dt$$

$$\boxed{Q = \int I \cdot dt}$$

Que If charge is a function of time as per $Q(t) = 2t^2+3t+5$ then find current at 0.1 s.

$$I = \frac{dQ}{dt}$$

$$I = \frac{d(2t^2+3t+5)}{dt}$$

$$I = 4t+3$$

$$I = 4(0.1)+3 = 3.4 \text{ Amp}$$

= Voltage (Potential) : It is a amount of work required to be done to brink 1 unit charge from infinite to given point.

Unit of Volatege = $\frac{\text{Joule}}{\text{Culamb}}$ = Volt

$$\boxed{V = \frac{dw}{dq}} \quad \because w = \text{Work / Energy}$$

: Power & energy

Power → It is a rate of energy with respect to time as non as power.

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$$\boxed{P = \frac{dw}{dt}} = \frac{\text{Joule}}{\text{sec}} = \text{watt}$$

$mW = 10^{-3}$ watt $nW = 10^{-9}$ watt $MW = 10^{6}$ watt

$\mu W = 10^{-6}$ watt $kW = 10^{3}$ watt $GW = 10^{9}$ watt

$$P = \frac{dw}{dq} \times \frac{dq}{dt}$$

$$\boxed{P = VI} \quad \boxed{P = V^2/R} \quad \boxed{P = I^2R}$$

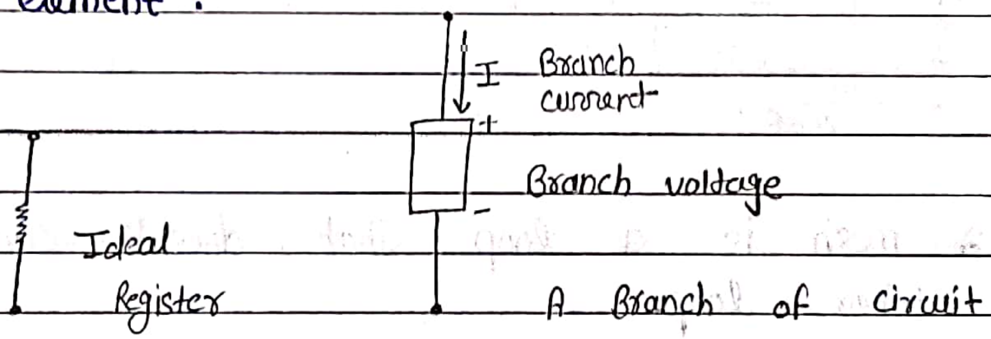
Energy :- It is a capicity of workdone is non as energy.

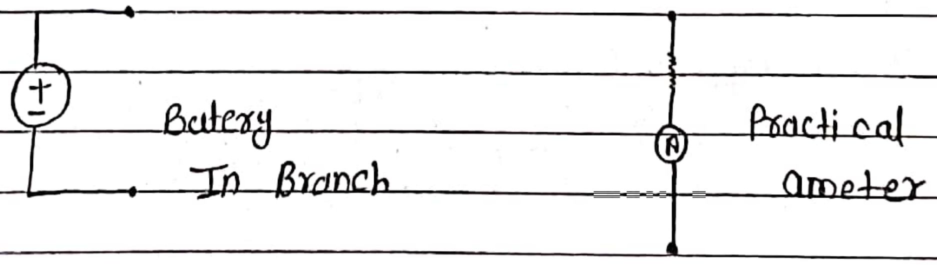
$$P = \frac{dw}{dt}$$

$$\int dw = \int P.dt$$

$$\boxed{W = \int P.dt} \text{ Joule.}$$

Brunch of circuit :- A branch is any poration of the circuit with two terminals connected to it. A branch may consist of one or more circuit element :





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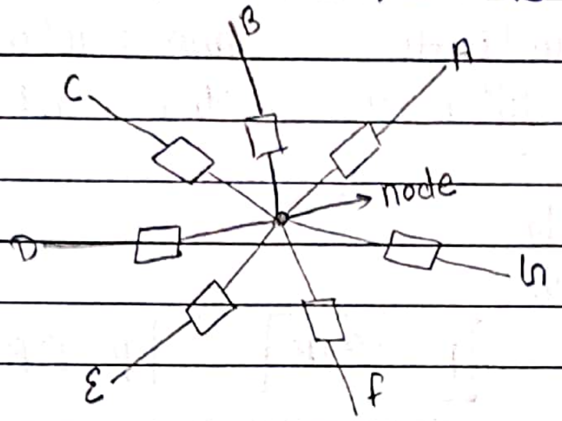
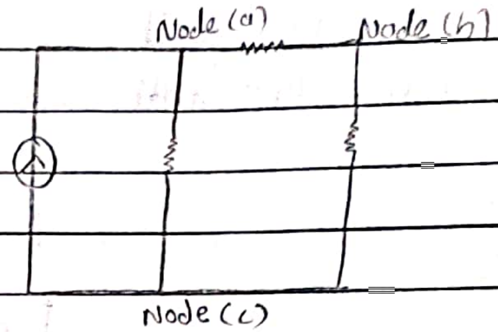
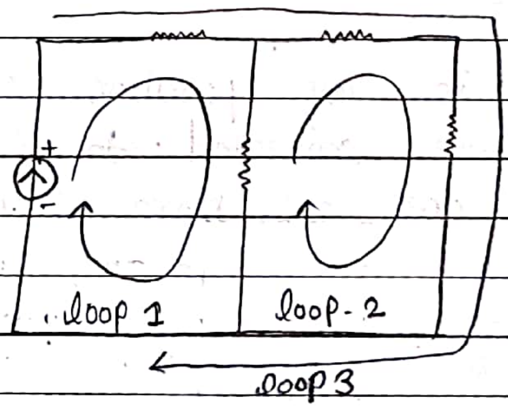
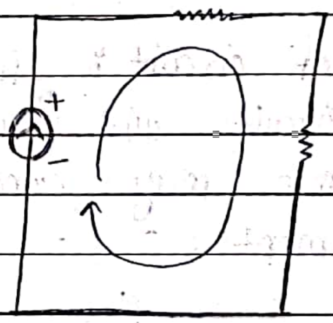
Node : A node is the junction of two or more branches non as node.





loop :- A loop is a close path by starting a node passing through a set of nodes and returning to the starting node, without passing through any node more than once.





mesh :- A mesh is a loop that doesn't contain other loop.

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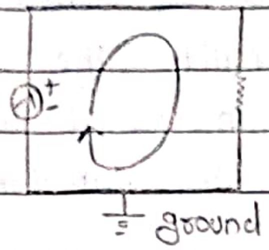
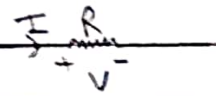
Circuit ground :



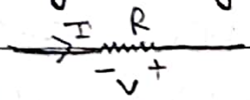
* ohm's law → The voltage across the element it is directly propesonal to the current folowing through it.

$V \propto I$



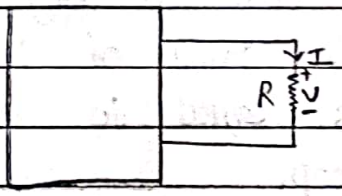
$\boxed{V = IR}$

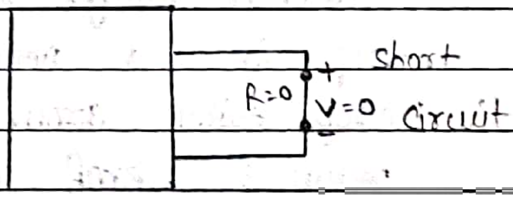
If polarity charge change so



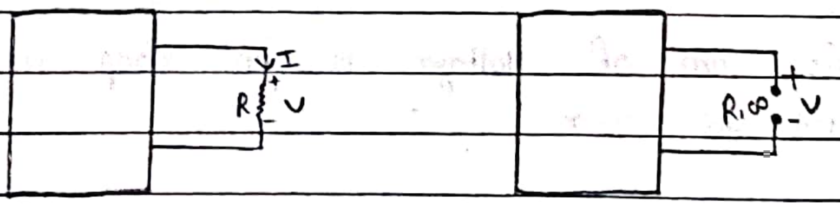
$\boxed{V = -IR}$

* Short circuit → An element with $R = 0$ is called short circuit.





* Open circuit → An element with $R = \infty$ is non as open circuit.



$V = IR$

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

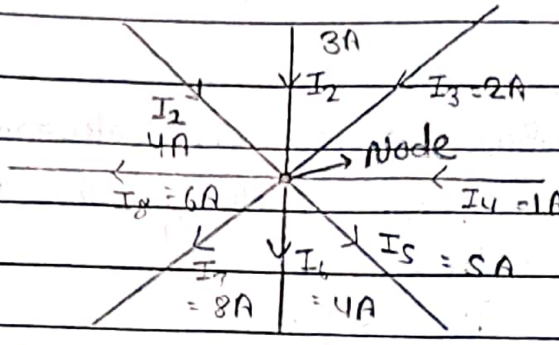
$I = \frac{V}{\infty}$

$I = 0$

Spiral

Date..................

* KCL (Krichoff current law) → KCL States that at any junction (Node) in an electric circuit the total current folowing towards that junction in equal to the total current folowing away from the junction.



at any node

$$\Sigma I_{income} = \Sigma I_{outgoing}$$
$$I_1 + I_2 + I_3 + I_4 = I_5 + I_6 + I_7 + I_8$$
$$I_1 + I_2 + I_3 + I_4 - I_5 - I_6 + I_7 - I_8 = 0$$
$$4 + 3 + 2 + 1 - 5 - 4 - 8 - 6$$
$$-13 \quad \text{Ans}$$

* KVL (Krichoff Voltage law) → KVL States that in any close loop in a network the algebric some of the voltage drop taken around the loop is equal to the resullent emf active in the loop.

Note :- Krichoff current law is based on law of charge conservation.

Statement : Algebric sum of voltage is in loop must be equal to zero.

Spiral

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$V = -IR$ $\qquad$ $V = -L\frac{dI}{dt}$ $\qquad$ $V = -\frac{1}{C}\int I \cdot dt$

$V - IR_1 - IR_2 - IR_3 = 0$

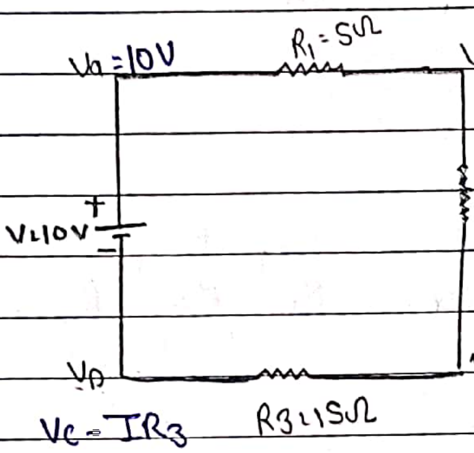
$\underbrace{V}_{\text{Sum of Voltage rise}} = \underbrace{IR_1 + IR_2 + IR_3}_{\text{sum of Voltage drop}}$

$10 = I5 + 10I + 15I$

$I = \frac{10}{30}$

$I = 0.33A$

Que

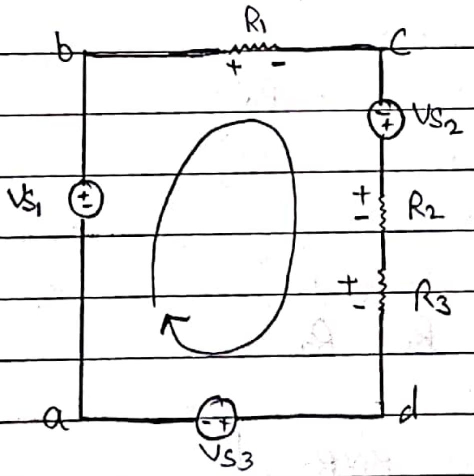


$V_b = V_a - IR_1$
$= 10 - 0.33$
$= 8.5V$

$V_c = V_b - IR_2$
$= 8.5 - 0.33$
$= 5.5V$

$V_c - IR_3$
$= 1V$

Que

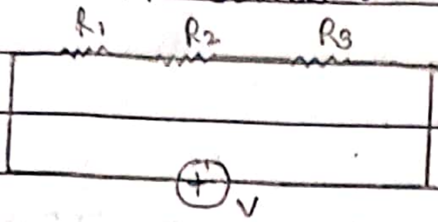


$V_{S_1} - IR_1 + V_{S_2} - IR_2 - IR_3 - V_{S_3} = 0$

$V_{S_1} + V_{S_2} - V_{S_3} = IR_1 + IR_2 + IR_3$

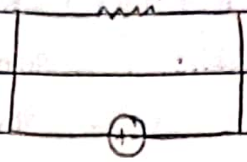
Spiral

* Register in series :

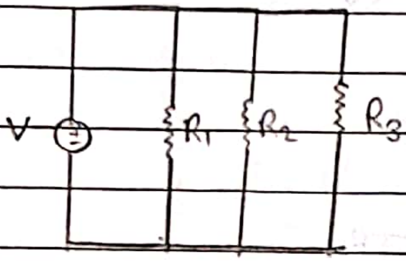


$R_{eq} = R_1 + R_2 + R_3$

$R_{eq} = R_1 + R_2 + R_3$



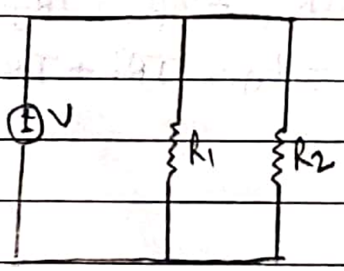
* Register in prallel :



$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

* Power in Sereis $= \frac{1}{P_1} + \frac{1}{P_2} + \frac{1}{P_3} + \cdots + \frac{1}{P_n}$

* Power in parallel $= P_1 + P_2 + P_3 + \cdots + P_n$



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

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

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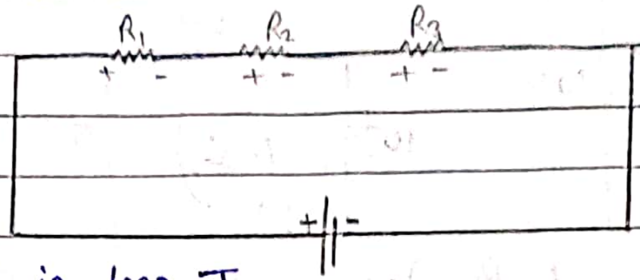
* Voltage divider rule :-

Current source



Apply KVL in loop I

$$V - IR_1 - IR_2 - IR_3 - \dots - IR_n = 0$$

$$V = IR_1 + IR_2 + IR_3 + IR_4 + \dots + IR_n$$

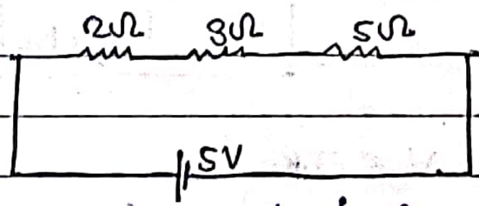
$$\boxed{I = \frac{V}{R_1 + R_2 + \dots + R_n}}$$

$$\boxed{V_1 = IR_1 = \left(\frac{R_1}{R_1 + R_2 + \dots + R_n}\right) V}$$

$$\boxed{V_2 = IR_2 = \left(\frac{R_2}{R_1 + R_2 + \dots - R_n}\right) V}$$

$$\boxed{V_n = IR_n = \left(\frac{R_n}{R_1 + R_2 + \dots + R_n}\right) V}$$

Que find V

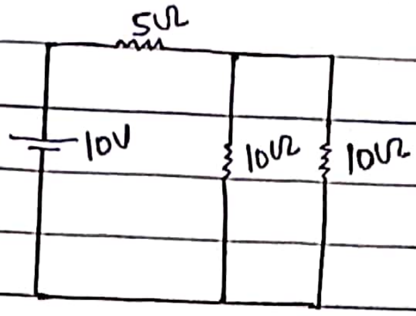


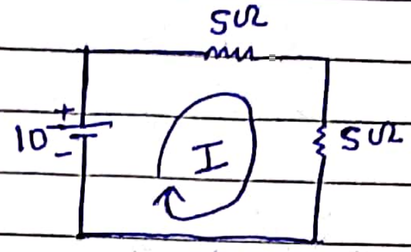
$$V_1 = \left(\frac{2}{2+3+5}\right) \times 5 = \frac{\cancel{2} \times \cancel{5}}{\cancel{10}_2} = 1V$$

$$V_2 = \frac{3 \times \cancel{5}}{\cancel{10}_2} = 1.5\ V$$

$$V_3 = \frac{5 \times \cancel{5}}{\cancel{10}_2} = 2.5\ V$$

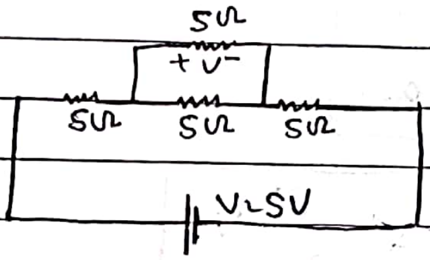
Que find v





$\left(\frac{R_1}{R_1+R_2}\right)V = \frac{5}{\cancel{10}} \times \cancel{10} = 5\Omega$

Que find v



$V = \left(\frac{2.5}{12.5}\right) \times 5$

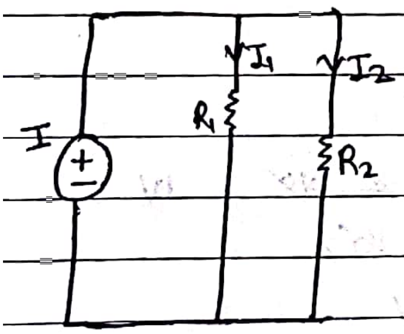
$V = 1V$

- Current divider rule :- across the R_1 & R_2 in parallel voltage R_1 & R_2 is same

$V_1 = V_2 = V_T$

$\boxed{V_T = R_{eq} I}$

$\boxed{V_T = \left(\frac{R_1R_2}{R_1+R_2}\right) I}$



$V = I_1R_1$

$\left(\frac{R_1R_2}{R_1+R_2}\right) I = I_1R_1$

$\boxed{I_1 = \left(\frac{R_2}{R_1+R_2}\right) I}$

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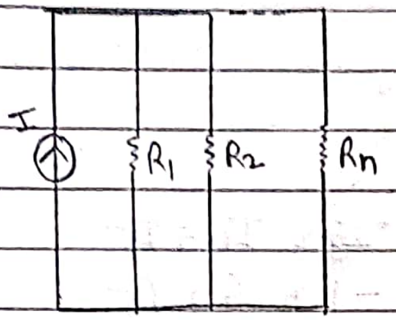
$$V_2 = I_2 R_2$$

$$\left(\frac{R_1 R_2}{R_1+R_2}\right) I = I_2 R_2$$

$$\boxed{I_2 = \left(\frac{R_1}{R_1+R_2}\right) I}$$

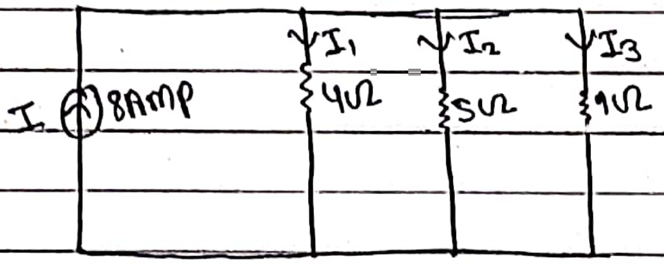


When more then two Register are conected in parallel then current devider rule is apply as.

$$\boxed{I_1 = \left(\frac{1/R_1}{1/R_1+1/R_2}\right) I}$$

$$\boxed{I_n = \left(\frac{1/R_n}{1/R_1+1/R_2+\cdots 1/R_n}\right) I}$$

Que



find I_1, I_2, I_3

$$I_1 = \left(\frac{1/4}{1/4+1/5+1}\right) \times 8$$

$$= \left(\frac{1/4}{\frac{5+4+20}{20}}\right) \times 8$$

$$= \frac{1/4}{\frac{29}{205}} \times 8 = \frac{40}{29}$$

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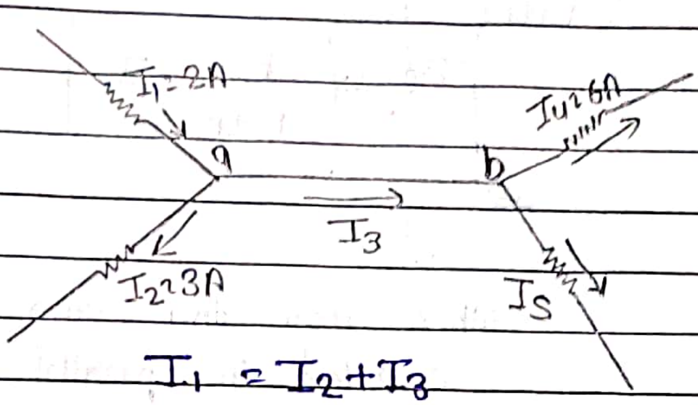
Determined the magnitude and correct direction of the current I_3 & I_5 for a network?



$I_1 = I_2 + I_3$

$2 - 3 = I_3$

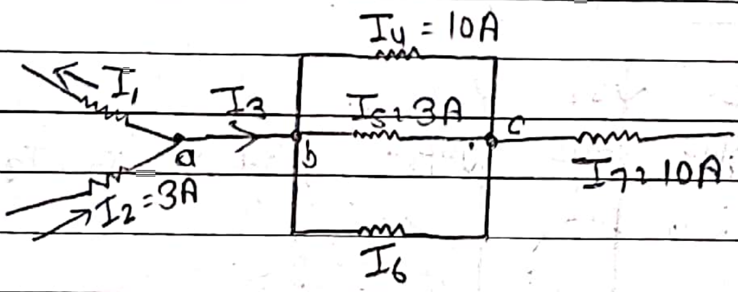
$I_3 = -1A$

$I_3 = I_4 + I_5$

$-1 = 6 + I_5$

$I_5 = -7A$

Find the magnitude of the unknown current for the circuit?



$I_1 = I_2 + I_3$

$I_3 = I_5 + I_4 + I_6$

$I_4 + I_5 + I_6 = I_7$

$10 + 3 + I_6 = 10$

$I_6 = -3A$

$I_3 = \cancel{3} + 10A - \cancel{3A}$

$I_3 = 10A$

$I_1 = 3 + 10$

$I = 13\ A$

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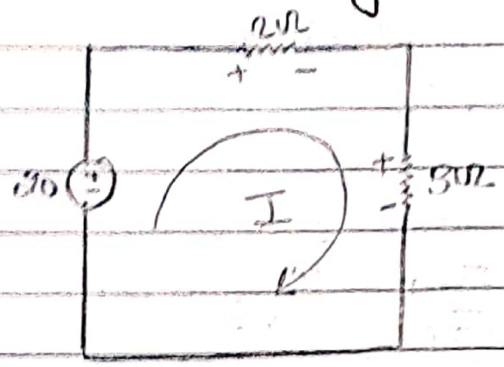
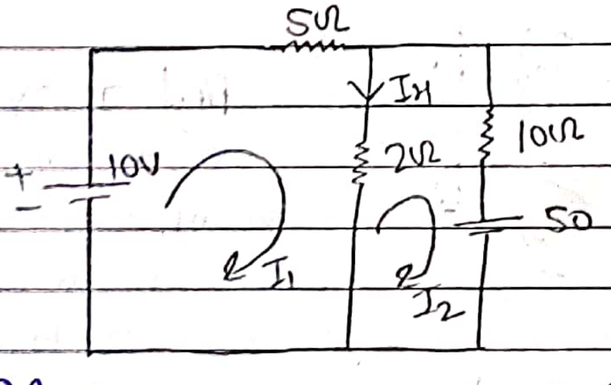
Que. For the circuit in figure find voltage V_1 & V_2 ?



$$20 - IR_1 + IR_2 = 0$$
$$20 = -2I + 3I$$
$$20 = 2I$$
$$I = 10A$$
$$V_1 = \left(\frac{R_1}{R_1+R_2}\right) I$$
$$V_1 = \left(\frac{2}{5}\right) \times 10^{2} = 4V$$

Imp

*- Mesh anylasis :-



KVL in ① loop

$$10 = 5I_1 + 2(I_1 - I_2)$$
$$10 = 5I_1 + 2I_1 - 2I_2$$
$$10 = 7I_1 - 2I_2 \quad (i)$$

KVL in ② loop

$$-50 = 2(I_2 - I_1) + 10I_2$$
$$-50 = 2I_2 - 2I_1 + 10I_2$$
$$-50 = 12I_2 - 2I_1 \quad (ii)$$

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Solve the eqn (1) & (2)

$(10 = 7I_1 - 2I_2) \times 6$

$60 = 42I_1 - 12I_2$

$50 = 12I_2 - 2I_1$

$10 = 40I_1$

$\boxed{I_1 = \frac{10}{40} = 0.25 A}$

Put the value of I in eqn (1)

$10 = 7 \times 0.25 - 2I_2$

$10 = 1.75 - 2I_2$

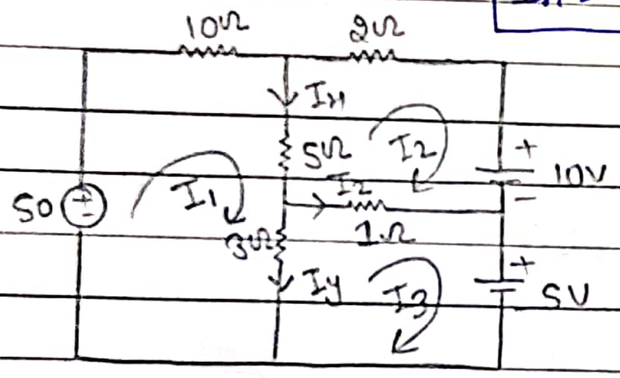
$I_2 = -\left(\frac{10 - 1.75}{2}\right)$

$\boxed{I_2 = -4.125 A}$

$I_H = I_1 - I_2$

$I_H = 0.25 + 4.125$

$\boxed{I_H = 4.375 A}$



find I_x, I_y & I_2

KVL in loop (1)

$50 - 10I_1 - 5(I_1 - I_2) - 3(I_2 - I_3) = 0$

$50 = 10I_1 + 5I_2 - 5I_2 + 5I_2 - 3I_3$

$50 = 10I_1 + 8I_2 - 3I_3$ — (1)

KVL in loop (2)

$-10 = 1(I_2 - I_3) + 5(I_2 - I_1) + 2I_2$

$-10 = 1I_2 - 1I_3 + 5I_2 - 5I_1 + 2I_2$

$-10 = 8I_2 - I_3 - 5I_1$ (11)

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Date..................

KVL in loop ③

$-5 = 3(I_3 - I_1) + 1(I_3 - I_2)$

$-5 = 3I_3 + I_3 - I_2 + 3I_1$

$-5 = 4I_3 - I_2 + 3I_1 \quad \text{—(III)}$

$50 = 10I_1 + 8I_2 - 3I_3 \quad \text{—(I)}$

$-10 = 8I_2 - I_3 - 5I_1 \quad \text{—(II)}$

$-5 = 4I_3 - I_2 + 3I_1 \quad \text{—(III)}$

$$D = \begin{bmatrix} 18 & 8 & -3 \\ -5 & 8 & -1 \\ 3 & -1 & 4 \end{bmatrix} = 18(32-1) + 8(-20+3) - 3(5+24)$$

$$= 18(31) + 8(-17) - 3(+19)$$

$$= \cancel{310 + 10} = 356$$

$$D_1 = \begin{vmatrix} 50 & -5 & -3 \\ 10 & -8 & 1 \\ 5 & 1 & -4 \end{vmatrix} = 1175 \qquad D_2 = \begin{vmatrix} 18 & 50 & -3 \\ 5 & 10 & 1 \\ 3 & 5 & -4 \end{vmatrix} = 355$$

$$D_3 = \begin{vmatrix} 18 & -5 & 50 \\ 5 & -8 & 10 \\ 3 & 1 & 5 \end{vmatrix} = 525$$

$I_1 = \frac{D_1}{D} = \frac{1175}{356} = 3.3A$

$I_2 = \frac{D_2}{D} = \frac{355}{356} = 0.99A$

$I_3 = \frac{D_3}{D} = \frac{525}{356} = 1.47A$

$I_x = I_1 - I_2$

$I_x = 3.3 - 0.99$

$I_x = 2.31 \text{ A}$

$I_y = I_1 - I_3$

$= 3.3 - 1.47$

$= 1.83 \text{ A}$

$I_z = I_3 - I_2$

$= 1.47 - 0.99$

$= 0.47 \text{ A}$

Date..................

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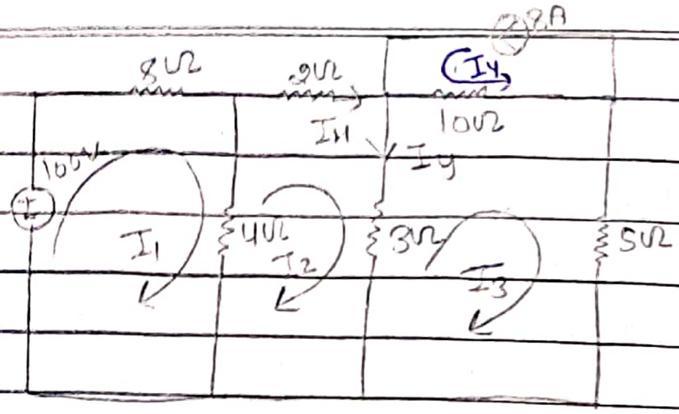

Find I_x & I_y

$$100 = 8I_1 + 4(I_1 - I_2)$$
$$100 = 8I_1 + 4I_1 - 4I_2$$
$$100 = 12I_1 - 4I_2 \quad -(1)$$

Apply KVL in loop (2)

$$0 = 4(I_2 - I_1) + 2I_2 + 3(I_2 - I_3)$$
$$= 4I_2 - 4I_1 + 2I_2 + 3I_2 - 3I_3$$
$$= 9I_2 - 4I_1 - 3I_3 \quad -(ii)$$

Apply KVL in loop (3)

$$0 = 3(I_3 - I_2) + 10(I_3 + I_4) + 5I_3$$
$$= 3I_3 - 3I_2 + 10I_3 + \cancel{10I_4} + 80 + 5I_3$$
$$= 18I_3 + 80 - 3I_2 \quad -(iii)$$

$$100 = 12I_1 - 4I_2 \quad -(1)$$
$$0 = 9I_2 - 4I_1 - 3I_3 \quad -(ii)$$
$$0 = 18I_3 + 80 - 3I_2 \quad -(iii)$$

$$\Delta = \begin{vmatrix} 12 & -4 & 0 \\ -4 & 9 & -3 \\ 0 & -3 & 18 \end{vmatrix} = \begin{matrix} 12(162+9) + 4(-72) \\ 12(153) + 288 \\ 1836 - 288 = 1548 \end{matrix}$$

$$\Delta_1 = \begin{vmatrix} 100 & -4 & 0 \\ 0 & 9 & -3 \\ -80 & -3 & 18 \end{vmatrix} = \begin{matrix} 100(162+9) + 4(-240) \\ 100(171) + 4(-240) \\ 17100 - 960 \\ 14340 \end{matrix}$$

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$$D_2 = \begin{vmatrix} 12 & 100 & 0 \\ -4 & 0 & -3 \\ 0 & -80 & 18 \end{vmatrix} = \begin{matrix} 12(-240) - 100(+72) \\ -2880 - 7120 \\ = 3600 \end{matrix} = 4320$$

$$D_3 = \begin{vmatrix} 12 & -4 & 100 \\ -4 & 9 & 0 \\ 0 & -3 & -80 \end{vmatrix} = \begin{matrix} 12(-720) - 4(-320) + 100(12) \\ -6160 \end{matrix}$$

$$I_1 = \frac{D_1}{D} = \frac{14340}{1548} = 9.26A$$

$$I_2 = \frac{D_2}{D} = \frac{4340}{1548} = 2.79A$$

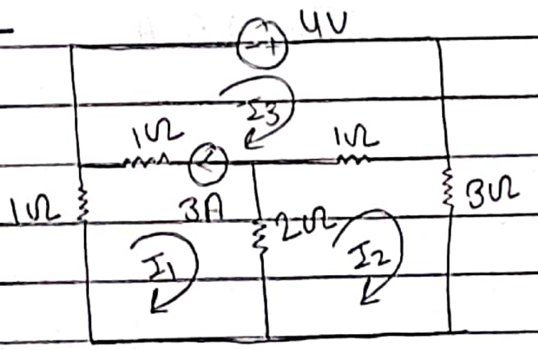
$$I_3 = \frac{-6160}{1548} = -3.97\ A$$

$I_x = I_2 = 2.79A$

$I_y = I_2 - I_3$

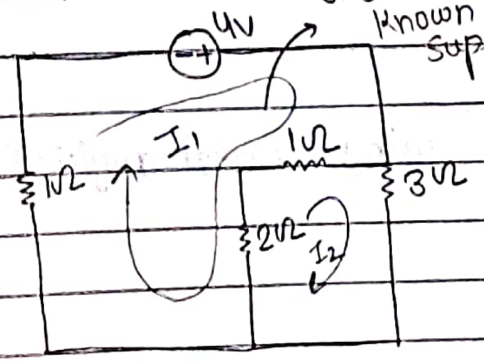
$= 6.76\ A$

* Super mesh :-



Find current in loop ?

this mesh is known as super mesh



$3 = I_3 - I_1$ (1)

Apply in KVL in Sper mesh

$4 = 9(I_1 - I_2) + 2(I_1 - I_2) + I_1$

$4 = I_1 - I_2 + 2I_1 - 2I_2 + I_1$

$4 = 4I_1 - 3I_2$

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Apply KVL in loop 2

$0 = 2(I_2 - I_1) + 1(I_2 - I_1) + 3I_2)$

$= 2I_2 - 2I_1 + I_2 - I_1 + 3I_2$

$0 = 6I_2 - 3I_1 = $

$4 = 4I_1 - 3I_2 \times 2$

$8 = 8I_1 - 6\cancel{I_2}$

$0 = 6\cancel{I_2} - 3I_1$

$8 = 5I_1$

$I_1 = \frac{8}{5} = 1.6\ A$

$6I_2 - 3I_1 = 0$

$6 \times I_2 = 3 \times \frac{8}{5}$

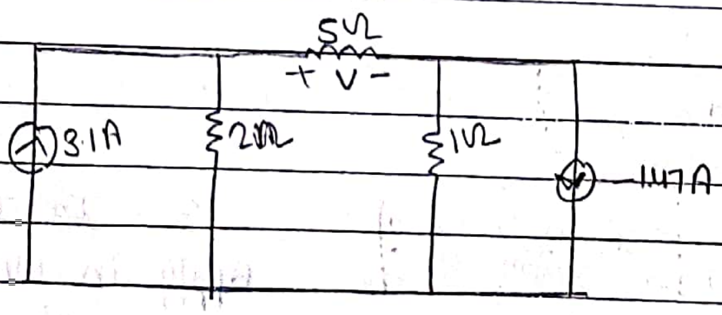
$I_2 = \frac{\cancel{3} \times \cancel{8}^{4}}{\cancel{6}_{3} \times 5} = 0.8A$

$3 = I_3 - I_1$

$I_3 = 3 + 1.6$

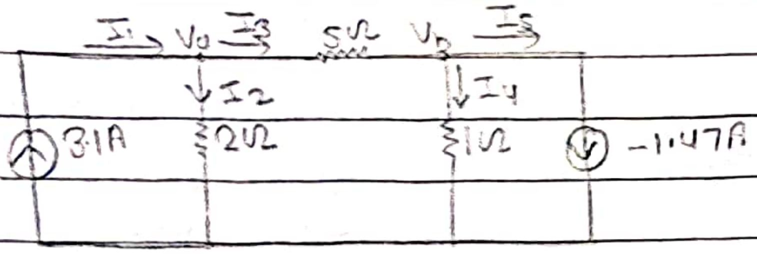
$I_3 = 4.6\ A.$

* Nodel Anylasis :-



find v using nodel anylsis?

Date..................



Apply Kcl at Node a

$I_1 = I_2 + I_3$

$31 = \frac{V_a}{2} + \frac{V_a - V_b}{5}$

$3.1 = \frac{5V_a + 2V_a - 2V_b}{10}$

$31 = 7V_a - 2V_b$ —(I)

Apply Kcl at Node b

$I_3 = I_4 + I_5$

$\frac{V_a - V_b}{5} = V_b + 1.47$

$\frac{V_a - V_b - V_b}{5} = 1.4$

$V_a - 6V_b = 7$ —(II)

$31 = 7V_a - 2V_b$

$49 = -7V_a + 42V_b$

$80 = 40V_b$

$V_b = 2V$

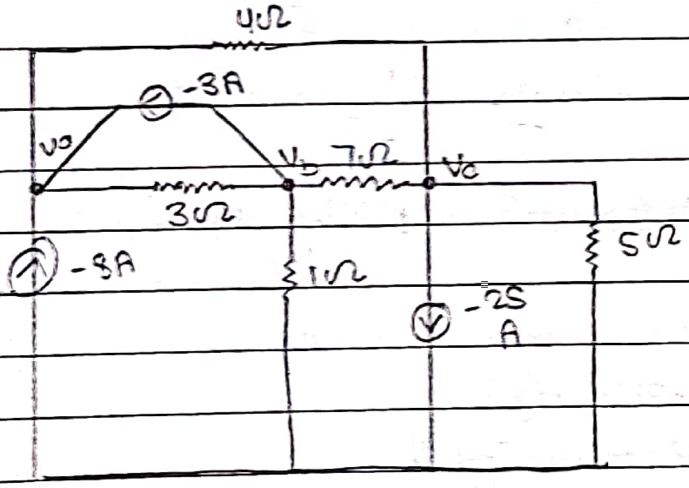
$-7 = V_a - 6 \times 2$

$V_a = 5V$

$V = V_a - V_b$

$V = 5 - 2 = 3V$

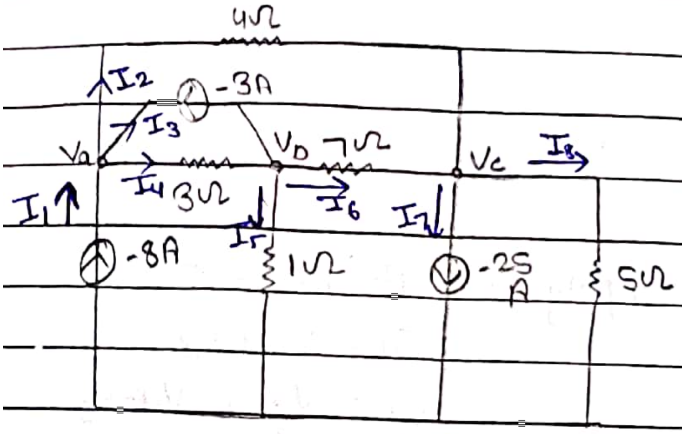
Q.



find V_a, V_b & V_c

Spiral

Date..................



Apply Kcl at node a

$I_1 = I_2 + I_3 + I_4$

$-8 = \frac{V_a - V_c}{4} + 3 + \frac{V_a - V_b}{3}$

$-8 \times 12 = 3V_a - 3V_c + 36 + 4V_a - 4V_b$

$-8 \times 12 = 7V_a - 3V_c + 36 - 4V_b$

$-96 - 36 = 7V_a - 3V_c - 4V_b$

$-132 = 7V_a - 3V_c - 4V_b$ — (I)

Apply Kcl at node 'b'

$I_3 + I_4 = I_5 + I_6$

$3 + \frac{V_a - V_b}{3} = V_b + \frac{V_b - V_c}{7}$

$3 = \frac{7V_b + V_b - V_c}{7} + \frac{V_b - V_a}{3}$

$3 = \frac{21V_b + 3V_b - 3V_c + 7V_b - 7V_a}{21}$

$63 = 31V_b - 7V_a - 3V_c$ — (II)

Apply Kcl at node 'c'

$I_2 + I_6 = I_7 + I_8$

$\frac{V_a - V_c}{4} + \frac{V_b - V_c}{7} = -25 + \frac{V_c}{5}$

$\frac{V_a - V_c}{4} + \frac{V_b - V_c}{7} - \frac{V_c}{5} = -25$

$\frac{35V_a - 35V_c + 20V_b - 20V_c + 28V_c}{140} = -25$

$35V_a - 83V_c + 20V_b = -3500$

$-132 = 7V_a - 4V_b - 3V_c$ — (I)

$63 = 31V_b - 7V_a - 3V_c$ — (II)

$-3500 = 35V_a + 20V_b - 83V_c$ — (III)

Spiral

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$$D_2 \begin{vmatrix} 7 & -4 & -3 \\ -7 & 31 & -3 \\ 35 & 20 & -83 \end{vmatrix} = -11172$$

$$D_1 = \begin{vmatrix} -132 & -4 & -3 \\ 63 & 31 & -3 \\ -3500 & 20 & -83 \end{vmatrix} = -60480$$

$$D_2 = \begin{vmatrix} 7 & -4 & -132 \\ -7 & 31 & 63 \\ 35 & 20 & -3500 \end{vmatrix} = -517440$$

$$V_a = \frac{D_1}{D} = \frac{-60480}{-11172} = 5.41V$$

$$V_b = \frac{D_2}{D} = \frac{-86436}{-11172} = 7.73V$$

$$V_c = \frac{D_3}{D} = \frac{-517440}{-11172} = 46.31V$$

* super node :- It is a node which a combination of two nodes known a super node.
when you apply KCL at super node at a time complete network of super node consid a one node entering current of super node equal to out going current of super nod

Spiral

Date..................

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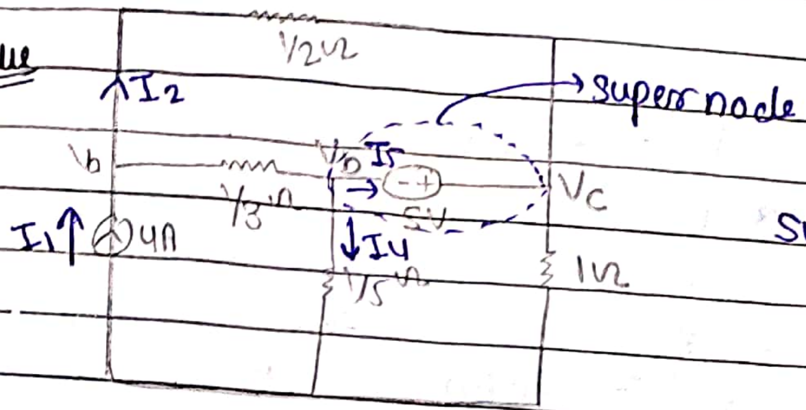


find V_a, V_b, V_c

$5V = V_c - V_b$ —(i)

Apply KCl ~~at~~ super node

$I_2 + I_3 = I_4 + I_5$

$$\left(\frac{V_a - V_c}{1/2}\right) + \left(\frac{V_a - V_b}{1/3}\right) = \frac{V_b}{1/5} + V_c$$

$$2(V_a - V_c) + 3(V_a - V_c) = 5V_a + V_c$$

$$2V_a - 2V_c + 3V_a - 3V_c = 5V_a + V_c$$

$$5V_a - 8V_b - 3V_c = 0 \quad \text{—(ii)}$$

Apply KCl at node a

$I_1 = I_2 + I_3$

$$4 = \left(\frac{V_a - V_c}{1/2}\right) + \left(\frac{V_a - V_b}{1/3}\right)$$

$$4 = 2V_a - 2V_c + 3V_a - 3V_b$$

$$4 = 5V_a - 3V_b - 2V_c \quad \text{—(iii)}$$

$$D = \begin{vmatrix} 0 & -1 & 1 \\ 5 & -8 & -3 \\ 5 & -3 & -2 \end{vmatrix} = 30$$

$$D_1 = \begin{vmatrix} 5 & -1 & 1 \\ 0 & 8 & -3 \\ 4 & -3 & -2 \end{vmatrix} = 79$$

$$D_2 = \begin{vmatrix} 0 & 5 & 1 \\ 5 & 0 & -3 \\ 5 & 4 & -2 \end{vmatrix} = -5$$

$$D_3 = \begin{vmatrix} 0 & -1 & 5 \\ 5 & -8 & 0 \\ 5 & -3 & 4 \end{vmatrix} = 145$$

$V_a = \frac{D_1}{D} = \frac{79}{30} = 2.63$ Volt

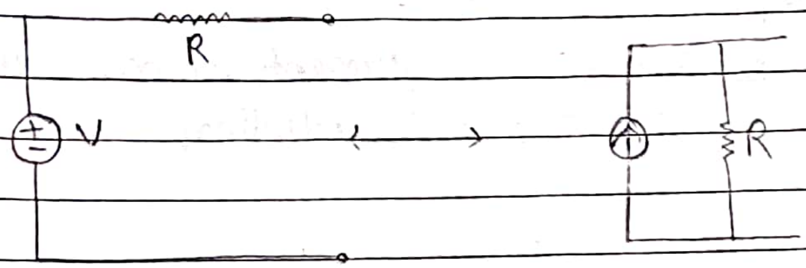
$V_c = \frac{D_3}{D} = \frac{145}{30} = 4.85$ Volt

$V_b = \frac{D_2}{D} = \frac{-5}{-30} = 0.16$ Volt

Spiral

* Source information :-

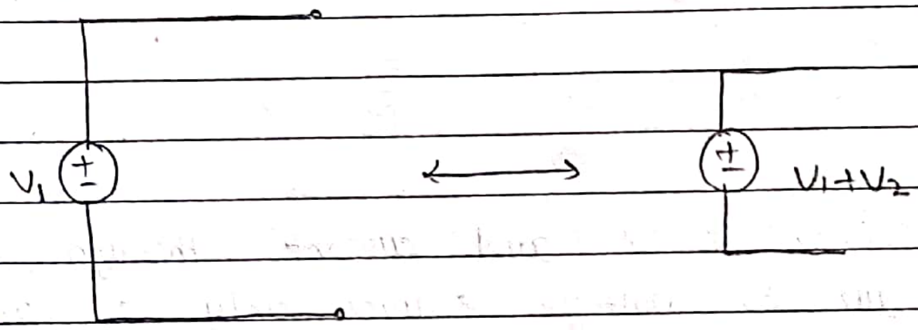
1) Voltage Source to current source :-



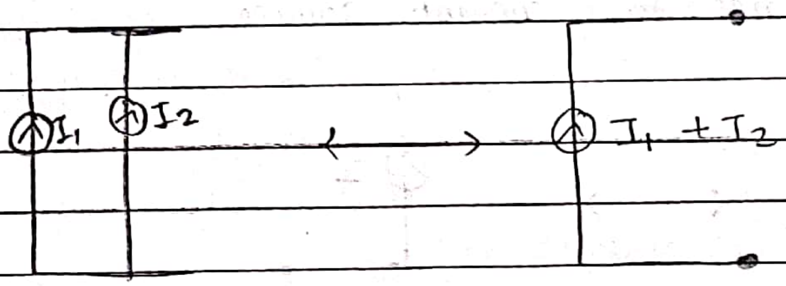
$V = IR$

$I = V/R$

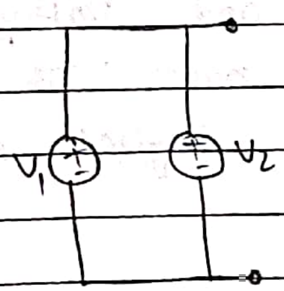
2) Voltage Source in series :-



3) if current source are in parallel :-



4) Voltage Source in parallel :-

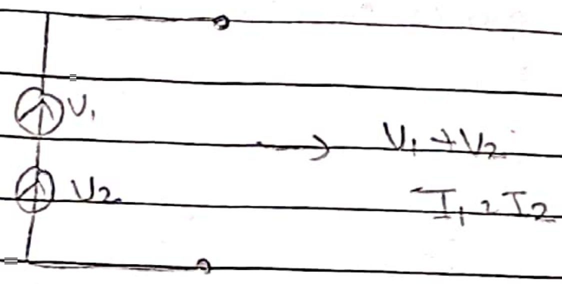


$V_1 = V_2$

Voltage Source will be identical

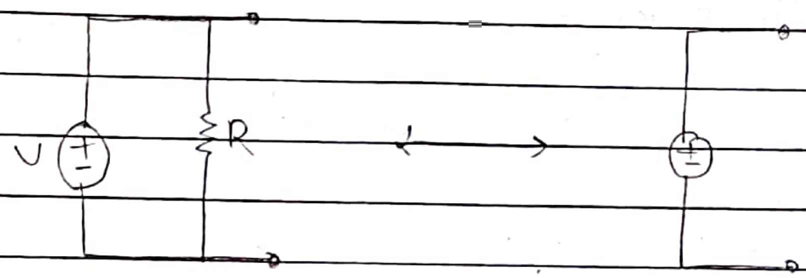
Date..................

⑤ Current source in sereis :-



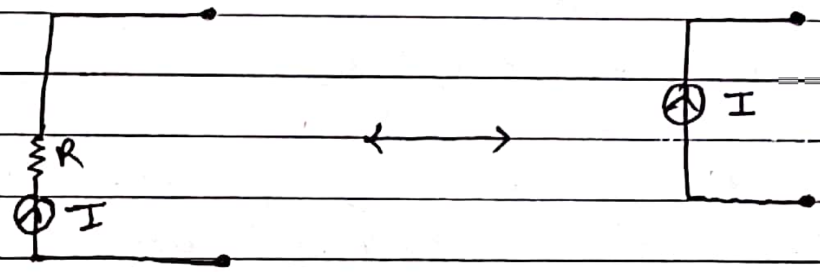
current source will be identical

* Network element parallel in voltage source :-



voltage across are is 'v' and current through register is V/R due to voltege source only so we can neglet register in network.

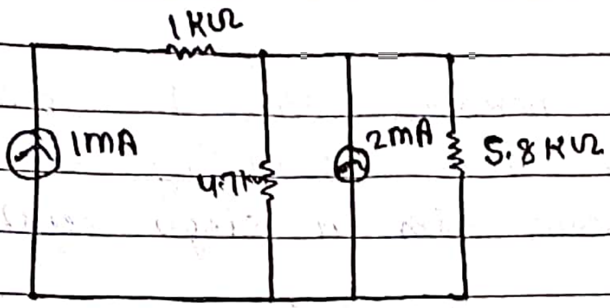
* Network element series to current source



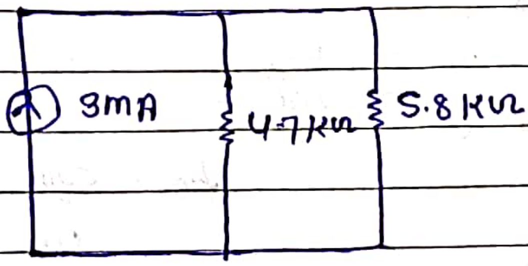
Current across are is 'I' and Voltage across is (V=IR) due to current Source. The resultant electrical network we can neglect the registance.

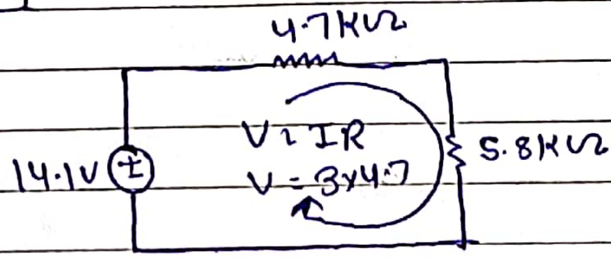
Date.................

4.



find
power dissipation
across 5.8 KΩ





$$14.1 = 4.7\times10^{3} + 5.8\times10^{3}$$

$$I\;\; 14.1 = \frac{1.41}{4.7\times10^{3}+5.8\times10^{3}}$$

$$\boxed{I = 1.34\times10^{-3}\ A}$$

$$P = I^2R$$

$$P = (1.34\times10^{-3})^2 \times 5.8\times10^{3}$$

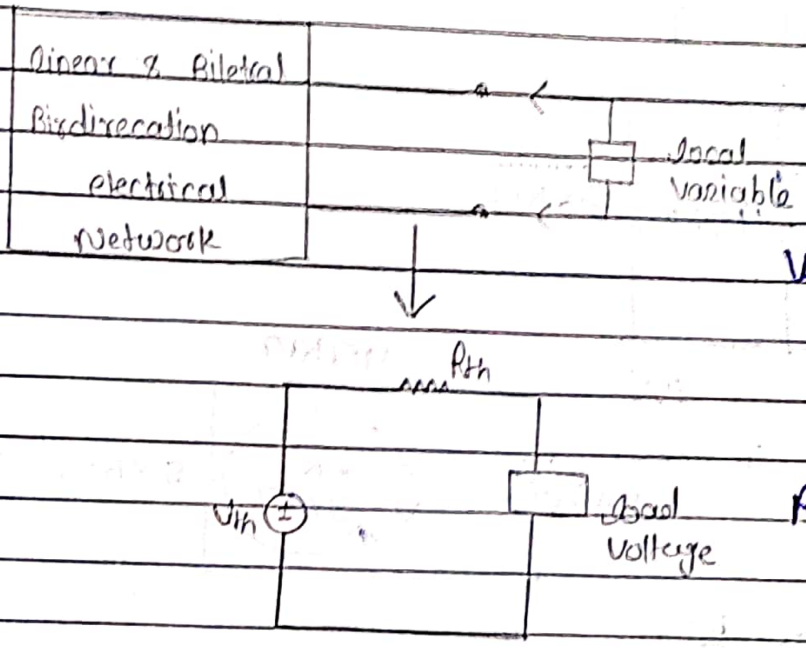
$$\boxed{P = 10.4\times10^{-3}\ W}$$

Date..................

Imp.

- Thevenin's theorem

A linear biletral to terminal network can be reduced to a simplified to terminal circuit consiteting of a single voltage source in serels with a single register.



Vth = equivalent voltage of the ckt or thevenin voltage

Rth = equivalent Registance of ckt or thevenin Regis.

Steps to apply thevnin theoram

Remove (open) the load and find the open circuit voltage at the terminal by any method. this open circuit voltage equal to thevenin voltage.

In the circuit of independent voltage source are short circuit and all independent current source are open circuited and obtain equivalent Registance Rth of the circuit $\boxed{R_{th} = R_{eq}}$

Now replace the linear circuit with it's thevenin equivalent and find voltage and current of the given circuit

Spiral

Date.................

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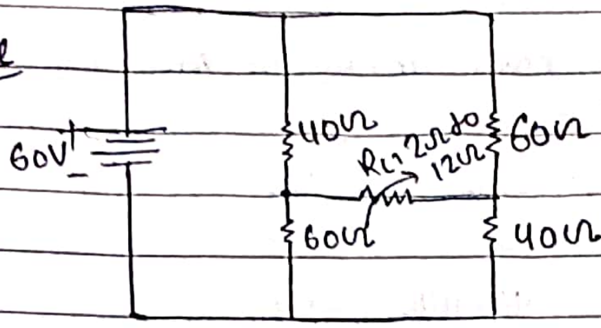


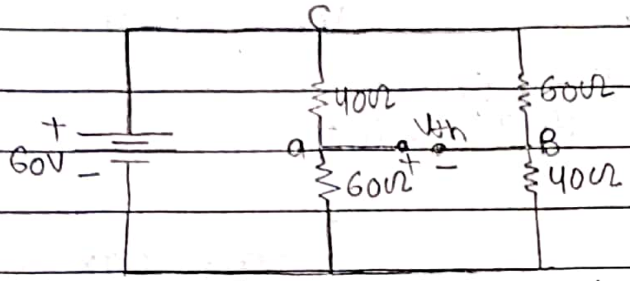
find the range of current R_L using thevenin theoram?

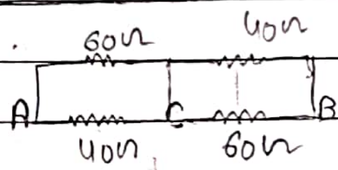
find V_{th}

$V_{th} = V_a - V_b$

$= 60\left(\frac{60}{100}\right) - 6\left(\frac{40}{100}\right)$

$= 12$ Volt



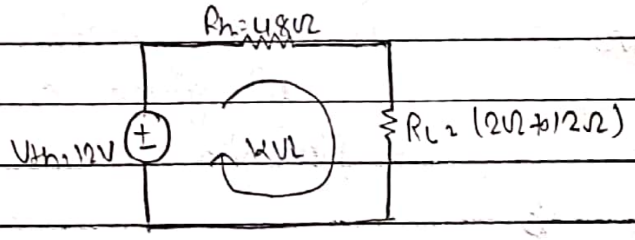


$40 \| 60 + 60 \| 40$

$\frac{60 \times 40}{100} + \frac{60 \times 40}{100}$

$R_{th} = 48\Omega$

thevenin equivalent circuit:



Apply the KVL in ckt

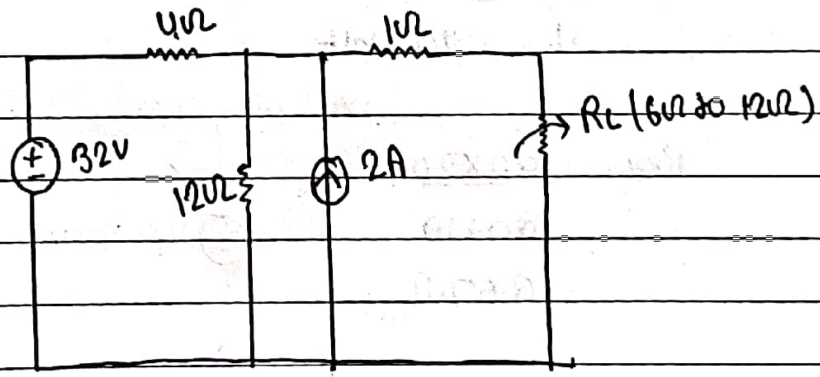
$12 = R_{th} I_L + I_L R_L$

$I_L = \frac{12}{R_{th} + R_L}$

$I_L = \frac{12}{48+2} = 0.24$ Amp

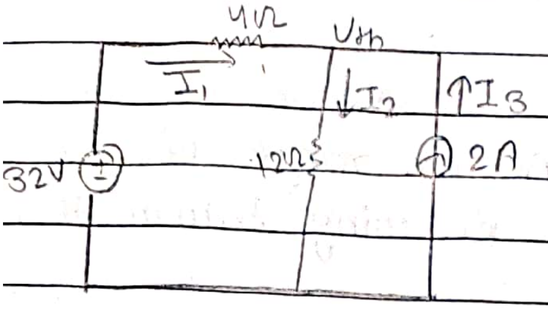
$I_L = \frac{12}{48+12} = \frac{12}{60} = 0.2$ Amp

Que



Find the Range of current in R_L using thevenin?

Date.................



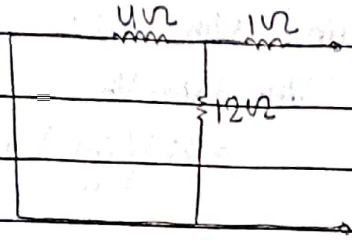
Apply nodel anylsis at node V_{th}

$I_1 + I_3 = I_2$

$\frac{32 - V_{th}}{4} + 2 = \frac{V_{th}}{12}$

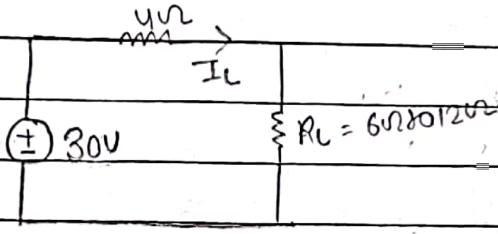
$96 - 4V_{th} = -24$

$V_{th} = 30$ volt



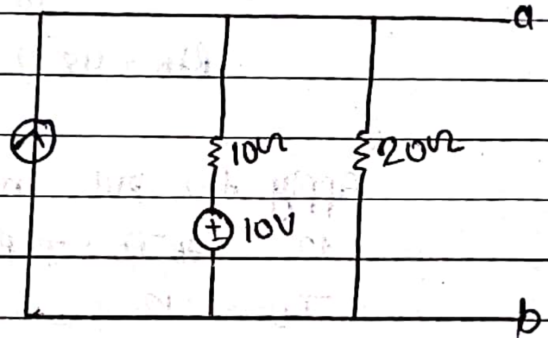
$\frac{4 \times 12}{16} + 1$

$= 4\Omega$



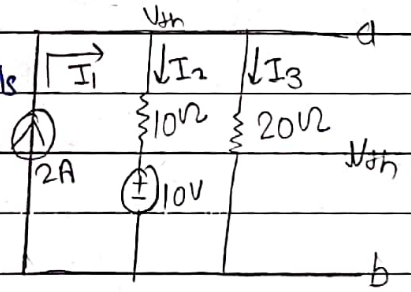
$I_L = \frac{30 \times}{4+6} = 8$ Amp

$I_L = \frac{30}{4+12} = 1.8$ Amp



find the theunin equivalent of given circuit ?

find V_{th}



Apply nodel Anylasis

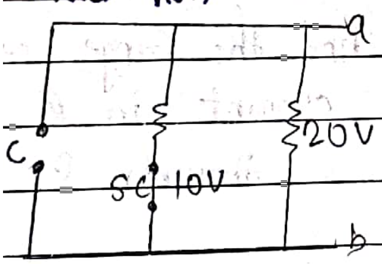
$I_1 = I_2 + I_3$

$2 = \frac{V_{th} - 10}{10} + \frac{V_{th}}{20}$

$2 \times 20 = V_{th} - 20$

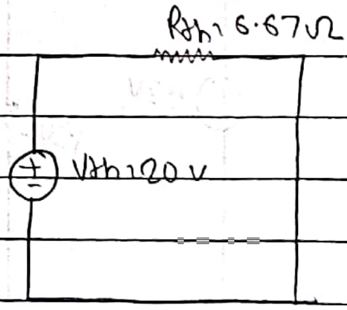
$V_{th} = 20$ Volt

find R_{th}

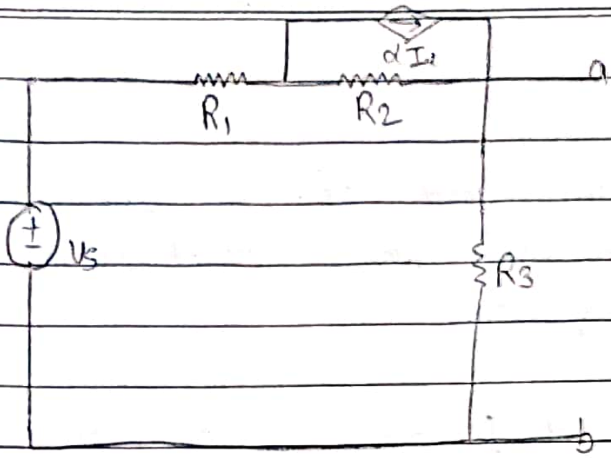


$R_{eq} = \frac{20 \times 20}{20 + 10}$

$= 6.67\Omega$

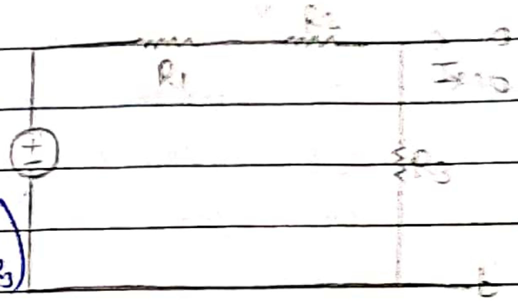


Date..................

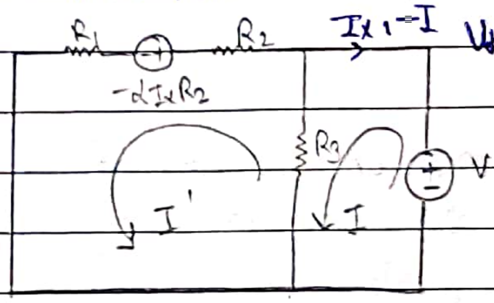


thevenin equivalent Registance ?

find V_{th}



find R_{th}



$V_{th} = V_s\left(\frac{R_3}{R_1+R_2+R_3}\right)$

Apply KVL in loop I'

$-\alpha I_x R_2 = R_1 I' + R_2 I' + R_3(I' - I)$

$-\alpha I_x R_2 = R_1 I' + R_2 I' + R_3 I' - R_3 I$

$-\alpha I_x R_2 = I'(R_1+R_2+R_3) - R_3 I$

$R_3 I + \alpha I R_2 = I'(R_1+R_2+R_3)$

$I(\alpha R_2 + R_3) = I'(R_1+R_2+R_3)$

$I' = \frac{I(\alpha R_2+R_3)}{R_1+R_2+R_3}$ — (ii)

$V = R_3(I' - I)$ — (i)

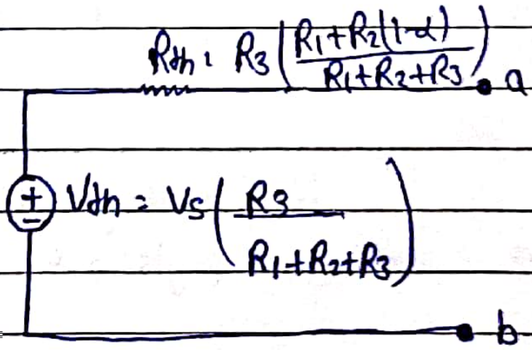
put the value of eqn (i)

$R_3\left(\frac{I(\alpha R_2+R_3)}{R_1+R_2+R_3} - I\right)$

$V = R_3 \times I\left(\frac{1 - \alpha R_2 + R_3}{R_1+R_2+R_3}\right)$

$\frac{V}{I} = R_{th} = R_3\left(\frac{R_1+R_2+\cancel{R_3}-\alpha R_2-\cancel{R_3}}{R_1+R_2+R_3}\right)$

$R_{th} = R_3\left(\frac{R_1+R_2-\alpha R_2}{R_1+R_2+R_3}\right)$



Spiral

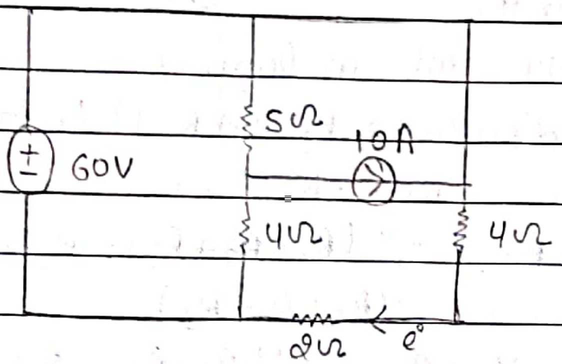
Date..................

Super position theoram →

The total current / voltage in part of a linear circuit equals to the algebric sum of the current / voltage produced by each source sepratelly.

Note :- To evalute the current / voltage replace all other voltage source by short circuit & current source by open circuit.

1

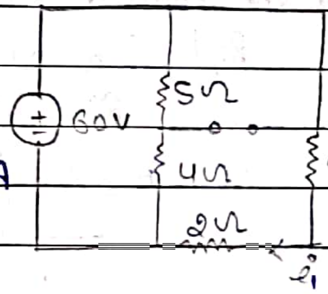


Find the current of 'i' through 2Ω register using super position theoram ↳

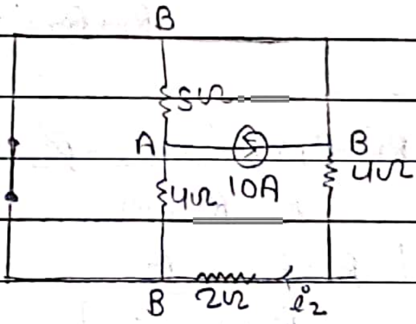
Consider 60 V voltage source.

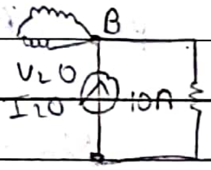
$i_1 = \frac{V}{R}$

$i_1 = \frac{60}{6} = 10A$



Consider 10A current Source



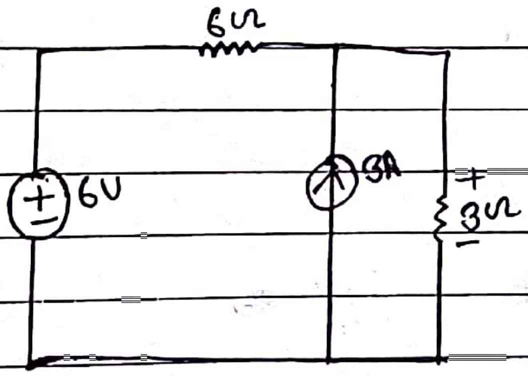


$i = i_1 + i_2$

$i = 10 + 0$

$i = 10A$

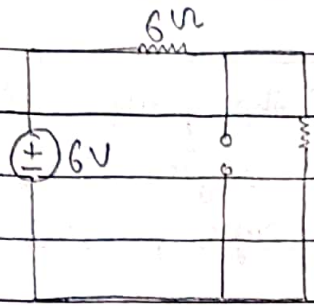
2



Find voltage across 3Ω Register ?

Spiral

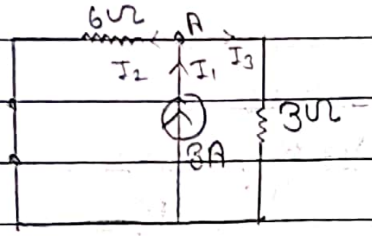
Date.................



Apply voltge divider rule

$V_1 = V\left(\frac{R_1}{R_1+R_2}\right)$

$V_1 = 6\left(\frac{3}{6+3}\right) = 2V$



Consider 3A current source in the ckt.
Apply nodel anylasis.

$I_1 = I_2 + I_3$

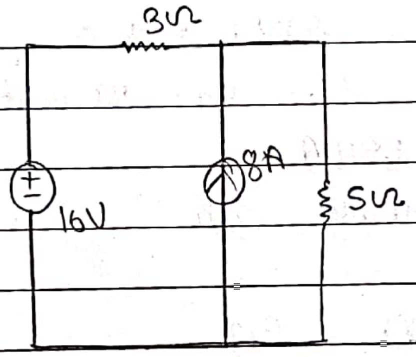
$3 = \frac{V_{out}-0}{6} + \frac{V_{out}-0}{3}$

$3\times 6 = 3\,V_{out}$

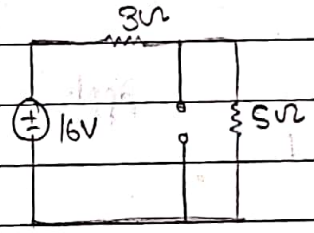
$V_{out} = 6$ Volt

$V_{total} = V_1 + V_2$
$= 2+6$
$= 8$ Volt

Q.4



find Vth

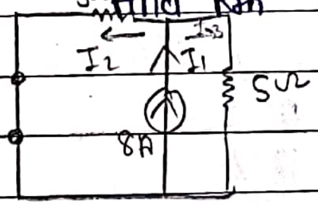


$V_1 = V\left(\frac{R_1}{R_1+R_2}\right)$

$V = \frac{16\times 5}{8}$

$V = 10V$

find Rth



$I_1 = I_2 + I_3$

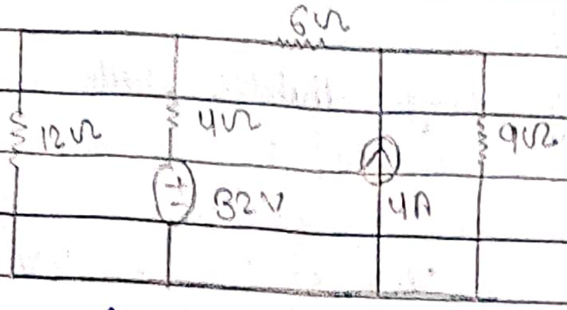
$8 = \frac{V_{out}}{3} + \frac{V_{out}}{5}$

$8\times 15 = 8V$

15 Volt

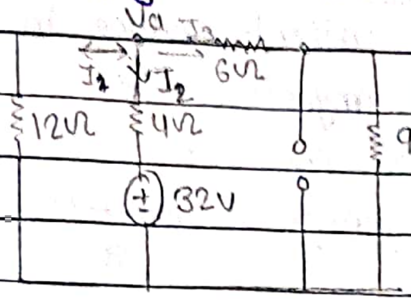
$V_{th} = 15+10$
$= 25$ volt

Date..................



determine the power dispidiate in 9Ω register of circuit using super position theoram

Apply KCl node Va



$I_1 = I_2 + I_3$

$\frac{-Va}{12} = \frac{Va-32}{4} + \frac{Va}{15}$

$\frac{Va-32}{4} + \frac{Va}{15} + \frac{Va}{12} = 0$

$\frac{15Va - 32(15) + 4Va + 5Va}{60} = 0$

apply ohm's law

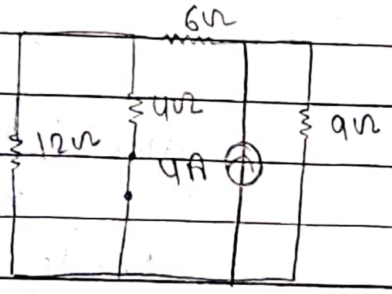
$V = IR$

$\frac{20}{15} = I$

$I = 1.34A$

$24Va = 480$

$Va = 20$ volt

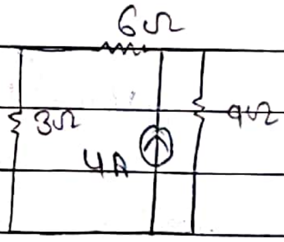


Apply current divider rule

12||4

$\frac{12 \times 4}{16} = 3Ω$

$I = I_1\left(\frac{R_2}{R_1+R_2}\right)$



$I = 4\left(\frac{3}{18}\right)$

$= 2A$

$P = I^2R$

$P = \frac{20}{15} \times \frac{20}{15} \times 9$

$I = I_1 + I_2$

$= 1.34 + 2$

$= 3.34$

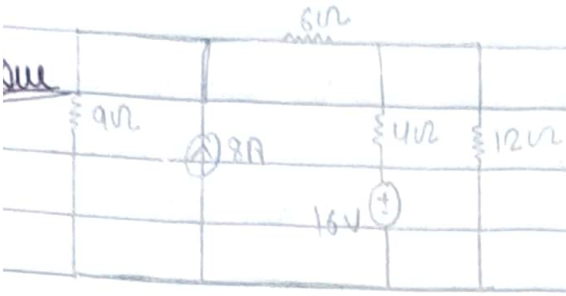
$P = (3.34)^2 \times 9$

$= 100$ watt

Spiral

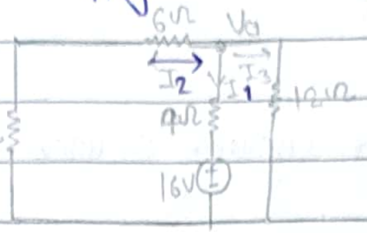
Date..................

Que



Determine the power in registance 9 Ω.

Apply nodal anylasis Va



$I_1 = I_2 + I_3$

$\frac{Va-16}{4} = \frac{-V}{15} + \frac{-V}{12}$

$\frac{Va-16}{4} + \frac{V}{15} + \frac{V}{12} = 0$

$\frac{15Va - 15(16) + \cancel{4}Va + 5V}{60} = 0$

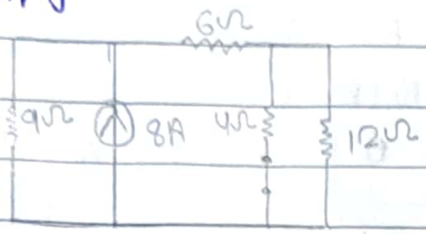
$\cancel{4}Va = 240$

$V = 10V$

$V = IR$

$\frac{10}{15} = I$

Apply current divider



$I = I_1 \left(\frac{R_2}{R_1+R_2} \right)$

$I = 8 \left(\frac{9}{18} \right)$

$I_1 = 4$ Amp.

$I_t = I_1 + I_2$

$I_t = \frac{10}{15} + 4$

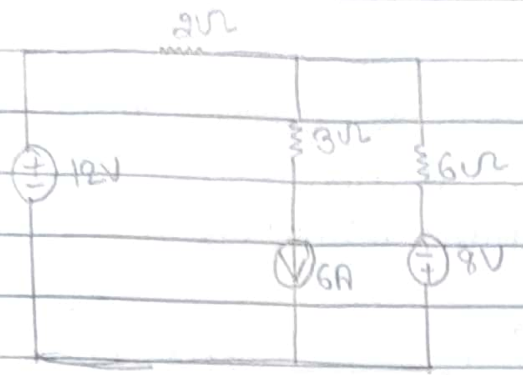
$I_{total} = \frac{70}{15}$ Amp

$P = I^2 R$

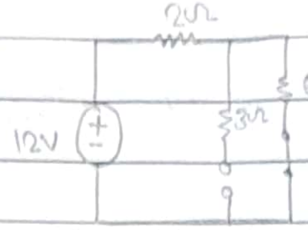
$P = \frac{\cancel{70}^{14}}{\cancel{15}_{3}} \times \frac{\cancel{70}^{14}}{\cancel{15}_{3}} \times \cancel{9}^{3} = 196$ watt

Que Using super position theoram find current in 2Ω register shown in figure. when the polarities of voltege source are reversed. what is the value of current across 2Ω register?

Date..................



Conisder 12 V Voltage Source

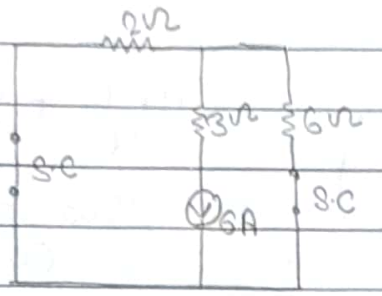


$V = IR$

$\frac{12}{8} = I$

$I = 1.5$

Consider 6A current Source

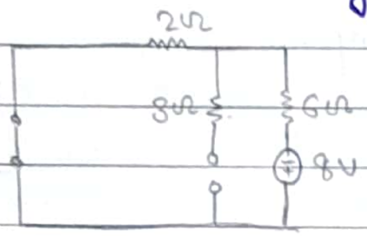


$I = I_1 \left(\frac{R_2}{R_1 + R_2} \right)$

$\cancel{I = 8^3 \left(\frac{6}{8} \right)} = I = 6 \left(\frac{6}{8} \right)$

$I = \frac{9}{2} = \text{Amp}$

Consider 8V Voltage Source



$V = IR$

$\frac{8}{8} = I$

$I = 1A$

$I_t = I_1 + I_2 + I_3$

$= 1.5 + 4.5 + 1$

$= 7$ Amp

if voltage source are reversed

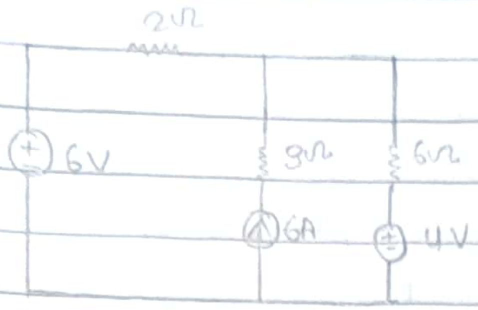
$1.5 + 4.5 - 1$

$= 5$ Amp.

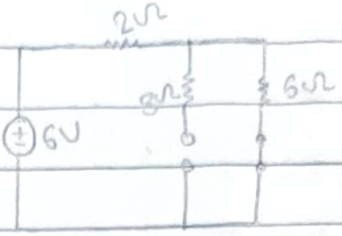
Que Using super position to find current 2Ω resister in the shown in figure. When the polarities voltage source are reverse what in the value of current across 2Ω resister ?

Spiral

Date....................



Consider 6V voltage source.

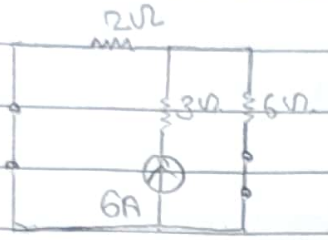


$V = IR$

$\frac{6}{8} = I$

$I = \frac{3}{4}$ A.

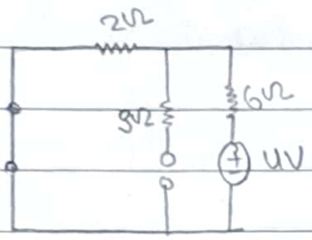
Consider 6A current source



$$I = I_1\left(\frac{R_2}{R_1+R_2}\right)$$

$$= 6\left(\frac{6}{11}\right) = \frac{36}{11} \text{ Amp.}$$

Consider 4V voltage source.



$V = IR$

$\frac{4}{8} = I$

$I = \frac{1}{2}$ Amp.

$$I_{total} = I_1 + I_2 + I_3$$

$$= \frac{3}{4} + \frac{36}{11} + \frac{1}{2}$$

$$I_t = \frac{33+144+22}{44} = \frac{199}{44} = 4.52$$

If voltage source are reverse

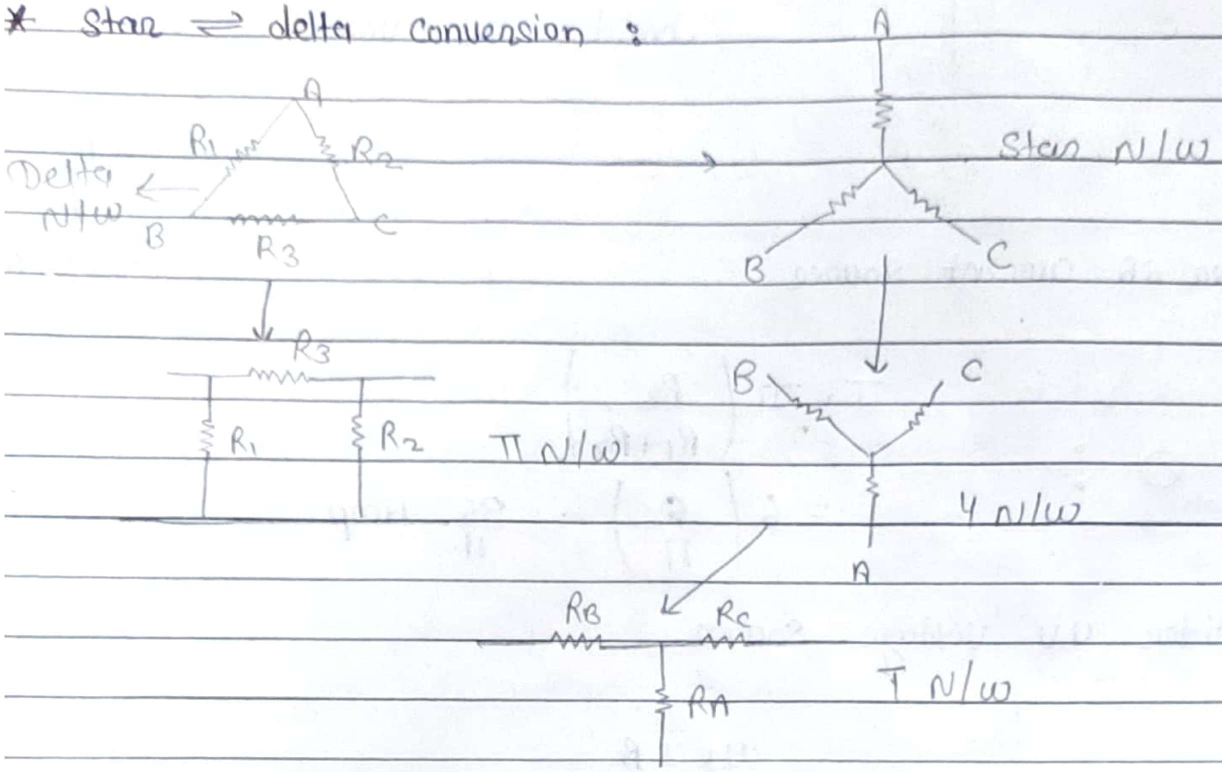
$$I_t = \frac{3}{4} + \frac{36}{11} - \frac{1}{2}$$

$$= \frac{33+144-22}{44}$$

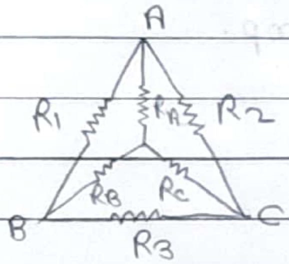
$$= \frac{155}{44} \text{ Amp.}$$

Date.................

* Star ⇌ delta conversion :



Delta → star



$$R_A = \frac{R_1 R_2}{R_1+R_2+R_3} \qquad R_B = \frac{R_1 R_3}{R_1+R_2+R_3}$$

$$R_C = \frac{R_2 R_3}{R_1+R_2+R_3}$$

Proof :

let us asume A, B, C are connected not any N/w

$$R_{AB\Delta} = R_1 \| (R_2+R_3)$$

$$= \frac{R_1(R_2+R_3)}{R_1+R_2+R_3}$$

$$= \frac{R_1R_2 + R_2R_3}{R_1+R_2+R_3}$$

$$R_{ABY} = R_A + R_B = \frac{R_1R_2 + R_2R_3}{R_1+R_2+R_3} \quad \text{—(1)}$$

Spiral

Date.................

$$R_{AC\Delta} = R_2 \| (R_1+R_3)$$
$$= \frac{R_2(R_1+R_3)}{R_1+R_2+R_3}$$

$$R_{ACY} = R_A + R_C = \frac{R_1R_2 + R_2R_3}{R_1+R_2+R_3} \quad \text{—(ii)}$$

$$R_{BC\Delta} = R_3 \| (R_2+R_3)$$
$$= \frac{R_3(R_2+R_1)}{R_1+R_2+R_3}$$

$$R_{BCY} = R_B + R_C = \frac{R_3R_2 + R_1R_3}{R_1+R_2+R_3} \quad \text{—(iii)}$$

Add equation ① + ② + ③

$$\cancel{2}(R_A + R_B + R_C) = \cancel{2}\left(\frac{R_1R_2 + R_2R_3 + R_1R_3}{R_1+R_2+R_3}\right)$$

$$R_A + R_B + R_C = \frac{R_1R_2 + R_2R_3 + R_1R_3}{R_1+R_2+R_3}$$

Subtract ④ - ①

$$\boxed{R_C = \frac{R_1R_3}{R_1+R_2+R_3}}$$

Subtract ④ - ②

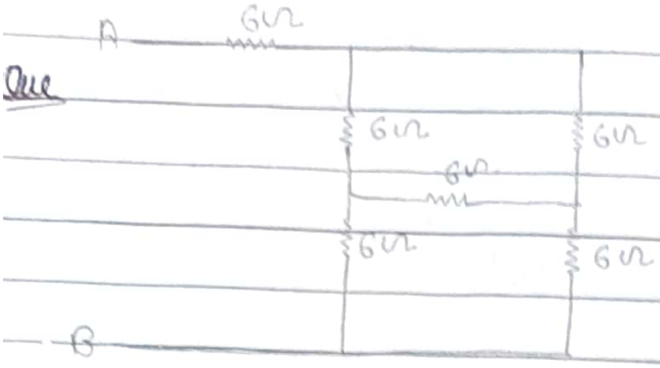
$$\boxed{R_B = \frac{R_2R_3}{R_1+R_2+R_3}}$$

subtract ④ - ③

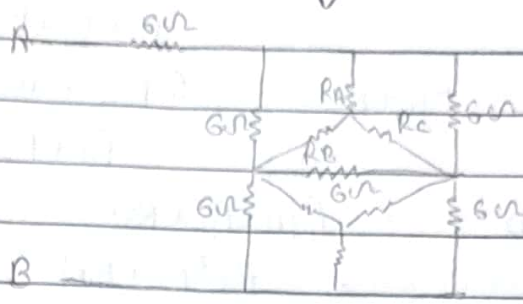
$$\boxed{R_A = \frac{R_1R_2}{R_1+R_2+R_3}}$$

Date.................

Que

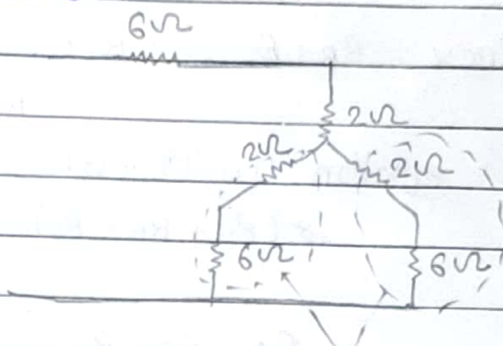


Find the R_{eq} in terminal A & B of given circuit.

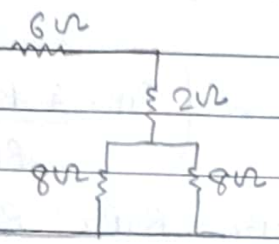


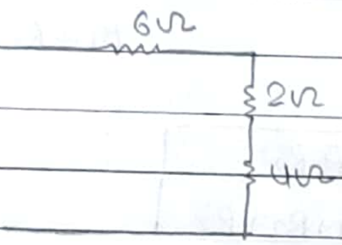
$R_A = R_B = R_C$

$= \frac{6 \times 6}{6+6+6} = 2\,\Omega$



Series

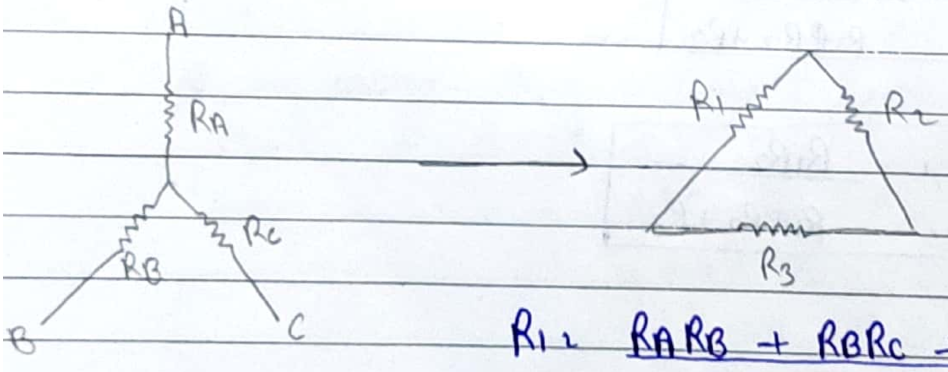




$6+2+4$

$R_{eq} = 12\,\Omega$

Star to Delta Conversion



$$R_1 = \frac{R_A R_B + R_B R_C + R_A R_C}{R_C}$$

$$R_2 = \frac{R_A R_B + R_B R_C + R_A R_C}{R_B}$$

Date..................

$$R_3 = \frac{R_A R_B + R_B R_C + R_A R_C}{R_A}$$

Proof :

We know that value of R_A, R_B, R_C $\Delta \rightarrow Y$

$$R_A = \frac{R_1 R_2}{R_1 + R_2 + R_3} \quad \text{—(iii)}$$

$$R_B = \frac{R_1 R_3}{R_1 + R_2 + R_3} \quad \text{—(ii)}$$

$$R_C = \frac{R_2 R_3}{R_1 + R_2 + R_3} \quad \text{—(i)}$$

multiply eqn (3) and (2)

$$R_A R_B = \frac{R_1^2 R_2 R_3}{(R_1 + R_2 + R_3)^2} \quad \text{—(A)}$$

multiply eqn (3) and (1)

$$R_A R_C = \frac{R_1 R_2^2 R_3}{(R_1 + R_2 + R_3)^2} \quad \text{—(B)}$$

multiply eqn (1) and (2)

$$R_B R_C = \frac{R_1 R_2 R_3^2}{(R_1 + R_2 + R_3)^2} \quad \text{—(C)}$$

Add (1) + (2) + (3)

$$R_A R_B + R_A R_C + R_B R_C = \frac{R_1^2 R_2 R_3 + R_1 R_2^2 R_3 + R_1 R_2 R_3^2}{(R_1 + R_2 + R_3)^2}$$

$$= \frac{\cancel{(R_1 + R_2 + R_3)} R_1 R_2 R_3}{(R_1 + R_2 + R_3)^{\cancel{2}}}$$

$$= \frac{R_1 R_2 R_3}{R_1 + R_2 + R_3} \quad \text{—(D)}$$

Put the value of (1) into D

$$R_A R_B + R_A R_C + R_B R_C = R_1 R_C$$

$$\boxed{R_1 = \frac{R_A R_B + R_B R_C + R_A R_C}{R_C}}$$

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Date.................

Put the value of eqn (2) into (D)

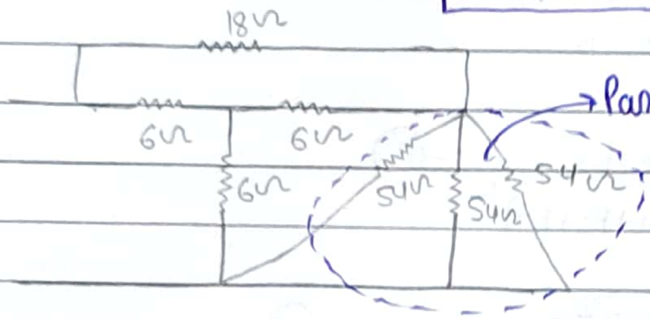
$$R_AR_B + R_BR_C + R_AR_C = R_2R_B$$

$$\boxed{R_2 = \frac{R_AR_B + R_BR_C + R_AR_C}{R_B}}$$

Put the value of eqn (3) into (D)

$$R_AR_B + R_BR_C + R_AR_C = R_3R_A$$

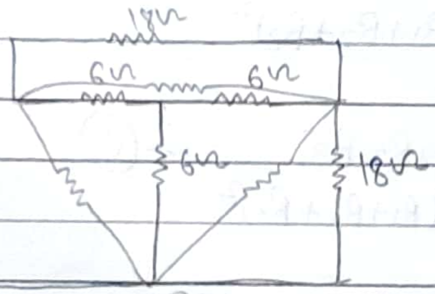
$$\boxed{R_3 = \frac{R_AR_B + R_BR_C + R_AR_C}{R_A}}$$



find the req of given circuit

$$\frac{1}{R} = \frac{1}{54} + \frac{1}{54} + \frac{1}{54}$$

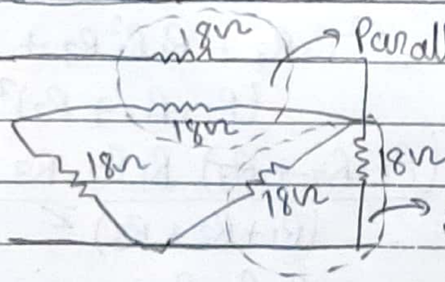
$$R = 18\Omega$$

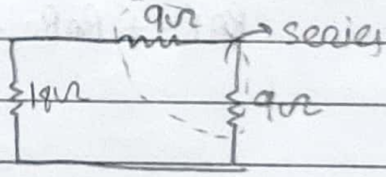


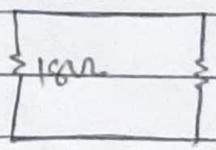
$$R_1 = \frac{R_AR_B + R_BR_C + R_AR_C}{R_C}$$

$$= 18\Omega$$

$$R_1 = R_2 = R_3 = 18\Omega$$



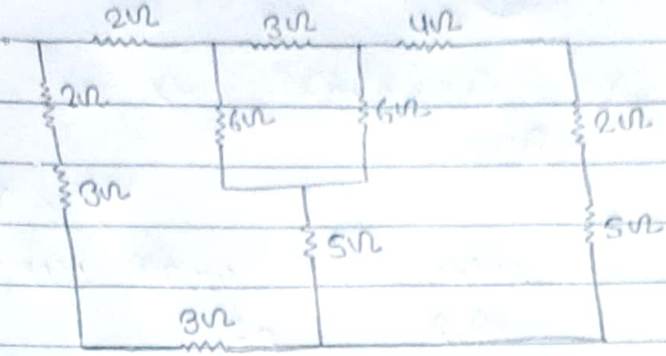




$$\frac{18 \times 18}{18 + 18}$$

$$R_{eq} = 9\Omega$$

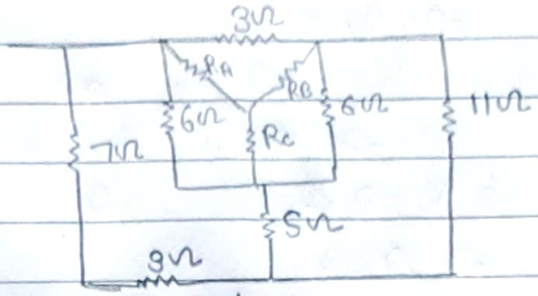
Date..................



find Req.

$R_{eq} = 4+2+5$
$= 11\,\Omega$

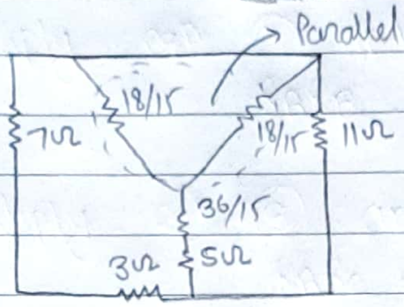
$R_{eq} = 2+2+3$
$= 7\,\Omega$

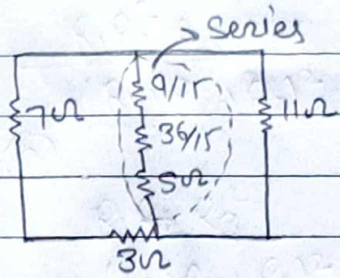


$R_A = \frac{6\times3}{15} = \frac{18}{15}$

$R_B = \frac{6\times6}{15} = \frac{36}{15}$

$R_C = \frac{6\times3}{15} = \frac{18}{15}$

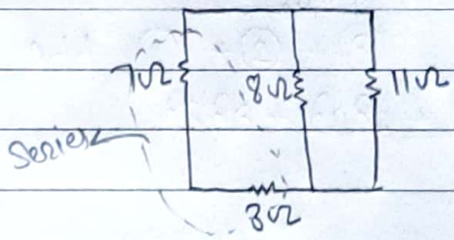


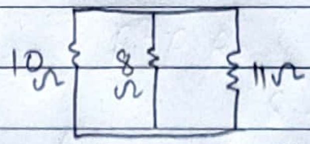


$\frac{9}{15} + \frac{36}{15} + 5$

$\frac{9+36+75}{15} = \frac{\cancel{120}^{\cancel{24}\,8}}{\cancel{15}_{3}}$

=





$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

$\frac{1}{R_{eq}} = \frac{1}{10} + \frac{1}{8} + \frac{1}{11} = \frac{44+55+40}{440}$

$R_{eq} = \frac{440}{139} = 3.6\,\Omega$

Spiral