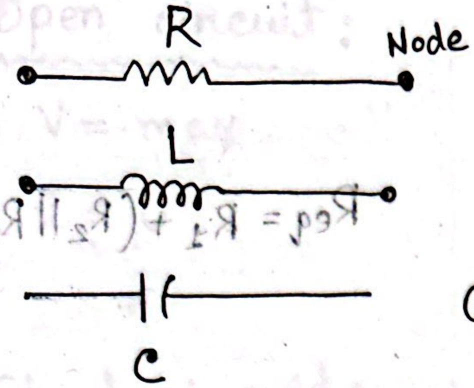
01 July 2024

Passive elements:



Resistance

Inductor

Capacitor

Ohm's Law:

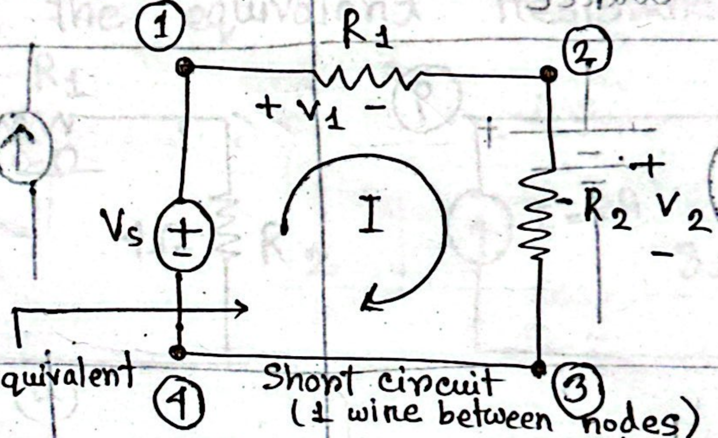
$I = \frac{V}{R}$; $R = \frac{V}{I}$; $V = IR$

Circuit:

(i) Series

(ii) Parallel

V_s = Voltage source

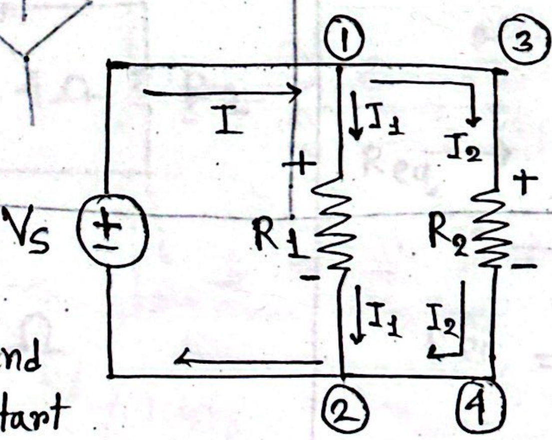


$R_{equivalent} = R_1 + R_2$

1st node end = second node start

(S) Series circuit

(Both are close loop circle)



$V = V_1 = V_2$

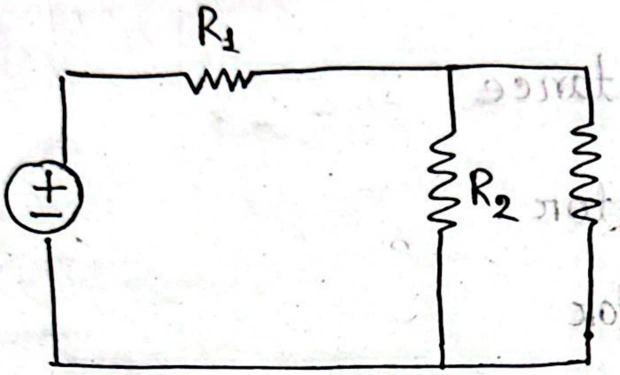
∴ Equivalent Resistance ($R_{equivalent}$)

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

1st node end = 2nd end

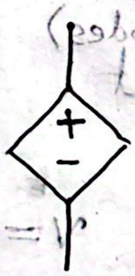
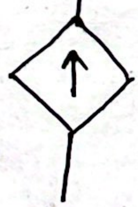
2nd node start = 1st start

(P) Parallel circuit



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

S-P (Series- Parallel)

	Voltage Source	Current Source
Independent :		
Dependent :		

Open circuit:

$V = max$

$I = 0$

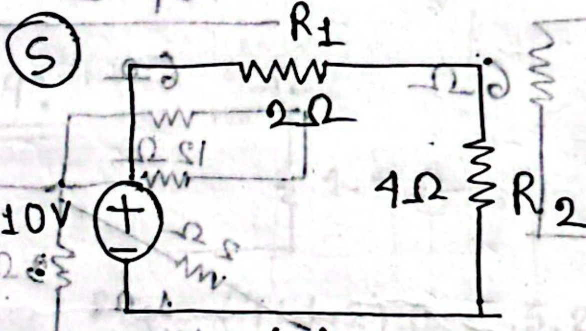
Short circuit:

$I = max$

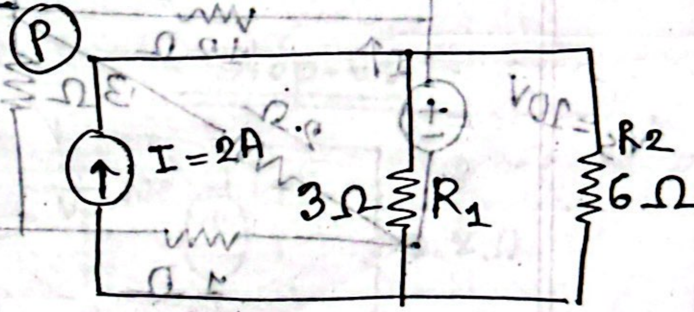
$V = 0$

	Series	Parallel
V	Divided voltage	Same voltage
I	Same current	Divided current

Determine the equivalent resistance

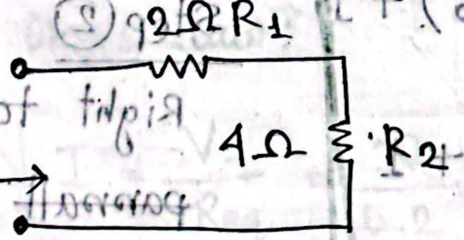


(a)

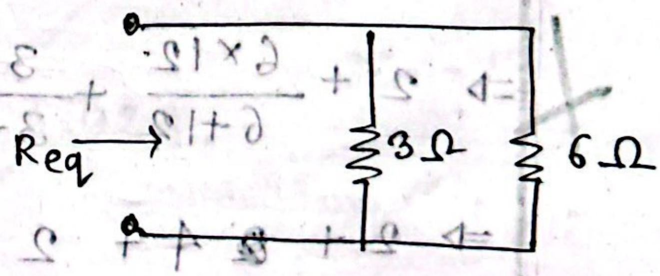


(b)

Soln:

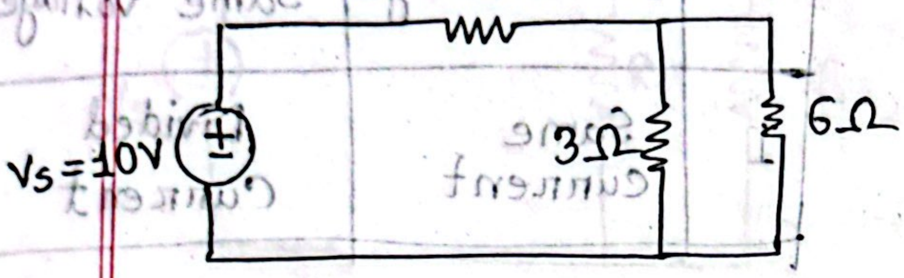


$$R_{eq} = R_1 + R_2$$
$$= (2+4)\,\Omega$$
$$= 6\,\Omega$$



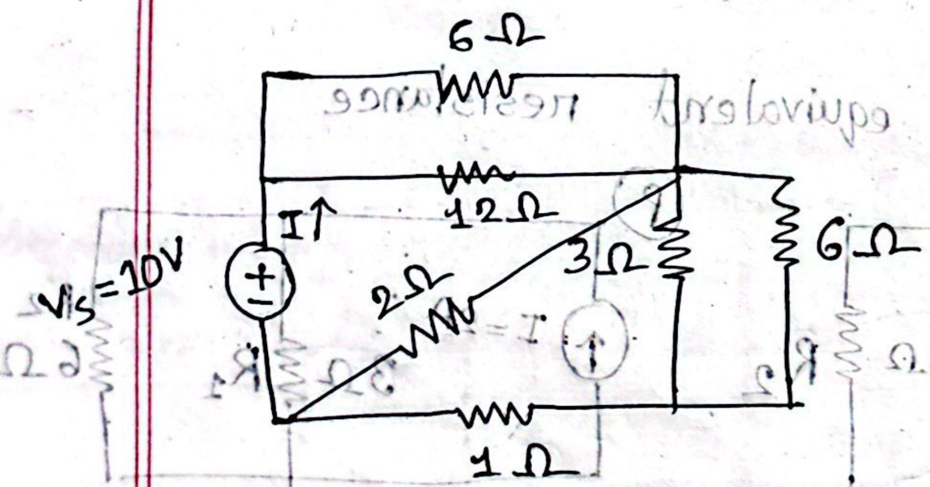
$$R_{eq} = \frac{3 \times 6}{3+6}\,\Omega$$
$$= 2\,\Omega$$

Find Req:

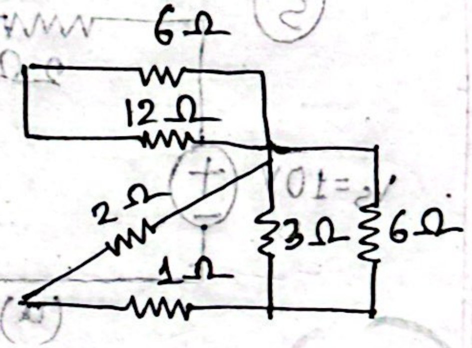


$$R_{eq} = [2 + (3 \| 6)]\,\Omega$$
$$= \left[2 + \frac{3 \times 6}{3+6}\right]\Omega$$
$$= (2+2)\,\Omega$$
$$= 4\,\Omega$$

Determine the equivalent resistance. and current



Step 1



$$2 + (6 \| 12) + (3 \| 6) + 1$$
$$\Rightarrow 2 + \frac{6 \times 12}{6+12} + \frac{3 \times 6}{3+6} + 1$$
$$\Rightarrow 2 + 4 + 2 + 1$$
$$\Rightarrow 9\,\Omega$$

Step 2

Right to left ~~parrall~~ solve parallel

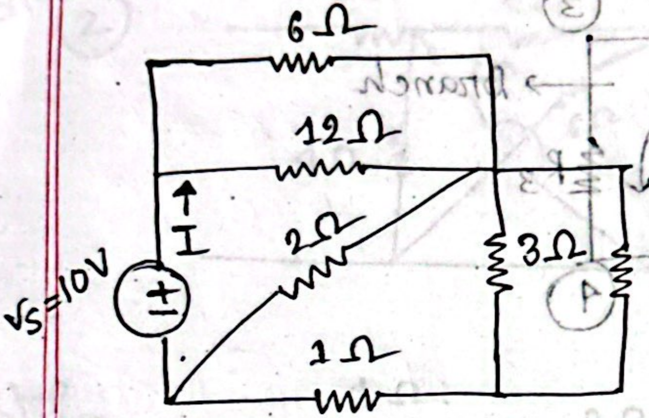
Step 3

Wrong Answer

Step 1 # source খুলবো

Step 2 # Vs left → right হলে circuit right to left solve

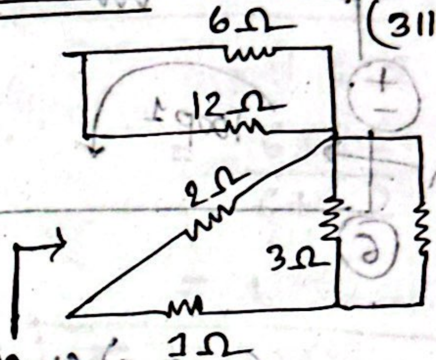
Solution :



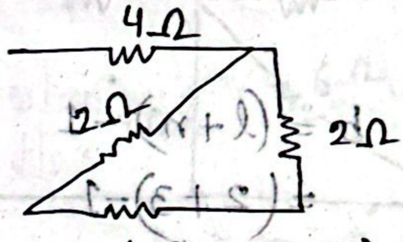
Step 1:

$(6 \| 12)\Omega = 4\Omega$

$(3 \| 6) = 2\Omega$

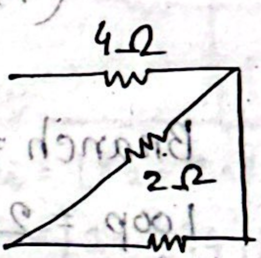


Step 2:



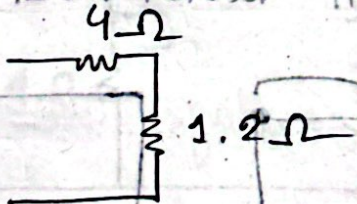
$(2+1) = 3\Omega$

Step 3:



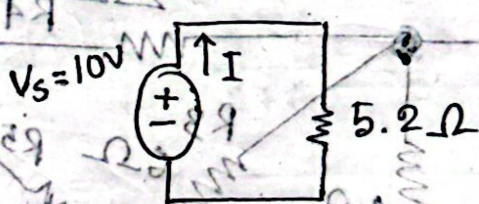
$(2 \| 3)\Omega = 1.2\Omega$

Step 4:



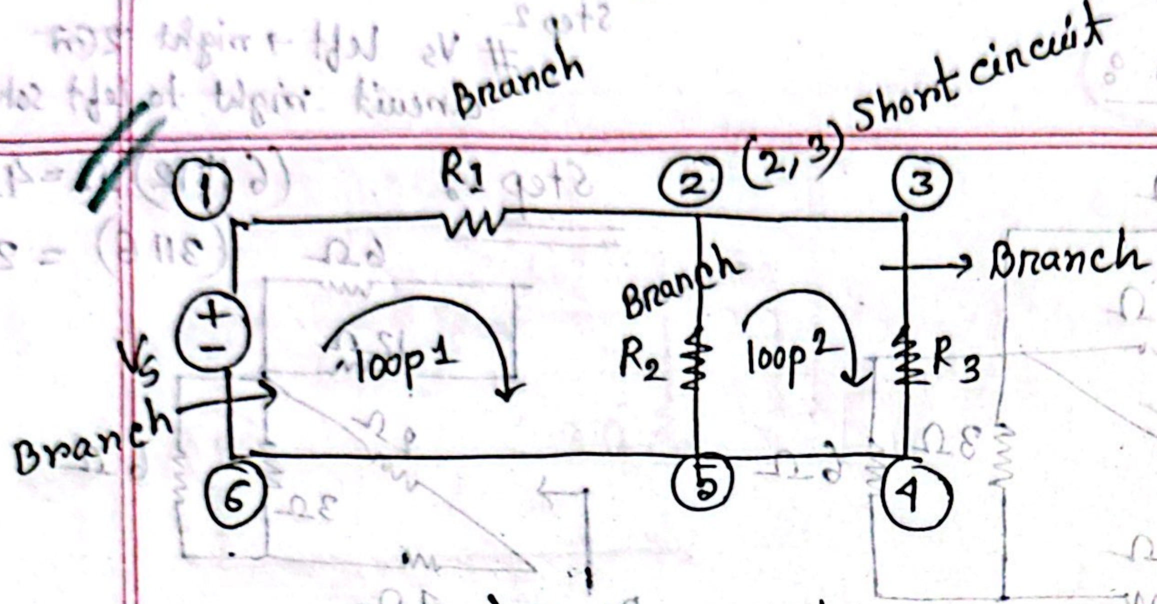
$R_{eq} = (4+1.2)\Omega = 5.2\Omega$

Step-6:



Using Ohm's law:

$$I = \frac{V_s}{R_{eq}} = \frac{10}{5.2} = 1.92A.$$



(4,5,6) Short circuit

Branch = 4 = b

Loop = 2 = l

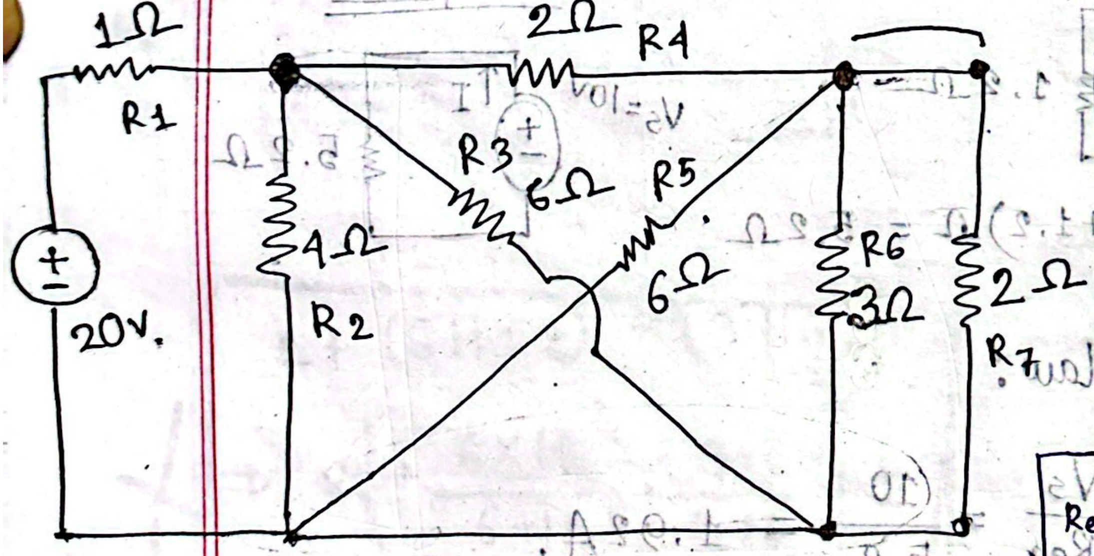
Node = 3 = n

$b = (l+n)-1$

$= (2+3)-1$

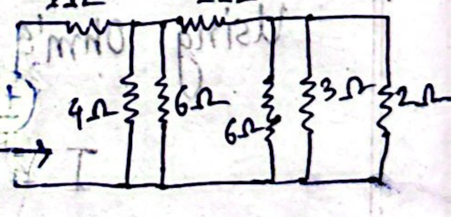
$= 4$

Determine the equivalent resistance.



Step1

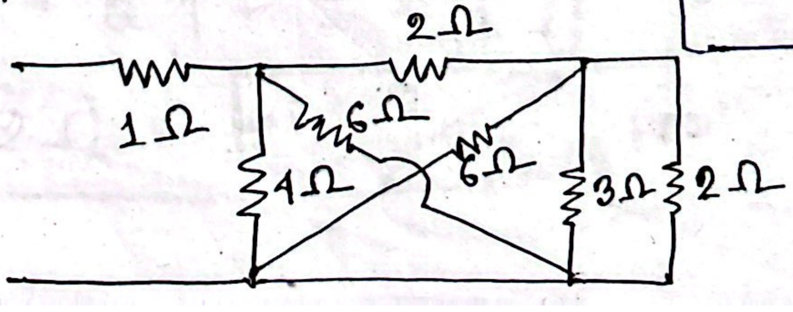
Soln: open source



$4 \| 6 = 2.4\Omega$

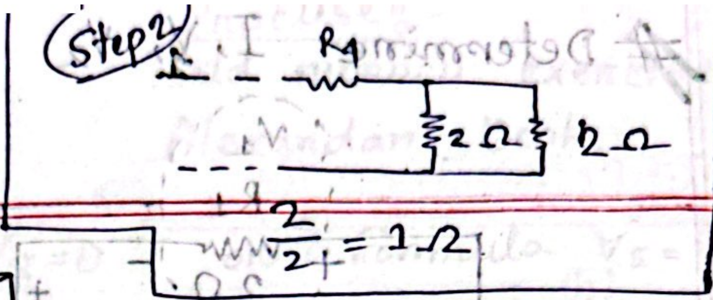
$3 \| 6 = 2\Omega$

Step 1: Open Source

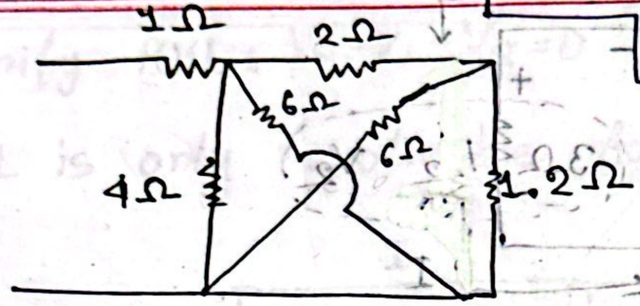


$\therefore 3 \| 2$

$= \frac{3 \times 2}{3+2} = 1.2$



Step 2

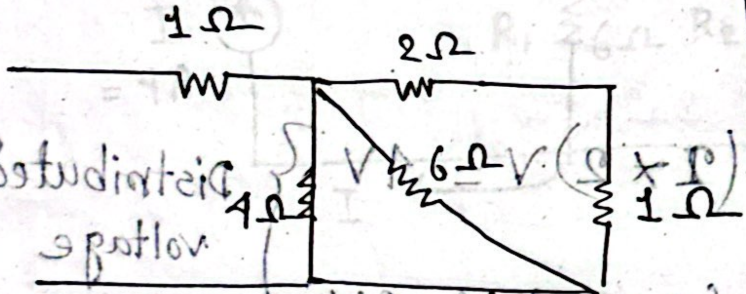


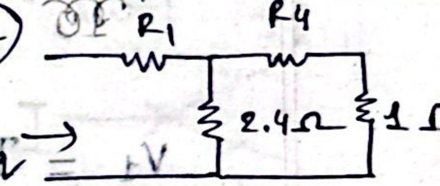
$6 \parallel 1.2$

$= \frac{6 \times 1.2}{6 + 1.2}$

$= 1$

Step 3



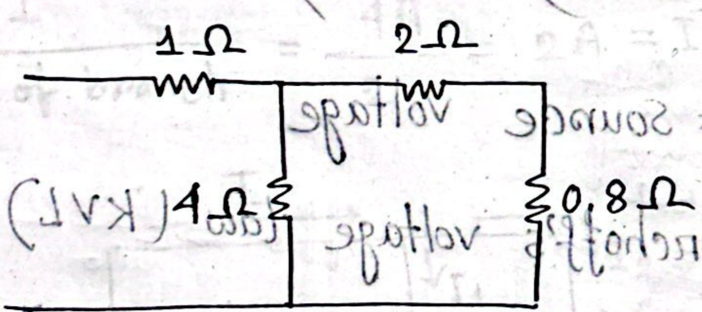


$Req = [R_1 + 2.4 \parallel (R_4 + 1\Omega)]$

$= [1 + 2.4 \parallel (2+1)]\ \Omega$

$= 1 + 2.4 \parallel 3 = 2.33$

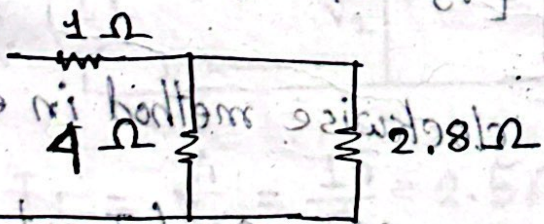
Step 4



$1 \parallel 6$

$= \frac{1 \times 6}{1 + 6} = 0.8\ \Omega$

Step 5



$1 + (4 \parallel 2.8)$

$1 + \frac{4 \times 2.8}{4 + 2.8} = 1.79\ \Omega$

$\approx 1.8\ \Omega$

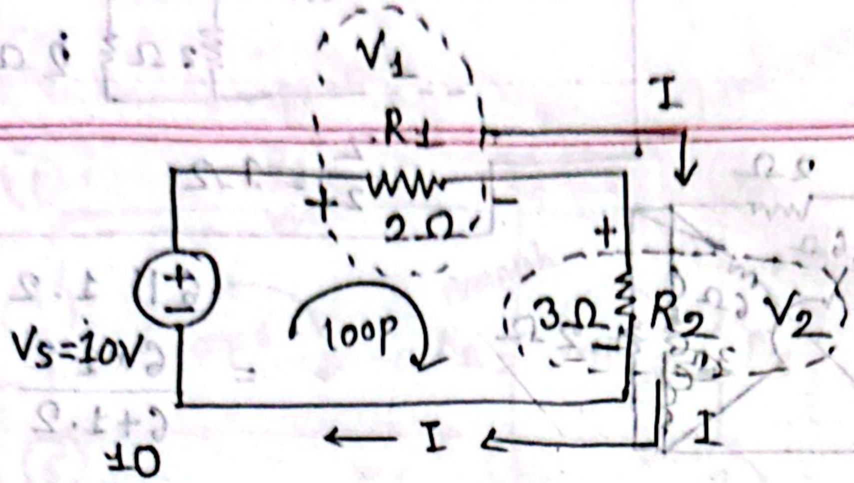
Wrong Answer.

Parallel

* যদি Resistance value সমান হলে যদি series parallel হয় তাহলে R value কে no. Branch value দিয়ে ভাগ দেওয়া যায়।

সেই parallel series এর

Determine I, V_1, V_2



$$I = \frac{10}{2+3} = 2A$$

$V_1 = IR_1 = (2 \times 2)V = 4V$
$V_2 = IR_2 = (2 \times 3)V = 6V$
} Distributed voltage

$V_s = 4 + 6 = 10V$ = Source voltage

This is called Kirchoff's voltage law (KVL)

$$\sum_{n=1}^{N} V_n = 0 \qquad [V_s - V_1 - V_2 \ldots = 0]$$

To find KVL : use clockwise method in each and every loop.

Applying KVL ; $-V_s + V_1 + V_2 = 0$ (Input wise)

$V_s - V_1 - V_2 = 0$ (output wise)

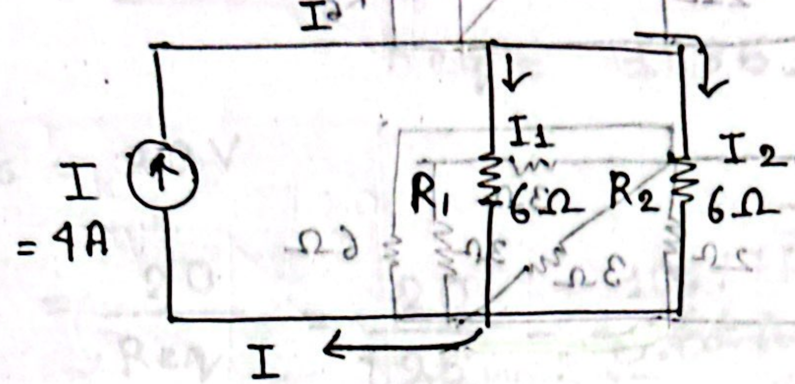
$\Rightarrow 10 - 4 - 6 = 0.$

OR $\Rightarrow -V_s + IR_1 + IR_2 = 0$

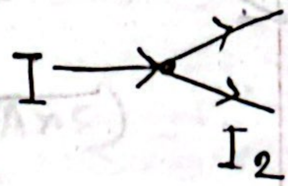
Practise:-
odd number exercise
Alexandar Book

To Verify KVL : $V_s - V_1 - V_2 = 0$ or Formula $V_s = V_1 + V_2$

* KVL is only applicable for series circuit.



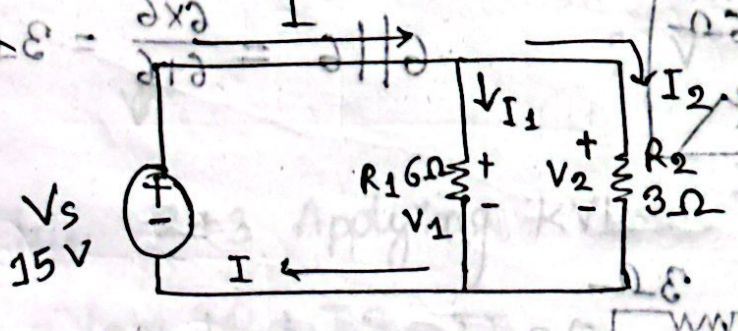
* Parallel applicable kirchoff current Law:



$I = I_1 + I_2$

$$\sum_{n=1}^{M} I_n = 0$$

$$\frac{I}{\text{no. of branch}} = \frac{4A}{2} = 2A = I_1 = I_2$$



Since [Source || R_1 || R_2]

$V_1 = V_2 = V_s = 15V$

$$I_1 = \frac{V_1}{R_1} = \frac{15}{6} = 2.5A$$

$$I_2 = \frac{V_2}{R_2} = \frac{15}{3} = 5A$$

Using KCL at node A

$I = I_1 + I_2 = 2.5 + 5 = 7.5A$

Another way to find I

$$\therefore R_{eq} = \frac{6 \times 3}{6+3} = 2\Omega$$

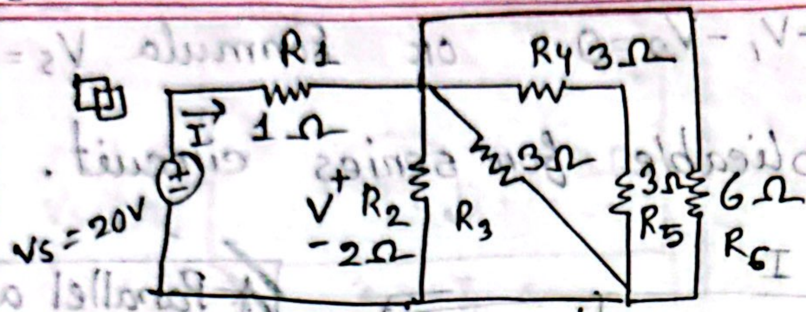
Ohm's law,

$$I = \frac{V_s}{R_{eq}} = \frac{15V}{2\Omega}$$

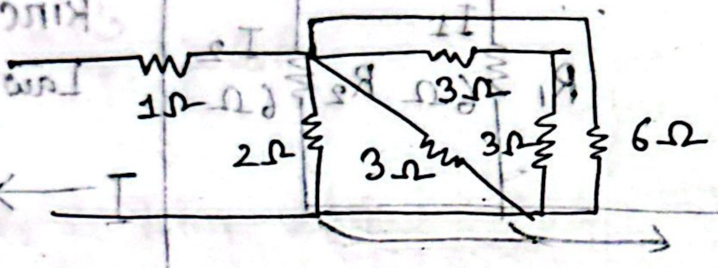
$I = 7.5A$

03/07/21

Determine the Req

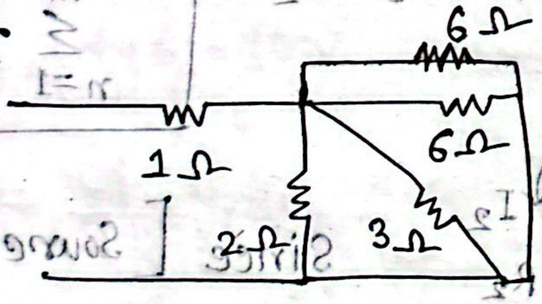


Step 1



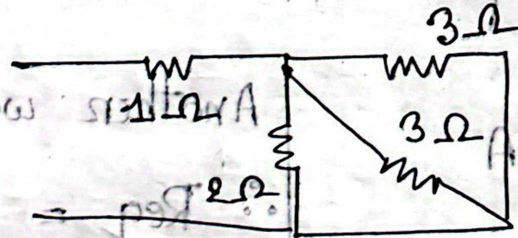
$R_4 + R_5 = 3 + 3 = 6\,\Omega$

Step 2



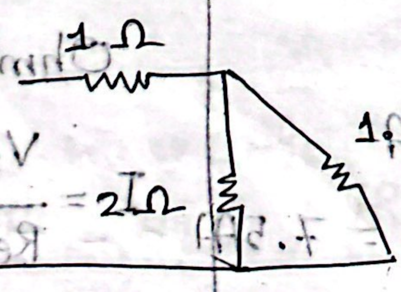
$6 \| 6 = \frac{6\times6}{6+6} = 3\,\Omega$

Step 3



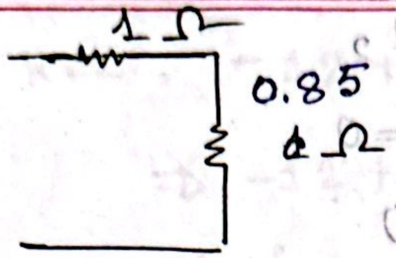
$3 \| 3 = \frac{3\times3}{3+3} = 1.5$

Step 4



$2 \| 1.5 = \frac{2\times1.5}{3.5} = \cancel{1\,\Omega}$ $0.85\,\Omega$

Step 5



$$R_{eq} = 1.86\,\Omega \quad \text{(Ans)}$$

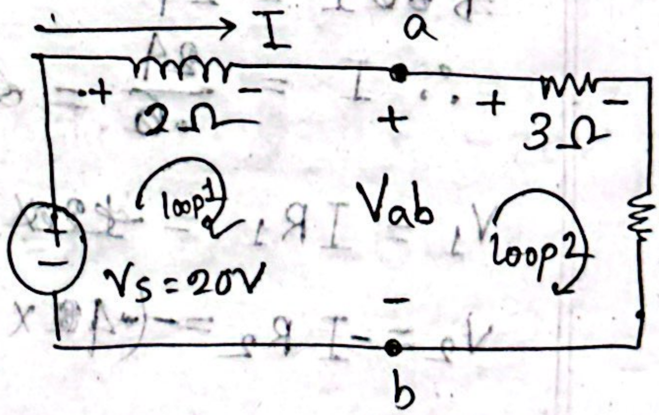
$V_s = 20V$

$$I = \frac{20}{R_{eq}} = \frac{20}{1.85} = \cancel{10.81A}\ 10.77A \quad \text{(Ans)}$$

$V_s = V$ Since $(V_s \parallel R_2)$

~~V = 20V (Ans)~~ $V = IR^{IV} = 10.77 \times 0.86\,\Omega$

$\therefore V = 9.25V$



~~2+3~~ Applying KVL

$-V_s + I2 + I3 + I5 = 0$

$\Rightarrow -20 + I(2+3+5) = 0$

$\Rightarrow I(10) = 20$

$\therefore I = \frac{20}{10} = 2A$

Applying KVL in loop 1, $-20 + I2 + V_{ab} = 0$

$\Rightarrow -20 + 2\times2 + V_{ab} = 0$

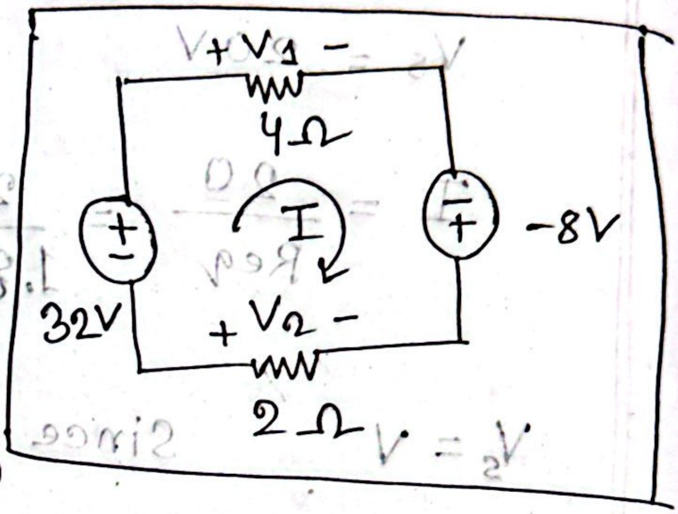
$\therefore V_{ab} = 16V$

Applying KVL in loop 2,

$-V_{ab} + 3I + 5I = 0$

$\Rightarrow -V_{ab} + 8 \times 2 = 0$

$\therefore V_{ab} = 16V$



□ Find V_1, V_2

~~V_1~~ Using KVL,

$-32 + IR_1 - (-8) \cancel{-V_2} \cancel{(-I2)} = 0$

$\Rightarrow -32 + 8 + I(4+2) = 0$

$\Rightarrow -24 + 6I = 0$

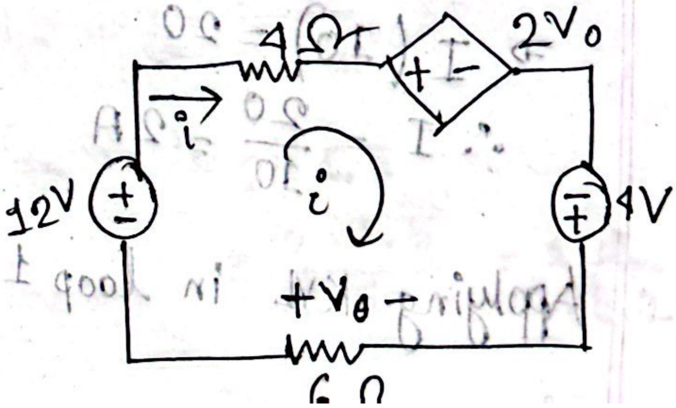
$\Rightarrow 6I = 24$

$\therefore I = \frac{24}{6} = 4A$

$V_1 = IR_1 = 4 \times 4 = 16V$

$V_2 = -IR_2 = -(4 \times 2) = -8V$

□ Find i and v_0



Using Ohm's law :,

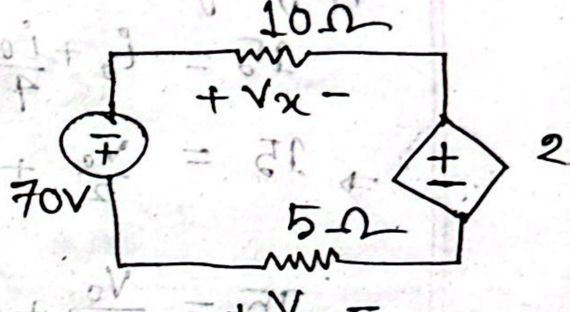
$V_0 = 6i$

Applying KVL, $-12 + 4i + 2V_0 - 4 + 6i = 0$

$\Rightarrow -12 + 4i + 2\times(-6i) - 4 + 6i = 0$

$\Rightarrow i = -8A$

Find V_x and V_0.



Applying KVL,

$+70 + \overset{V_x}{\cancel{10I}} + 2 \cdot - V_0$

$\Rightarrow 70 + 10I + \overset{(2\times 10I)}{\cancel{20}}(-5I) = 0$

$\Rightarrow \cancel{72 + I + 15 = 0}$ $\quad 35I = -70$

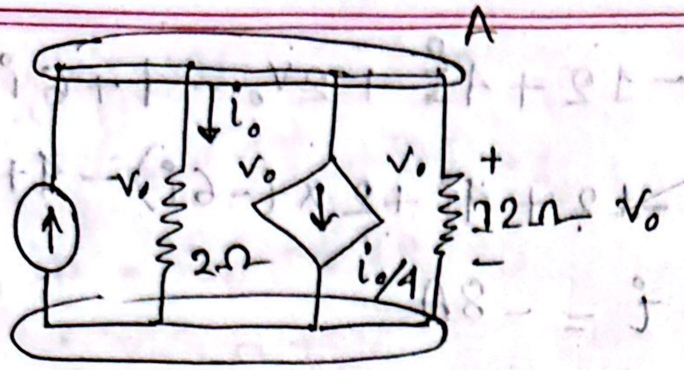
$\Rightarrow \cancel{I = \frac{-72}{15} = 4.8\,A}$ $\quad I = -2A$

$V_x = \cancel{IR}\ 10I = \cancel{-20} \times 4.8 = \cancel{9.6V}\ -20V$

$V_0 = -5I = -5 \times -2 = \cancel{10V}\ 10V$

$I \begin{cases} + \text{ enter} \\ - \text{ out} \end{cases}$

Find V_o and i_o



2|2, 8, 12
2|1, 4, 6
1, 2, 3

Applying KCL at node A

$$15 = i_o + \frac{i_o}{4} + i_1$$

$$\Rightarrow 15 = \frac{V_o}{2} + \frac{V_o/2}{4} + \frac{V_o}{12}$$

$$\Rightarrow 15 = \frac{V_o}{2} + \frac{V_o}{8} + \frac{V_o}{12}$$

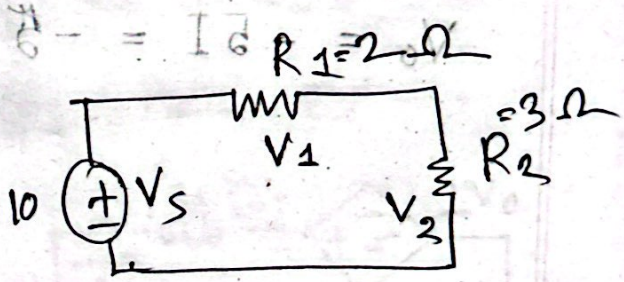
$$\Rightarrow 15 = \frac{6V_o + 1.5V_o + V_o}{24} = \frac{17V}{24}$$

$$\therefore V = \frac{15 \times 12}{8.5} = \frac{15 \times 24}{17} = 21.176\,V$$

Ohm's law, $i_o = \frac{V_o}{2} = \frac{21.17}{2} = 10.58\,A$

Voltage divider Rule

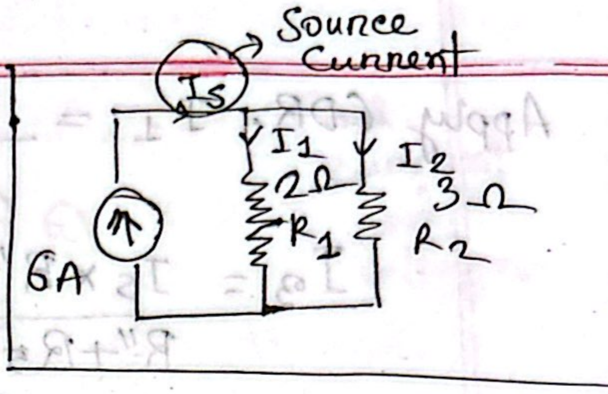
Applicable for (S) circuit



$$V_1 = \frac{V_s R_1}{R_1 + R_2} \qquad V_2 = \frac{V_s R_2}{R_1 + R_2}$$

$$V_1 = \frac{10 \times 2}{5} = 4V \qquad V_2 = \frac{10 \times 3}{5} = 6V.$$

যেটা node এ ঢুকবে ওইটাই source current



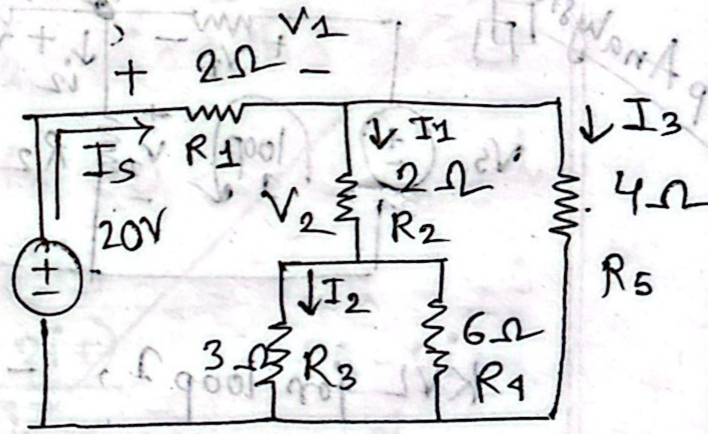
Current Divider Rule:

$$I_1 = \frac{I_s \times R_2}{R_1 + R_2} = \frac{6\times 3}{5} = 3.6A$$

$$I_2 = \frac{I_s \times R_1}{R_1 + R_2} = \frac{6\times 2}{5} = 2.4A$$

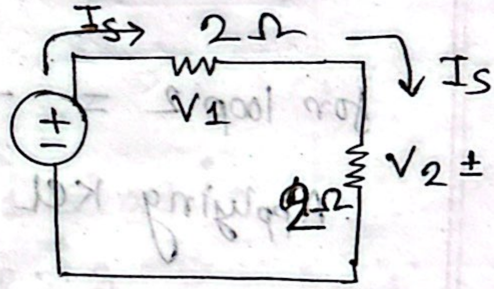
যদি ৩টা থাকে $I_1 = \frac{I_s \times (R_2 || R_3)}{R_1 + R_3 + R_2}$

$\boxed{\text{P}}$ Find V_1, V_2, I, I_2 & I_3



$R_3 || R_4 = 2\Omega$

$$R_{eq} = 2 + (2+2) || 4$$
$$= 2 + 4 || 4$$
$$= 2 + 2 = 4\Omega$$



$\therefore I_s = \frac{20}{4} = 5A$ (Ans)

another way, KVL,

$$-20 + V_1 + V_2 = 0$$
$$\Rightarrow -20 + 2I_s + 2I_s = 0$$
$$\Rightarrow -20 + 4I_s = 0$$
$$\Rightarrow I_s = 5A$$

$V_1 = 2I_s = 10V$ (Ans)

$V_2 = 2I_s = 10V$ (Ans)

CDR,

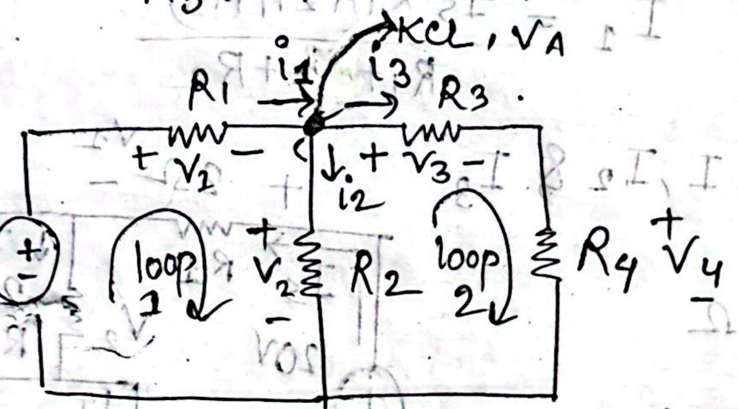
$\therefore \cancel{I_3\ I_2 = I_1 = \frac{I_s \times R_2}{2+2} = \frac{5\times 2}{4} = 2.5A}$

Apply CDR, $I_1 = \frac{I_S \times R_5}{R'' + R_5} = \frac{5 \times 4}{4+4} = 2.5A$ (Ans)

$I_3 = \frac{I_S \times R''}{R'' + R_5} = \frac{5 \times 4}{4+4} = 2.5A$ (Ans)

$I_2 = \frac{I_1 \times R_4}{R_3 + R_4} = \frac{2.5 \times 6}{3+6} = 1.66A$ (Ans)

loop Analysis



KVL for loop 1, $-V_S + V_1 + V_2 = 0$ —— (I)

for loop 2 $= -V_2 + V_3 + V_4$ —— (II)

Applying KCL in node A,

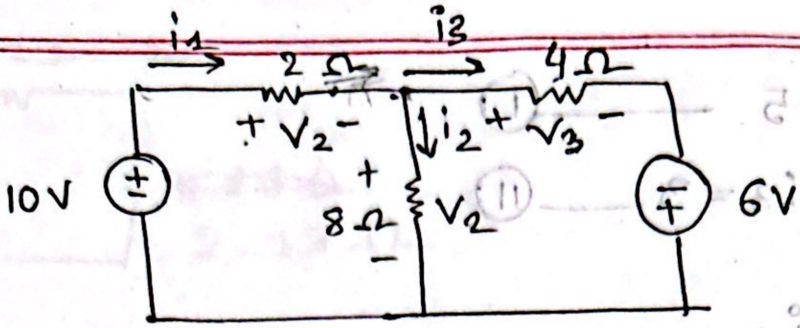
$i_1 = i_2 + i_3$ —— (III)

Ohm's law ~~এবং~~ Apply করে solve করবো

$i_1 = \frac{V_1}{R_1}$ $i_3 = \frac{V_3}{R_3}$ | $V_1 = V_S - V_A$

$i_2 = \frac{V_2}{R_2}$ $i_4 = \frac{V_4}{R_4}$

C.W 08/07/202



find current and voltage

KVL,

$\cancel{-10 + 2i_1 + 8i_2 = 0}$ —— (I)

$\cancel{-8i_2 + 4i_3 - 6 = 0}$ —— (II)

(I) + (II) $-10 + 2i_1 + \cancel{8i_2} - \cancel{8i_2} + 4i_3 - 6 = 0$

$\Rightarrow -16 + 2i_1 + 4i_3 = 0$

$\Rightarrow -16 + 2i_1 = -4i_3$

$\therefore i_3 = \frac{-(16 - 2i_1)}{-4} = \frac{16 - 2i_1}{4}$ //

$\cancel{-8i}$ $-16 + 2i_1 = -4\, \frac{16 - 2i_1}{4}$

Applying KCL at node A, $i_1 = i_3 + i_2$

$i_1 - i_2 - i_3 = 0$

Using ohms law,

$V_1 = 2i_1 = 2 \times 3 = 6V$

$V_2 = \cancel{2 \times 3 = 6V}\ 8i_2 = 4V$

$V_3 = 4i_3 = 4 \times 2.5 = 10V$.

Quiz - I
25/7/24
Monday } 10.40am

$5i_2+i_3=5$ —— (I)

$-4i_2+2i_3=3$ —— (II)

$i_3=5-5i_2$

(II) $-4i_2+2(5-5i_2)=3$

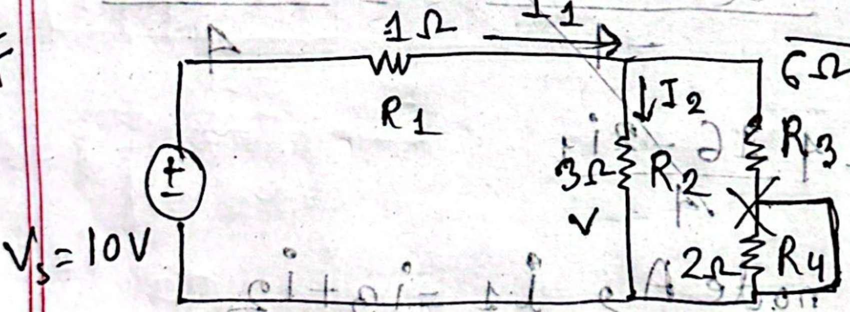
$\Rightarrow -4i_2+10-10i_2=3$

$\Rightarrow -14i_2=-7$ ∴ $i_2=\frac{-7}{-14}=\frac{1}{2}=0.5$

$i_3=5-(5\times 0.5)=2.5$

$i_1=i_3+i_2=2.5+0.5=3$

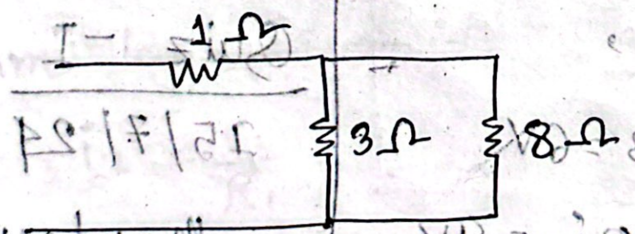
#

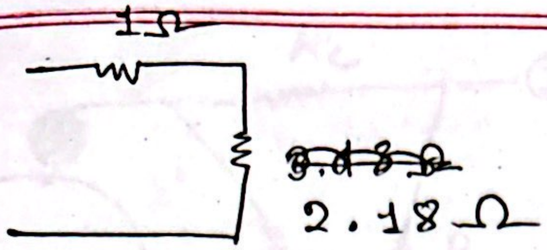


→ short circuit দিয়ে I চলে যাবে

Find I_1, I_2, I_3 & V.

Ans:





$8 \parallel 3 = 2.18\,\Omega$

$R_{eq} = 1 + 2.18\,\Omega$

$= 3.18\,\Omega$

$V = I \times 3.18$

$= 3.18 \times 0.31\,A$

$\cancel{= 7.74} = 0.98\,V$

$I_2 = \dfrac{I_1 \times (R_3 + R_4)}{3+2} = 0.496\,A$

$I_3 = \dfrac{I_s\,(R_2)}{3+2} = 0.186\,A$

$I_1 = \dfrac{V_s}{R_{eq}}$

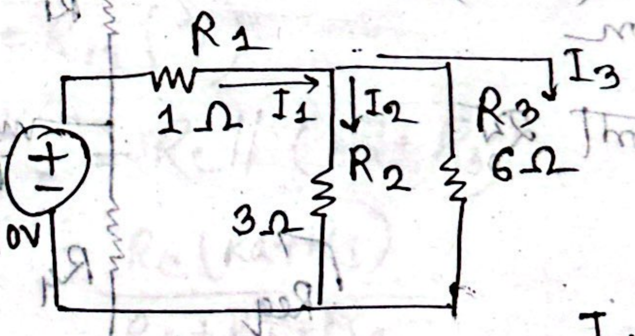
$= \dfrac{10}{3.18}$

$= 0.31\,A$

3.14 A

Wrong

Soln



$3 \parallel 6 = \dfrac{3 \times 6}{3+6}$

$= 2\,\Omega$

$R_{eq} = 1 + 2 = 3\,\Omega$

$I_1 = \dfrac{10}{3} = 3.33A$

$I = 2.22A \mid I_3 = 1.11A$

We can also use,

Applying KVL, lopp 1

$-V_S + I_1 1 + I_2 3 = 0$

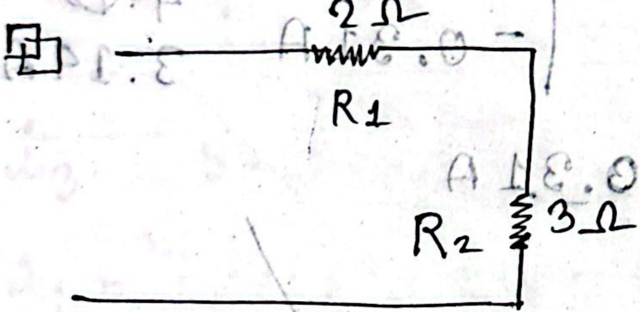
$1 I_1 + I_2 3 = 10$

loop 2, $-3I_2 + 6I_3 = 0$

$\Rightarrow -I_2 + 2I_3 = 0$ — (11)

KCL,

Node (A) $I_1 = I_2 + I_3$



Conductance

$G = \frac{1}{R}$ ℧/s

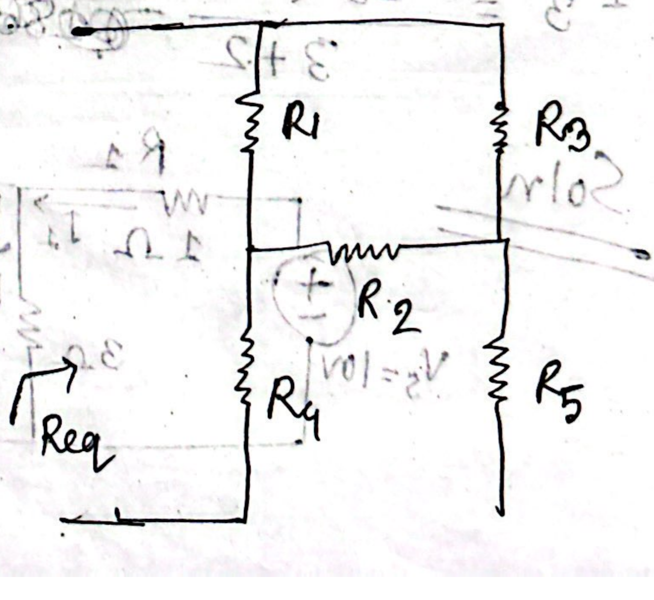
$R_{eq} = 2 + 3 = 5\ \Omega$

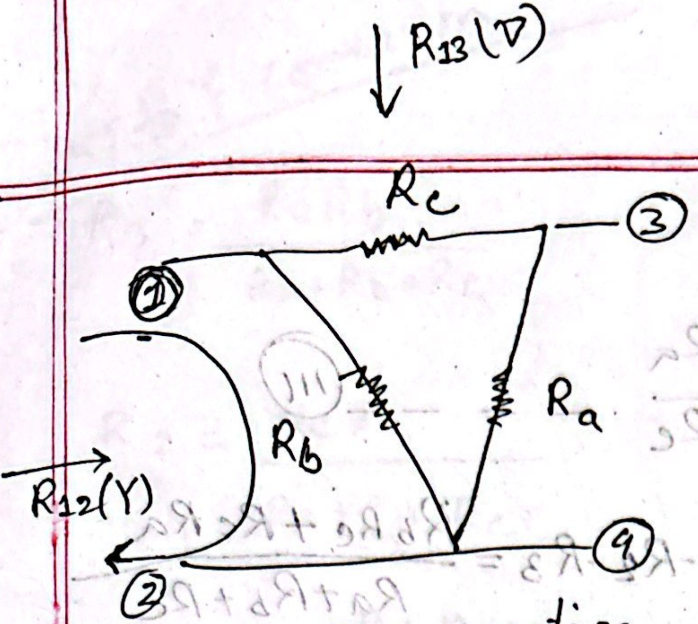
$G_1 = \frac{1}{2}$, $G_2 = \frac{1}{3}$ $G_{eq} = \frac{2 \times 3}{3 \times 2} = 1.2S$

WYE DELTA (Y-∇)

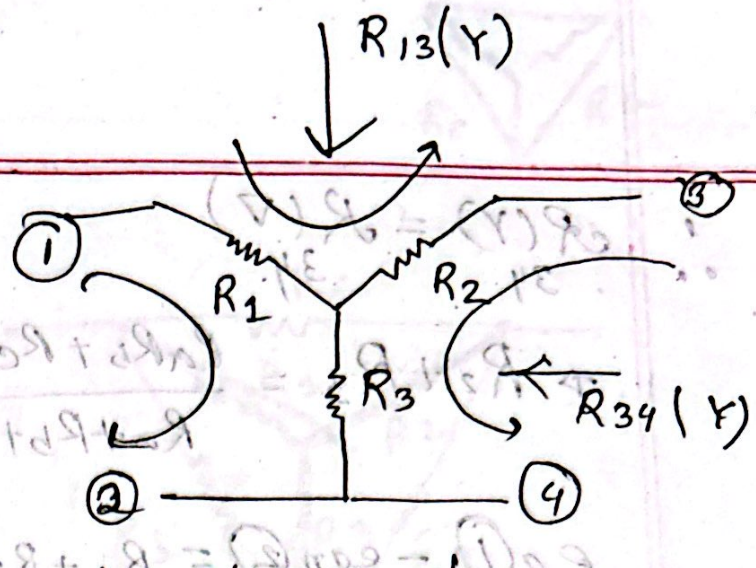
Tranformation

T-π ও বলা হয়





∇ connection



Y connection

$R_{12}(\nabla) = R_b \,||\, (R_c + R_a)$

$R_{12}(Y) = R_1 + R_3$

$R_{13}(\nabla) = R_c \,||\, (R_a + R_b)$

$R_{13}(Y) = R_1 + R_2$

$R_{34}(\nabla) = R_a \,||\, (R_b + R_c)$

$R_{34}(Y) = R_2 + R_3$

$\therefore R_{12}(Y) = R_{12}(\nabla)$

$\Rightarrow R_1 + R_3 = R_b \,||\, (R_c + R_a)$

$$\therefore R_1 + R_3 = \frac{R_b(R_c + R_a)}{R_a + R_b + R_c} = \frac{R_bR_c + R_bR_a}{R_a + R_b + R_c} \quad \text{--- (1)}$$

$\therefore R_{13}(Y) = R_{13}(\nabla)$

$\Rightarrow R_1 + R_2 = R_c \,||\, (R_a + R_b)$

$$= \frac{R_c(R_a + R_b)}{R_a + R_b + R_c}$$

$$\therefore R_1 + R_2 = \frac{R_cR_a + R_cR_b}{R_a + R_b + R_c}$$

$\therefore\ R_{34}(Y) = R_{34}(\nabla)$

$\Rightarrow R_2 + R_3 = \dfrac{R_aR_b + R_cR_a}{R_a+R_b+R_c}$ ---- (III)

eq (1) − eqn (2) $= R_1 + R_3 - R_2 - R_3 = \dfrac{R_bR_c + R_cR_a}{R_a+R_b+R_c}$

$\therefore R_1 - R_2 = \dfrac{R_bR_c + R_cR_a}{R_a+R_b+R_c}$ — (IV)

~~eq (1) − eq (4) = $R_1 + R_3$ R R~~

eq (2) + eq (4) $= R_1 + \cancel{R_2} + R_1 - \cancel{R_2} = \dfrac{2R_bR_c}{R_a+R_b+R_c}$

$= 2R_1 = \dfrac{2R_bR_c}{R_a+R_b+R_c}$

$\Rightarrow R_1 = \dfrac{\cancel{2}R_b}{R_a+R_b+R_c}$ — (V)

~~eq (V) in (IV), $R_2 = \dfrac{R_b}{R_a+R_b+R_c} - \dfrac{R_bR_c + R_cR_a}{R_a+R_b+R_c}$~~

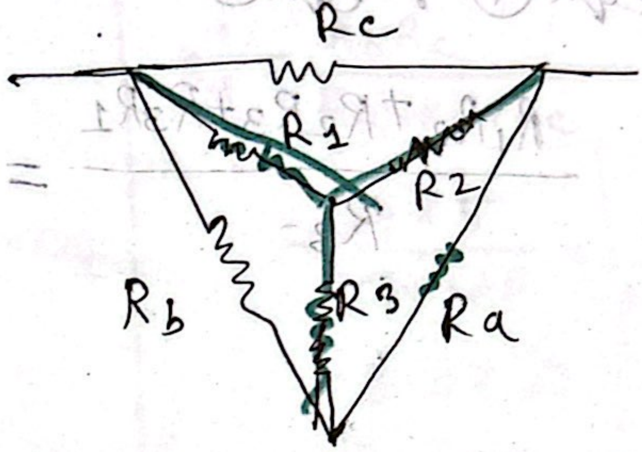
Substituting R_1 in eq (II)

$R_2 = \dfrac{R_cR_a}{R_a+R_b+R_c}$ — (VI)

∇ to Y conversion

$$R_3 = \frac{R_aR_b}{R_a+R_b+R_c}$$

$$R_2 = \frac{R_cR_a}{R_a+R_b+R_c}$$



$$R_1 = \frac{R_bR_c}{R_a+R_b+R_c}$$

∇ conversion

$$\therefore R_1R_2 + R_2R_3 + R_3R_1 = \frac{R_bR_c(R_cR_a)}{(R_a+R_b+R_c)^2} + \frac{(R_cR_a)(R_aR_b)}{(R_a+R_b+R_c)^2} + \frac{(R_bR_c)(R_a}{(R_a+R_b+R_c}$$

$$= \frac{R_aR_bR_c^2 + R_a^2R_bR_c + R_aR_b^2R_c}{(R_a+R_b+R_c)^2}$$

$$= \frac{\cancel{R_a^2R_bR_c+}\, R_aR_bR_c\,\cancel{(R_a+R_b+R_c)}}{\cancel{(R_a+R_b+R_c)}^2}$$

$$= \frac{R_aR_bR_c}{R_a+R_b+R_c} \quad (A)$$

$$\therefore R_1R_2+R_2R_3+R_3R_1 = \frac{R_aR_bR_c}{R_a+R_b+R_c}$$

$R_1 \; Y \; R_2 \; R_3$

$R_1 R_2 R_3$

eqn (A) ÷ eqn (1) :

$$\frac{R_1R_2+R_2R_3+R_3R_1}{R_3} = \frac{\dfrac{\cancel{R_a}R_bR_c}{\cancel{R_a+R_b+R_c}}}{\dfrac{\cancel{R_a}\cancel{R_b}}{\cancel{R_a+R_b+R_c}}}$$

$$R_c = \frac{R_1R_2+R_2R_3+R_3R_1}{R_3}$$

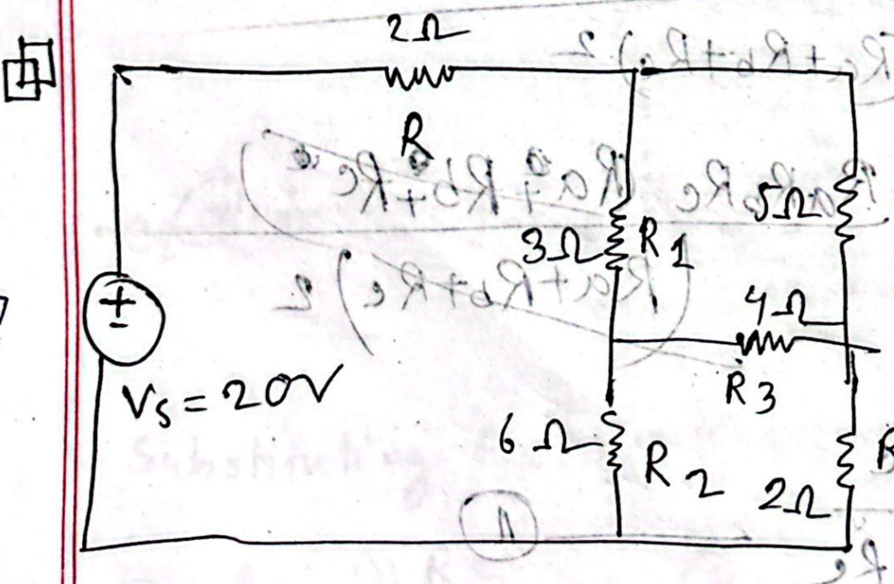
Similarly,

$$R_b = \frac{R_1R_2+R_2R_3+R_3R_1}{R_2}$$

$$R_a = \frac{R_1R_2+R_2R_3+R_3R_1}{R_1}$$

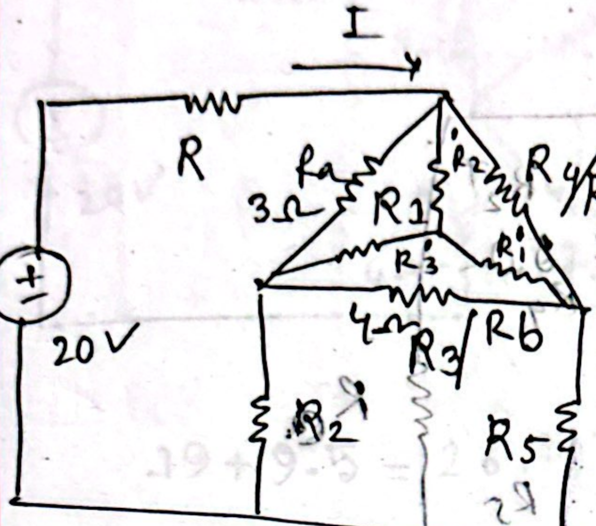
Y to ∇ conversion

WΔ
YΔ



Find I

In ∇ format,



$$R_1' = \frac{R_b R_c}{R_a+R_b+R_c}$$

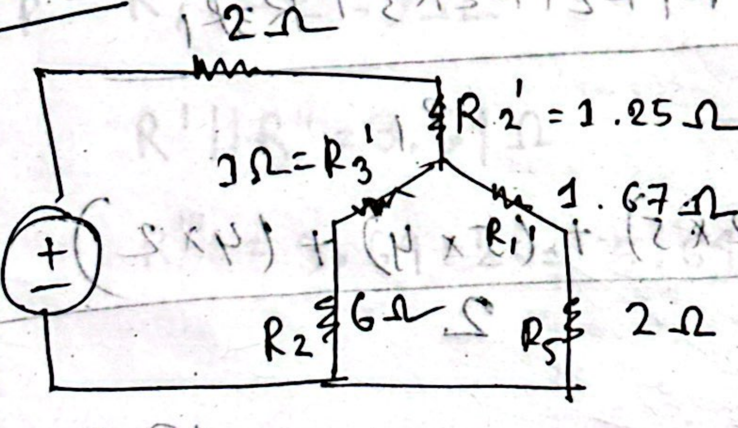
$$= \frac{4\times 5}{3+4+5} = \frac{20}{12}$$

$$= 1.67\,\Omega$$

$$R_2' = \frac{R_a + R_c}{R_a+R_b+R_c} = \frac{15}{12} = 1.2$$

$$R_3' = \frac{12}{12} = 1\,\Omega$$

Erase



$$R'' = R_2 + R_3' = 6+1 = 7\,\Omega$$

$$R''' = R_5 + R_1' = 2 + 1.67 = 3.67\,\Omega$$

$$R^{IV} = R'' \parallel R''' = \frac{7 * 3.67}{7+3.67} = 2.407\,\Omega$$

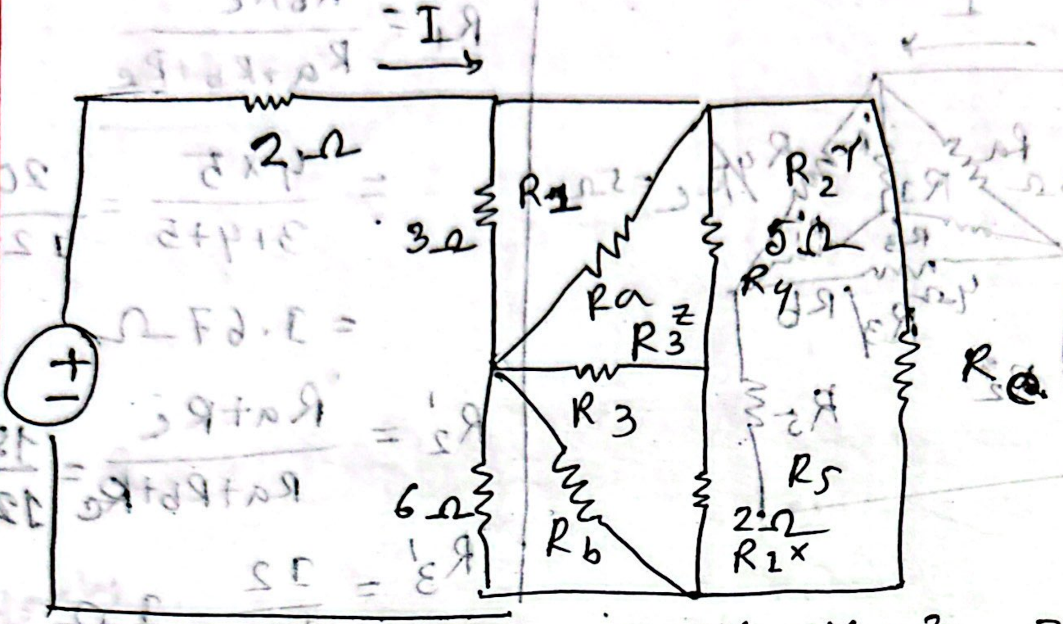
$$R^{V} = R^{IV} + R_2' = 3.65\,\Omega$$

$$R^{VI} = 2 + 3.65 = 5.65\,\Omega.$$

Ohm's law,

$$I = \frac{V_s}{R_{eq}} = \frac{20}{5.65} = 3.53\,A$$

Y ধরে করলে,



Soln:

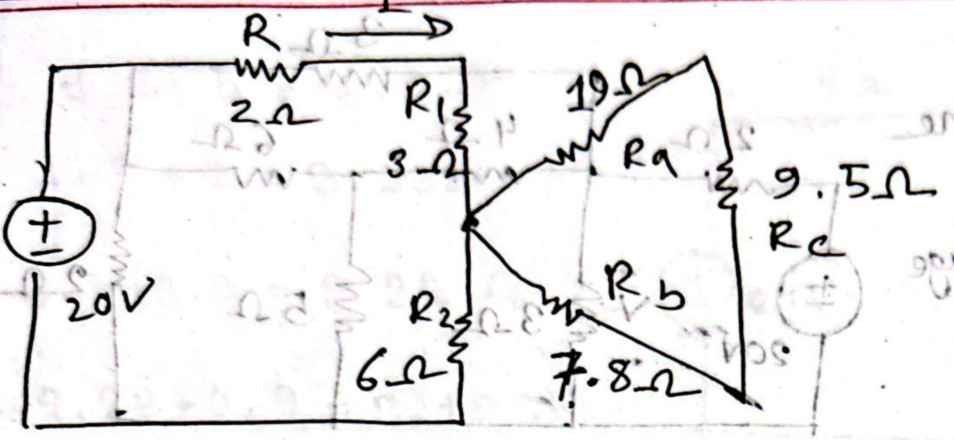
$$R_a = \frac{R_1^x R_2^y + R_2^y R_3^z + R_3^z R_1^x}{R_1}$$

$$= \frac{(2\times5)+(5\times4)+(4\times2)}{2}$$

$$= \frac{10+20+8}{2} = \frac{38}{2} = 19\Omega$$

$$R_b = \frac{38}{R_2} = \frac{38}{5} = 7.8\Omega$$

$$R_c = \frac{38}{4} = 9.5\Omega$$



$$19+9.5 = 28.5 \parallel 7.8$$

$$R' = 6.12\,\Omega$$

$$R'' = R_1 + R_2 = 9\,\Omega$$

$$R' \parallel R'' = 3.64\,\Omega$$

$$R''' = 3.64 + 2 = 5.64\,\Omega$$

$$\therefore I = \frac{V_s}{R'''} = \frac{20}{5.64} = 3.5$$

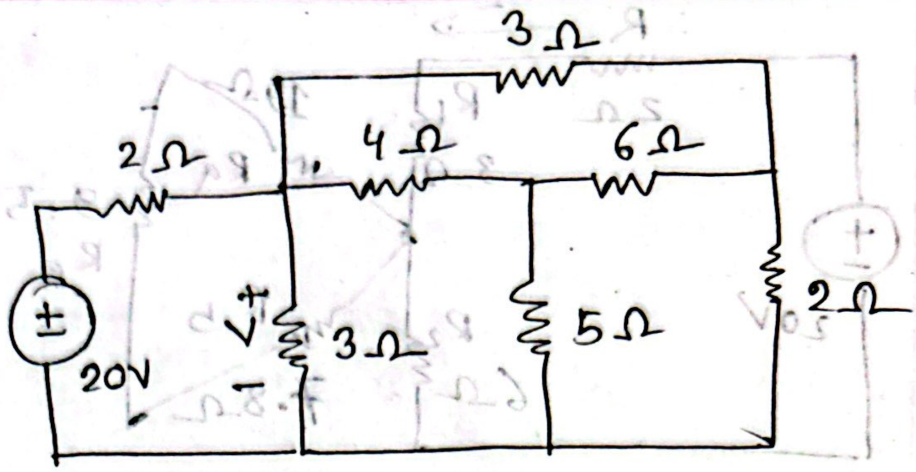
(Am).

D:W 09/07/2024

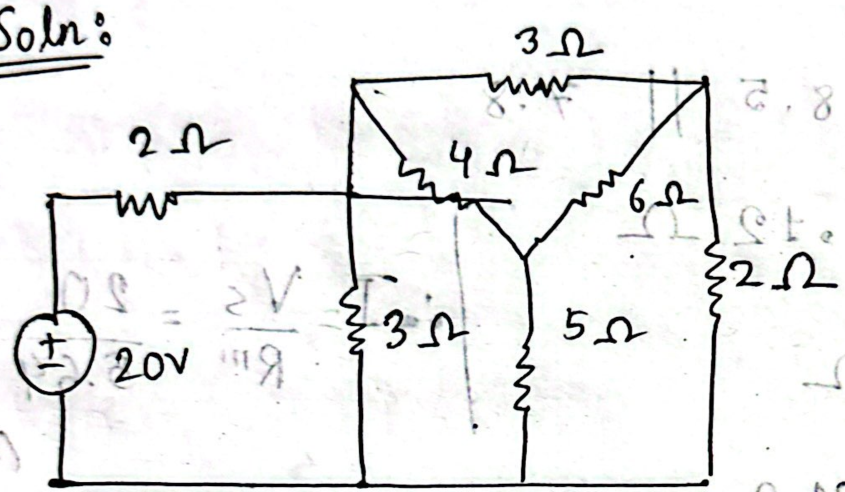
Module III

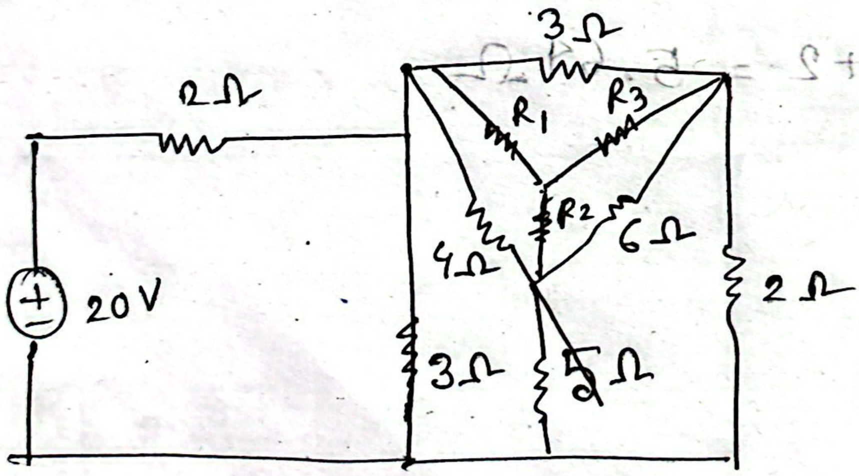
~~Population and Environment~~

Determine the current I and the voltage V.



Soln:





$$R_1 = \frac{3 \times 4}{3+4+6} = 0.9\,\Omega$$

$$R_2 = \frac{4 \times 6}{3+4+6} = 1.8\,\Omega$$

$$R_3 = \frac{3 \times 6}{3+4+6} = 1.3\,\Omega$$

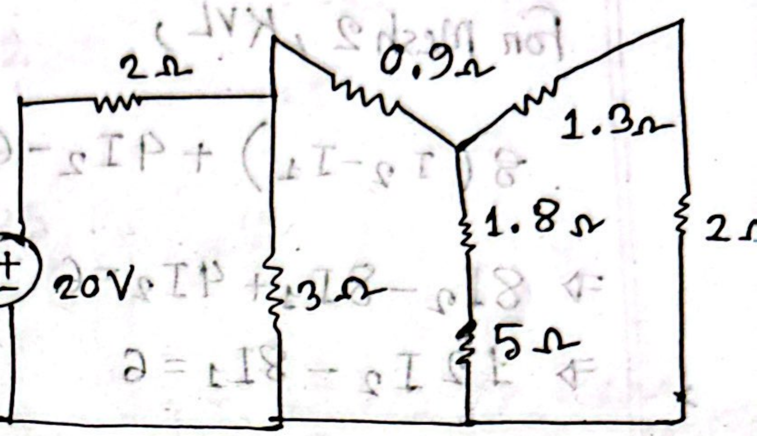
$1.8 + 5 = 6.8\,\Omega$

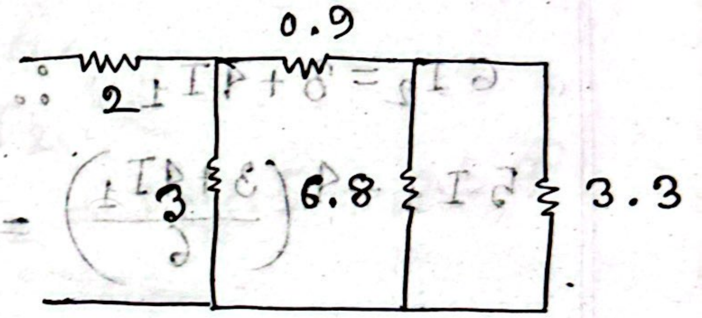
$1.3 + 2 = 3.3\,\Omega$

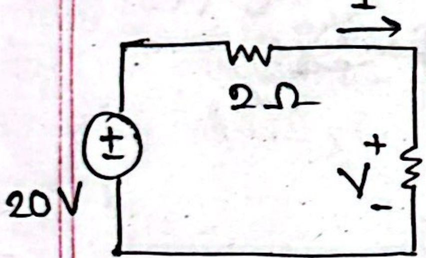
$6.8 \| 3.3 = 2.22\,\Omega$

$2.22 + 0.9 = 3.12\,\Omega$

$R' = 3.12 \| 3 = 1.53\,\Omega$





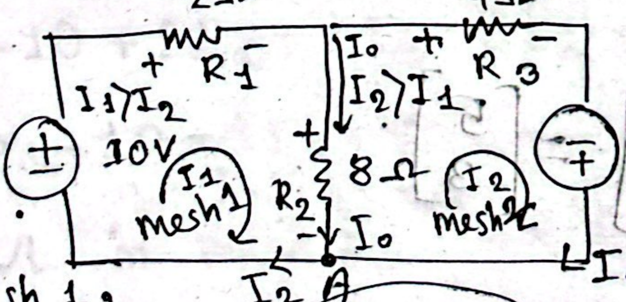


$I = \frac{V_s}{R_{eq}} = \frac{20}{3.53} = 5.6\,A$ (Ans)

$V = IR' = 5.6 \times 1.53$

$= 8.5\,V$ (Ans)

Mesh Analysis



KVL in mesh 1,

$-10 + 2I_1 + \underbrace{8(I_1 - I_2)}_{\text{Shared in both Mesh}} = 0$

$\Rightarrow -10 + 2I_1 + 8I_1 - 8I_2 = 0$

$\Rightarrow -10 + 10I_1 - 8I_2 = 0$

$\Rightarrow 10I_1 - 8I_2 = 10$

$\therefore 5I_1 - 4I_2 = 5$ ——— (1)

For Mesh 2, KVL,

$$8(I_2 - I_1) + 4I_2 - 6 = 0$$

$$\Rightarrow 8I_2 - 8I_1 + 4I_2 = 6$$

$$\Rightarrow 12I_2 - 8I_1 = 6$$

$$\therefore 6I_2 - 4I_1 = 3 \quad \text{—(ii)}$$

$$5I_1 - 4I_2 = 5 \quad \text{—(i)}$$

$$6I_2 = 3 + 4I_1 \quad \therefore I_2 = \frac{3+4I_1}{6}$$

$$5I_1 - 4\left(\frac{3+4I_1}{6}\right) = 5$$

$$\Rightarrow 30I_1 - 12 - 16I_1 = 30$$

$$\Rightarrow 14I_1 = 42$$

$$\therefore I_1 = 3A$$

$$\therefore (5\times 3) - 4I_2 = 5$$

$$\therefore I_2 = 2.5A$$

Another way, Cramer's Rule,

$$\begin{bmatrix} 5 & -4 \\ -4 & 6 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 5 \\ 3 \end{bmatrix}$$

$$\Delta = \begin{bmatrix} 5 & -4 \\ -4 & 6 \end{bmatrix} = 30 - 16 = 14$$

$$\Delta_1 = \begin{bmatrix} 5 & -4 \\ 3 & 6 \end{bmatrix} = 42$$

$$\Delta_2 = \begin{bmatrix} 5 & 5 \\ -4 & 3 \end{bmatrix} = 35$$

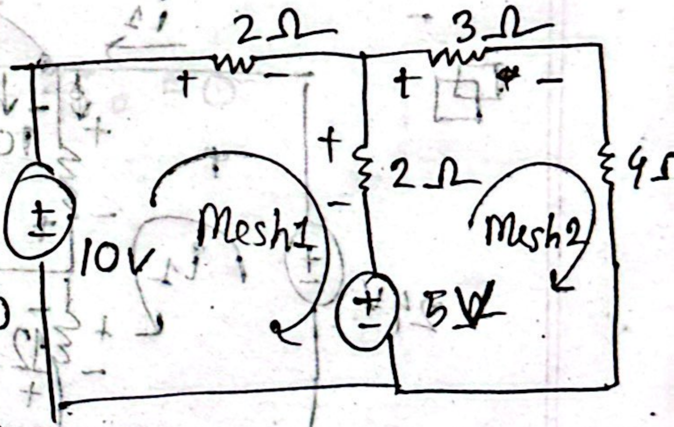
$I_1 = \dfrac{\Delta_1}{\Delta} = 3\,A$ (Ans) $I_2 = \dfrac{\Delta_2}{\Delta} = 2.5A$ (Ans

Applying KCL in node A,

$I_1 = I_0 + I_2$

$\Rightarrow I_0 = I_1 - I_2 = 3 - 2.5 = 0.5\,A$

Find the mesh current



KVL in Mesh 1,

$-10 + 2I_1 + 2(I_1 - I_2) = 0$

$\Rightarrow -10 + 2I_1 + 2I_1 - 2I_2 = 0$

$\Rightarrow -10 + 4I_1 - 2I_2 = 0$ $\therefore 4I_1 - 2I_2 = 5$

KVL in mesh 2,

$-5 + 2(I_2 - I_1) + 3I_2 + 4I_2 = 0$

$\Rightarrow -5 + 2I_2 - 2I_1 + 3I_2 + 4I_2 = 0$

$\therefore 5I_2 - 2I_1 + 4I_2 = 5$ $\therefore 9I_2 - 2I_1 = 5$

$$4I_1 = \cancel{10}^{5} + 2I_2$$

$$\therefore I_1 = \frac{\cancel{20}\,5 + 2I_2}{4}$$

0.93A

1.715A

$$9I_2 - 2\left(\frac{5\cancel{0} + 2I_2}{4}\right) = 5$$

$$\Rightarrow 3\cancel{6}8\,I_2 - \cancel{20}\,10 - \cancel{8}4\,I_2 = 20$$

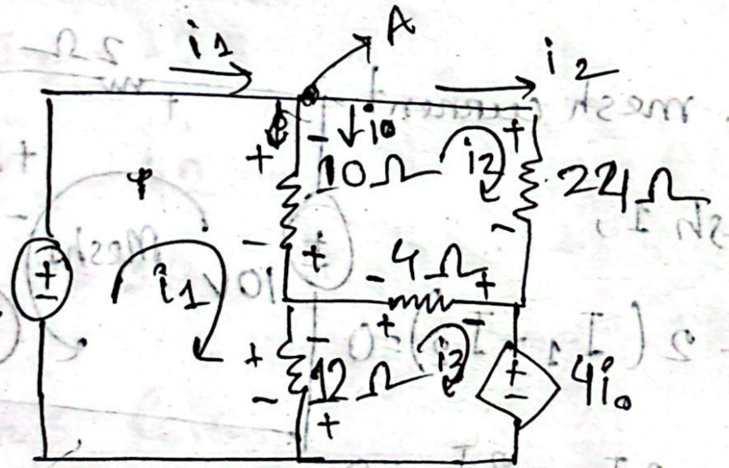
$$\Rightarrow 16I_2 = \cancel{30}\ \frac{32}{16}$$

$$\therefore I_2 = \cancel{2.38A}\ 2A$$

~~1.875A~~

2.25A

$I_1 =$ ~~3.75A~~ ~~2.25A~~



KVL in mesh 1,

$$-24 + 10(I_1 - I_2) + 12(I_1 - I_3) = 0$$

$$\Rightarrow -24 + 10I_1 - 10I_2 + 12I_1 - 12I_3 = 0$$

$$\Rightarrow 22I_1 - 10I_2 - 12I_3 = 24$$

$$\therefore 11I_1 - 5I_2 - 6I_3 = 12$$

KVL in mesh 2,

$$(I_2 - I_3)$$

$$+10(I_2 - I_1) + 24 I_2 + 4 I_2 = 0$$

$$\Rightarrow +10 I_2 - 10 I_1 + 24 I_2 + 4 I_2 - 4 I_3 = 0$$

$$\Rightarrow -10 I_1 + 38 I_2 - 4 I_3 = 0 \qquad \therefore -5 I_1 + 19 I_2 - 2$$

KVL in mesh 3,

$$12(I_3 - I_1) + 4(I_3 - I_2) + 4i_o = 0$$

$$\Rightarrow 12 I_3 - 12 I_1 + 4 I_3 - 4 I_2 + 4i_o = 0$$

$$\Rightarrow -12 I_1 + 16 I_3 - 4 I_2 + 4i_o = 0$$

$$\therefore \cancel{-6 I_3} + 28 I_3 - 2 I_2 + 4 i_o = 0$$

Applying KCL in node A

$$i_1 = i_o + i_2$$

$$i_o = i_1 - i_2$$

putting i_o,

$$2 I_3 - 2 I_2 + 4(I_1 - I_2) = 0$$

$$\Rightarrow 2 I_3 - 2 I_2 + 4 I_1 - 4 I_2 = 0$$

$$\therefore 4 I_1 - 6 I_2 + 2 I_3 = 0.$$

$$-i_1 - i_2 + 2i_3 =$$

$$2 I_1 - 3 I_2 + I_3 = 0$$

$$\Delta =$$

$$\begin{bmatrix} 11 & -5 & -6 \\ -5 & 19 & -2 \\ -1 & -1 & 2 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} 12 \\ 0 \\ 0 \end{bmatrix}$$

$$\Delta_1 = \begin{bmatrix} 12 & -5 & -6 \\ 0 & 19 & -2 \\ 0 & -1 & 2 \end{bmatrix} = 12(38-2)$$

$$=$$

$$\Delta_2 = \begin{bmatrix} 11 & 12 & -6 \\ -5 & 0 & -2 \\ -1 & 0 & 2 \end{bmatrix} =$$

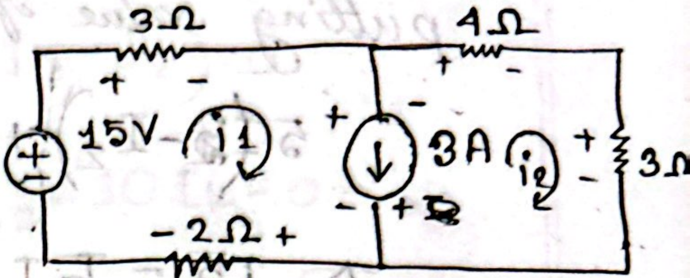
$$\Delta_3 = \begin{bmatrix} 11 & -5 & 12 \\ -5 & 19 & 0 \\ -1 & -1 & 0 \end{bmatrix} =$$

$$\cancel{\Delta} = I_1 = \frac{\Delta_1}{\Delta} =$$

$$I_2 = \frac{\Delta_2}{\Delta} =$$

$$I_3 = \frac{\Delta_3}{\Delta} =$$

Find mesh currents:



mesh1, $-15+3I_1+2I_1=0$

$\Rightarrow 5I_1 = 15 \quad \therefore I_1 = 3A$

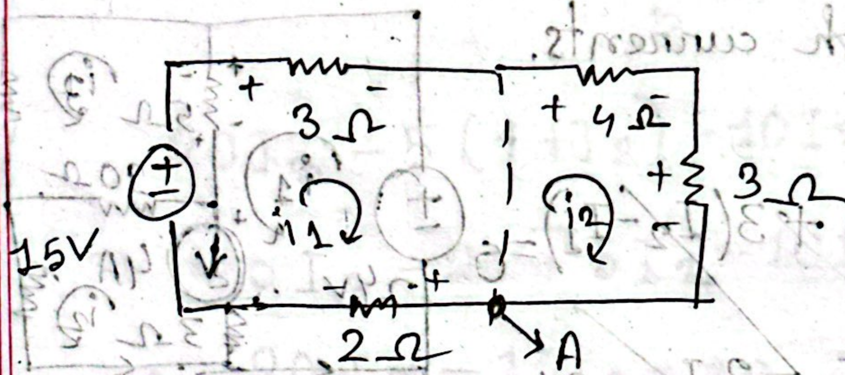
KVL in mesh 2,

$4I_2+3I_2=0$

$\Rightarrow 7I_2=0$

$\Rightarrow$

যদি mesh এর মাঝখানে current source থাকে তাহলে supermesh (পুরো circuit) both mesh কে একসাথে solve করবে



KVL in Supermesh: $-15+3I_1+4I_2+3I_2+2I_1=0$

$\Rightarrow 5I_1+7I_2=15$ —— (I)

Applying KCL in node A,

$I_s = I_1+I_2$

$\Rightarrow I_1+I_2=3A$

$\Rightarrow I_1 = 3-I_2$ —— (II)

putting value of eq (iii) in eq (2).

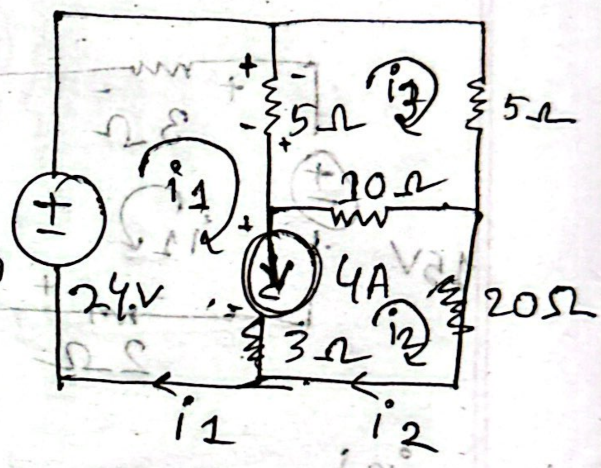
$$5(3 - I_2) + 7I_2 = 15$$

$$\Rightarrow 15 - 5I_2 + 7I_2 = 15$$

$$\Rightarrow 2I_2 = 0$$

$\therefore I_2 = 0\ A$ $\quad\quad$ $\therefore I_1 = 3 - 0 = 3A$

$\boxed{\ }$ Find mesh currents.



~~Supermesh 1~~

~~$-24 + 5(I_3 - I_1) + 3(I_2 - I_1) = 0$~~

~~$\Rightarrow 5I_3 - 5I_1 + 3I_2 - 3I_1 = 24$~~

~~$\Rightarrow -8I_1 + 3I_2 + 5I_3 = 24$ (1)~~

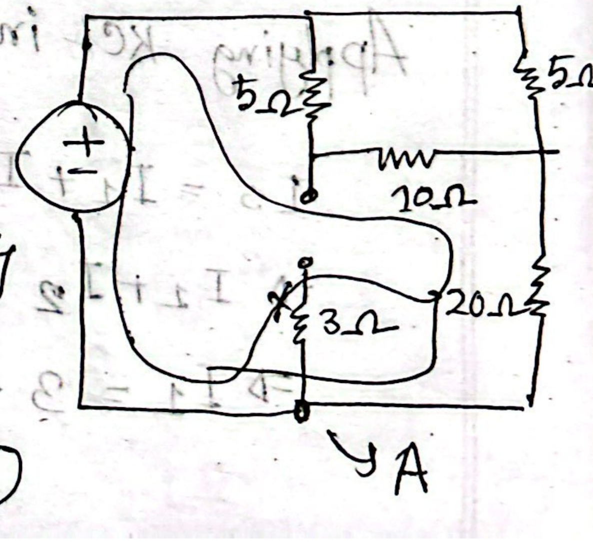
~~Supermesh $(i_3 + i_2)$,~~

Soln:

KVL in supermesh,

$$\therefore -24 + 5(I_1 - I_3) + 10(I_2 - I_3) + 20I_2 = 0$$

$$\therefore 5I_1 + 30I_2 - 15I_3 = 24 \quad (1)$$



KVL, In mesh 3

$$+5(I_3 - I_1) + 5I_3 + 10(I_3 - I_2) = 0$$

$$\Rightarrow 5I_3 - 5I_1 + 5I_3 + 10I_3 - 10I_2 = 0$$

$$\Rightarrow 20I_3 - 5I_1 - 10I_2 = 0 \quad (11)$$

Applying KCL in node A;

$$\cancel{4 = i_2 + i_1} \quad 4 + i_2 = i_1$$

$\therefore$

eq 11 $\quad 20I_3 - 5(4 + I_2) - 10I_2 = 0$

$$\Rightarrow 20I_3 - 20 - 5I_2 - 10I_2 = 0$$

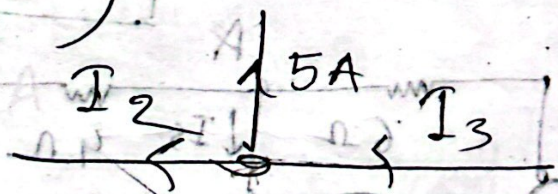
$$\Rightarrow 20I_3 - 15I_2 = 20$$

$$\Rightarrow 4I_3 - 3I_2 = 4 \qquad \therefore I_2 = \frac{4 - 4I_3}{-3}$$

$$\cancel{4 = 4 - 4I}$$

eq 1 $\quad 5I_1 + 30\left(\frac{4 - 4I_3}{-3}\right)$

Wrong



$$\cancel{I} \quad I_3 = I_2 + 5$$

15/07/24 - Quiz - Mesh Analysis পর্যন্ত

$-15i_2+20i_3=20$ ——— (B)

$35i_2-15i_3=4$

$\Rightarrow \cancel{35}\quad I_2=\dfrac{4+15I_3}{35}$

$-15\left(\dfrac{4+15I_3}{35}\right)+20I_3=20$

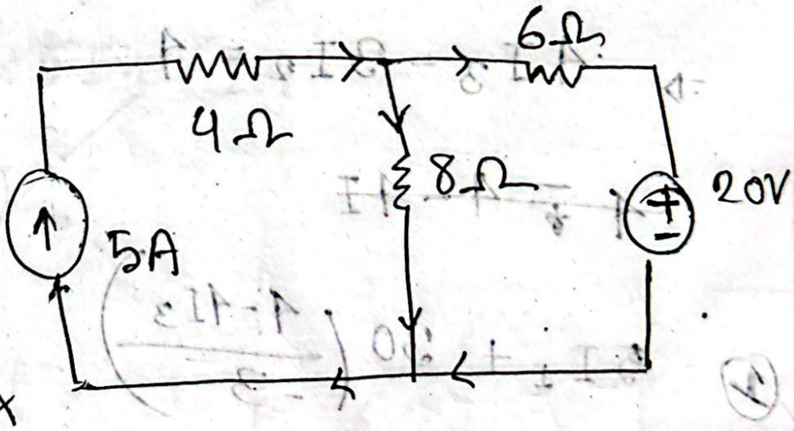
$\Rightarrow -60-225I_3+20I_3=700$ Wrong

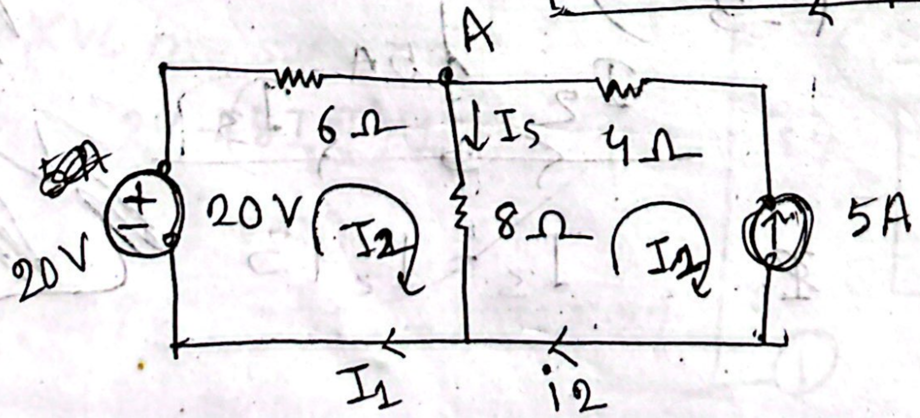
$\Rightarrow -205I_3=760$

$\therefore \cancel{I_3=-3.7}$

$\cancel{i_2}=\boxed{}$

Find mesh current





$I_1=5A$

KVL in mesh 1,

$$-20 + 6I_1 + 8(I_1 - I_2) = 0$$

$$\Rightarrow -20 + 6I_1 + 8I_1 - 8I_2 = 0$$

$$\Rightarrow 14I_1 - 8I_2 = 20 \quad \text{——— (1)}$$

KCL in node A,

$$I_1 = 5 + I_2$$

$$14(5 + I_2) - 8I_2 = 20$$

$$\Rightarrow 70 + 14I_2 - 8I_2 = 20$$

$$\Rightarrow 6I_2 = -50$$

$$\therefore I_2 = -8.33\ A$$

$$I_1 = 5 + (-8.33) = -3.33\ A$$

wrong

KVL in mesh 2,

Soln: $I_2 = 1.42\ A$

I_S mesh এর মাঝখানে নেই, তাই circuit open করতে হবে না।

Lab

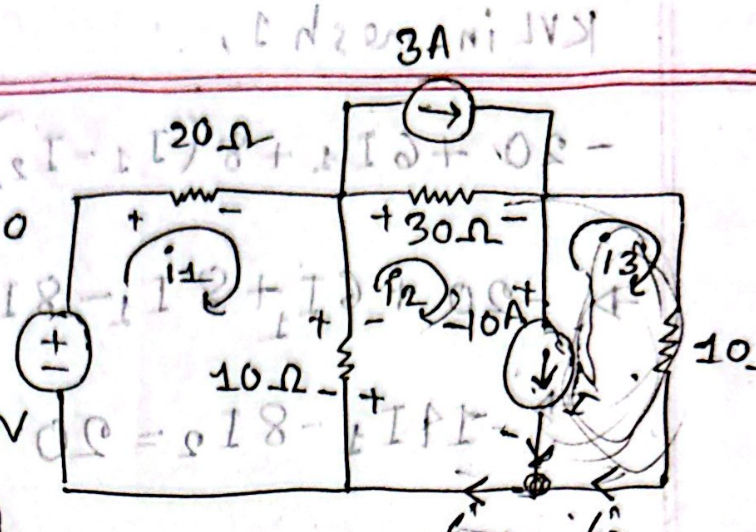
KVL in mesh 1,

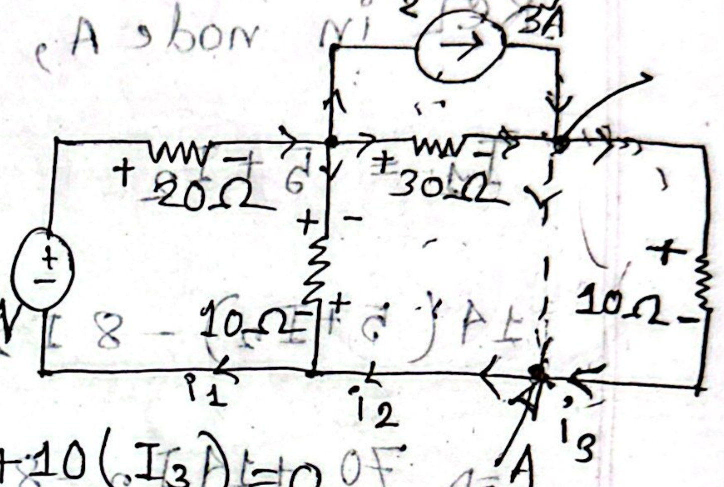
$-10+20I_1+10(I_1-I_2)=0$

$\Rightarrow 20I_1+10I_1-10I_2=10$

$\Rightarrow 30I_1-10I_2=10$

$\therefore 3I_1-I_2=1$ —— (1)





KVL in mesh 2 and 3

Supermesh,

$10(I_2-I_1)+30(I_2-3)+10(I_3)=0$

$\Rightarrow 10I_2-10I_1+30I_2-90+10I_3=0$

$\Rightarrow 40I_2-10I_1+10I_3=90$

$\Rightarrow -I_1+4I_2+I_3=9$ —— (II)

KCL in node A, $I_3+I=i_2$

$\Rightarrow I_3+(-10)=i_2$

$\Rightarrow I_3=I_2+10$ —— (III)

$-I_1+4I_2+(I_2+10)=0$

$\Rightarrow -I_1+4I_2+I_2+10=0$

$\Rightarrow 5I_2 \mp 10 = I_1$

putting this value in eqn ①

$3(5I_2 \mp 10) - I_2 = 1$

$\Rightarrow 15I_2 \mp 30 - I_2 = 1$

$\Rightarrow 14I_2 = \cancel{29}\ 31$

$\therefore I_2 = \cancel{2.07\,A}\ 2.214\,A$

$3I_1 + 2.214 = 1$ ①

$\therefore I_1 = \cancel{1.023\,A}\ 1.0714$

eqn ⑪, $-1.023 + (4 \times 2.07) + I_3 = 9$

$\Rightarrow I_3 = 7.783\,A$

$\cancel{-i_1 - i_2 - i_3}$ (111)

$$\begin{bmatrix} 3 & -1 & 0 \\ -1 & 4 & 1 \\ 0 & 1 & -1 \end{bmatrix}$$

$3(-4+1) - (-1)(1+0)$

$-12 + 3 + 1$

$-12 + 4$

$\Delta = 14$

$\Delta 1 = -4$

$\Delta 2 = 58$ ②

$\Delta 3 = -39$

$-\frac{1}{37}$

142.9

$I_1 = 0.285$

$I_2 = -4.14$

$I_3 = 2.78$

(-10A)

$\times 1_3' \times 1_2'$

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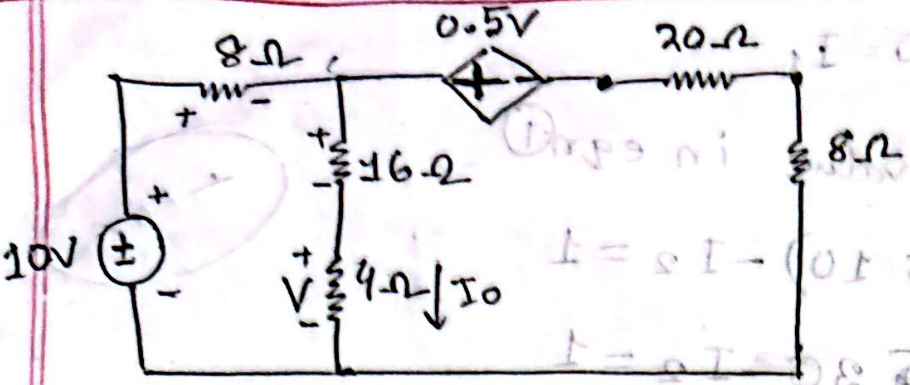
Lab 04



KVL in mesh 1,

$$-10+8I_1+16(I_1-I_2)+4(I_1-I_2)=0$$

$$\Rightarrow 8I_1+20I_1-20I_2=10$$

$$\Rightarrow 28I_1-20I_2=10$$

$$\therefore 14I_1-10I_2=5 \quad \text{(i)}$$

KVL in mesh 2,

$$4(I_2-I_1)+16(I_2-I_1)+0.5\times4+20I_2+8I_2$$

$$\Rightarrow 4I_2-4I_1+16I_2-16I_1+28I_2=-\cancel{0.5}\ 2.0$$

$$\Rightarrow -20I_1+48I_2=\cancel{0.025}\ \cancel{0.200}\ 2$$

$$\Rightarrow 10I_1+24I_2=\frac{0.5}{2}=\cancel{0.025}\ 1$$

$$\Rightarrow 5I_1+12I_2=\cancel{0.125}\ 0.5 \quad \text{(ii)}$$

(co wrong)

= wrong

= wrong

= wrong

$8 + 20 = 28\,\Omega$

$16 + 4\,\Omega = 20\,\Omega$

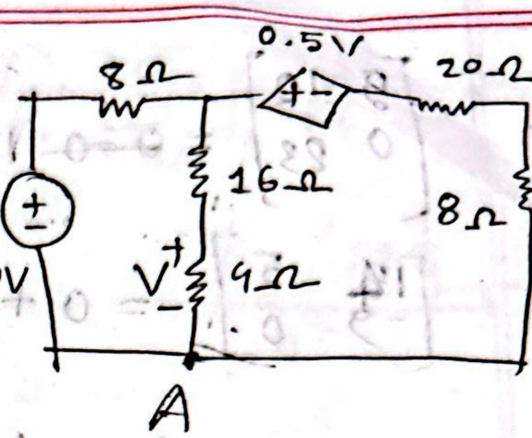
$20 \parallel 28 = 11.67\,\Omega = R'$

$\cancel{V_{ab} = I \times}\ 11.67 + 8$

$\therefore\ R_{eq} \Rightarrow 19.67\,\Omega$

$I = \frac{V_s}{R_{eq}} = \frac{10}{19.67} = 0.5\,A$

$\cancel{V_{ab} = IR' = 11.67 \times 0.5 = 5.8}35\ V$



$V_{ab} = 4I_o$

$= 4(I_1 - I_2)$

KCL at node

$I_1 = I_o + I_2$

$\therefore I_o = I_1 - I_2$

~~KVL~~ Applying KVL in mesh 1,

$14I_1 - 10I_2 = 5$

Applying KVL in mesh 2, $0.5(4(I_1 - I_2))$

$4I_2 - 4I_1 + 16I_2 - 16I_1 + \cancel{0.5V_{ab}}\ 2I_1 - 2I_2 + 20I_2 + 8I_2 = 0$

$\Rightarrow -20I_1 + 48I_2 + \cancel{(0.5 \times 5.835)} = 0$

$\Rightarrow \cancel{20I_1 + 48I_2 = 2.9175}$ $\quad -20 \quad 46$

$\Rightarrow \cancel{5I_1 + 12I_2 = 0.73}$ $\quad \therefore -18I_1 + 46I_2 = 0$

$\Rightarrow -9I_1 + 23I_2 = 0$

$\begin{bmatrix} 14 & -10 \\ -9 & 23 \end{bmatrix} = \cancel{115 + 108 = 223}$

$= -232$

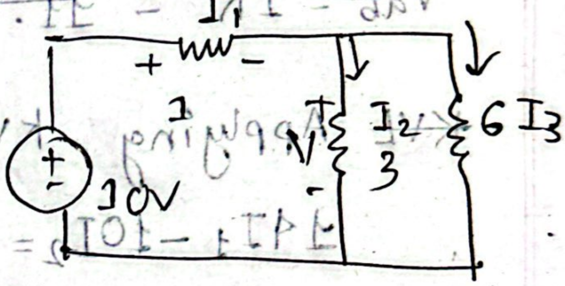
$-1(-6V)$

$\begin{bmatrix}5 & 10\\ 0 & 23\end{bmatrix} = \cancel{0-0}\ 115$

$\begin{bmatrix}14 & 5\\ -9 & 0\end{bmatrix} = 0 + 45 = 45$

$\therefore I_1 = \frac{\Delta_1}{\Delta} = \cancel{0.5A}$ $0.49A$ $\qquad I_2 = \frac{\Delta_2}{\Delta} = \cancel{0.02A}$ $= 0.19A$

Prac $\quad I_1 = \frac{10}{3} = 3.33$



$I_2 = \frac{3.33 \times 6}{3+6} = \cancel{6.67}\ 2.22$

$I_3 = 1.11$

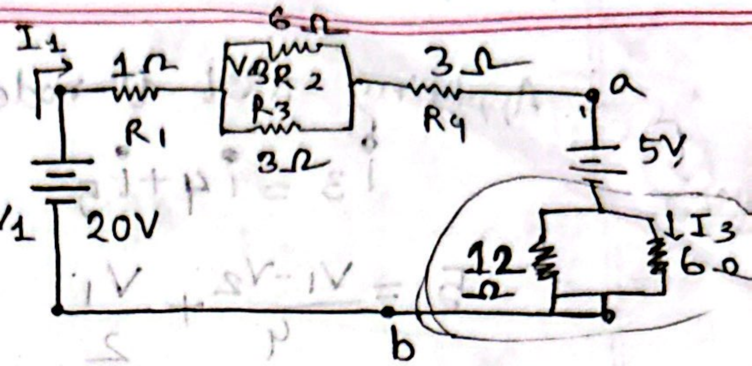
$\frac{6\times 3}{6+3} = 2 + 1 = 3\,\Omega$

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

c.w 15/07/2024

MID
24/7/24

Quiz Ans

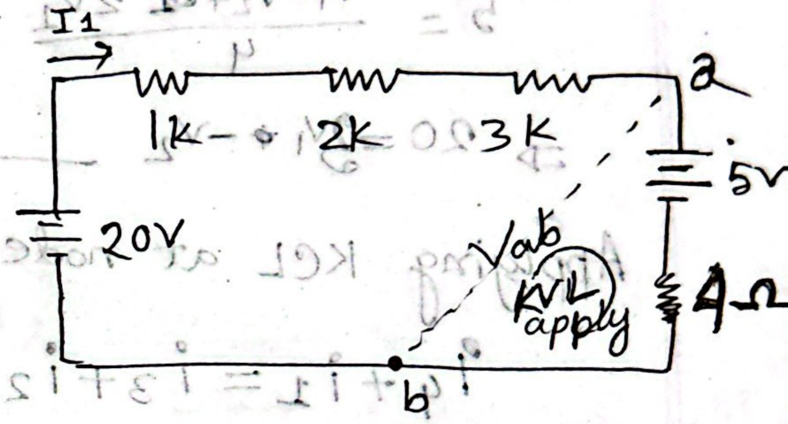


$R_2 \| R_3 = 2\,\Omega$

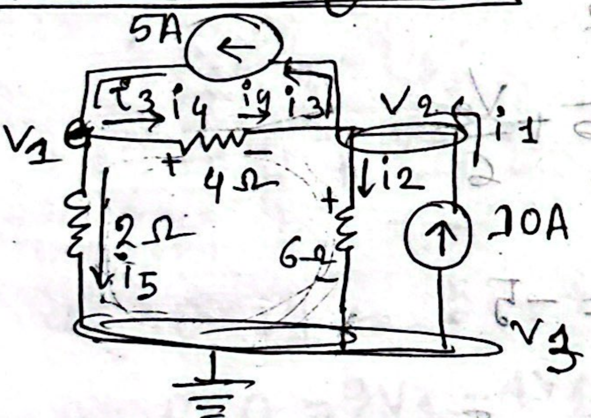
$R_5 \| R_6 = 4\,\Omega$

~~$1+2+3+4 = 22$~~

V_4



Nodal Analysis:



(i) node identification

(ii) reference/ground node

(iii) Flow of current

$$i = \frac{V_{High} - V_{Low}}{R}$$

Applying Ohm's law,

$i_1 = 10A$

$i_2 = \frac{V_2 - 0}{6} = \frac{V_2}{6}$

$i_3 = 5A$

$i_4 = \frac{V_1 - V_2}{4}$

$i_5 = \frac{V_1 - 0}{2} = \frac{V_1}{2}$

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$\frac{L\,4,6.}{2,3}$

$4\times 3 = 12$

Applying KCL at node V_1,

$$i_3 = i_4 + i_5$$

$$5 = \frac{V_1 - V_2}{4} + \frac{V_1}{2}$$

$$5 = \frac{V_1 - V_2 + \cancel{V_2}\, 2V_1}{4}$$

$$\Rightarrow 20 = 3V_1 + -V_2 \quad \text{———} \quad (1)$$

Applying KCL at node 2,

$$i_4 + i_1 = i_3 + i_2$$

$$\Rightarrow \frac{V_1 - V_2}{4} + 10 = 5 + \frac{V_2}{6}$$

$$\Rightarrow \frac{V_1 - V_2}{4} - \frac{V_2}{6} = -5$$

$$\Rightarrow \frac{3V_1 - 3V_2 - 2V_2}{12} = -5$$

$$\Rightarrow 3V_1 - 5V_2 = -60 \quad \text{———} \quad (11)$$

$\Rightarrow$

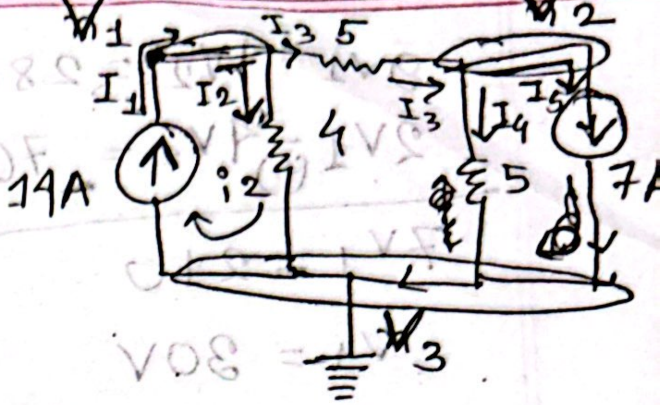
$$(1) - (11) \Rightarrow 20 + 60 = \cancel{3V_1} - V_2 - \cancel{3V_1} + 5V_2$$

$$\Rightarrow 80 = 4V_2$$

$$\Rightarrow V_2 = \frac{80}{4} = 20V \text{ (Ans)}$$

$$3V_1 = 20 + 20 = 40 \quad \therefore V_1 = 13.33\,V \text{ (Ans)}$$

Determine node voltage:-



Applying KCL

$i_1 = 14A$

$i_2 = \frac{V_1}{4}$

$i_3 = \frac{V_1 - V_2}{5}$

$i_4 = \frac{V_2}{5}$

$i_5 = 7$

Applying KCL at V_1,

$i_1 = i_2 + i_3$

$14 = \frac{V_1}{4} + \frac{V_1 - V_2}{5}$

$\Rightarrow 20 \times 14 = 5V_1 + 4V_1 - 4V_2$

$\Rightarrow 280 = 9V_1 - 4V_2$ —— (I)

Applying KCL at V_2,

$i_3 = i_4 + i_5$

$\Rightarrow \frac{V_1 - V_2}{5} = \frac{V_2}{5} + 7$

$\Rightarrow V_1 - V_2 - V_2 = 35$

$\therefore V_1 - 2V_2 = 35$ —— (II)

(I)

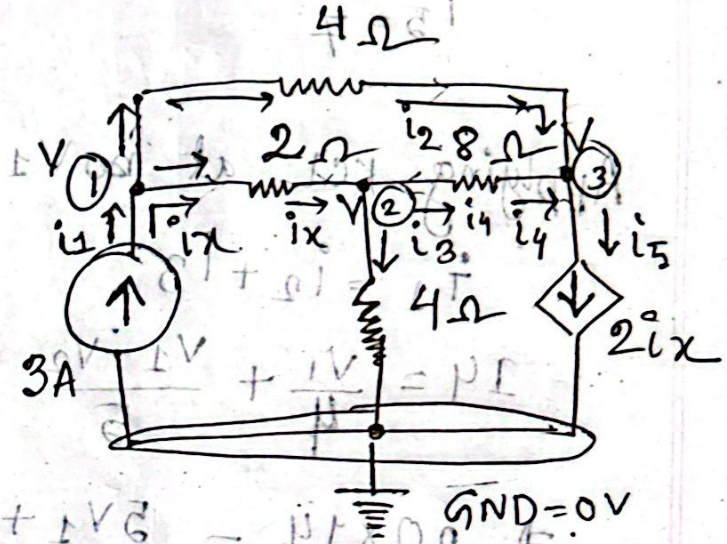
$2V_1 - 4V_2 = 70$

(i) - (ii)

$$9V_1 - 4V_2 = 280$$
$$-\; 2V_1 \overset{(+)}{-} 4V_2 = -70$$
$$7V_1 = 210$$
$$V_1 = 30V$$

$$V_1 - 2V_2 = 35$$
$$\Rightarrow -2V_2 = 5$$
$$\therefore V_2 = -2.5\ V$$

Determine node Voltages and i_x.



$$i_1 = 3A$$
$$i_2 = \frac{V_1 - V_3}{4}$$
$$i_3 = \frac{V_2 - 0}{4}$$
$$i_4 = \frac{V_2 - V_3}{8}$$

$$i_5 = 2i_x = 2\frac{V_1 - V_2}{2} = V_1 - V_2$$
$$i_x = \frac{V_1 - V_2}{2}$$

Apply KCL in node 1,

$$i_1 = i_2 + i_x$$
$$3 = \frac{V_1 - V_3}{4} + \frac{V_1 - V_2}{2}$$
$$12 = 3V_1 - 2V_2 - V_3 = 12$$
$$\therefore \cancel{5V_1 - 4V_2 - V_3 = 12} \quad \text{——— ①}$$
$$12 = 3V_1 - 2V_2 + 2V_1 - 2V_2$$

$4\overline{)4.8}$
1.2

Applying KCL in V_2,

$i_x = i_3 + i_4$

$\Rightarrow \frac{V_1 - V_2}{2} = \frac{V_2}{4} - \frac{V_2 - V_3}{8}$

$\Rightarrow 8V_1 - 8V_2 = 2V_2 + V_2 - V_3$

$\Rightarrow \cancel{8V_1 - 9V_2 - V_3 = 0}$

$4V_1 - 7V_2 + V_3 = 0$ —— (II)

Applying KCL at node 3,

$i_2 + i_4 = i_5$

$\Rightarrow \frac{V_1 - V_3}{4} + \frac{V_2 - V_3}{8} = \frac{V_1 - V_2}{2}$

$2V_1 - 2V_3 + V_2 - V_3 = 8V_1 - 8V_2$

$\Rightarrow -6V_1 - 3V_3 + 9V_2$

$\Rightarrow -2V_1 - V_3 + 3V_2 =$

$2V_1 - 3V_2 + V_3 = 0$ —— (III)

$$\Delta = \begin{bmatrix} 3 & -2 & -1 \\ 4 & -7 & 1 \\ 2 & -3 & 1 \end{bmatrix} = 3(-7+3) + 2(4-2) - 1(-12+14)$$
$$= -10$$

$$\Delta_1 = \begin{bmatrix} 12 & -2 & -1 \\ 0 & -7 & 1 \\ 0 & -3 & 1 \end{bmatrix} = 12(-7+3) = -48$$

$$\Delta_2 = \begin{bmatrix} 3 & 12 & -1 \\ 4 & 0 & 1 \\ 2 & 0 & 1 \end{bmatrix} = 3(0-0) - 12(4-2) - 1(0-0)$$
$$= -24$$

$$\Delta_3 = \begin{bmatrix} 3 & -2 & 12 \\ 4 & -7 & 0 \\ 2 & -3 & 0 \end{bmatrix} = 12(-12+14) = 24$$

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$V_s \rightarrow$ Short circuit

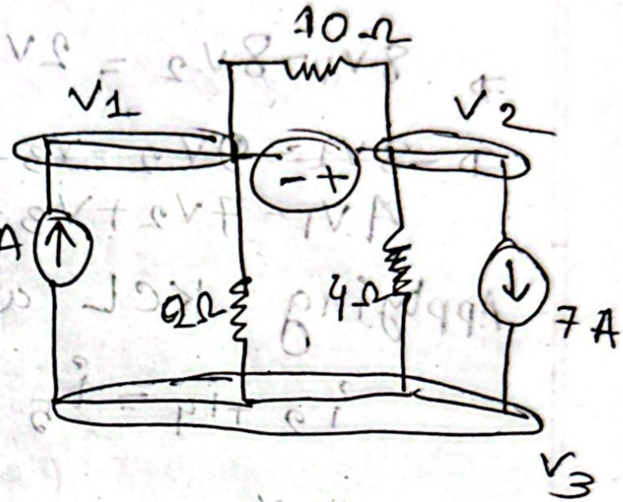
$I_s \rightarrow$ Open "

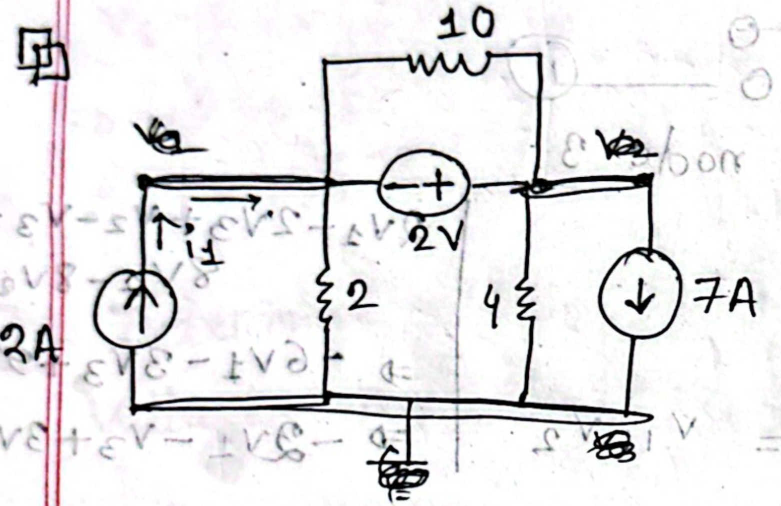
$$V_1 = \frac{-48}{-10} = 4.8\,V$$

$$V_2 = \frac{-24}{-10} = 2.4\,V$$

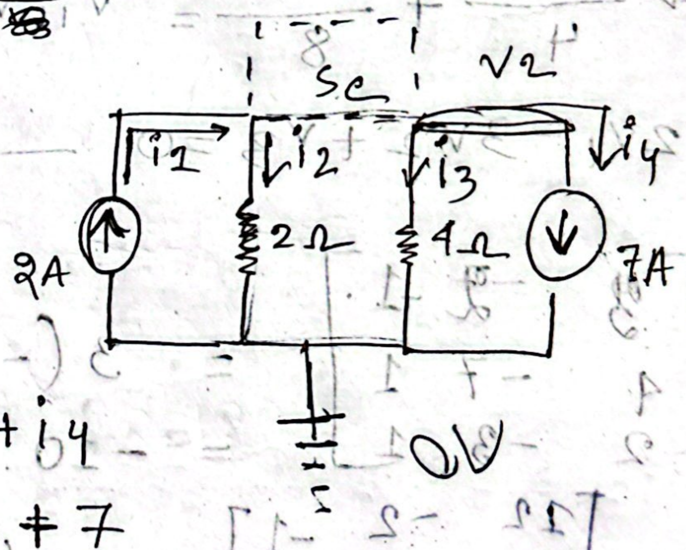
$$V_3 = \frac{24}{-10} = -2.4\,V$$

$$i_x = \frac{V_1 - V_2}{2} = 1.2\,A$$





Step Solution:



Applying KCL in Supernode; $i_1 = i_2 + i_3 + i_4$

$$2 = i_2 + i_3 + 7$$

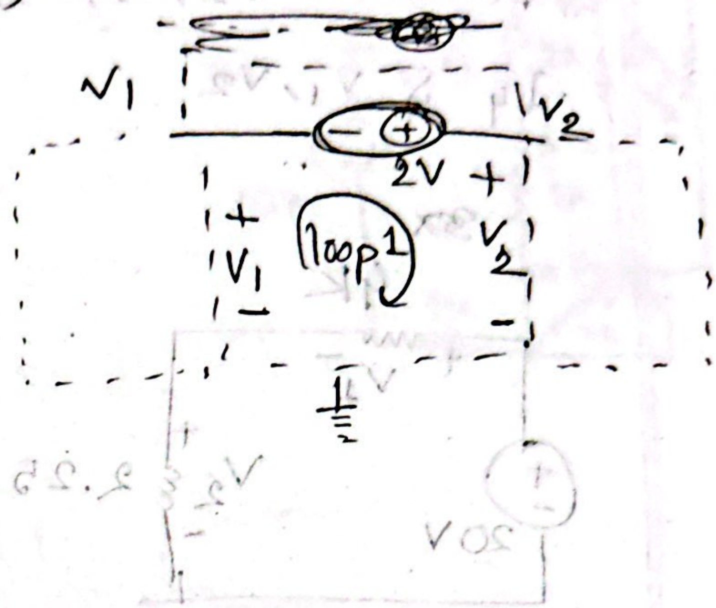
$$\Rightarrow \frac{V_1}{2} + \frac{V_2}{4} = -5$$

$$\Rightarrow 2V_1 + V_2 = -20 \quad (1)$$

Applying KVL in loop 1,

$-V_1 - 2 + V_2 = 0$

$\Rightarrow -V_1 + V_2 - 2 = 0$ ...... (11)



eq (1) − eq (2),

$$2V_1 + \cancel{V_2} = -20$$
$$(+)\,-V_1 \overset{(-)}{+} \cancel{V_2} = (-)2$$
$$\cancel{V_1 + 2V_2 = -22}$$
$$3V_1 = -22$$

$\therefore V_1 = -\frac{22}{3} = -7.33V$

Putting $V_1 = -7.33V$ in eq (11)

$-(-7.33) + V_2 = 2$

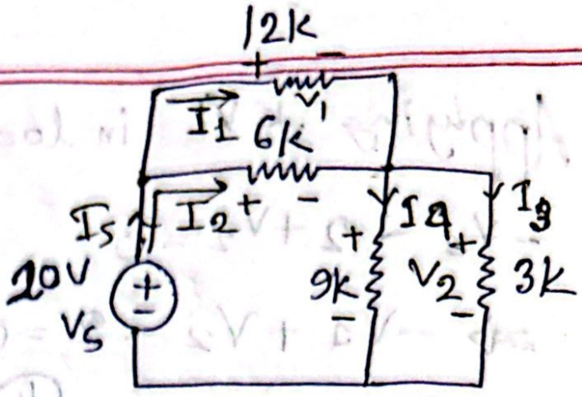
$\Rightarrow V_2 = 2 - 7.33 = -5.33V$ (Ans).

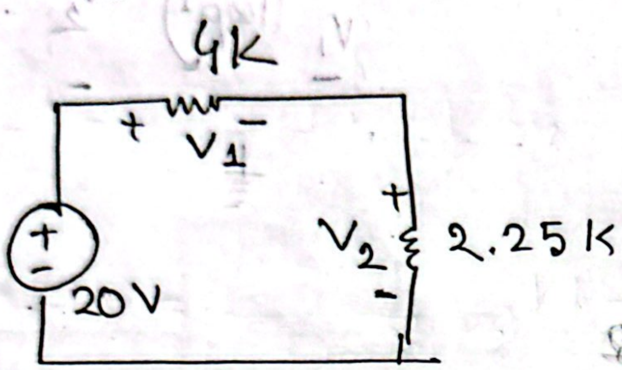
*** ২টা Node এর মাঝখানে V_s থাকলে Super node

*** ২টা mesh এর মাঝে I_s থাকলে Supermesh

19/08/24
Revision

Determine I_1, I_2, I_3, I_4 & V_1, V_2





$$V_1 = \frac{20 \times 4}{4+2.25} = 12.8V$$

$$V_2 = \frac{20 \times 2.25}{4+2.25} = 7.2V$$

$R_{eq} = 6.25K$

$$I = \frac{20}{6.25} = 3.2A$$

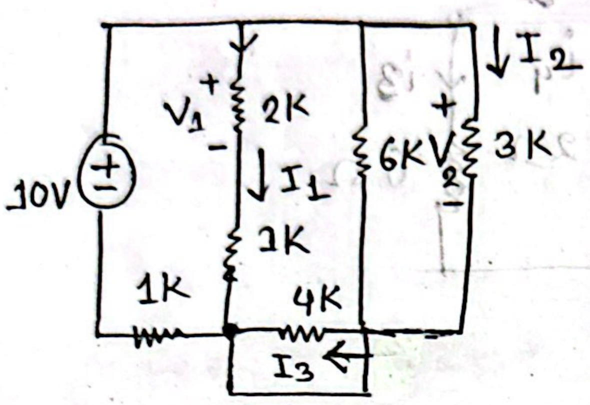
✓ $I_1 = \dfrac{3.2 \times 6}{12+6} = 1.067A$

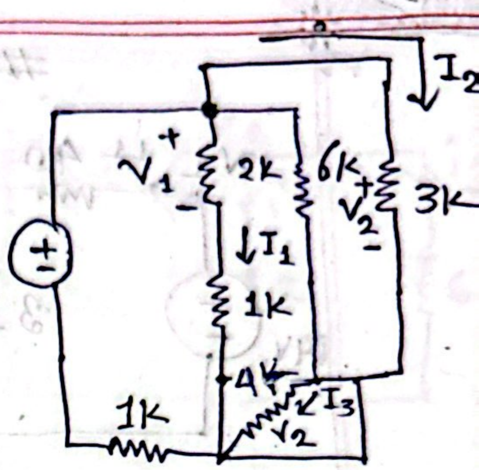
✓ $I_2 = \dfrac{3.2 \times 12}{12+6} = 2.13A$

$I_3 = \dfrac{3.2 \times 3}{3+9} = 0.8A$

$I_4 = \dfrac{3.2 \times 9}{3+9} = 2.4A$

Determine, V_1, V_2, V_3 & I_1, I_2, I_3



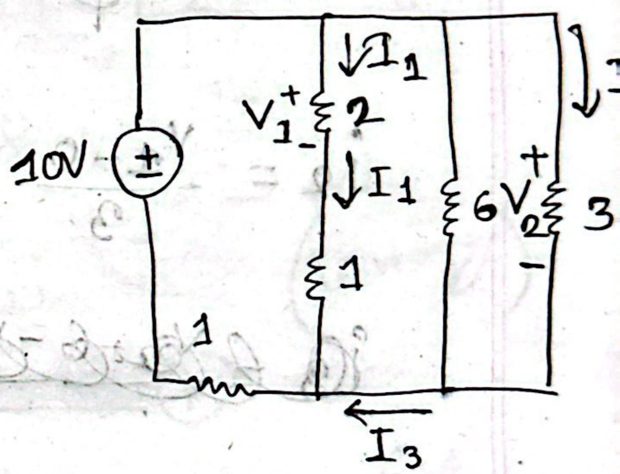


$Req = 1 + ((2+1) \parallel (6 \parallel 3))$

$= 1 + (3 \parallel 2)$

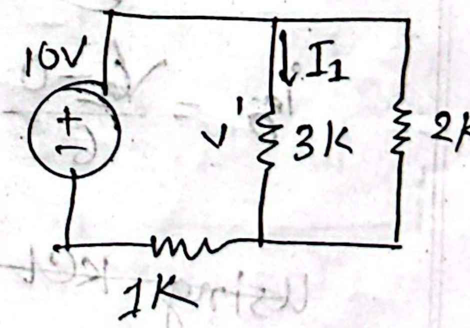
$= 1 + 1.2$

$= 2.2\,\Omega$



$I_S = \frac{V_S}{Req} = \frac{10}{2.2} = 4.54\,A$

$V_1 = I_1 \times 2 = 3.6\,V$



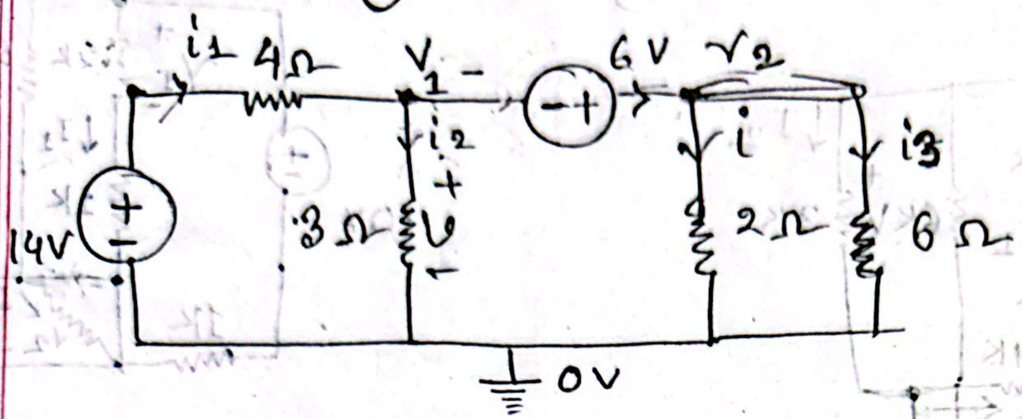
$I_1 = \frac{4.54 \times 2}{3+2} = 1.816\,A$

$I_2 = 2.724\,A = \frac{4.54 \times}{6+}$

$V' = I_1 \times 3 = 5.4$

10K hour

~~Determine V_1, V_2, V_3 & I_1, I_2, I_3~~



$$i_1 = \frac{14 - V_1}{4}$$

$$i_2 = \frac{V_1 - 0}{3} = \frac{V_1}{3}$$

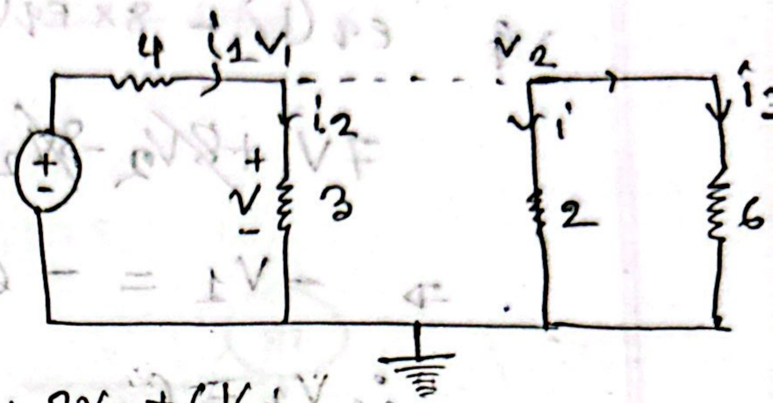
$$i = \frac{V_2}{2}$$

$$i_3 = \frac{V_2 - 0}{6} = \frac{V_2}{6}$$

~~Using KCL at node sup.~~

$$3 \,\big|\, \underline{3,6,2}$$
$$1,2,2$$

KCL at supernode,



$i_1 \pm i_2 + i_3 + i$

$$\Rightarrow \frac{14 - V_1}{4} = \frac{V_1}{3} + \frac{V_2}{6} + \frac{V_2}{2}$$

$$\Rightarrow \frac{14 - V_1}{4} = \frac{4V_1 + 2V_2 + 6V_2}{6}$$

$$\Rightarrow 168 - 12V_1 = 16V_1 + 8V_2 + 24V_2$$

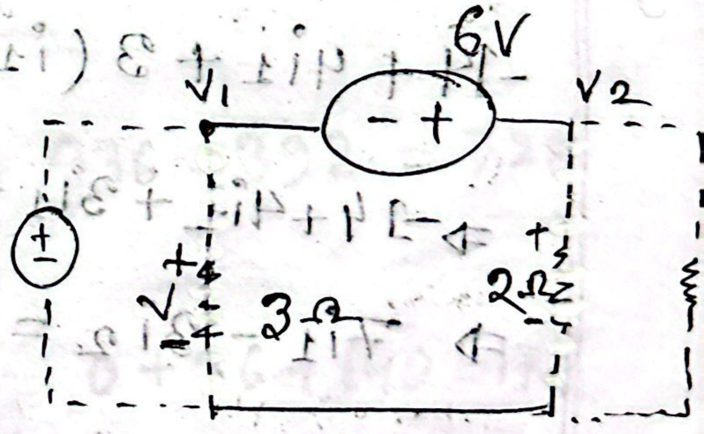
$$\Rightarrow -28V_1 - 32V_2 = -168$$

$$\Rightarrow 14V_1 + 16V_2 = 84$$

$$\Rightarrow 7V_1 + 8V_2 = 42 \quad \text{——(i)}$$

(wrong)

KVL in loop 1,



$\cancel{= V \mp 6 + 2I = 0}$

$\cancel{\Rightarrow -3I =}$

$$-V_1 - 6 + V_2 = 0$$

$$\Rightarrow V_2 - V_1 = 6 \quad \text{——(ii)}$$

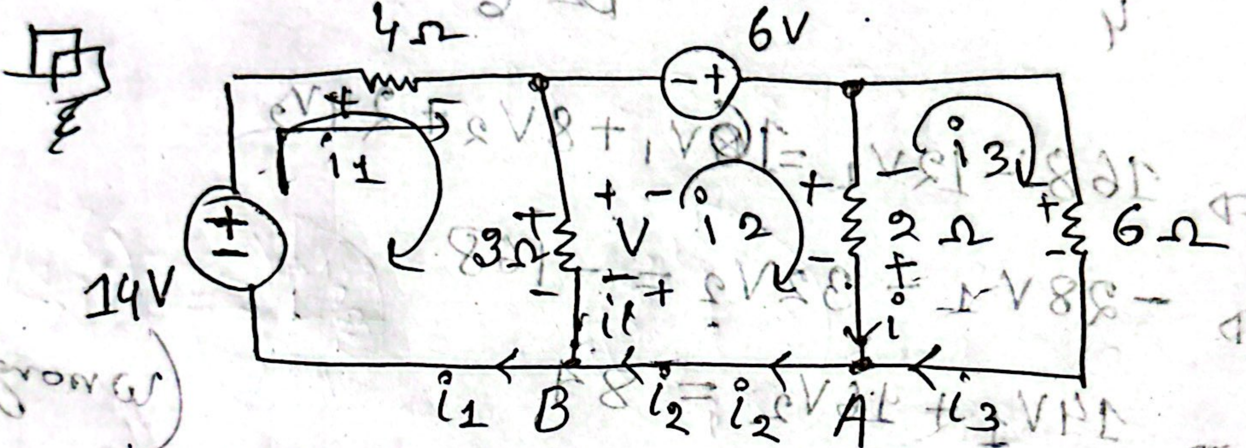
(K) ... current in + / out − } mesh analysis

$eq(i) - 8 \times eq(ii)$,

$$7V_1 + \cancel{8V_2} - \cancel{8V_2} - 8V_1 = 42 - 48$$

$$\Rightarrow -V_1 = -6$$

$$\therefore V_1 = 6$$



KVL in mesh1,

$$-14 + 4i_1 + 3(i_1 - i_2) = 0$$

$$\Rightarrow -14 + 4i_1 + 3i_1 - 3i_2 = 0$$

$$\Rightarrow 7i_1 - 3i_2 = 14$$

KVL in mesh2,

$$+3(i_2 - i_1) - 6 - 2(i_2 - i_3) = 0$$

$$\Rightarrow 3i_2 - 3i_1 + 2i_2 + 2i_3 = 6$$

$$\Rightarrow -3i_1 + 5i_2 - 2i_3 = 6 \quad \text{—— (ii)}$$

KVL in mesh 3,

$$2i_3 - 2i_1 + 6i_3 \cancel{-2i_1} = 0$$

$$\Rightarrow 8i_3 - 2i_1 = 0 \quad \text{—— (iii)}$$

$$\begin{bmatrix} 7 & -3 & 0 \\ -3 & 5 & -2 \\ -2 & 0 & 8 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} 14 \\ 6 \\ 0 \end{bmatrix}$$

$$\Delta = 280 - 84 = 196$$

$$\Delta_1 = \begin{bmatrix} 14 & -3 & 0 \\ 6 & 5 & -2 \\ 0 & 0 & 8 \end{bmatrix} = 560 + 144 = \cancel{916}\ 70$$

$$\Delta_2 = \begin{bmatrix} 7 & 14 & 0 \\ -3 & 6 & -2 \\ -2 & 0 & 8 \end{bmatrix} = 336 + 392 = 728$$

$$\Delta_3 = \begin{bmatrix} 7 & -3 & \cancel{0}\,14 \\ -3 & 5 & \cancel{-2}\,6 \\ -2 & 0 & \cancel{8}\,0 \end{bmatrix} = 0 + 36 + 140 = 176$$

$I_1 = 3.6A$	$I_2 = 3.7A$	$I_3 = 0.89A$

KCL in node A,

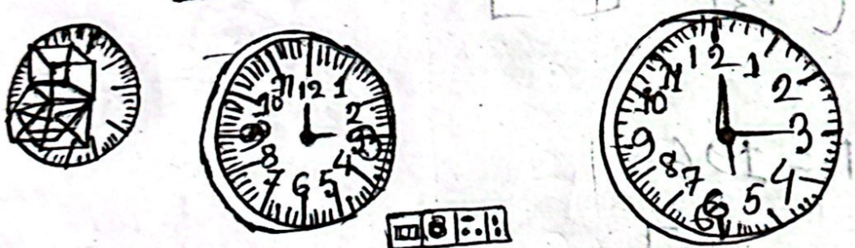
$$i_2 = i + i_3$$

$$i = i_2 - i_3 = 2.8A$$

Apply KCL at node B,

$$i' + i_2 = i_1$$

$$\Rightarrow i' = i_1 - i_2 = 3.6 - 3.7 = -0.13A$$



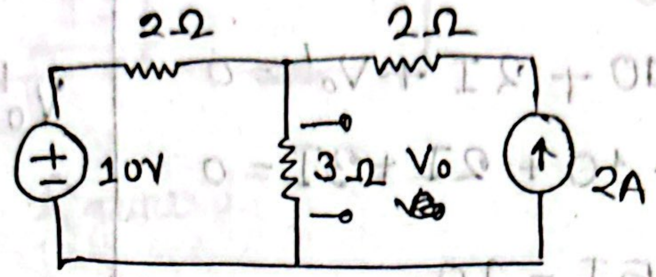
Clock
Wall Mounted Watch
Clock, WallClock

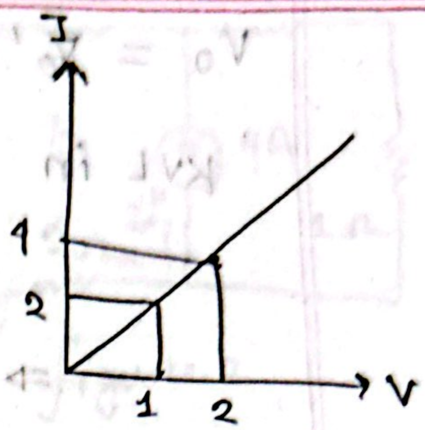
Final

25/08/2021

Superposition (Theorem)

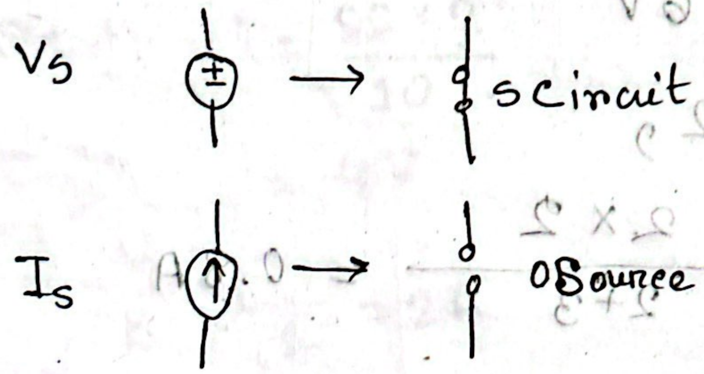
(Only Applicable for Linear circuit) ***





Determine V_o voltage: (using superposition)

প্রতিবার ১টা source নিয়ে কাজ করবো,



Step ① :

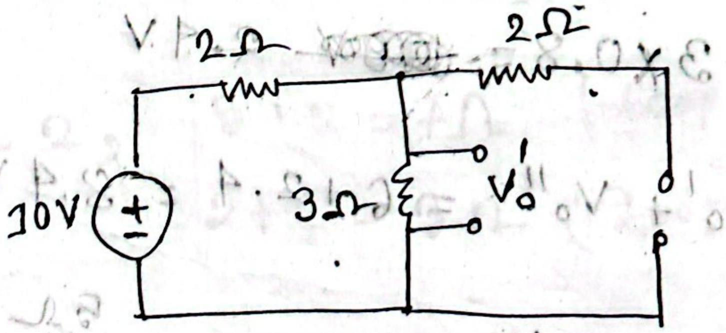


Figure 1

Step-2:

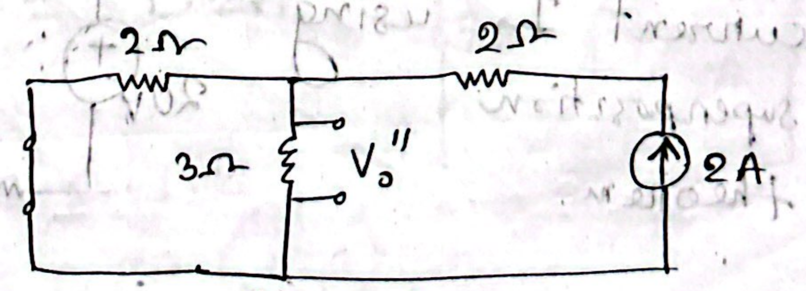


Figure 2

$V_0 = V_0' + V_0''$

KVL in figure 1,

$$-10 + 2I + V_0' = 0$$

$$\Rightarrow -10 + 2I + 3I = 0$$

$$\Rightarrow 5I = 10$$

$$\therefore I = 2A$$

$$V_0' = \frac{10 \times 3}{2+3} = 6V$$

$V_0' = 3 \times 2 = 6V$

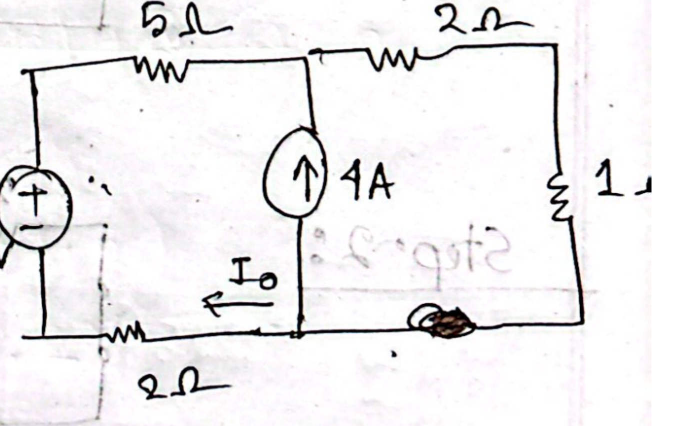
CDR in figure 2,

$$I'' = \frac{2 \times 2}{2+3} = 0.8A$$

$V_0'' = 3 \times 0.8 = 2.4V$

$\therefore V_0 = V_0' + V_0'' = 6 + 2.4 = 8.4V$ (Ans)

Determine the current I_o using superposition theorem



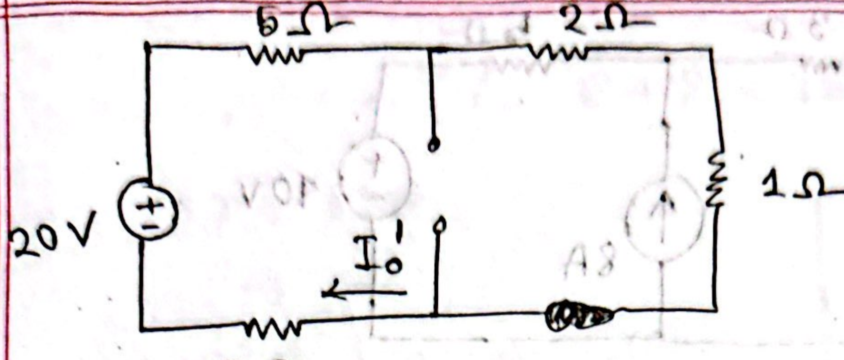


figure 1

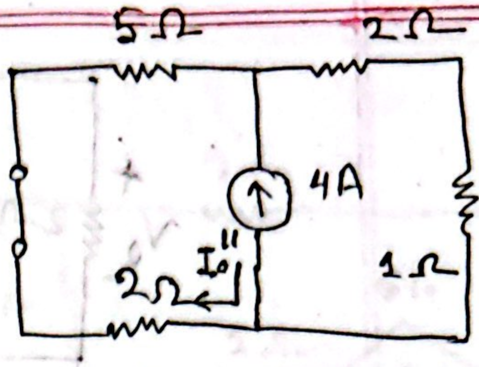


figure 2

$\cancel{I_0 = \frac{V}{R}}$

$V' = \frac{20 \times 2}{10}$

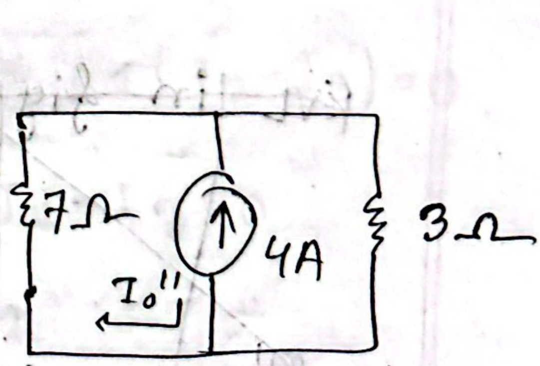
$= 4V$

$I_0' = \frac{V'}{R} = \frac{4}{2} = 2A$

in figure 2, $5 + 2 = 7\Omega$ (loop 1)

$2 + 1 = 3\Omega$ (loop 2)

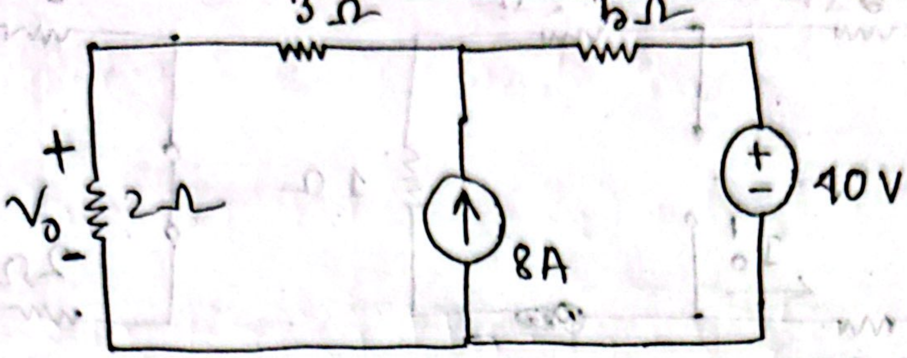
$I_0'' = \frac{-4 \times 3}{7+3} = -1.2A$



$I_0 = I_0' + I_0'' = 2 - 1.2$

$I_0 = 0.8A$ (Ans)

using superposition theorem, find V_o



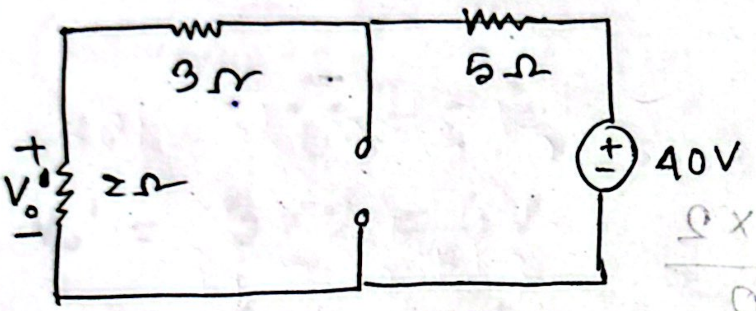


figure 1

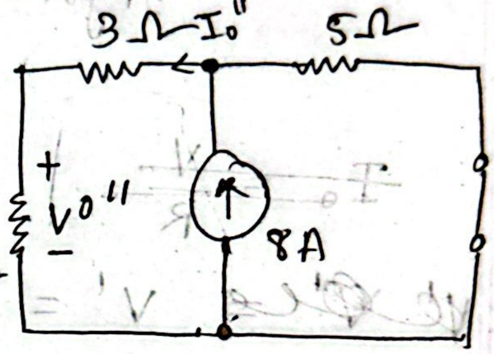


fig 2

VDR in fig 1,

$$V_o' = \frac{40 \times 2}{5+3+2} = 8V$$

$$I_o'' = \frac{8 \times 5}{5+5} = 4A$$

$$V_o'' = 2I = 4 \times 2 = 8V$$

~~KVL in fig 2,~~ $\cancel{2I + 3I + 8 = 0}$

$\cancel{\Rightarrow 5I = -8}$

$\cancel{\Rightarrow I = -1.6A}$

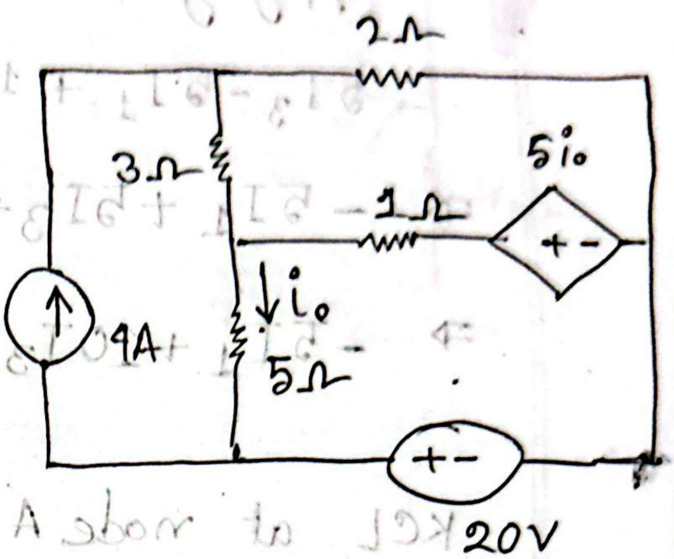
$\cancel{V_o'' = 2 \times -1.6 = -3.2V}$

$\cancel{\frac{V_o}{2}}$

$V_0 = V_0' + V_0'' = 8 + 8 = 16V$

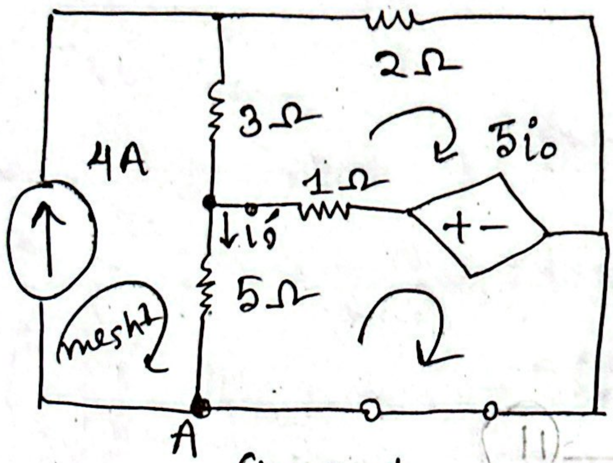
~~$= 8 \cdot 3/2$~~

~~$= 4.8V$~~



Find I_0 using

(1) Superposition theorem.



(II)

figure 1

KVL in mesh 1,

$I_1 = 4A$

KVL in mesh 2,

$3(I_2 - I_1) + 2(I_2) - 5i_0' + 1(I_2 - I_3) = 0$

$\Rightarrow 3I_2 - 12 + 2I_2 - 5i_0' + I_2 - I_3 = 0$

$\Rightarrow 6I_2 - I_3 - 5(4 - I_3) = 12$

$\Rightarrow 6I_2 + 4I_3 = 32$ (III)

Applying KVL in mesh 3,

$$5I_3 - 5I_1 + 1(I_3 - I_2) + 5i_0' + 4I_3 = 0$$

$$\Rightarrow -5I_1 + 5I_3 + 1I_3 - I_2 + 5i_0' + 4I_3 = 0$$

$$\Rightarrow -5I_1 + 10I_3 - I_2 + 5i_0' = 0 \quad \text{—— (I)}$$

KCL at node A,

$$i_1 = i_0' + i_3$$

$$\Rightarrow 4 = i_0' + i_3$$

$$\therefore i_0' = 4 - i_3 \quad \text{—— (II)}$$

$$\therefore \; -(5\times 4) + 10I_3 - I_2 + 5(4 - i_3) = 0$$

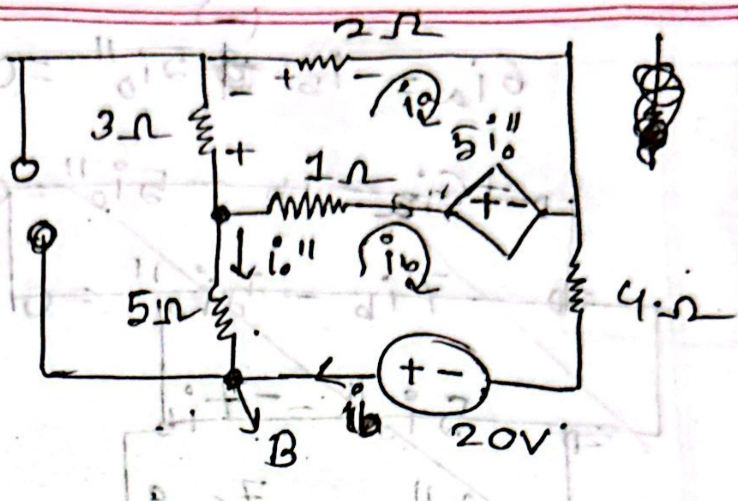
$$\Rightarrow -\cancel{20} + 10I_3 - I_2 + \cancel{20} - 5I_3 = 0$$

$$\Rightarrow 5I_3 - I_2 = 0$$

$i_3 = 0.95$

i_3 value in eq (II), $i_0' = 3.05A$

KVL in mesh 1,



$3(i_a)+2(i_a)-5i_o''$
$+1(i_a-i_b)=0$

$\Rightarrow 3i_a+2i_a-5i_o''$
$+i_a-i_b=0$

$\Rightarrow 6i_a-i_b-5i_o''=0$ —— (I)

KVL in mesh 2,

$-20+5i_b+1(i_b-i_a)+5i_o''+4i_b=0$

$\Rightarrow 5i_b+i_b-i_a+5i_o''+4i_b=20$

$\Rightarrow 10i_b-i_a+5i_o''=20$ —— (II)

~~(I) + (II) $\Rightarrow 6i_a-i_b-5i_o''+10i_b-i_a+5i_o''=+20$~~

~~$\Rightarrow 5i_a+9i_b=20$~~

~~$\Rightarrow 5i_a=20-9i_b$~~

~~$\therefore i_a=\frac{20-9i_b}{5}$~~

Applying KCL at node B,

$i_o''+i_b=0$

$\Rightarrow i_o''=-i_b$

$$6i_a - i_b - 5i_o'' = 0$$

$$\cancel{\Rightarrow +6i_a - i_b - 5i_o'' = 0}$$
$$\cancel{\Rightarrow 7i_b - 5i_o'' = 0}$$
$$\cancel{\Rightarrow 5i_o'' = -7i_b}$$
$$\cancel{i_o'' = -\tfrac{7}{5} i_b}$$

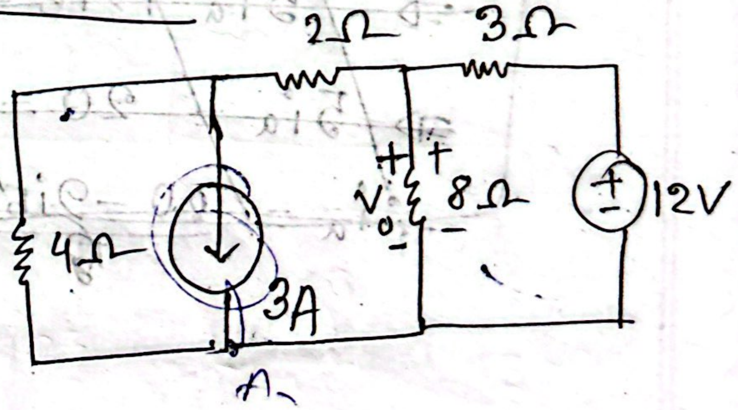
$$6i_a - i_b - 5(-i_b) = 0$$
$$\Rightarrow 6i_a - i_b + 5i_b = 0$$
$$\Rightarrow 6i_a + 4i_b = 0$$

$$10i_b - i_a + 5i_o'' = 20$$
$$\Rightarrow 10i_b - i_a + 5(-i_b) = 20$$
$$\Rightarrow 5i_b - i_a = 20$$

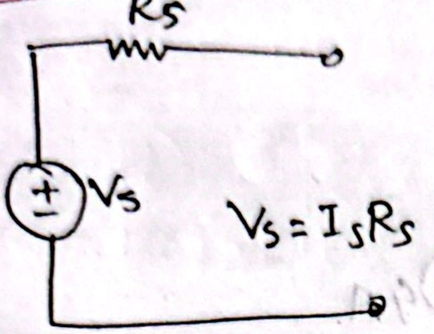
$$i_o = i_o' + i_o'' = 3.05 + (-3.53)$$
$$= -0.48 \quad \text{(Ans)}$$

Source Transformation

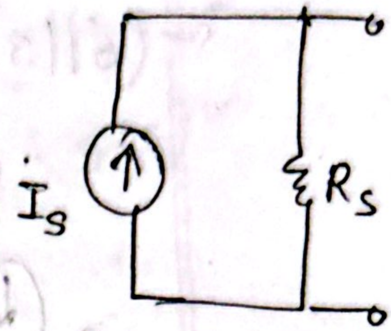
☐ Use source transformation to find v_o.



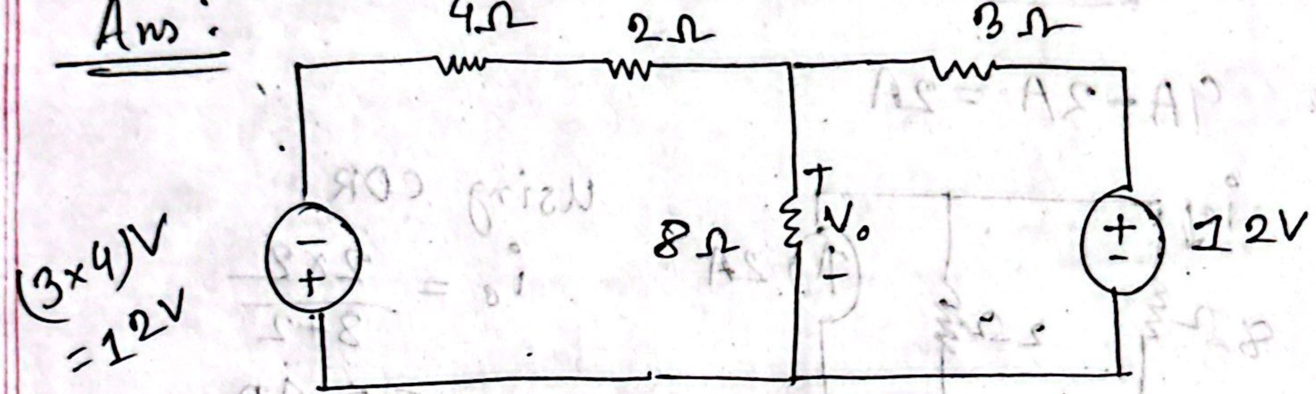
Theory:



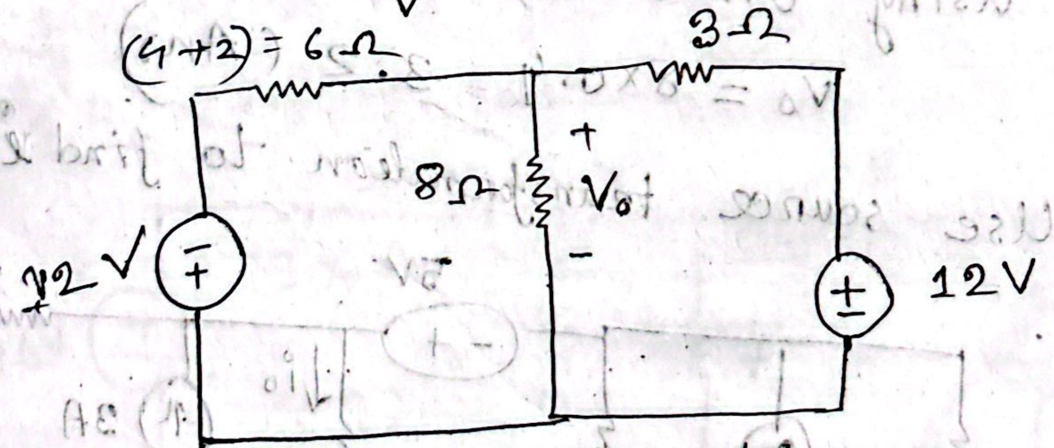
$V_S = I_S R_S \Rightarrow I_S = \frac{V_S}{R_S} \Rightarrow$



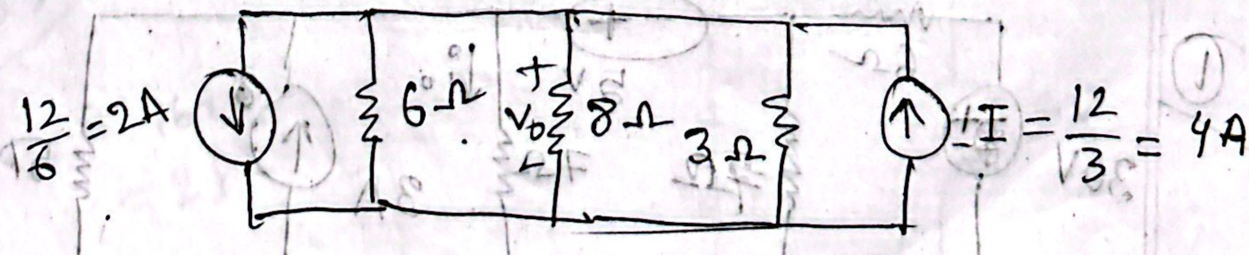
Ans:



⇓

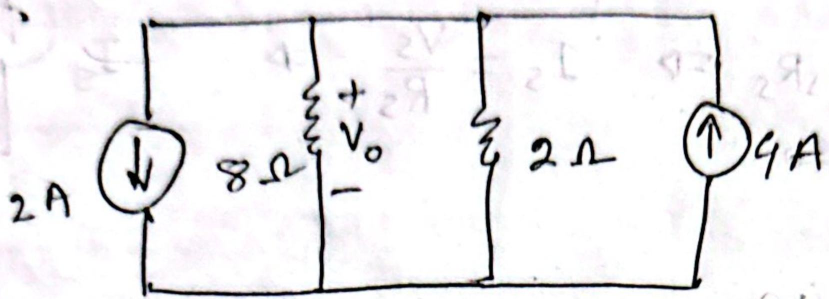


⇓

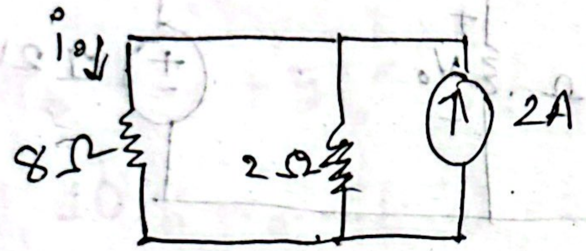


B

$\rightarrow (6 \| 3)\,\Omega = \frac{6\times 3}{6+3} = 2\,\Omega$



$4A - 2A = 2A$



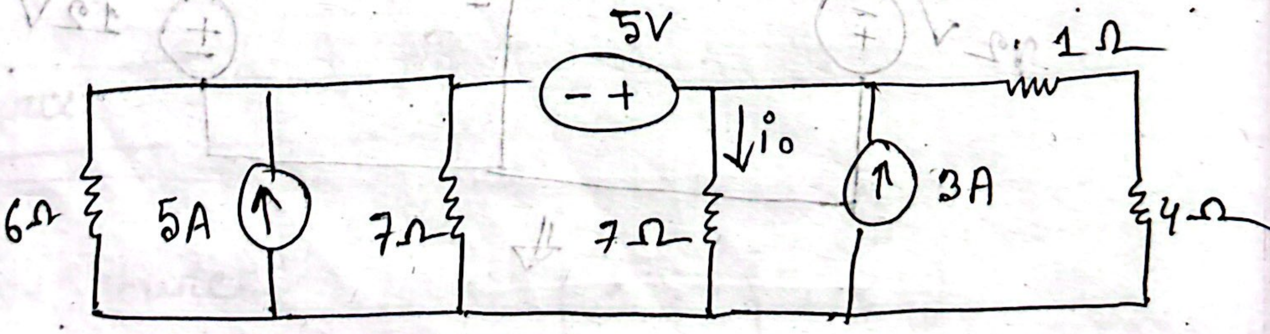
Using CDR,

$$i_o = \frac{2\times 2}{8+2} = 0.4A$$

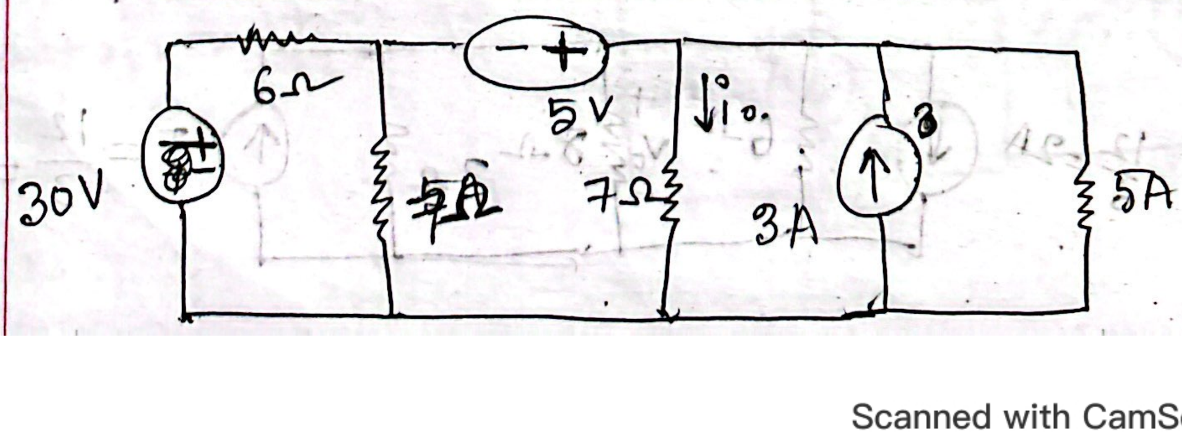
Using Ohm's law,

$$V_o = 8\times 0.4 = 3.2 \text{ (Ans)}$$

Use source transformation to find i_o

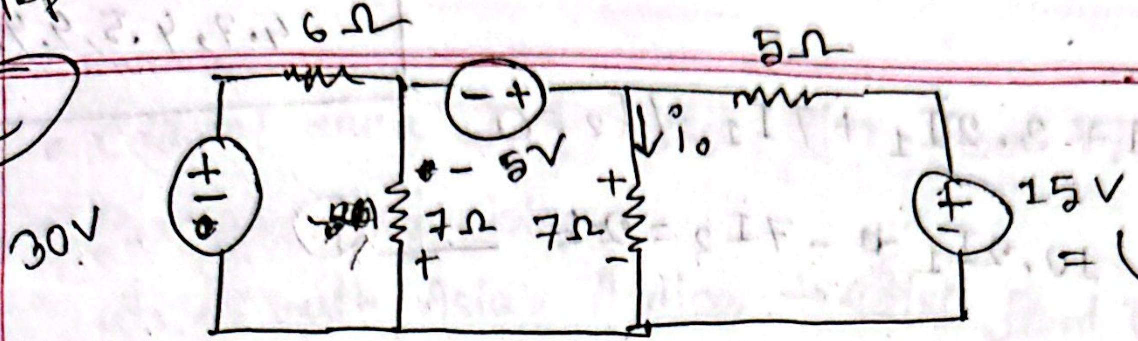


Step ①



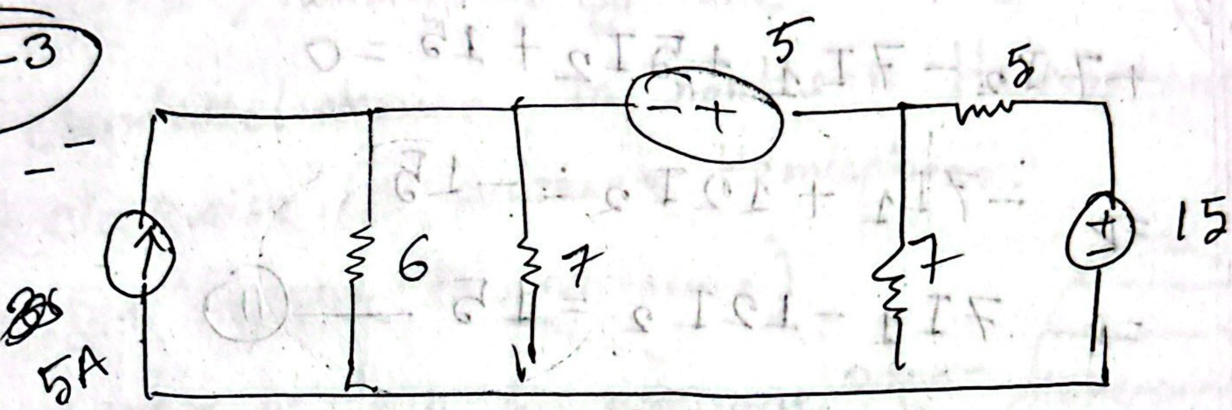
V_s = Series
I_s = Parallel

Step ②



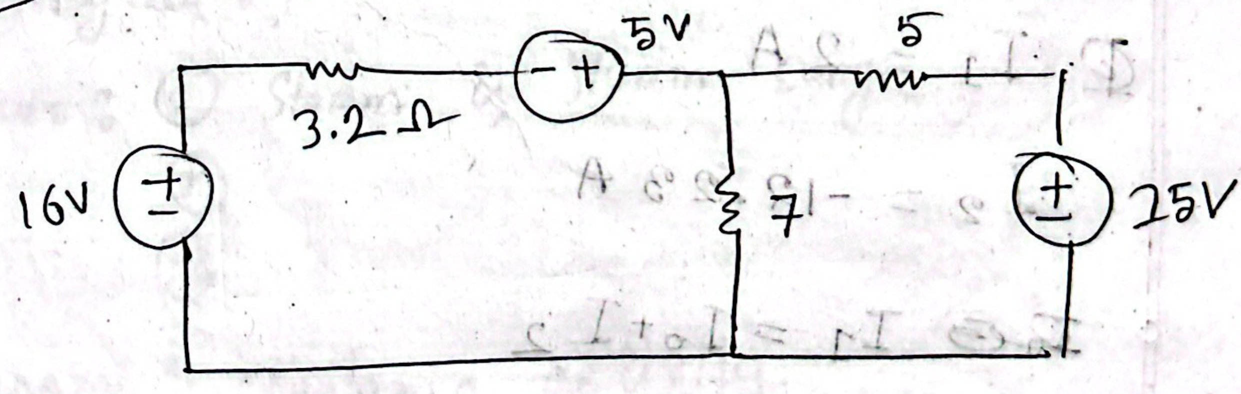
$= (3\times5)^V$

Step-3



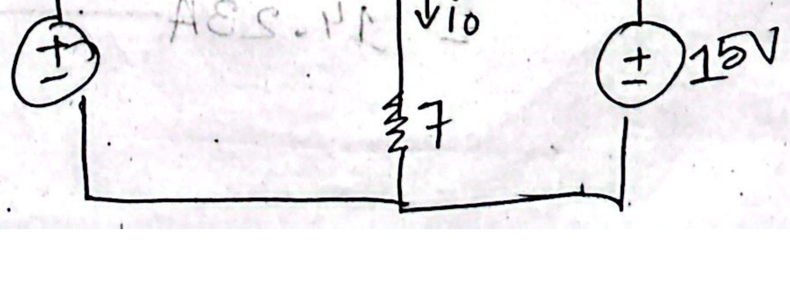
$6 \| 7 = \frac{6\times7}{6+7} = 3.2\,\Omega$

Step 4 $5\times3.2 = 16\,V$



Step 5

16+5
=21



Ex- 4.7, 4.4, 4.5

Pracprob-

4.7, 4.5, 4.4.

mesh 1

$-21 + 3.2I_1 + 7I_1 - 7I_2 = 0$

$\Rightarrow 10.2I_1 - 7I_2 = 21$ —— (I)

mesh 2

$+7I_2 - 7I_1 + 5I_2 + 15 = 0$

$\Rightarrow -7I_1 + 12I_2 = -15$

$\Rightarrow 7I_1 - 12I_2 = 15$ —— (II)

$$\begin{bmatrix} 10.2 & -7 \\ 7 & -12 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 21 \\ 15 \end{bmatrix}$$

$\Delta = -73.4$

$\Delta_1 = -147$

$\Delta_2 = 6$

$I_1 = 2A$

$I_2 = -12.23 A$

$I_1 = I_0 + I_2$

$I_0 = I_1 - I_2$

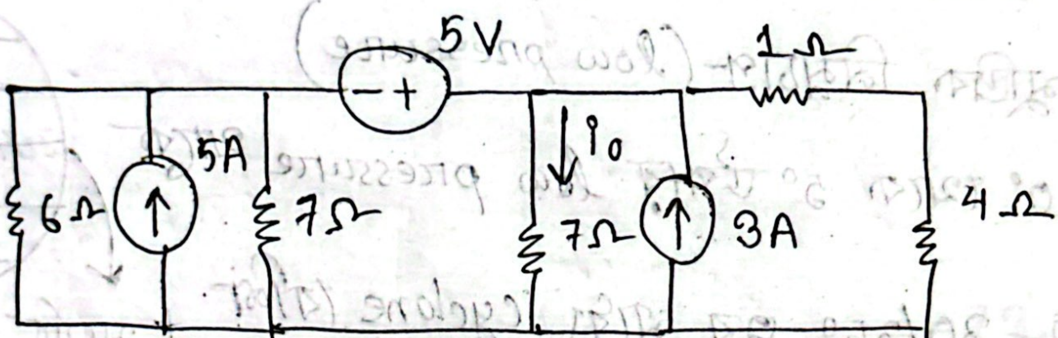
$= 14.23A$

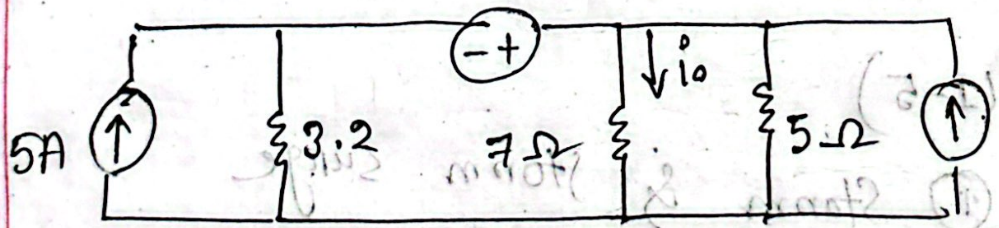
MID $\left\{ \begin{array}{l} \text{Assignment — 15} \\ \text{Class Test — 15} \\ \quad \searrow \text{(Mesh, Node Analysis)} \end{array} \right.$ (Next Monday) 02/09/2024

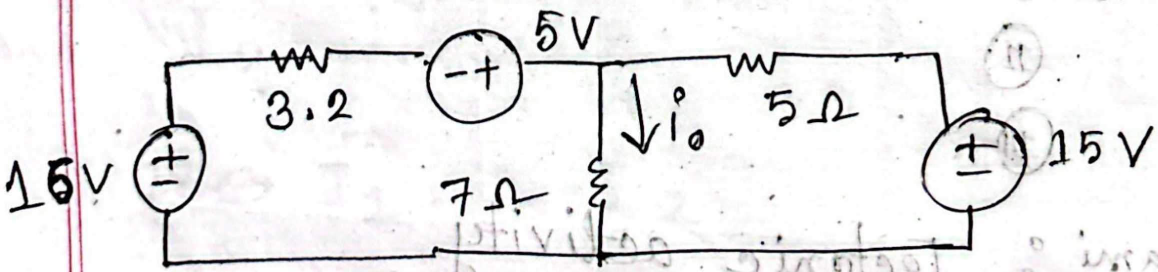
28/08/2024

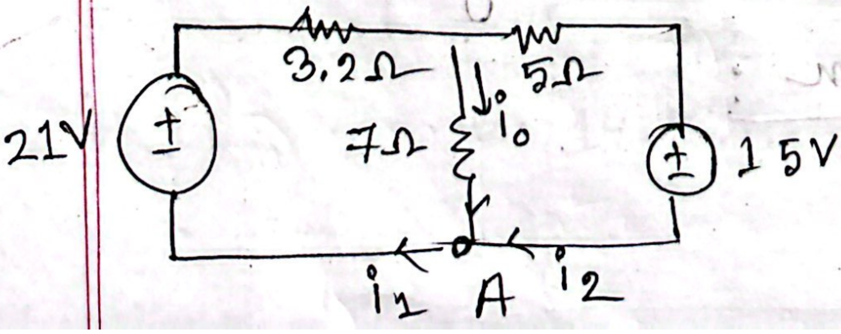
Thevenin's Theorem :-

Find i_o using ~~super~~ source tranformation









KCL at nodA,

$i_o + i_2 = i_1$

$\therefore i_o = i_1 - i_2$

Applying KVL in mesh 1,

$$-21 + 3.2 i_1 + 7(i_1 - i_2) = 0$$

$$\Rightarrow 10.2 i_1 - 7 i_2 = 21 \quad \text{——— (i)}$$

Applying KVL in mesh 2,

$$-7 i_1 + 12 i_2 = -15 \quad \text{——— (ii)}$$

$i_1 = 2A$

$i_2 = -0.081 A$

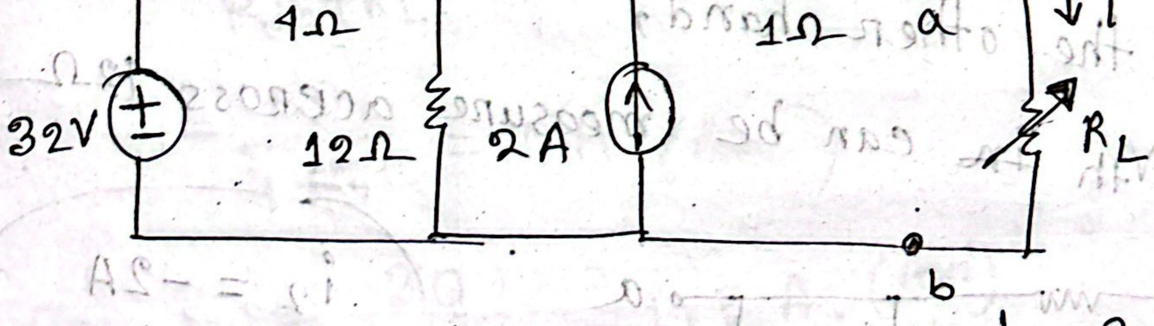
$i_o = i_1 - i_2$

$= 2 - (-0.081)$

$= 2.081 A$ (Ans)

Thevenin's Theorem

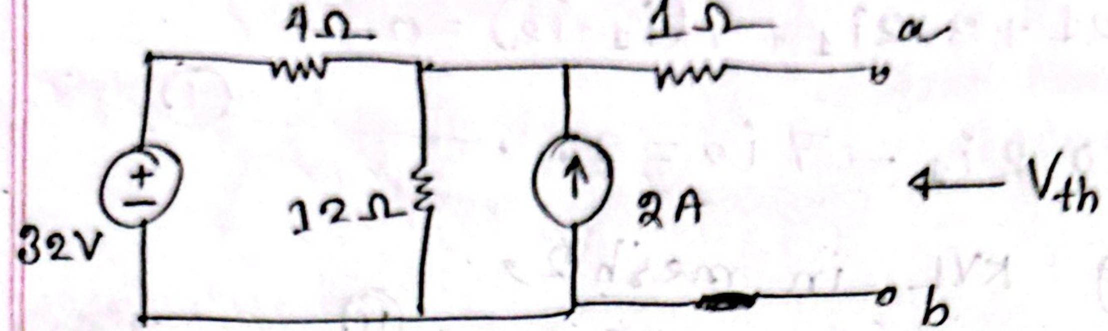
\# Find the Thevenin equivalent circuit the following figure to the left of the terminal a-b then find i, ($R_L = 6\Omega$, 16-



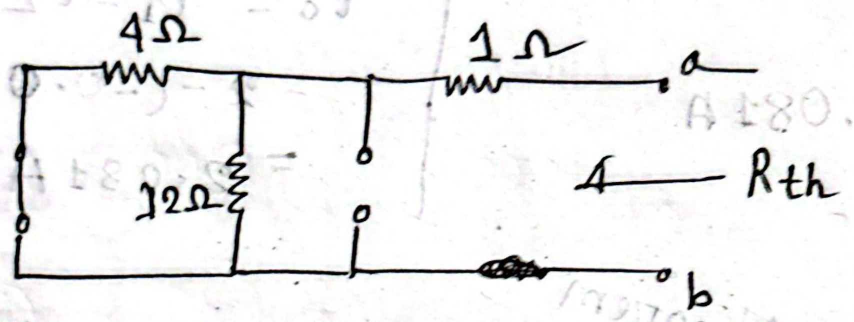
R_{th} = Thevenin Equivalent Resistance

V_{th} = " " Voltage

Step 1: Open R_L,



Step 2: Superposition formula,



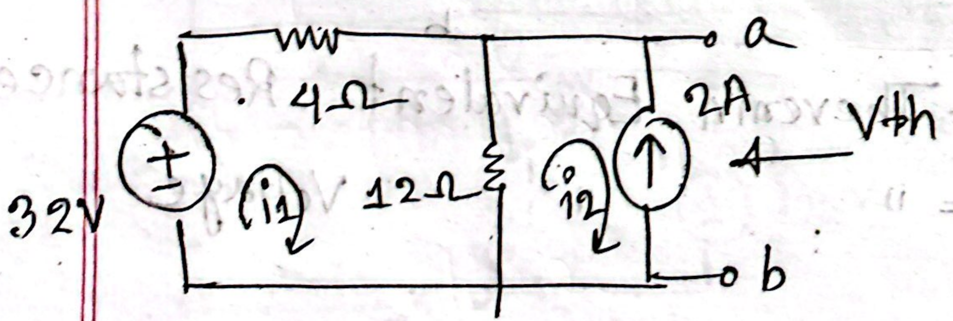
$\therefore R_{th} = [(4 \parallel 12) + 1]\ \Omega$

$= (3+1)\ \Omega = 4\ \Omega$

On the other hand,

V_{th} ~~in~~ can be measure accross 12Ω

$i_2 = -2A$



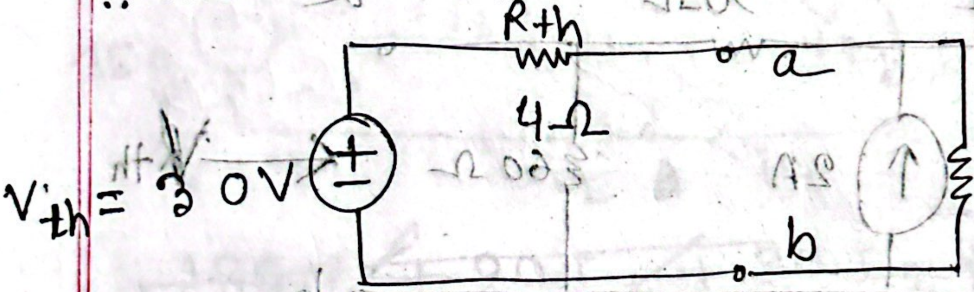
KVL in mesh 1,

$$-32 + 4I_1 + 12I_1 - 12\times(-2) = 0$$

$$\Rightarrow I_1 = 0.5\,A$$

$$\therefore V_{th} = 12(I_1 - I_2) = 12(0.5 - (-2)) = 30\,V$$

∴ Thevnin Equivalent circuit,

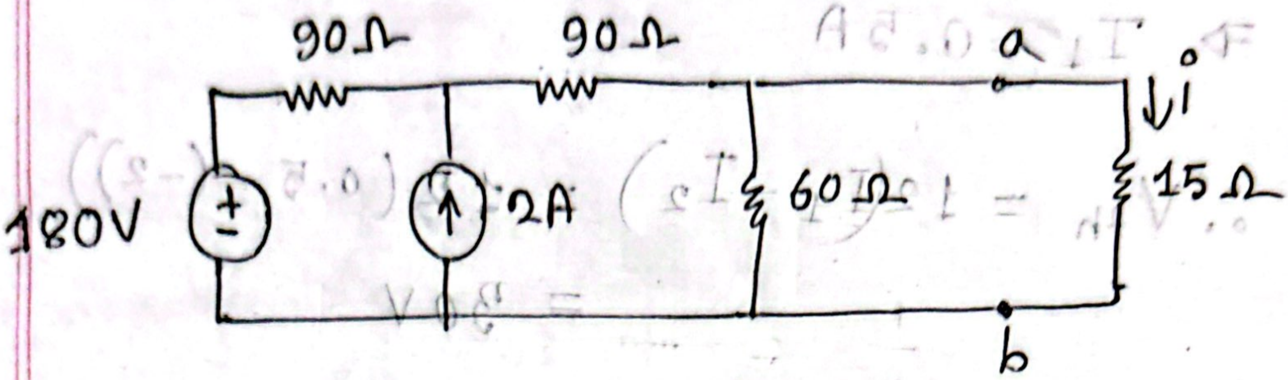


$$i = \frac{V_{th}}{R_{th}+R_L}$$ [using Ohm's Law]

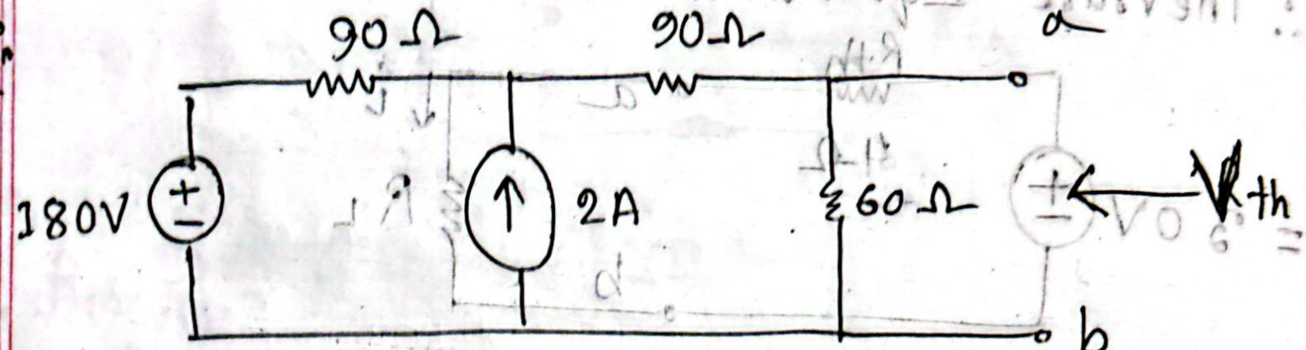
$$\Rightarrow \frac{30}{4+6} = 3A \text{ (Ans)}$$

or $$i = \frac{30}{4+16} = 1.5\,A. \text{ (Ans)}$$

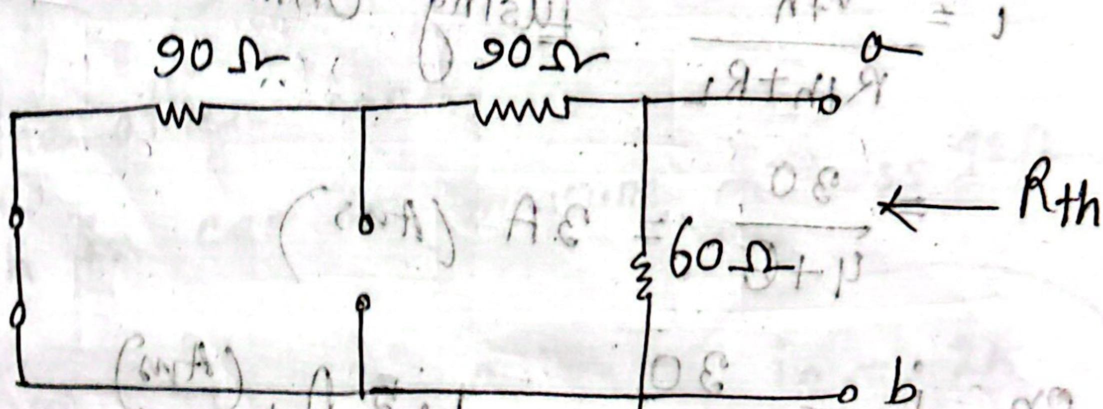
Find the Thevenin equivalent circuit for the following figure to the left of terminals a-b.



V_{th}:



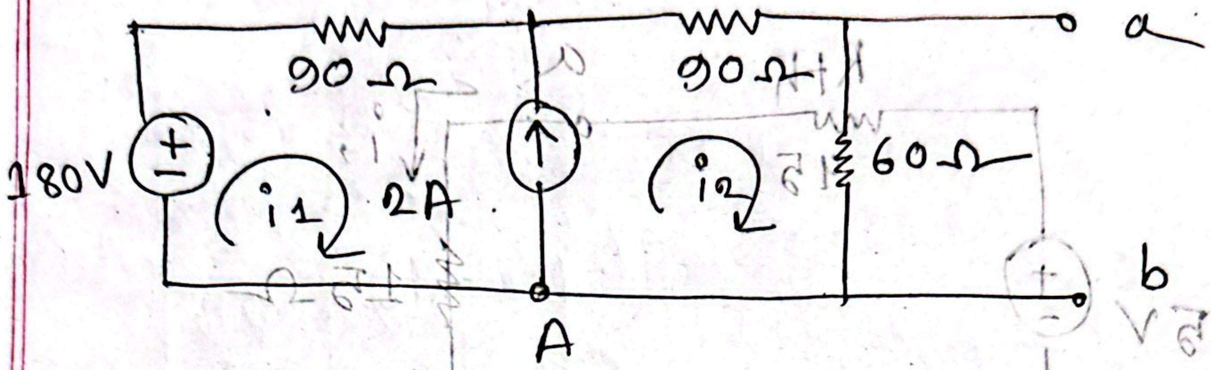
R_{th}:

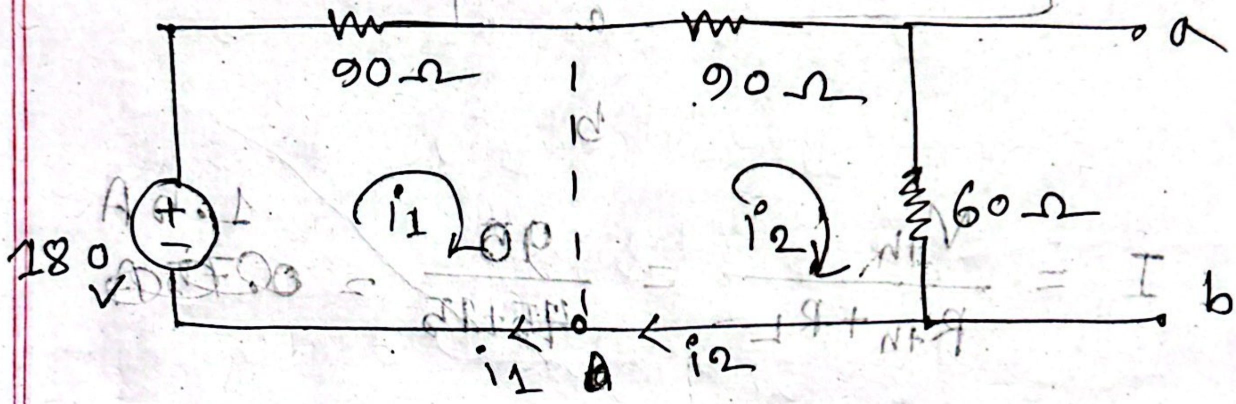


$$R_{th} = (90+90) \parallel 60$$

$$= 45\,\Omega$$

V_{th} can be measured accross 60Ω.





~~$180V + 90I_1 + 90I_2 + 60I_2 = 0$~~

$\Rightarrow 90I_1$

VDR,

$V_1 = \frac{180 \times 90}{90+90+60}$

$V_2 = \frac{180 \times 90}{90+90+60}$

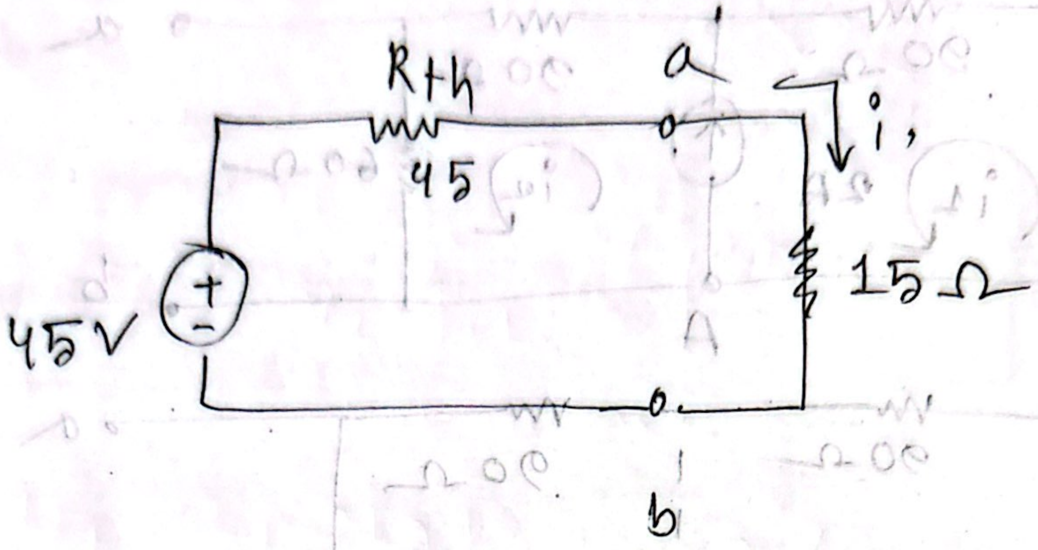
$V_3 = \frac{180 \times 60}{90+90+60}$

$\therefore V_3 = \frac{180 \times 60}{90+90+60}$

~~$V_{th} = 45\ V$~~

$i_2 = i_1 + i_s$

Thervnin Equivalent Circuit,



$$I = \frac{V_{th}}{R_{th}+R_L} = \frac{90}{45+15} = \cancel{0.75A}\ 1.5\,A$$

with superposition,

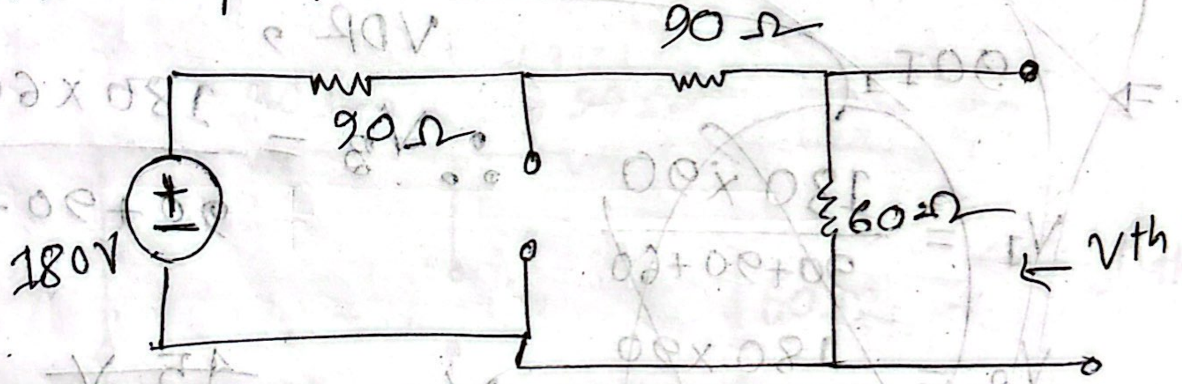


Fig1

VDR,

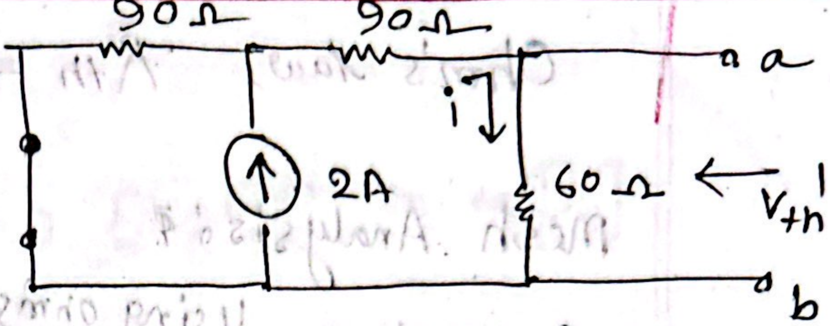
$V_{th}' = 45V$

$$\cancel{-180 + 90I_1 + 90I_2 + 60I_2 = 0}$$

$$\Rightarrow \cancel{90I_1 + 150I_2} = 180$$

CDR,

$$i = \frac{2\times 90}{90+(90+60)}$$



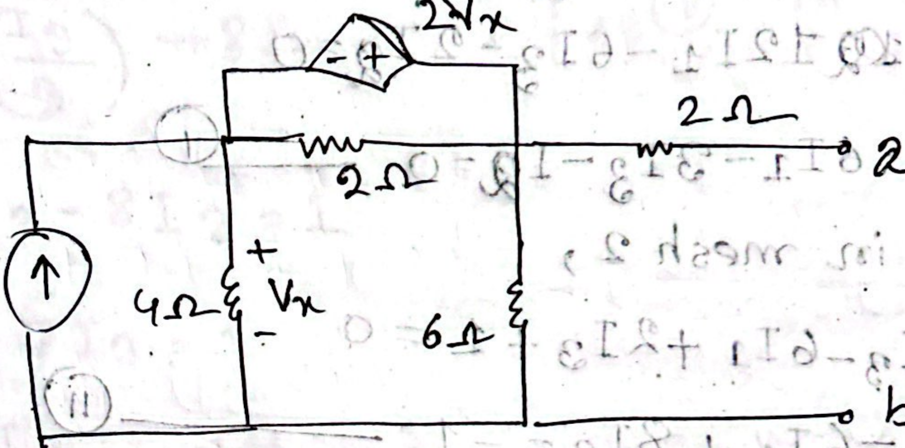
$= 0.75A$

Using Ohm's law,

$$V_{th}'' = 60i = 60\times 0.75$$

$$= 45V$$

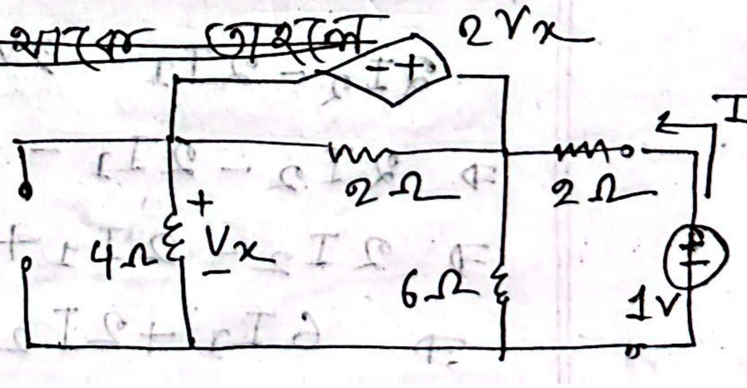
$$V_{th} = V_{th}' + V_{th}'' = 45+45 = 90V$$



Find the Thevenin equivalent circuit at terminal a-b:-

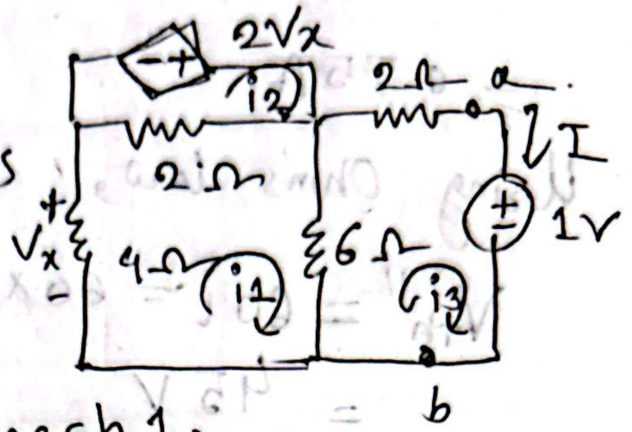
~~যদি dependent source থাকে তাহলে~~

যদি terminal এর আগে
R parallel থাকে 1A বসাবো
R series থাকলে 1V বসাবো



Ohm's law, $R_{th} = \frac{V}{I} = \frac{1}{I}$

Mesh Analysis;



~~KVL Branch~~ Using ohm's law,

~~Vx~~ $V_x = 4I_1$

KVL in mesh 1,

$4I_1 + 2I_1 - 2I_2 + 6I_1 - 6I_3 = 0$

$\Rightarrow 12I_1 - 6I_3 - 2I_2 = 0$

$\Rightarrow 6I_1 - 3I_3 - I_2 = 0$ —— (i)

KVL in mesh 2,

$6I_3 - 6I_1 + 2I_3 + 1 = 0$

$\Rightarrow -6I_1 + 8I_3 = -1$ —— (ii)

~~$\Rightarrow 3I_1 - 4I_3 = 1$ (ii)~~

KVL in mesh 2,

$2I_2 - 2I_1 - 2V_x = 0$

$\Rightarrow 2I_2 - 2I_1 - 2(-4I_1) = 0$

$\Rightarrow 2I_2 - 2I_1 + 8I_1 = 0$

$\Rightarrow 6I_1 + 2I_2 = 0$ $\therefore 3I_1 + I_2 = 0$ (iii)

$\Rightarrow I_2 = 3I_1$ —— (IV)

$\therefore 6I_1 - 3I_3 + 3I_1 = 0$ [eq (IV) in eq (I)]

$\Rightarrow 9I_1 - 3I_3 = 0$

$\Rightarrow 3I_1 - I_3 = 0$

$\Rightarrow I_1 = \frac{I_3}{3}$ —— (V)

$\therefore 6\left(\frac{I_3}{3}\right) - 8I_3 = 1$ [eq (V) in eq (II)]

$\Rightarrow 2I_3 - 8I_3 = 1$

$\Rightarrow -6I_3 = 1$

$\Rightarrow I_3 = -\frac{1}{6}$

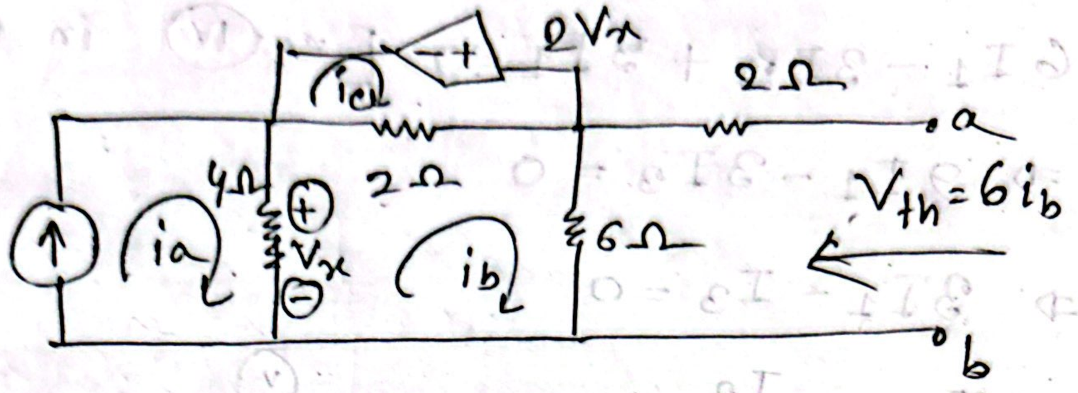
Applying KCL at node a,

$i_3 + I = 0$

$\Rightarrow I = i_3$

$\Rightarrow = -\left(-\frac{1}{6}\right) = \frac{1}{6}$

$$R_{th} = \frac{V}{I} = \frac{1}{I} = \frac{1}{1/6} = 6\Omega$$



$i_a = 5A$

KVL in mesh b,

$$4I_b - 4I_a + 2I_b - 2I_c + 6I_b = 0$$

$$\Rightarrow \overset{12}{\cancel{10}} I_b - 20 - 2I_c = 0$$

$$\Rightarrow 6I_b - I_c = 10 \quad \text{——— (1)}$$

KVL in mesh c,

$2I_c - 2I_b - 2V_x = 0$ $\quad \therefore V_x = I_c - I_b$

$$V_x = 4(5 - I_b)$$

$$\therefore V_x = 20 - 4I_b$$

$\cancel{I_c - I_b = 4I_b - 20}$ $20 - 4I_b$ $\cancel{I_c - I_b = 25 - I_b}$

$\cancel{\Rightarrow I_c \quad 20}$ $= 5$ (11) $\Rightarrow I_c - I_b =$

$$\begin{bmatrix} 5 & -1 \\ -5 & 1 \end{bmatrix} \begin{bmatrix} I_b \\ I_c \end{bmatrix} = \begin{bmatrix} 10 \\ 20 \end{bmatrix}$$

$I_b = 1A$

$I_c = 5A$

$\cancel{25 - I}$

$5I_b - 5 = 10$

$\Rightarrow \cancel{5}\, I_b = 1$

$I_c - I_b = V_x = 20 - 4I_b$

$\Rightarrow \cancel{I_c = 20}$ $-3I_b - I_c = -20$

$\therefore I_b - I_c = 20$

$\cancel{I_b = -3.333}$

$6I_b - I_c = 10$

$3I_b + I_c = 20$

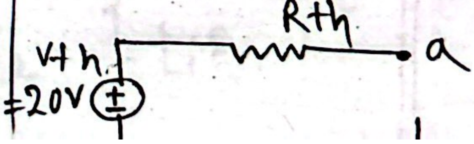
$9I_b = 30$

$\therefore I_b = 3.333$

$V_{th} = 6i_b$

$= 6 \times 3.333$

$\approx 20V$

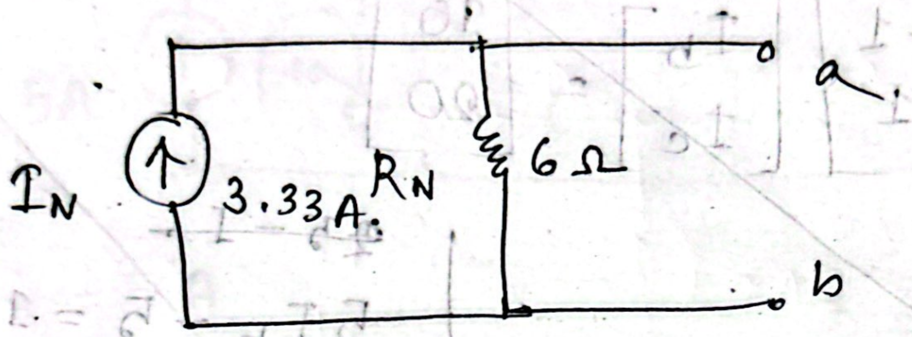


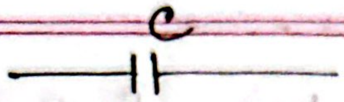
Norton Theorem

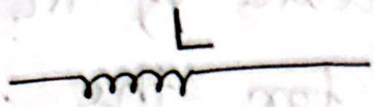
I_N = Norton Current $= \frac{V_{th}}{R_{th}}$

R_N = Norton Resistance = R_{th}

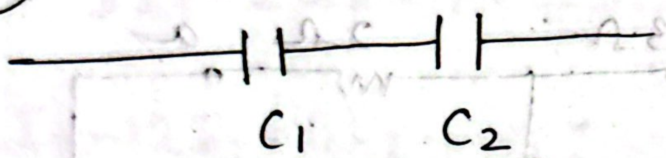
Norton equivalent circuit,

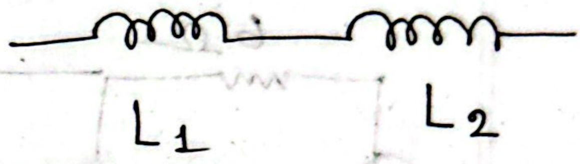


Capacitor 

Inductor 

⑤



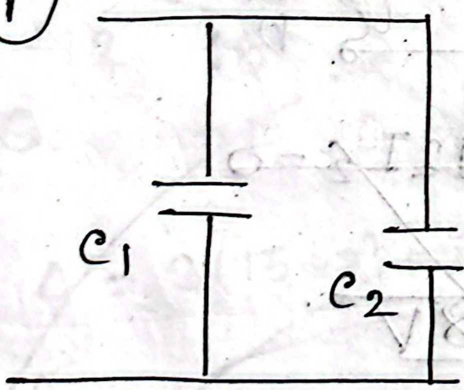


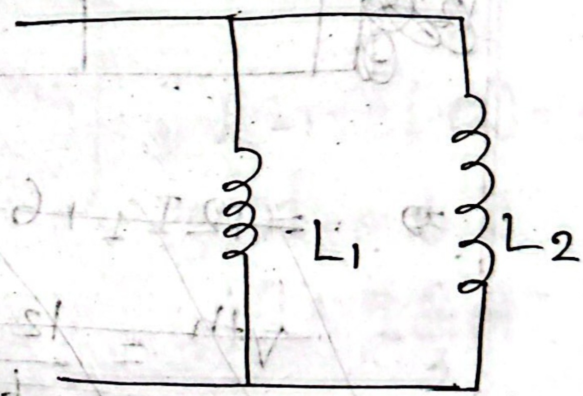
$$C_{eq} = \frac{C_1 C_2}{C_1 + C_2}$$

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

Energy : $W_c = \frac{1}{2} C V_c^2$

Ⓟ





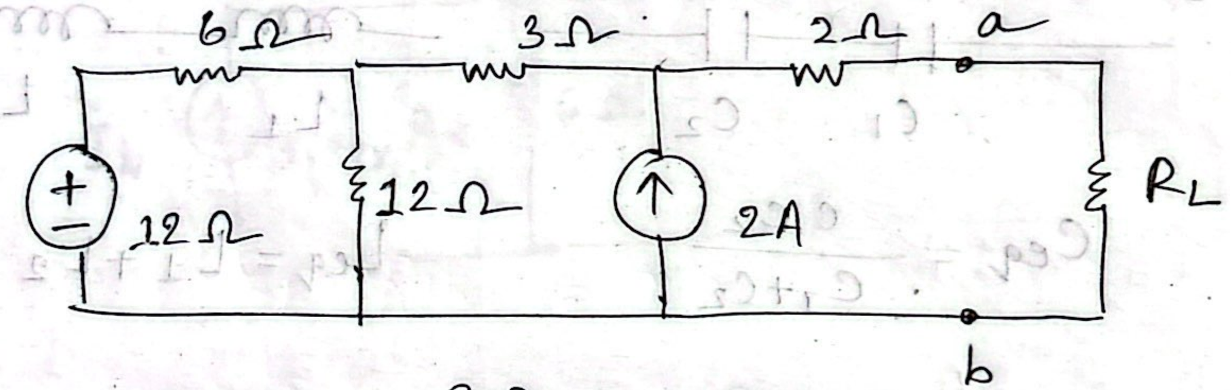
$$C_{eq} = C_1 + C_2$$

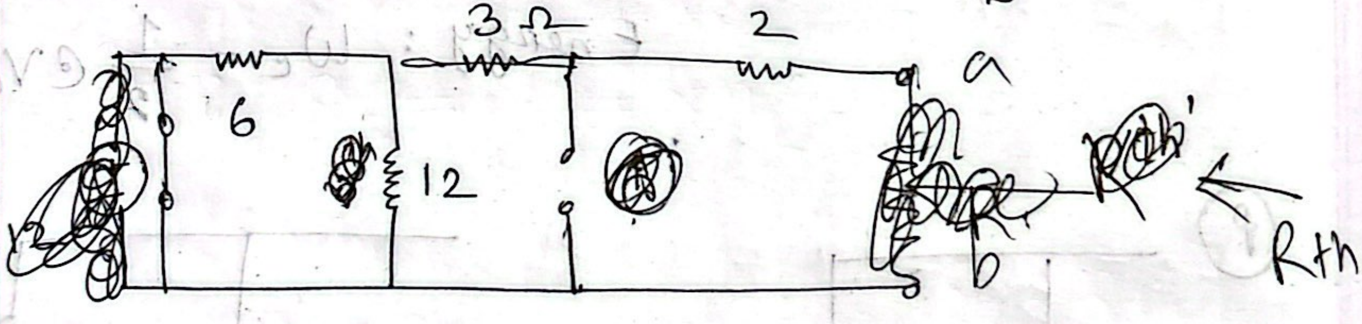
$$L_{eq} = \frac{L_1 L_2}{L_1 + L_2}$$

Energy : $W_L = \frac{1}{2} L i^2$

Maximum power transfer Theorem

Find the value of R_L for maximum power transfer for the following circuit, Find the maximum power.





~~$12I_1 + 6I_1 + 12I_1 - 12I_2 = 0$~~

~~$V_{th} = \frac{12 \times 12}{6+12} = 8\,V$~~

~~$R_{th} = 3+2+12+6 = 23\,\Omega$~~

$$R_{th} = (6 \| 12) + 3 + 2$$

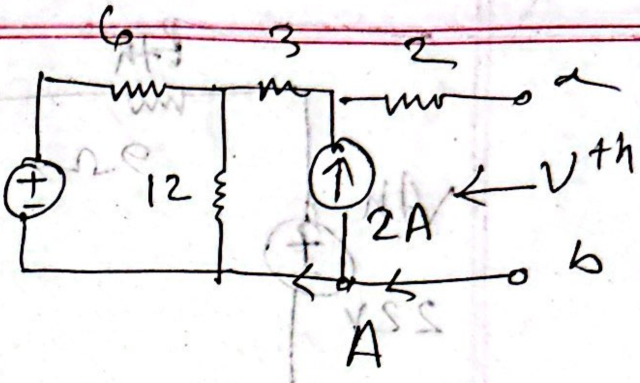
$$= 4 + 3 + 2 = 9\,\Omega$$

$$-12+6I_1+12I_1-12I_2=0$$

$$\Rightarrow 18I_1-12I_2=12$$

$$\Rightarrow 9I_1-6I_2=6 \quad \text{--- (i)}$$

$$\Rightarrow 3I_1-2I_2=2 \quad \text{--- (I)}$$



$$12I_2-12I_1+3I_2+2I_3+V_{th}=0$$

$$\Rightarrow -12I_1+15I_2+2I_3=-V_{th}=0 \quad \text{--- (II)}$$

(2×0) $\therefore -12I_1+15I_2+V_{th}=0$

KCL at node A, $I_3=2+I_2$

$$\therefore I_3-I_2=2 \quad \text{--- (III)}$$

$$\Rightarrow I_2=-2$$

$$\begin{bmatrix} 3 & -2 & 0 \\ -12 & 15 & 2 \\ 0 & -1 & 1 \end{bmatrix}\begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix}=\begin{bmatrix} 2 \\ -V_{th} \\ 2 \end{bmatrix}$$

$$3I_1-2(-2)=2$$

$$\Rightarrow 3I_1=2$$

$$\therefore I_1=\frac{2}{3}A$$

$$\Delta=3(15+2)+2(-12-0)=$$

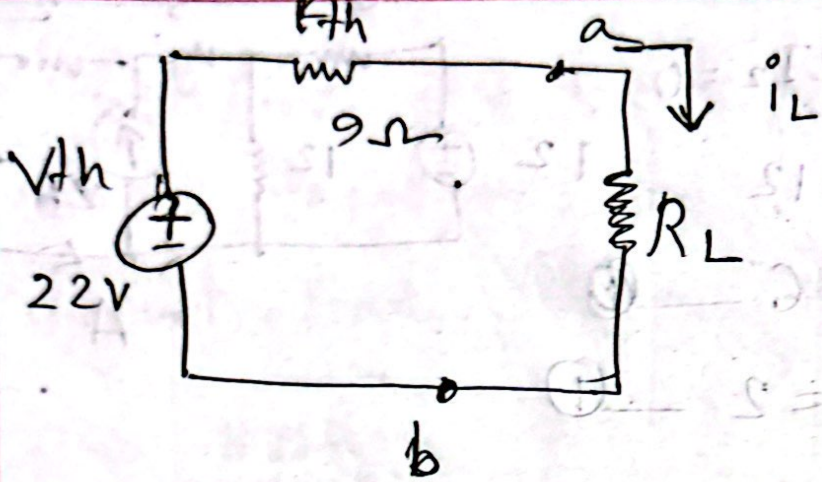
$\Delta_1=$

$\Delta_2=$

$\Delta_3=$

$$\left(-12\times\frac{2}{3}\right)+(15\times -2)+V_{th}=0$$

$$\therefore V_{th}=22V$$



For maximum power transfer

$$R_L = R_{th} = 9\,\Omega$$

$$P = i_L^2 R_L = \left(\frac{V_{th}}{R_{th}+R_L}\right)^2 \times R_L$$

$$= \left(\frac{V_{th}}{R_{th}+R_{th}}\right)^2 \times R_{th} \qquad [R_L = R_{th}]$$

$$= \frac{V_{th}^2}{4R_{th}} = \frac{(22)^2}{4\times 9} = 13.4\,W \text{ (Ans)}$$

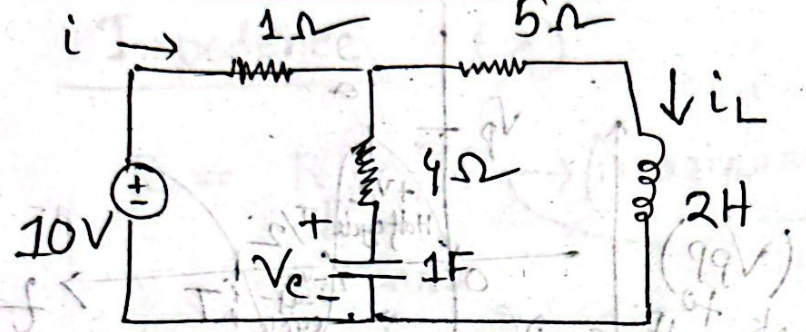
DC

$\boxed{D}$ (Farade) Capacitor Res এর উল্টো → open

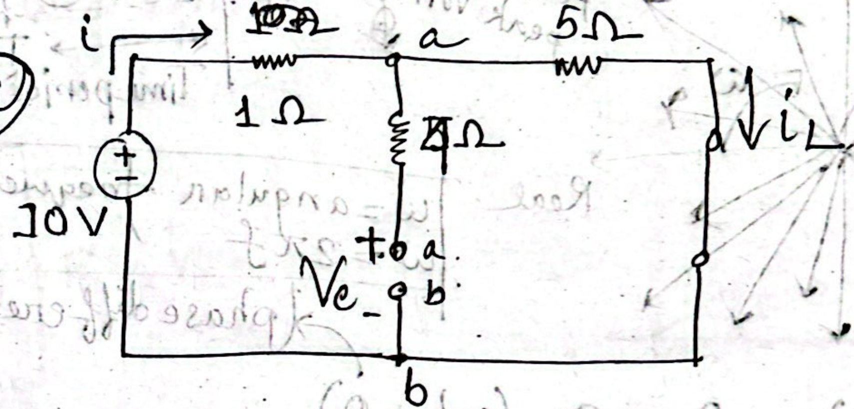
(Henry) Inductor = Resistor এর মিত্র → short circuit

Low to high

Under dc conditions, find (a) i, v_c, i_L.
(b) The energy stored in capacitor and Inductor



Soln: (a)



$$i = i_L = \frac{12}{(1+5)} = 2A$$

$$V_c = 5 i_L = 5 \times 2 = 10V$$

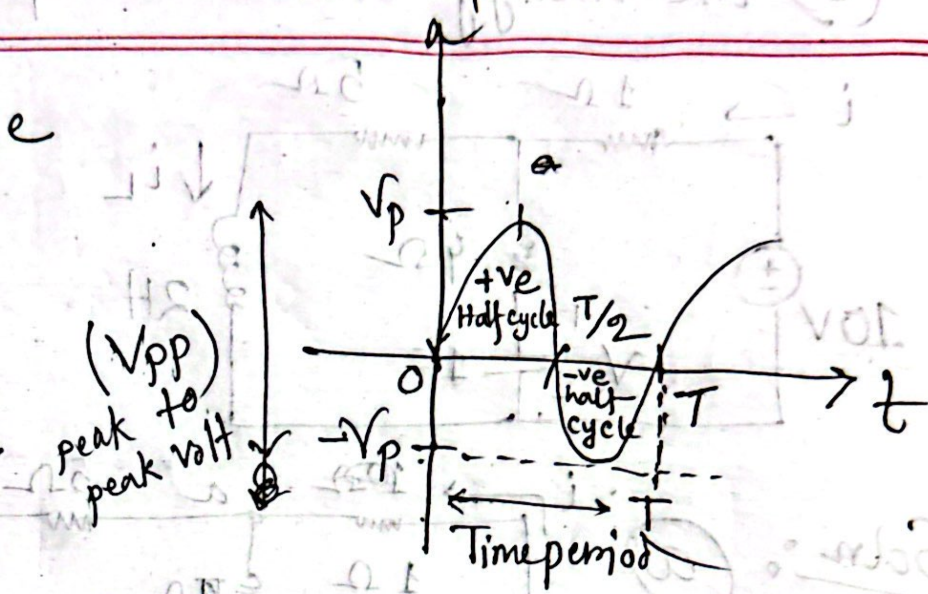
(b) $$W_c = \frac{1}{2} C V_c^2 = \frac{1}{2} \times 1 \times 10^2 = 50\ J$$

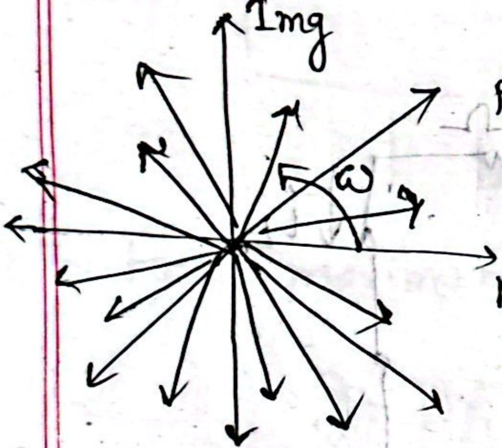
$$W_L = \frac{1}{2} L i_L^2 = \frac{1}{2} \times 2 \times 2^2 = 4\ J$$

AC

V_p = Peak Voltage

T = Period

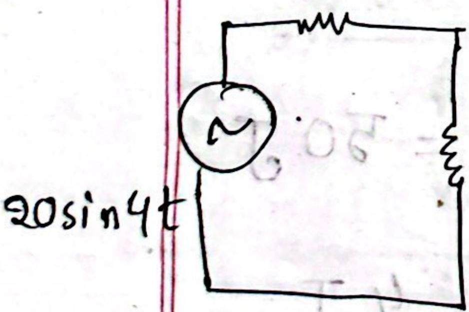


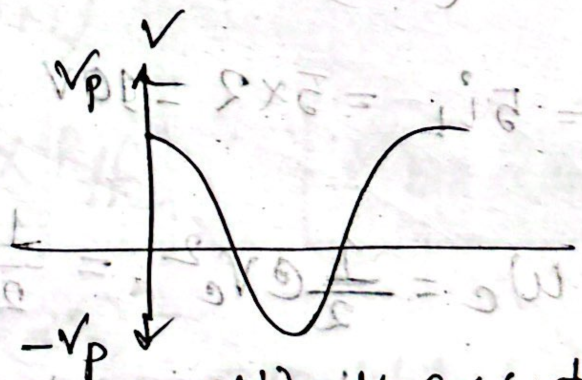


ω = angular frequency
$\omega = 2\pi f$

$$V(t) = \text{Amp} \sin(\omega t \pm \theta)$$
$$= V_p \sin(\omega t \pm \theta)$$

θ (phase difference)





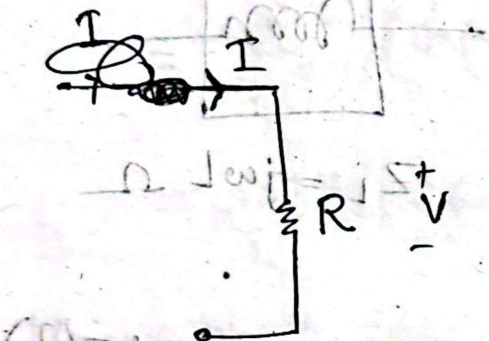
$v(t) = V_p \cos(\omega t \pm \theta)$

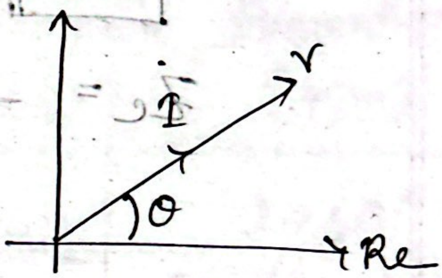
04/09/2024

Impedence (z)

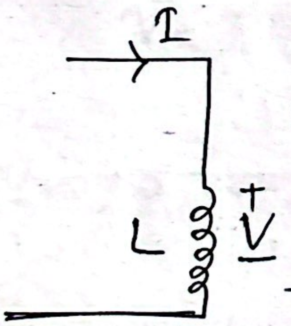
$Z = R + jX$ → (imaginary part / reactance part) → depends on L, C

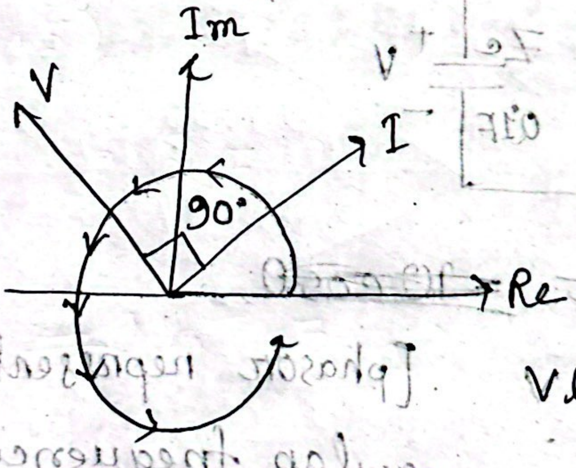
R ↓ Real part (Resistance)



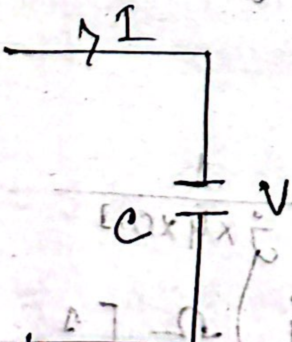


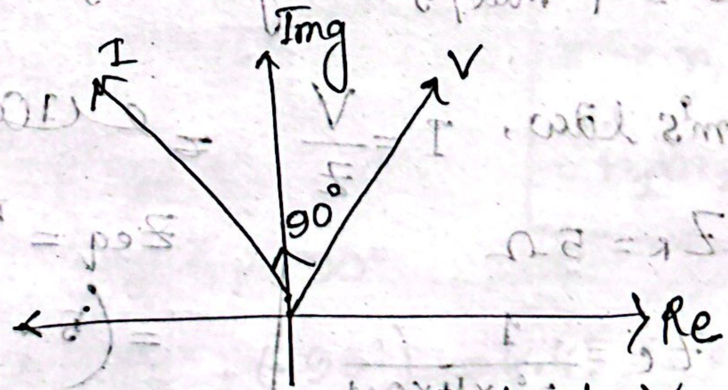
Here, Resistance is a linear property



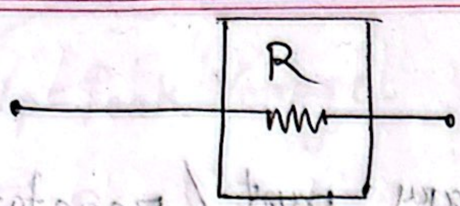


V leads I

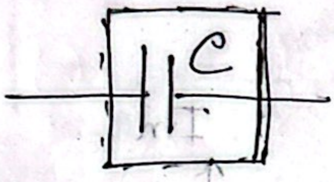




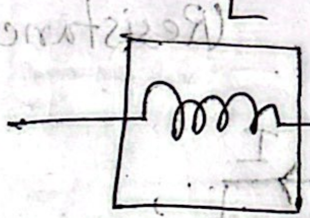
I leads V



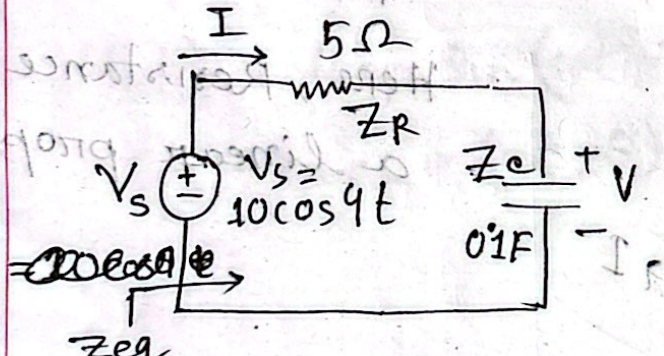
$Z_R = R + 0 = R\,\Omega$



$Z_C = \dfrac{1}{j\omega C}\ \Omega$



$Z_L = j\omega L\ \Omega$



Find V(t) and I(t)

$V_S = 10\cos 4t$ ~~= 10 cos 0~~

$= 10\angle 0^\circ$ V [phasor representation]

$\omega = 4$ rad/s = angular frequency

Ohm's law, $I = \dfrac{V}{Z}$

$Z_R = 5\,\Omega$

$Z_C = \dfrac{1}{j \times 4 \times 0.1}$

$Z_{eq} = 5 + \dfrac{1}{j \times 4 \times 0.1}$

$= (5 - 2.5j)\,\Omega$ $\left[\dfrac{1}{j} = -j\right]$

~~Rec → Pol (Shift (+)~~
angle — polar form
j — rectang form

$$I = \frac{V_s}{Z_{eq}} = \left(\frac{10\cos 4t}{5-2.5j}\right)A = \left(\frac{10\angle 0^\circ}{5-2.5j}\right)A$$

$$= \frac{10\angle 0^\circ}{5.59\angle -26.56^\circ}$$

$$= \frac{10}{5.59}\angle\left(0-(-26.56)\right)^\circ$$

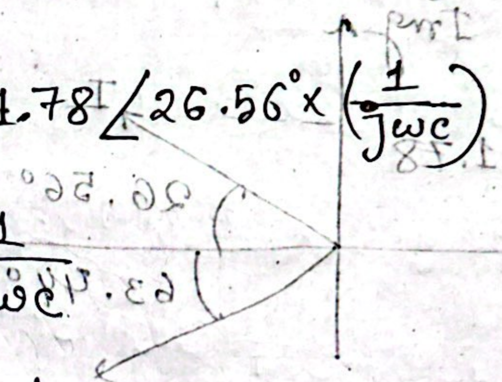
$$= 1.78\angle +26.56^\circ A$$

$5-2.5j$
(Rectangular Formation)
$= (+/-)$

$10\angle 0^\circ$
(polar formation)
$(\div/\times)$

Using Ohm's law,

$$V = I Z_c = 1.78\angle 26.56^\circ \times \left(\frac{1}{j\omega c}\right)$$



$$V = I Z_c = I \times \frac{1}{j\omega c}$$

$$= 1.78\angle 26.56^\circ \times \frac{1}{j \times 4 \times 0.1}$$

$$= \frac{1.78\angle 26.56^\circ}{0.4j}$$

$$= 1.78\angle 26.56 \times (-j2.5)$$

$$= 1.78\angle 26.56 \times 2.5\angle -90^\circ$$

$$= (1.78 \times 2.5)\angle(26.56^\circ + (-90^\circ)) = 4.45\angle -63.44^\circ V$$

$$\div \rightarrow \frac{r_1\angle\theta_1}{r_2\angle\theta_2} = \frac{r_1}{r_2}(\theta_1-\theta_2$$

$$\times \rightarrow r_1\angle\theta_1 \times r_2\angle\theta_2 = r_1 \times r_2(\theta_1+\theta_2)$$

Scanned with CamScanner

$V_s = 10\cos 4t$

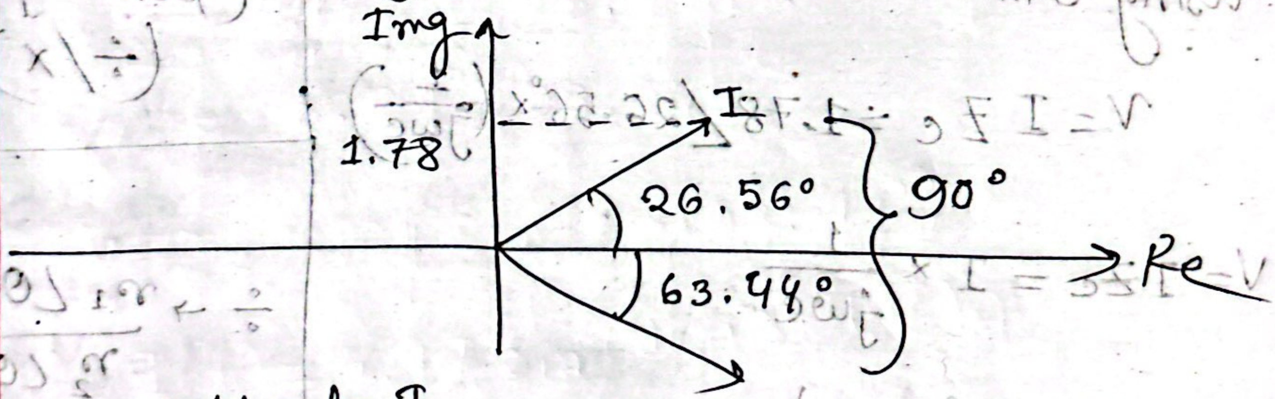
$v(t) = 4.45\cos(4t - 63.44°)\,V$

=

$I(t) = (1.78\cos(4t + 26.56)\,A$

=

Phasor Diagram,

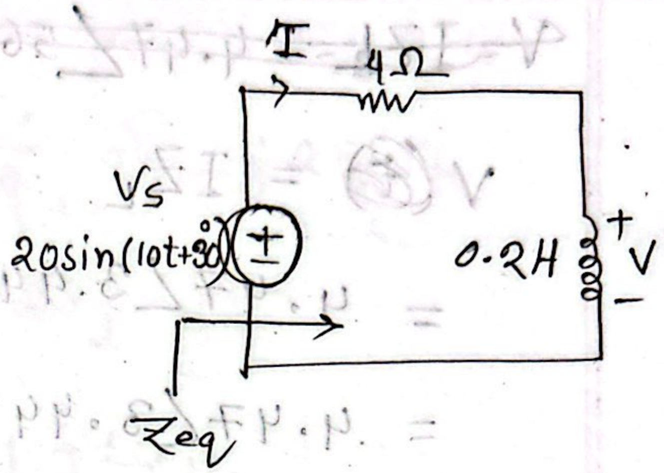


V leads I

This circuit behaves like inductor.

$V(t)$ & $I(t)$

Soln:



$$V_s = 20\sin(10t + 30^\circ)$$

$$= 20\angle 30^\circ \ V$$

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

$$\boxed{\omega = 10 \ rad/s}$$

$$Z_R = 4\,\Omega$$

$$Z_L = j\omega L = 0.2 \times 10\,j = 2j$$

$$Z_{eq} = (4 + 2j)\,\Omega$$

$$I = \frac{V_s}{Z_{eq}} = \left(\frac{20\sin(10t + 30^\circ)}{4 + 2j}\right) A$$

$$= \frac{20\angle 30^\circ}{4 + 2j} = \frac{20\angle 30^\circ}{4.47\angle 26.56^\circ}$$

$$\frac{20}{4.47}\angle(30^\circ - 26.56^\circ)$$

$$= 4.47\angle 3.44^\circ$$

Using Ohm's law,

$\cancel{V = IZ_L = 4.47\angle 56.56^\circ \times 20j(4+2j)}$

$V\,(\ ) = IZ_L$

$= 4.47\angle 3.44^\circ \times -j\omega l$

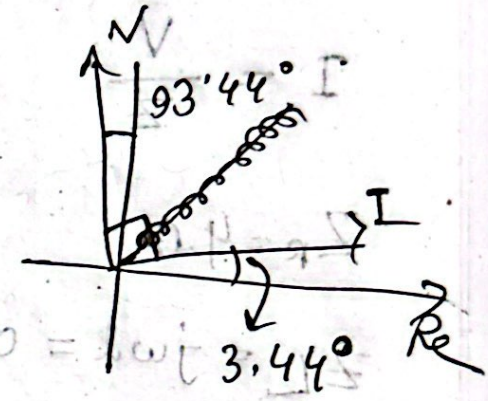
$= 4.47\angle 3.44^\circ \times j \times 10 \times 0.2$

$= 4.47\angle 3.44^\circ \times 2j$

$= 4.47\angle 3.44^\circ \times 2\angle 90^\circ$

$= 4.47 \times 2\angle 3.44^\circ + 90^\circ$

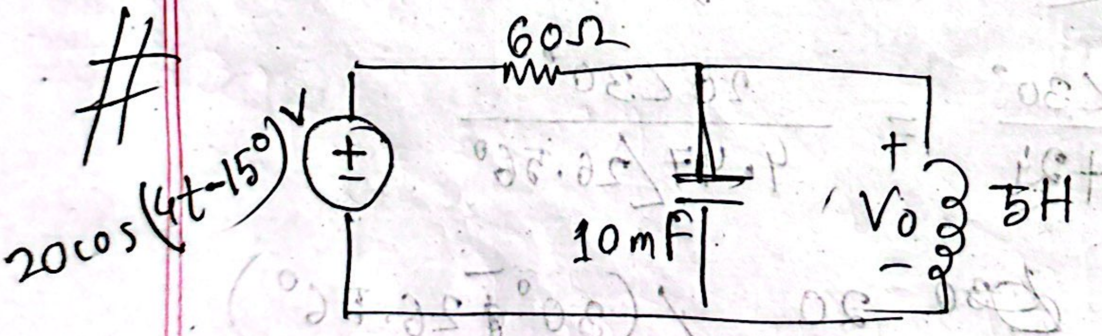
$= 8.94\angle 93.44^\circ$



$V(t) = 8.94\sin(10 + 93.44^\circ)\ V$

$I(t) = 4.47\sin(10 + 3.44^\circ)\ A$

#



$V_s = 20\cos(4t - 15^\circ)\ V$ | $\omega = 4\ rad/s$

$= 20\angle -15^\circ\ V$

$Z_R = 60\,\Omega$

$Z_C = \frac{1}{j\omega C} = \frac{1}{4j \times 10 \times 10^{-3}} = -j25\,\Omega$

$Z_L = j\omega L = j4 \times 5 = 20j\,\Omega$

$Z_C \parallel Z_L = (-j25 \parallel j20)$

$= \frac{-j25 \times j20}{-j25 + j20}$

$= \frac{25\angle -90^\circ \times 20\angle 90^\circ}{-j5}$

$= \frac{25 \times 20(-90^\circ + 90^\circ)}{5\angle -90^\circ}$

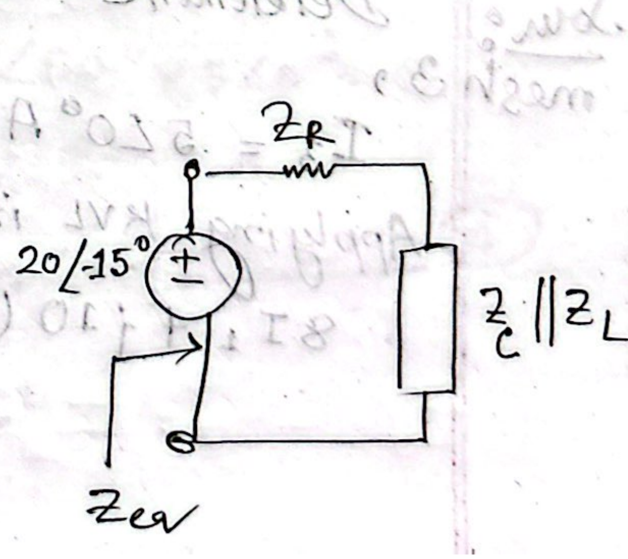
$= \frac{25 \times 20}{5}\angle 0 - 90^\circ$

$= 100\angle 90^\circ\,\Omega$

$Z_{eq} = Z_R + Z_C \parallel Z_L$

$= 60 + j100\,\Omega$

$= 116.61\angle 59.03^\circ$



Applying VDR,

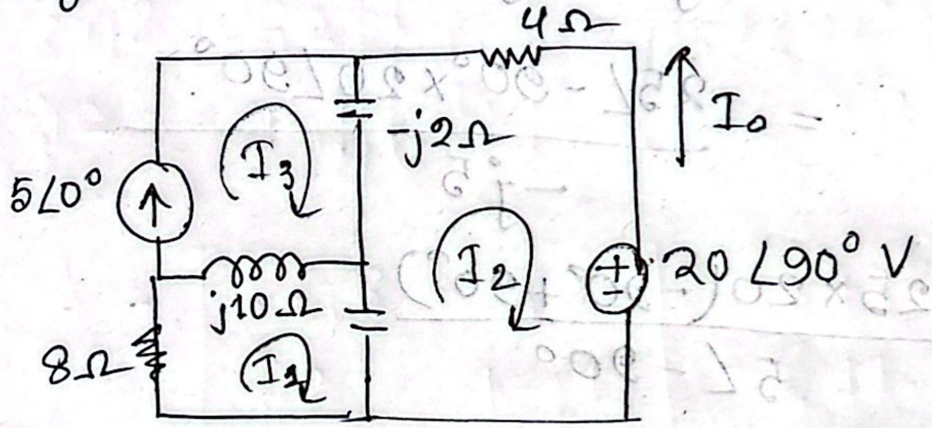
$$V_o = \frac{20\angle -15^\circ \times 100\angle 90^\circ}{60 + j100}$$

$$= \frac{20 \times 100 \angle -15^\circ + 90^\circ}{116.61 \angle 59.03^\circ}$$

$$= 17.15 \angle 15.96^\circ \text{ V}$$

$$v_o(t) = 17.15 \cos(4t + 15.96^\circ) \text{ V}$$

\#



Determine current I_o using mesh analysis.

Soln: mesh 3,

$$I_3 = 5\angle 0^\circ \text{ A} \quad \text{—— (1)}$$

Applying KVL in mesh 1,

$$8I_1 + j10(I_1 - I_3) + (-j2)(I_1 - I_2) = 0$$

$$\Rightarrow 8I_1 + j10I_1 - j10I_3 - j2I_1 + j2I_2 = 0$$

$$\Rightarrow (8+j8)I_1 + j2I_2 - j10I_3 = 0 \quad \text{(II)}$$

Applying KVL in mesh 2,

$$+(-j2)(I_2 - I_1) + (-j2)(I_2 - I_3) + 4I_2 + 20\angle 90^\circ = 0$$

$$\Rightarrow -j2I_1 + j^2 I_1 - j2I_2 + j2I_3 + 4I_2 + 20\angle 90^\circ = 0$$

$$\Rightarrow j2I_1 + 4I_2 - j4I_2 + j2I_3 + j20 = 0$$

$$\Rightarrow j2I_1 + (4-j4)I_2 + j2I_3 = -j20$$

$$\Rightarrow j2I_1 + (4-j4)I_2 + j2I_3 + j2I_3 = 20\angle -90^\circ \quad \text{(III)}$$

In equation (II) & (III) substituting $I_3 = 5\angle 0^\circ A$

$$I_1(8+j8) + j2I_2 - j10 \times 5\angle 0^\circ = 0$$

$$\Rightarrow I_1(8+j8) + j2I_2 - 10\angle 90^\circ \times 5\angle 0^\circ = 0$$

$$\Rightarrow I_1(8+j8) + j2I_2 - 50\angle 90^\circ = 0$$

$$\therefore I_1(8+j8) + j2I_2 = 50\angle 90^\circ \quad \text{(A)}$$

$$j2I_1 + (4 - j4)I_2 + j2 \times 5\angle 0^\circ = 20\angle -90^\circ$$

$$\Rightarrow j2I_1 + (4 - j4)I_2 + 2\angle 90^\circ \times 5\angle 0^\circ = 20\angle -90^\circ$$

$$\Rightarrow j2I_1 + (4 - j4)I_2 + \underbrace{10\angle 90^\circ}_{j10} = 20\angle -90^\circ$$

$$\Rightarrow j2I_1 + (4 - j4)I_2 = j20 - j10$$

$$\Rightarrow j2I_1 + (4 - j4)I_2 = -j30 = 30\angle -90^\circ \quad \text{(B)}$$

$$\begin{bmatrix} 8 + j8 & j2 \\ j2 & 4 - j4 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 50\angle 90^\circ \\ 30\angle -90^\circ \end{bmatrix}$$

$$\Delta = \begin{bmatrix} 8 + j8 & j2 \\ j2 & 4 - j4 \end{bmatrix} = (8 + j8)(4 - j4) - j2 \times j2$$

$$= 11.31\angle 45^\circ \times 5.65\angle -45^\circ - 2\angle 90^\circ \times 2\angle 90^\circ$$

$$= 63.90\angle 0^\circ - 4\angle 180^\circ$$

$$= 63.90 - (-4)$$

$$= 67.90^\circ = \Delta$$

$$\Delta_1 = \begin{bmatrix} 50\angle 90^\circ & j2 \\ 30 & 4 - j4 \end{bmatrix}$$

$$\Delta_2 = \begin{bmatrix} 8 + j8 & 50\angle 90^\circ \\ j2 & 30\angle -90^\circ \end{bmatrix}$$

$$I_0 = -I_2 = \frac{-\Delta_2}{\Delta} = 6.12\angle 144.78^\circ A$$