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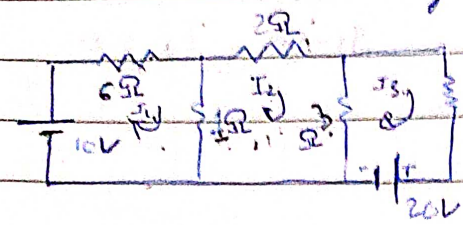
Mesh Analysis → Normal Mesh
→ Mesh with current source
→ Super Mesh

Q1)



$(I_1 - I_2) + 6I_1 - 10 = 0$

Applying KVL in mesh

$1(I_1 - I_2) + 6I_1 - 10 = 0 \Rightarrow 7I_1 - I_2 = 10$ — (1)

$3(I_2 - I_3) + 1(I_2 - I_1) + 2I_2 = 0 \Rightarrow -I_1 + 6I_2 - 3I_3 = 0$

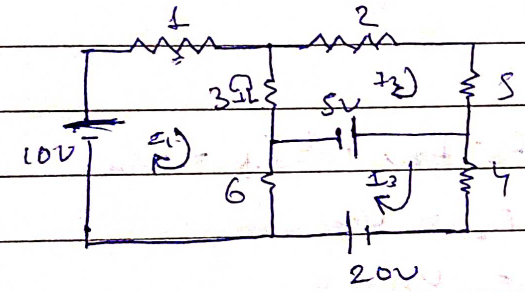
$10I_3 + 3(I_3 - I_2) + 20 = 0 \Rightarrow 13I_3 - 3I_2 = -20$

$I_3 = 1.68$

$I_1 = 1.34$

$I_2 = -0.61$

Q2)



~~$I_1 + 3I_1 + 6I$~~ $1I_1 + 3(I_1 - I_2) + 6(I_1 - I_3) = 10$

$10I_1 - 3I_2 - 6I_3 = 10$

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

$\Rightarrow -3I_1 + 10I_2 = 5$

$4I_3 + 6(I_3 - I_1) = 25$

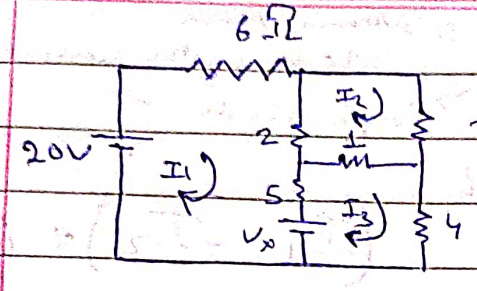
$10I_3 - 6I_1 = 25$

$I_1 = 4.27A$

$I_2 = 0.784A$

$I_3 = 5.06A$

Q4



given $I_1 = 0$

$2(I_1 - I_2) + 5(I_1 - I_3) + 6I_1 = -V_x + 20$

$2I_1 - 2I_2 + 5I_1 - 5I_3 + 6I_1 = -V_x + 20$

$13I_1 - 2I_2 - 5I_3$

$2I_2 - 5I_3 + V_x = 20$ (1)

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

$6I_2 - I_3 = 0$

$5(I_3 - I_1) + 1(I_3 - I_2) + 4I_3 = V_x$

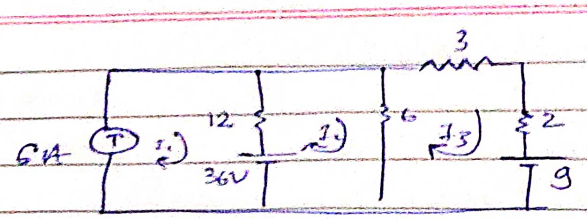
$10I_3 - I_2 = V_x$

$10I_3 - 2I_2 - V_x = 0$

$I_3 = 4.44\,mA$

$I_2 = 0.74\,mA$

$V_x = 43.70\,V$



$I_1 = 6$ (1)

mesh 2 KVL

$6I_2 - 6I_3 + 12I_2 - 12I_1 = 36$

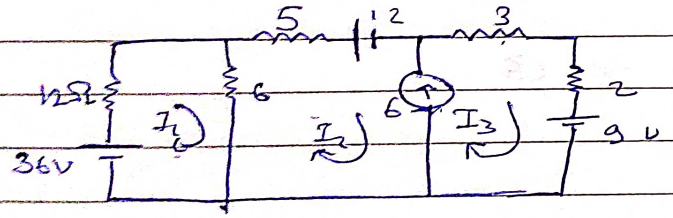
$18I_2 - 6I_3 = 108$ (2)

Mesh 3 KVL

$3I_3 + 2I_3 + 6I_3 - 6I_2 = -9$

$11I_3 - 6I_2 = -9$ (3)

$I_2 = 7A$, $I_3 = 3A$ (IV)



(1) → current source

$36 = 18I_1 + 6I_2 = 0$

$12I_1 + 6I_1 - 6I_2 = 36$

$18I_1 - 6I_2 = 36$ (V)

writing current eq for 5A supermesh

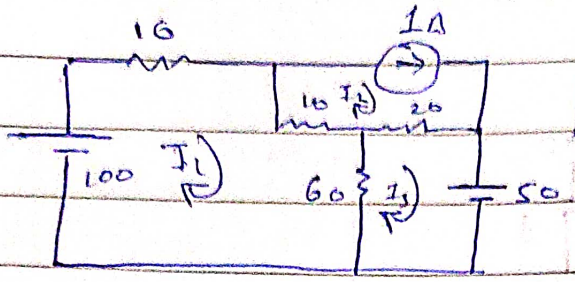
$I_3 - I_2 = 6$

Mesh 2 and 3 form supermesh

$6(I_2 - I_1) + 5I_2 + 3I_3 + 2I_3 = -21$

$6I_2 - 6I_1 + 5I_2 + 3I_3 + 2I_3 = -21$

Q4



$I_2 = 1$ (-1)

KVL to Mesh1

$10(I_1 - I_2) + 60(I_1 - I_3) + 10I_1 = 100$

$80I_1 - 10I_2 - 60I_3 = 100$ (-2)

$-80I_1 - 60I_3 = 110$ (-3)

KVL to Mesh3

$60(I_3 - I_1) + 20(I_3 - I_2) = -50$

$-60I_1 - 20I_2 + 80I_3 = -50$ (-4)

$-60I_1 + 80I_3 = -30$ (-5)

V_A kitaraf + nai to −

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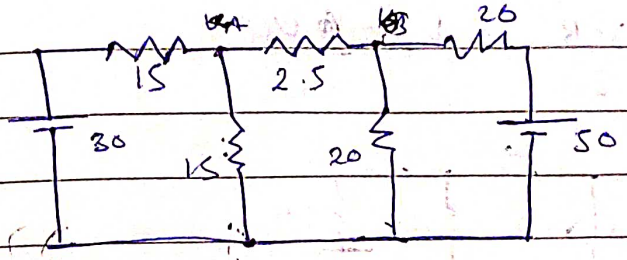
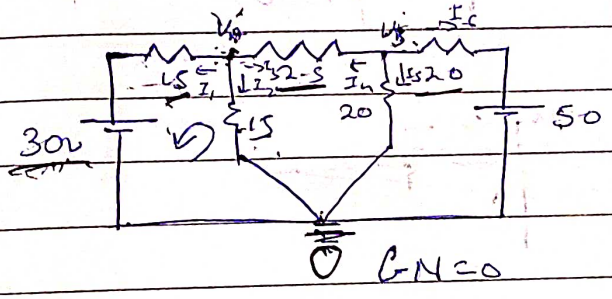
Nodal Analysis → Normal
→ current source
→ super node

Steps

→ Identify nodes
→ ll equipotential node →
→ ll ground node
→ Apply formula and solve → Formula : jaha se nikal raha hai − jaha pe jaa raha hai +/− V / Resistance





Applying KCL to V_A

$$\frac{V_A - 30}{15} + \frac{V_A}{15} + \frac{V_A - V_B}{2.5} = 0 \quad \text{(1)}$$

$$8V_A - 6V_B = 30 \quad \text{(1)}$$

$$\frac{V_B - 50}{20} + \frac{V_B}{20} + \frac{V_B - V_A}{2.5} = 0$$

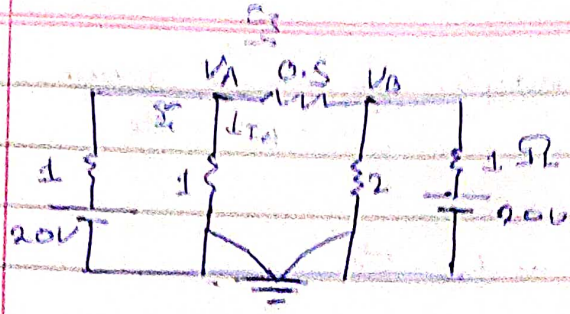
$$\frac{8V_B - 8V_A + V_B + V_B - 50}{20} = 0$$

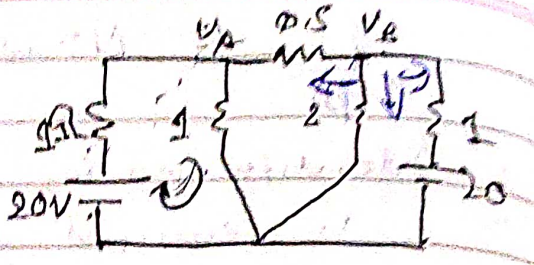
$$-8V_A + 10V_B = 50 \quad \text{(2)}$$

$$V_A = 18.75, \quad V_B = 20$$

$$\frac{V_A - V_B}{2.5} = \frac{18.75 - 20}{2.5} = -0.5A$$

Q)

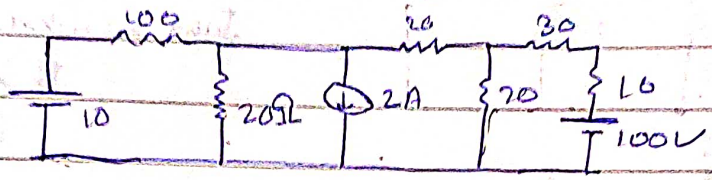


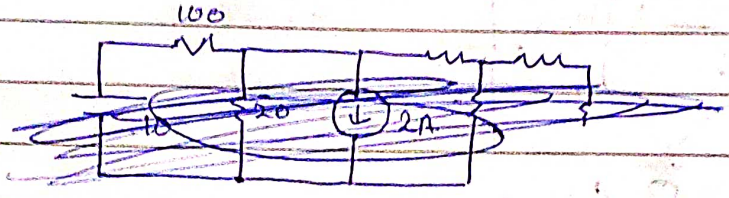


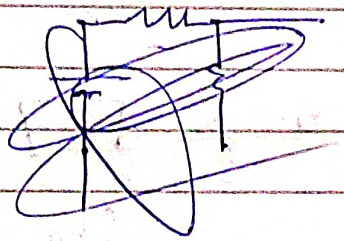
$$\frac{V_A - 20}{1} + \frac{V_A}{1} + \frac{V_A - V_B}{0.5}$$

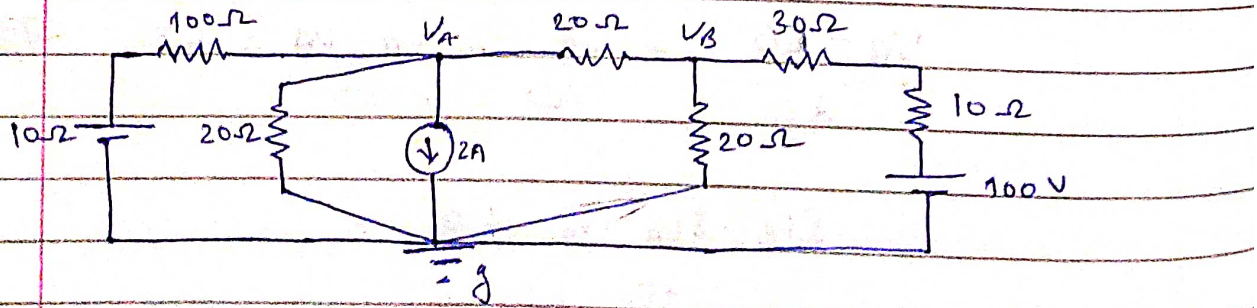
$$\frac{V_B - 20}{1} + \frac{V_B}{2} + \frac{V_B - V_A}{0.5}$$

Q)



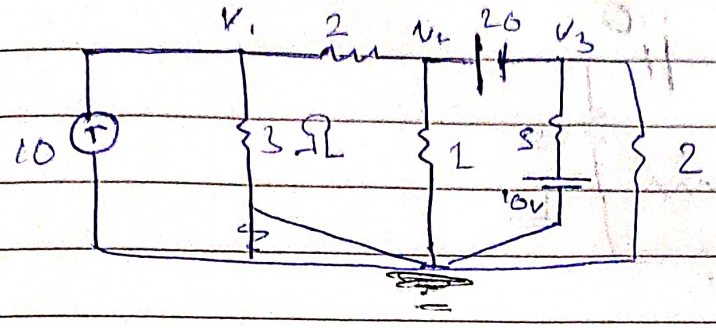






$$\frac{V_A}{20} + \frac{V_A - 10}{100} + \frac{V_A - V_B}{20} + 2 = 0$$

$$\frac{V_B}{20} + \frac{V_B - V_A}{20} + \frac{V_B - 100}{40} = 0$$



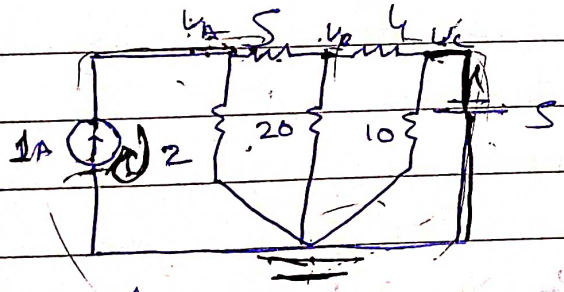
$$-10 + \frac{V_1}{3} + \frac{V_1 - V_2}{2} = 0$$

$$\frac{V_2 - V_1}{2} + \frac{V_2}{1}$$

$$\frac{V_2 - V_3}{\text{Cancelled}} = 20$$

$$\frac{V_2 - V_1}{2} + \frac{V_2}{1} + \frac{V_3}{2} + \frac{V_3 - 10}{5} = 0$$

Q.



Applying V_A

$$\frac{V_A}{2} - 1 + \frac{V_A - V_B}{5} = 0$$

Applying V_B

$$\frac{V_B - V_A}{5} + \frac{V_B - V_C}{4} + \frac{V_B}{20} = 0$$

Applying V_C

$$V_C + 5 = 0$$

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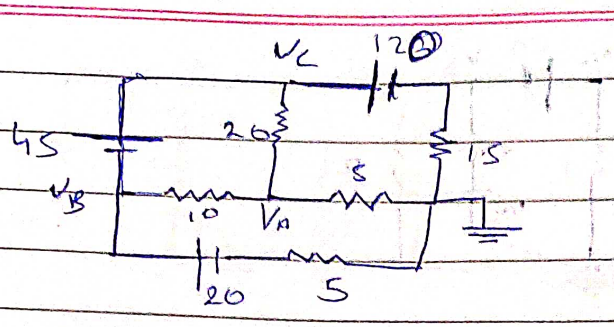
Q)



$$\frac{V_A - V_B}{10} + \frac{V_A - V_C}{20} + \frac{V_A}{5} = 0 \quad (1)$$

$$V_C - V_B = 45 \quad (2)$$

$$\frac{V_B - V_A}{10} + \frac{V_B - 20}{5} + \frac{V_C - 120}{15} + \frac{V_C - V_A}{20}$$

$$\frac{V_A}{5} + \frac{V_A - V_B}{10} + \frac{V_A - V_C}{20} = 0$$

$$\frac{V_C - 120}{15} + \frac{V_C - 120}{15} = 0$$

$$\frac{V_B - 20}{5} + \frac{V_B - V_A}{10} = 0$$

$$V_C - V_B = 45$$

Superposition

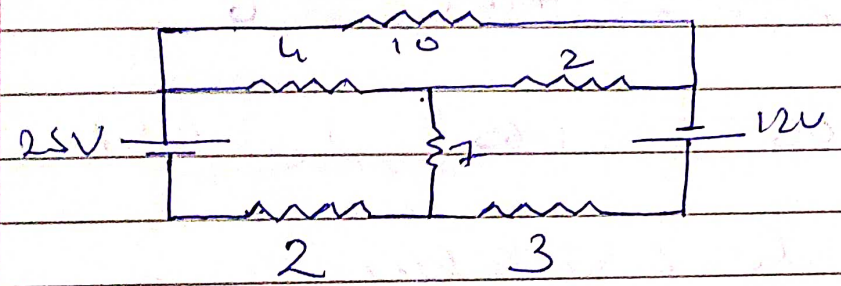
Basics

1) No of Sources + 1 step are used in solving problem

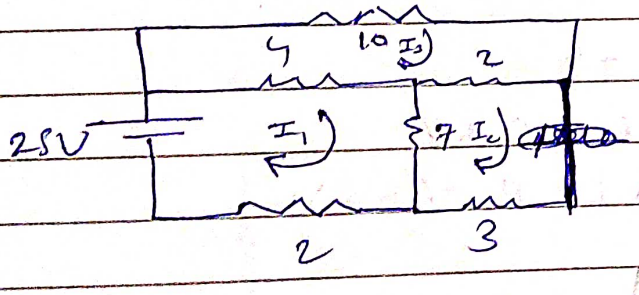
2) Every step should have only 1 source

3) Voltage → Short circuit
   Current → open "

Q)



Step 1 → When 25V is acting alone



Applying KVL in Mesh 1 :

$$13 I_1 - 7 I_2 - 4 I_3 = 25$$

Mesh 2

$$-7 I_1 + 12 I_2 - 2 I_3 = 0$$

Mesh 3

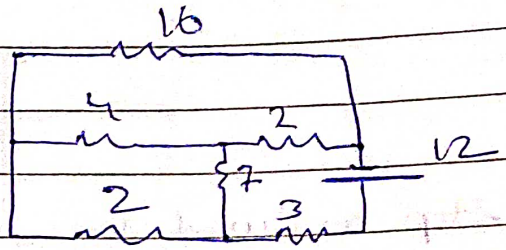
$$-4 I_1 - 2 I_2 + 16 I_3 = 0$$

$I_1 = 3.46 A$, $I_2 = 2.21 A$, $I_3 = 1.14 A$

10Ω k liye I_3 jaraha hai

$I' = I_3 = 1.14 A$ (→)

Step 2



$+13 I_1 - 7 I_2 - 4 I_3 = 0$

$-7 I_1 + 12 I_2 - 2 I_3 = 12$

$-4 I_1 - 2 I_2 + 16 I_3 = 0$

$I_1 = 1.06, \quad I_2 = 1.69, \quad I_3 = 0.47$

$I'' = I_3 = 0.47 \text{ A} (\rightarrow)$

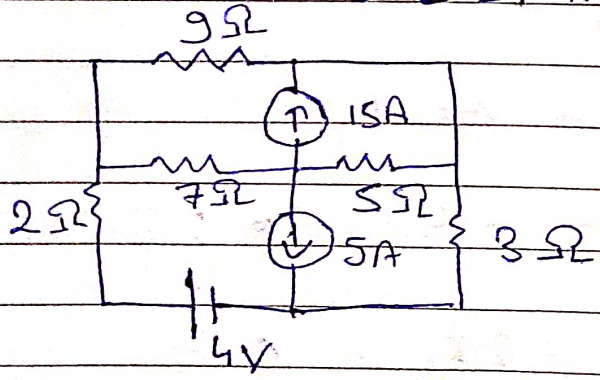
$I = I' + I''$

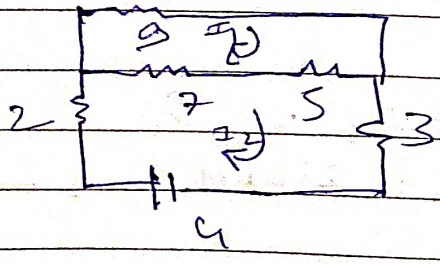
$= 1.14 + 0.47$

$= 1.61 \text{ A} (\rightarrow)$

Q4

Supermesh



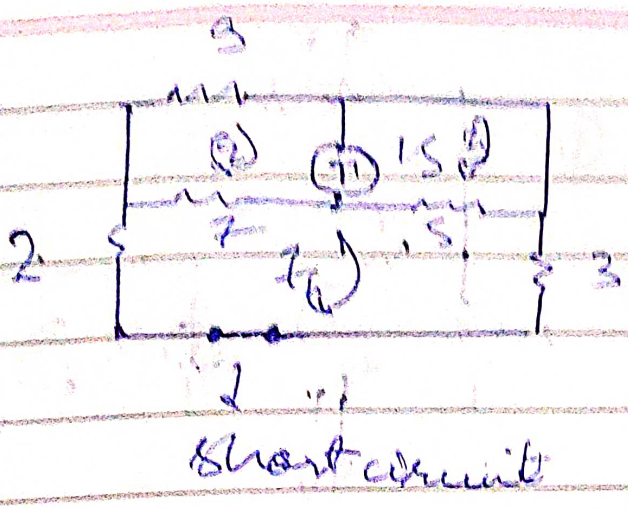


$21 I_1 - 12 I_2 = 0$

$-12 I_1 + 17 I_2 = 4$

$I_1 = 0.22 \text{ A} \quad I_2 = 0.39 \text{ A}$

$I' = I_2 = 0.39 \text{ A} (\downarrow)$



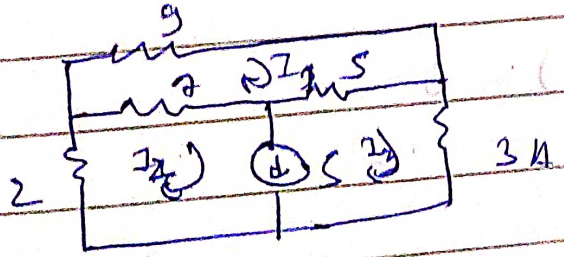
$$7(I_1 - I_2) + 5(I_1 - I_3) + 3I_1 + 2I_1 = 0$$

$$17I_1 - 7I_2 - 5I_3 = 0 \quad (1)$$

$$I_3 - I_2 = 15 \quad (2)$$

$$7(I_2 - I_1) + 9I_2 + 5(I_3 - I_1) = 0$$

$$I_1 = 3.16 \text{ A}, \quad I_2 = -1.76 \text{ A}, \quad I_3 = 13.23 \text{ A}$$



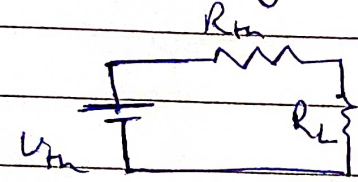
Thevinin Theorm

Steps

Step1 Calculate V_{th}.
By replacing load Resistance with V_{th} and Solve like Nodal and anaylsis

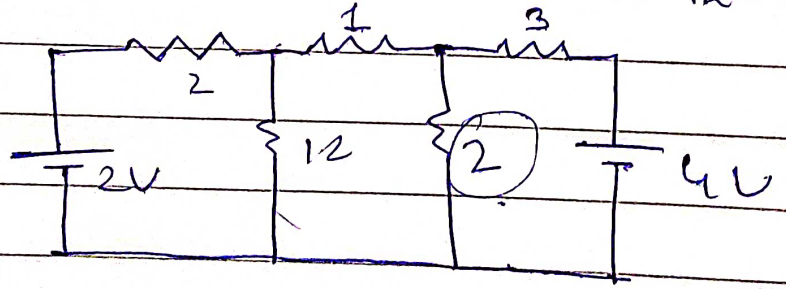
Step2 Calculat R_{th}
Replace
Voltage source ⇒ Short circuit
Current source ⇒ Open circuit
Solve by series parallel method

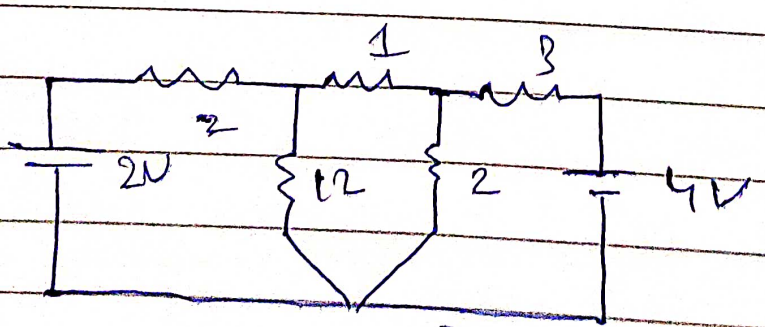
Step3

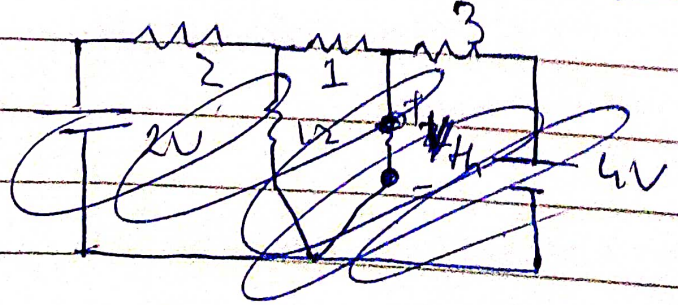


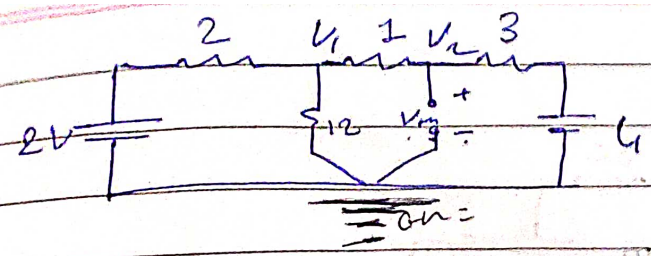
$$I_L = \frac{V_{th}}{R_{th} + R_L}$$

Q1









$$\frac{V_1 - 2}{2} + \frac{V_1}{12} + \frac{V_1 - V_2}{1} = 0$$

$$\frac{V_2 - V_1}{1} + \frac{V_2 - 4}{3} = 0$$

$V_1 = 2.4V \quad V_2 = 2.8V$

Calculating Voltage eqⁿ

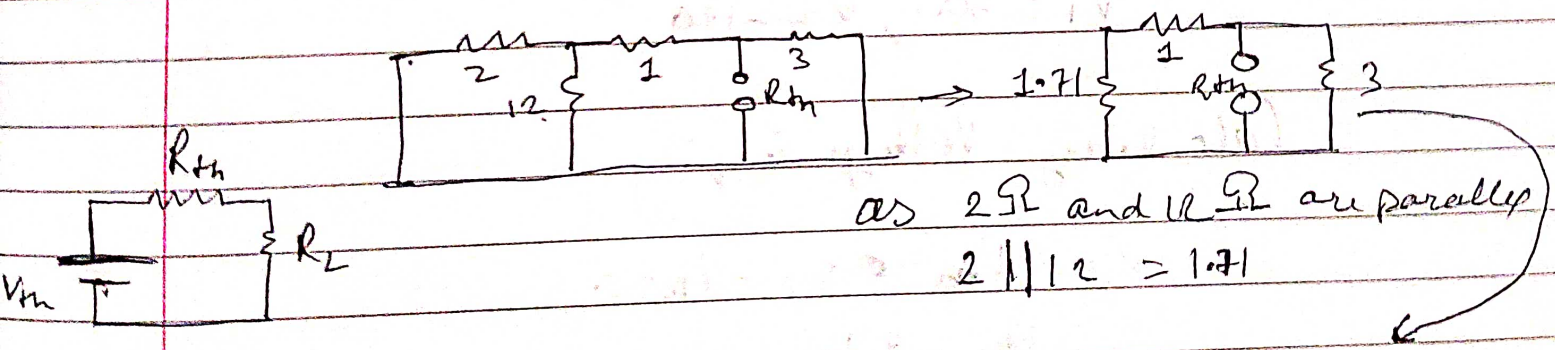
$V_2 = V_{th}$

$V_{th} = 2.8V$

As $V_2 - V_{th} - 0_n = 0$

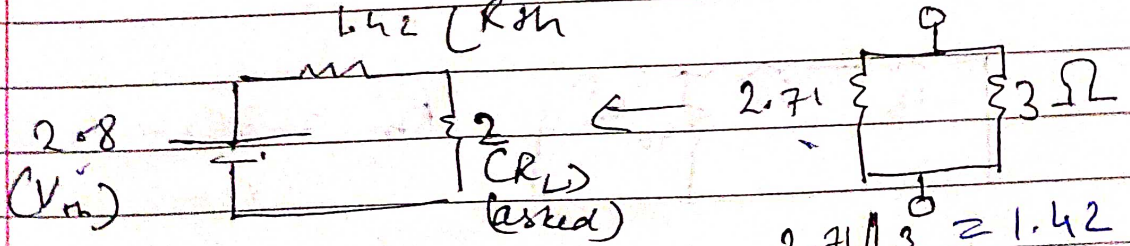
$V_2 = V_m$

Calculate Rth



as 2Ω and 1Ω are parallel

$2 \| 12 = 1.71$



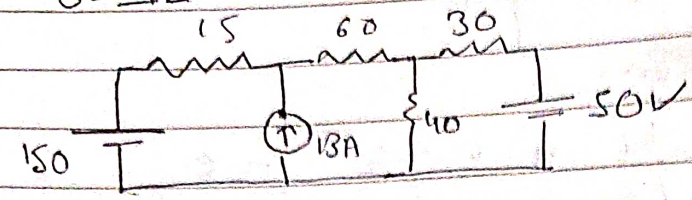
$2.71 \| 3 = 1.42$

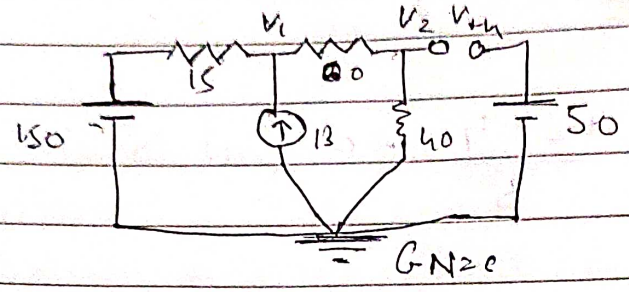
$I_L = \frac{2.8}{1.42 + 2}$

$V = IR$

$V_2 = I_L R_L$

Q4 30Ω





$$\frac{V_1 - 150}{15} - 13 + \frac{V_1 - V_2}{60} = 0$$

$$5V_1 - V_2 = 1380 \quad (1)$$

$$\frac{V_2 - V_1}{60} + \frac{V_2}{40} = 0$$

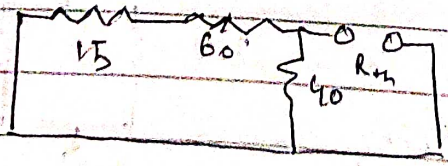
$$-2V_1 + 5V_2 = 0 \quad (2)$$

$$V_1 = 300, \; V_2 = 120$$

Calculating Voltage Eq^n

$$V_2 - V_{th} - 50 - GN = 0$$

$$V_{th} = 70V$$



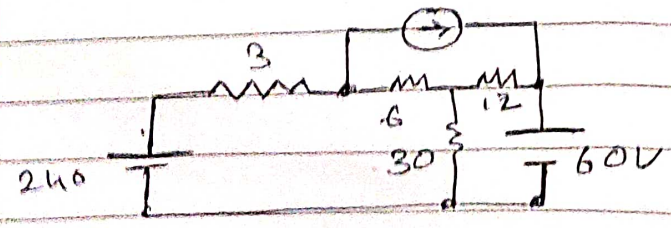
$$R_{th} = \frac{75 \times 40}{75 + 40} = 26.09$$

$$I_L = \frac{70}{26.09 + 30} \rightarrow V_{th}$$

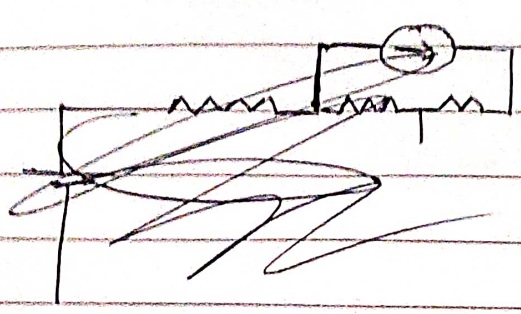
$$= 0.624 \text{ A}$$

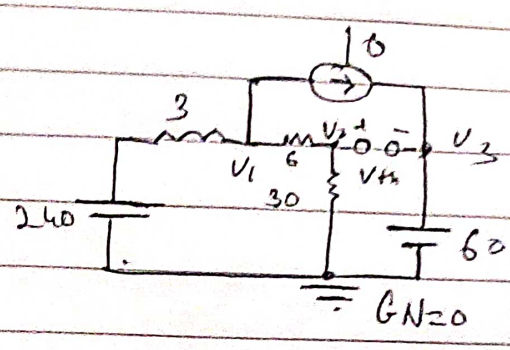
↓ Rth ↓ through

03)



through 12





$$\frac{V_1 - 240}{3} + 10 + \frac{V_1 - V_2}{6} = 0$$

$$\frac{V_2 - V_1}{6} + \frac{V_2}{30} = 0$$

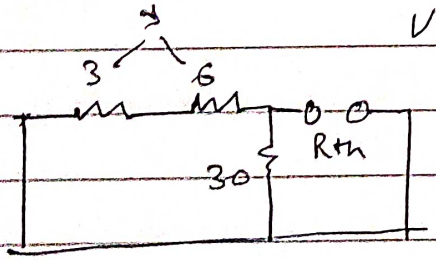
$V_3 = 60$ (By observation)

$V_1 = 193.84$ $V_2 = 161.53$

Voltage eq^n $V_2 - V_{th} - V_3 = 0$

$161.53 - 60 = V_{th}$

$V_{th} = 101.53V$



91/80

$R_{th} = 6.92$

$$I_L = \frac{V_{th}}{R_{th} + 12} = \frac{101.53}{6.92 + 12}$$

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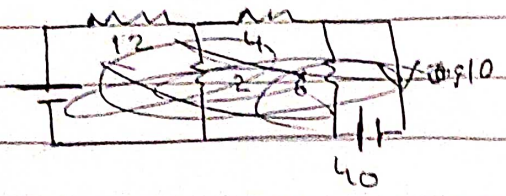
Norton's



Step1) Calculate I_4

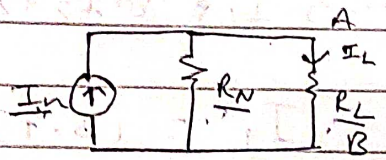
By replacing load resistance with I_N and Solving like Mesh

Step2) Find R_N by replacing

Voltage source → short circuit

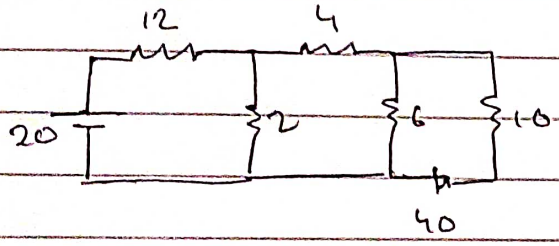
Current source → open circuit

Step3) Calculate I_L

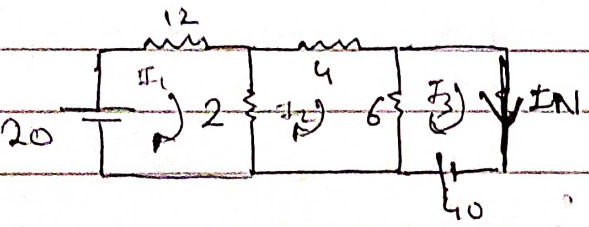


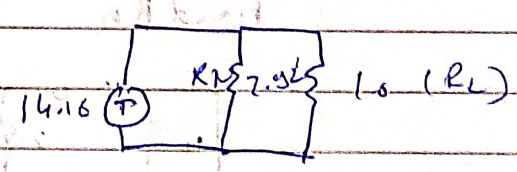
$$I_L = I_N R_N / R_N + R_L$$

Q)



$$\frac{I_N R_L}{R_N + R_L}$$





$$14 I_1 - 2 I_2 - 0 I_3 = 20$$
$$-2 I_1 + 12 I_2 - 6 I_3 = 0$$
$$0 I_1 - 6 I_2 + 6 I_3 = 40$$

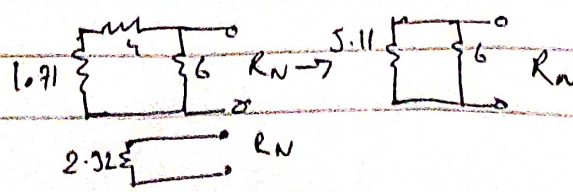
$$I_1 = 2.5, \quad I_2 = 7.5, \quad I_3 = 14.16$$

$$I_3 = I_N = 14.16 A$$

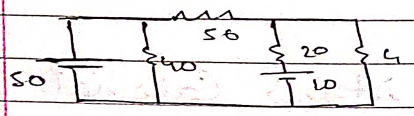
Calculate R_N

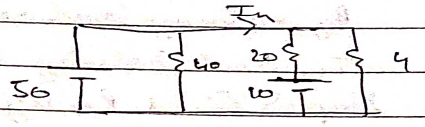
$$\frac{I_N R_N}{R_N + R_L}$$

Calculate $I_L = \frac{14.16 \times 2.92}{2.92 + 10} = 3.2A$



Q4



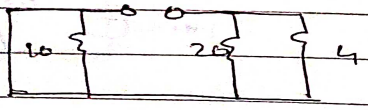


$$40I_1 - 40I_2 + 0I_3 = 50$$
$$-40I_1 + 60I_2 - 20I_3 = -10$$
$$0I_1 - 20I_2 + 24I_3 = 10$$

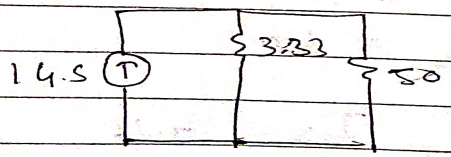
$$I_1 = 15.75$$
$$I_2 = 14.5$$
$$I_3 = 12.5$$

$$I_n = I_2 = 14.5$$

Find R_n



~~80 40 20 10~~ / ~~24 12 6 3~~ $= 3.33\ \Omega$



$$I_L = \frac{14.5 \times 3.33}{3.33 + 5}$$

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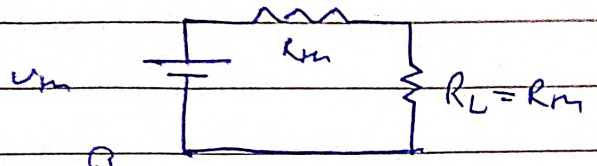
Step 1

Max power → Calculate V_{Th}
by replacing R_L with V_{Th} with No Source

Step 2 → Calculate R_{Th}
By replacing Voltage → Short
current → open

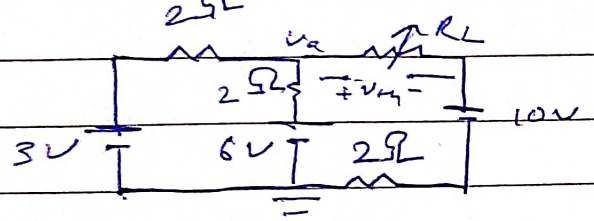
Step 3 : $R_L = R_{Th}$

Step 4 : Cal P_{max}



$$P_{max} = \frac{V_{Th}^2}{4R_{Th}}$$

Q)



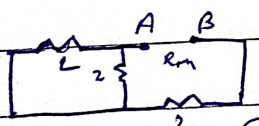
$$\frac{V_a - 3}{2} + \frac{V_a - 6}{2} = 0$$

$$V_a = 9/2 = 4.5$$

$$V_A - V_{Th} - 10 = 0$$

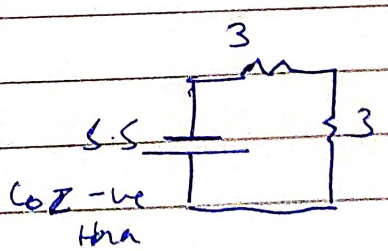
$\therefore V_{Th} = -5.5$ DO polarity is taken wrong
(terminal B is + wrt A)

Calculate R_{Th}



$R_{Th} = 3\Omega$

$R_L = R_{Th}$



$$P_{max} = \frac{V_{Th}^2}{4R_{Th}}$$