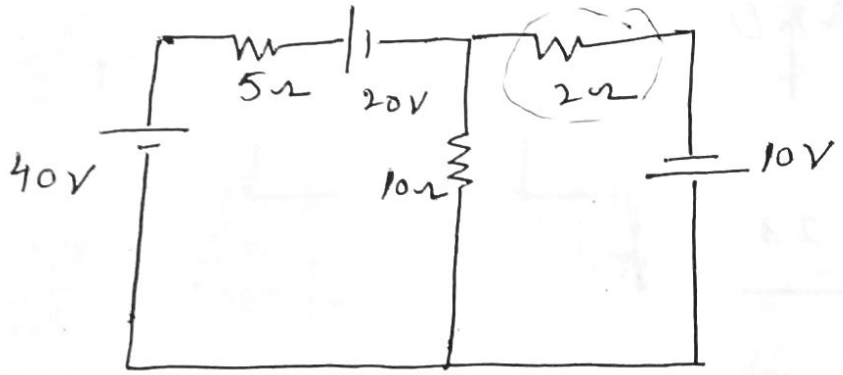
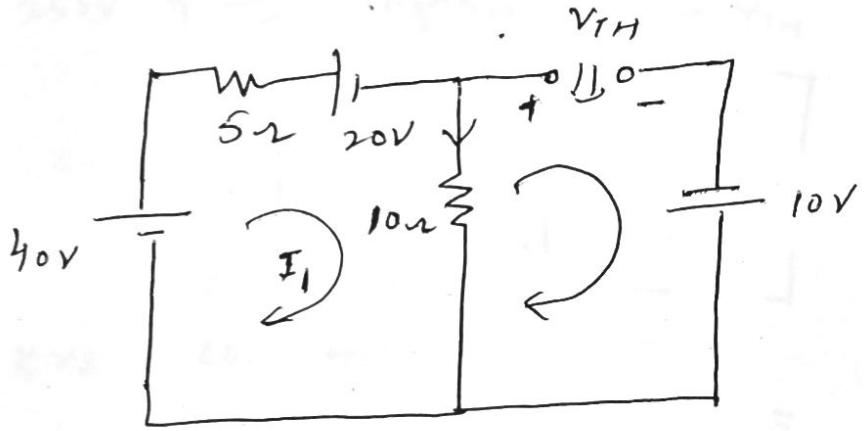
THEVENIN'S NUMERICALS

With 2 loops (simple)

1. Find the current through 2Ω resistor



Solution:- Step I:- Calculate V_{TH} or V_{OC}



Applying loop 1

$$5I_1 + 20 + 10I_1 - 40 = 0$$

$$15I_1 + 20 = 40$$

$$15I_1 = 40 - 20$$

$$I_1 = \frac{20}{15} = \frac{4}{3} = 1.33\,A$$

$$\boxed{I_1 = 1.33\,A}$$

(2) To Calculate V_{TH} applying loop

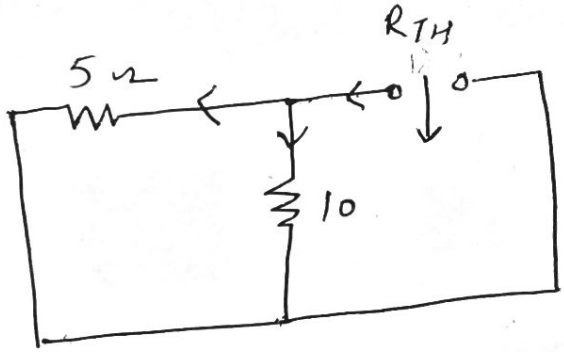
$$V_{TH} - 10 - 10 I_1 = 0$$

$$V_{TH} - 10 - 10(1.33) = 0$$

$$V_{TH} = 13.3 + 10$$

$$\boxed{V_{TH} = 23.33}$$

Step II :- Calculate R_{TH} (Short voltage source & open ckt current source)

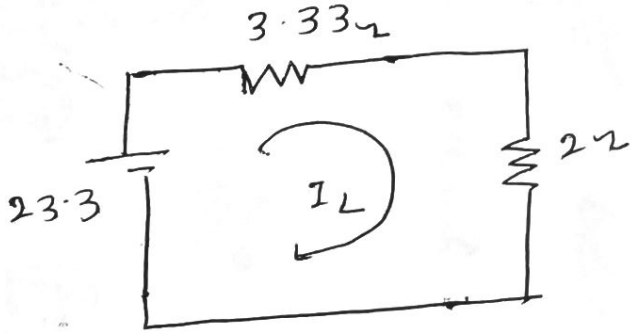


$$R_{TH} = 5 \,||\, 10$$

$$= \frac{5 \times 10}{10 + 5} = \frac{50}{15}\,10 = 3.3$$

$$= \boxed{3.33}\ \Omega$$

Step III :- Calculation of I_L

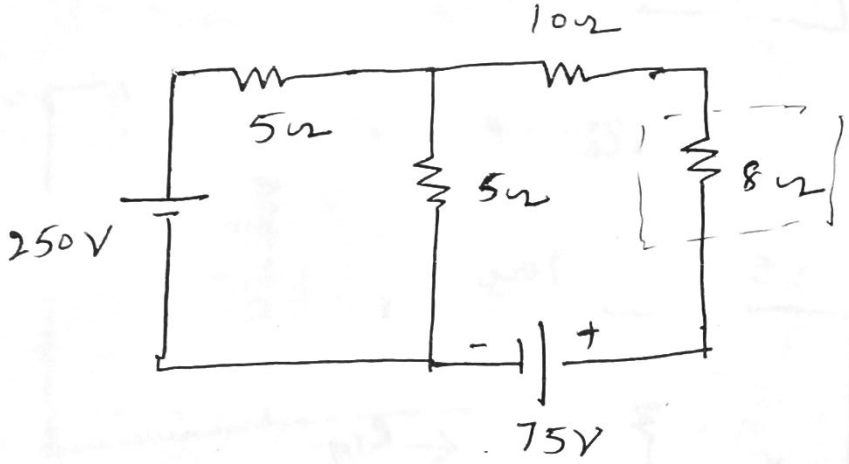


$$I_L = 23.33$$

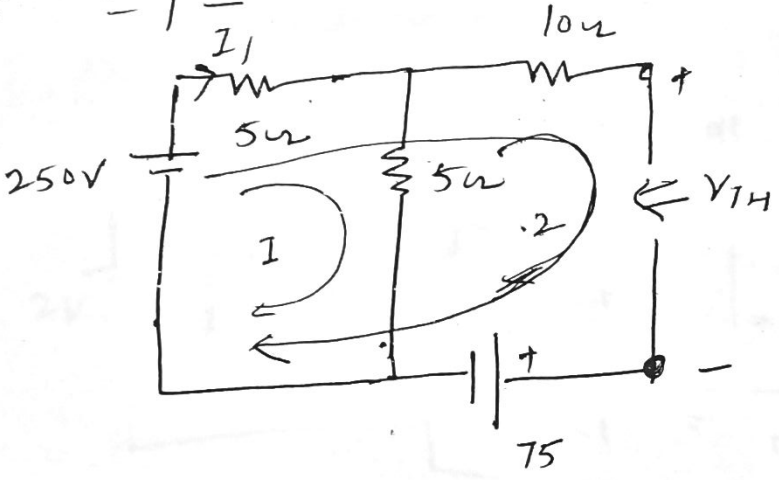
$$I_L = \frac{23.33}{3.33 + 2}$$

$$\boxed{I_L = 4.38\ A}$$

Numerical :-2 Find the current through 8Ω resistor



Solution :- Step I :- To calculate V_{OC} or V_{TH} or E_{TH}



Because of V_{OC} or V_{TH} there will be no current across 10Ω

Using KVL in loop 1

$$5I_1 + 5I_1 - 250 = 0$$

$$10I_1 = 250$$

$$I_1 = \frac{250}{10}$$

$$\boxed{I_1 = 25\ A}$$

Using KVL in loop 2

$$5I_1 + 10I_1 + V_{TH} + 75 - 250 = 0$$

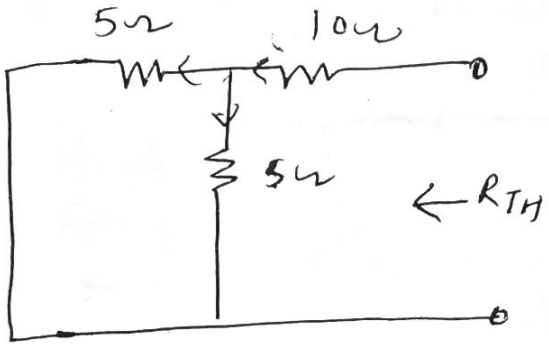
$$15(25) + V_{TH} = 175$$

$$125 + V_{TH} = 175$$

$$V_{TH} = 175 - 125$$

$$V_{TH} = 50V$$

Step II :- To calculate R_{TH}



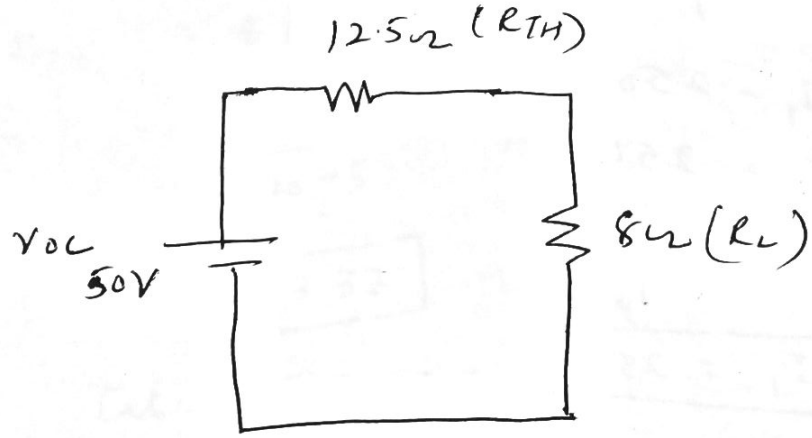
$$R_{TH} = 10 + 5 \| 5$$

$$= 10 + \frac{5 \times 5}{5+5}$$

$$= 10 + \frac{25}{10}$$

$$R_{TH} = 12.5\ \Omega$$

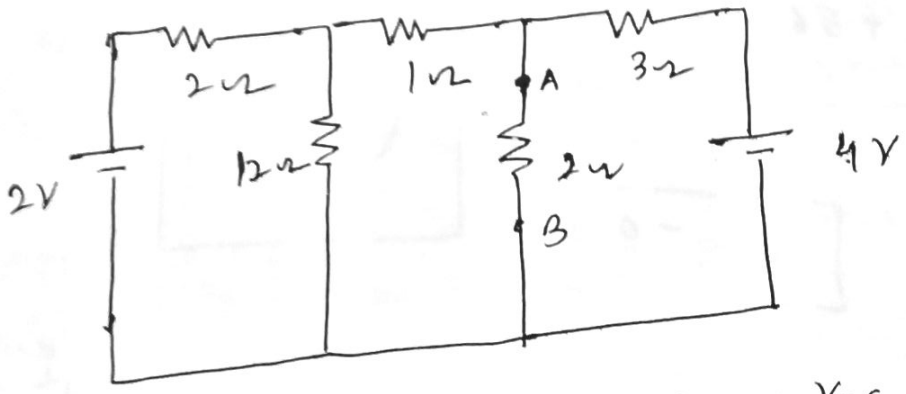
Step III :-



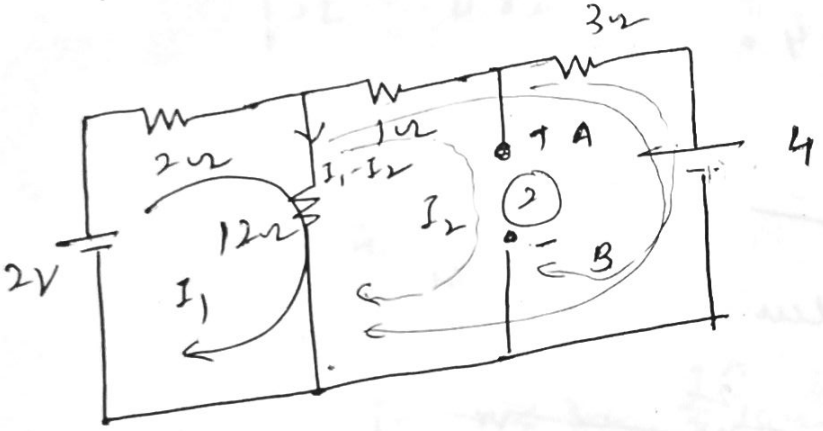
$$I_L = \frac{50}{12.5 + 8}$$

$$I_L = 2.44$$

Numerical 3 :- Find current through 2Ω resistor



Solution :- Step I :- To calculate V_{TH} or V_{OC}



Using KVL in loop I_1

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

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

$$\boxed{14I_1 - 12I_2 = 2} \quad -(1) \Rightarrow 7I_1 - 6I_2 = 1$$

Using KVL in loop (2)

$$I_2 + 3I_2 + 4 - 12(I_1 - I_2) = 0$$

$$4I_2 + 4 - 12I_1 + 12I_2 = 0$$

$$16I_2 - 12I_1 = -4$$

$$\boxed{-12I_1 + 16I_2 = -4} \quad (2) \quad -6I_1 + 8I_2 = -2$$

From eqn (1) & (2)

$42I_1 - 36I_2 = 6$

$-42I_1 + 56I_2 = -14$

$20I_2 = -8$

$$\boxed{I_2 = -0.4\,A}$$

4.0
1.2
2.8

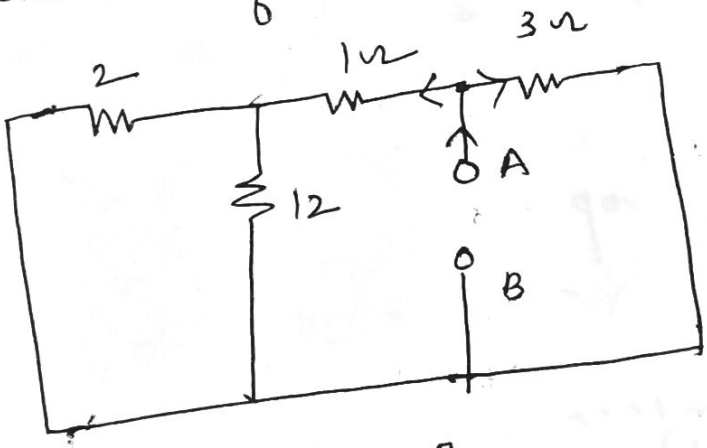
$3I_2 + 4 - V_{TH} = 0$

$3(-0.4) + 4 = V_{TH}$

$-1.2 + 4 = V_{TH}$

$$\boxed{V_{TH} = 2.8\,V}$$

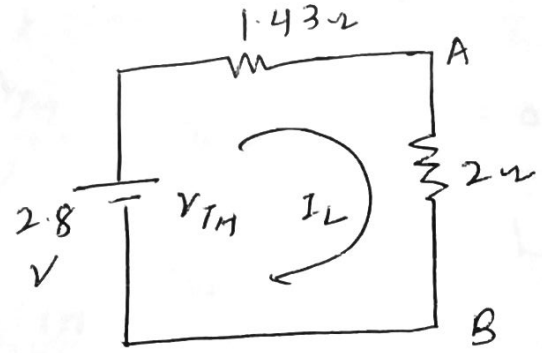
Step II :- Calculation of R_{TH}



$R_{TH} = [(2 \parallel 12) + 1] \parallel 3$

$$\boxed{R_{TH} = 1.43\,\Omega}$$

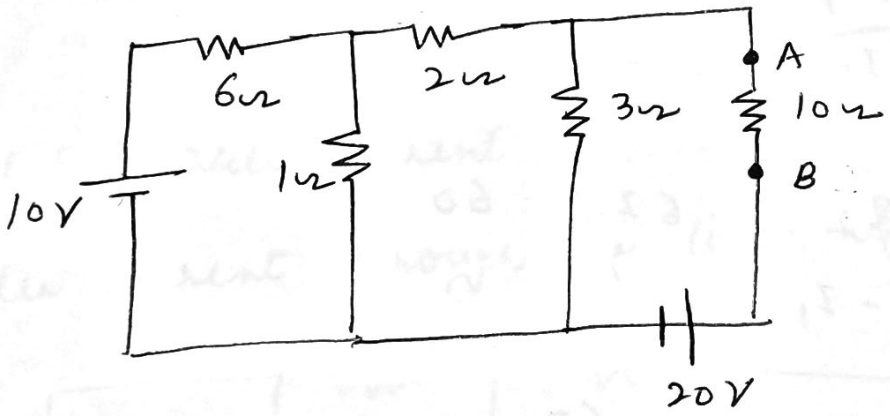
(iii) Calculation of I_L



$$I_L = \frac{V_{TH}}{1{\cdot}43+2\Omega} = \frac{2{\cdot}8}{3{\cdot}43}$$

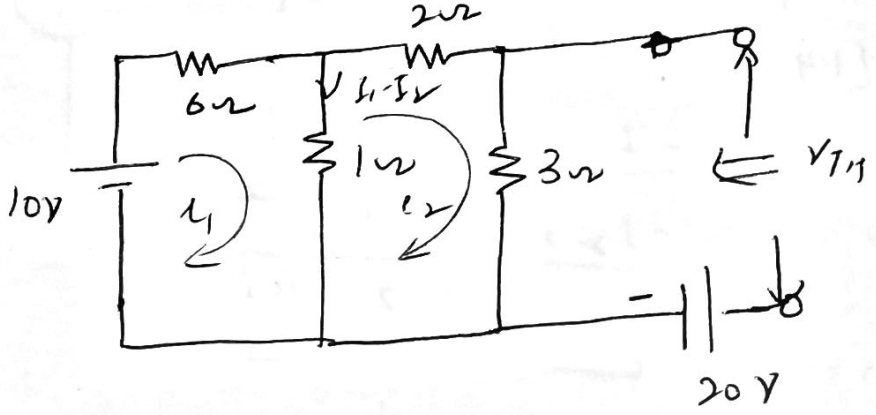
$$\boxed{I_L = 0{\cdot}82\ A}$$

Numerical :- 4 Find the current through 10Ω resistor



Solution :-

Step I :- Calculation of V_{TH}



Using KVL in Mesh (1)

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

$$\boxed{7I_1 - I_2 = 10} \quad (1)$$

Using KVL in Mesh (2)

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

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

$$\boxed{6I_2 - I_1 = 0} \quad (2)$$

From eqn (1) & (2)

$$7I_1 - I_2 = 10 \quad \times 6$$

$$-I_1 + 6I_2 = 0$$

$$42I_1 - 6I_2 = 60$$

$$-I_1 + 6I_2 = 0$$

$$41I_1 = 60$$

$$I_1 = 1.46$$

$$7(1.46) - I_2 = 10$$

$$10.22 - I_2 = 10$$

$$-I_2 = 10 - 10.22$$

$$\boxed{I_2 = 0.2 \text{ A}}$$

Using Thevenin = n

$V_{TH} + 20 - 3I_2 = 0$

$V_{TH} + 20 - 3(0.2) = 0$

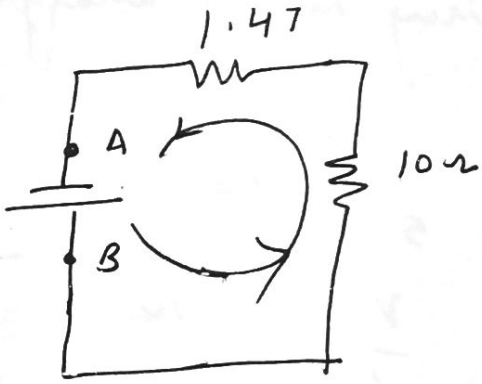
$V_{TH} + 20 - 0.6 = 0$

$V_{TH} = -19.28$ [This means B is +ve & A is -ve]

Step III :- Calculation of I_L

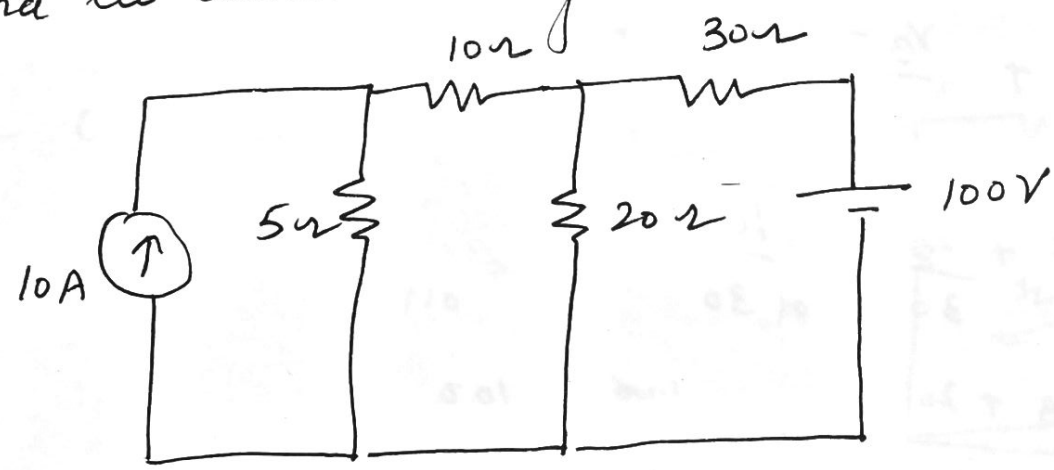
$$I_L = \frac{19.28}{1.47 + 10}$$

$$= 1.68A$$



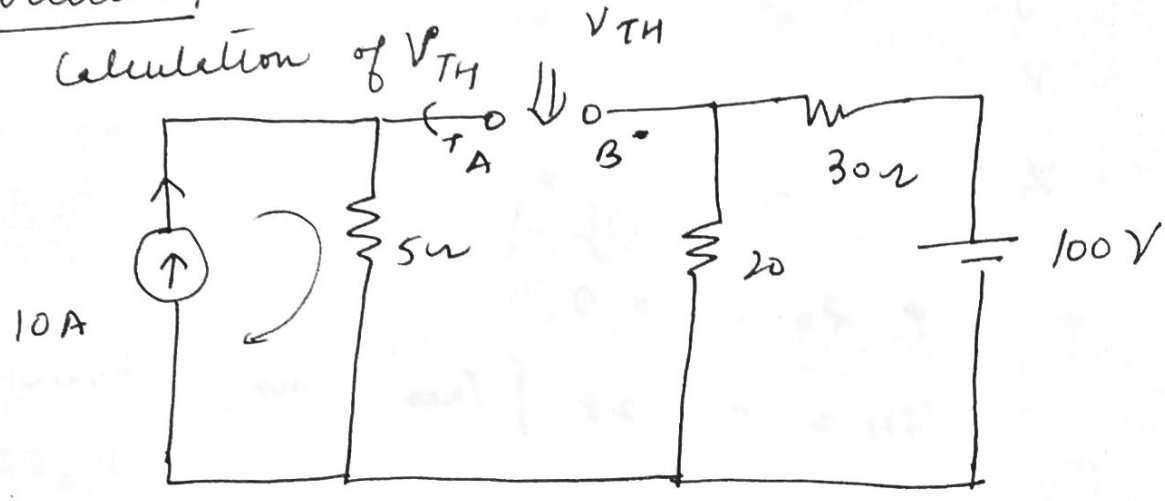
Numerical 5 (With current source)

Find the current through the 10Ω resistor.



Solution :-

Step I :- Calculation of V_{TH}



Using nodal analysis at node 1 (A)

$$\frac{V_A}{5} - 10 = 0$$

$$\frac{V_A}{5} = 10$$

$$V_A = 50$$

Using nodal analysis at node B

$$\frac{V_B}{20} + \frac{V_B - 100}{30} = 0$$

$$\frac{V_B}{20} + \frac{V_B}{30} = \frac{100}{30}$$

$$\frac{30V_B + 20V_B}{20 \times 30} = \frac{100}{30}$$

$$\frac{50V_B}{20} = 100$$

$$V_B = \frac{100 \times 20}{50} = 40$$

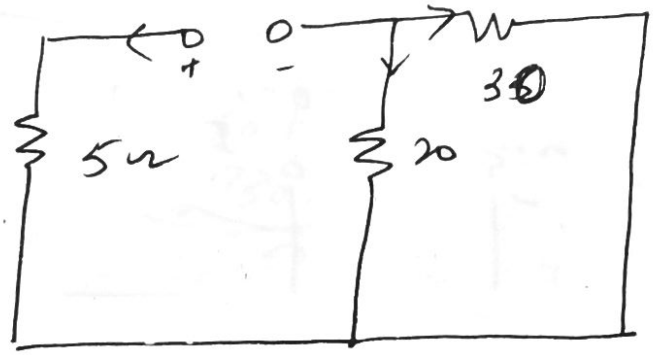
Now $V_{TH} = V_A - V_B$

$= 50 - 40$

$= 10\ V$

$\boxed{V_{TH} = 10\ V}$

Step II :- Calculation of R_{TH} [open ckt current & short ckt V.S]



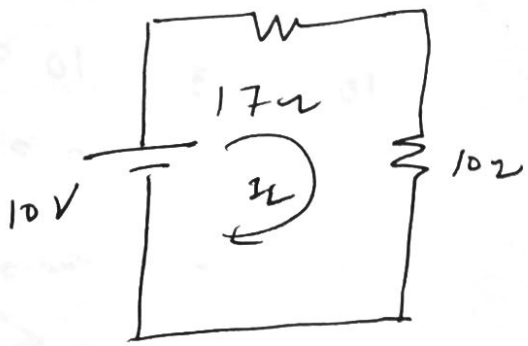
$R_{TH} = 5 + 20 \parallel 30$

$= 5 + \frac{20 \times 30}{20 + 30}$

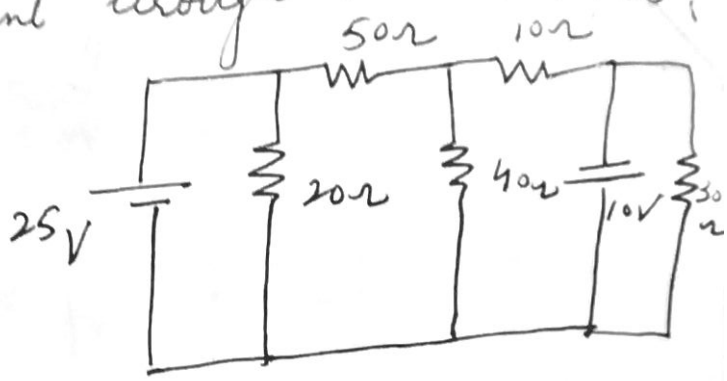
$= 17\ \Omega$

III :- Calculation of I_L

$I_L = \frac{10}{17 + 10} = 0.37A$



Numerical 6) Find the current through 40Ω resistor

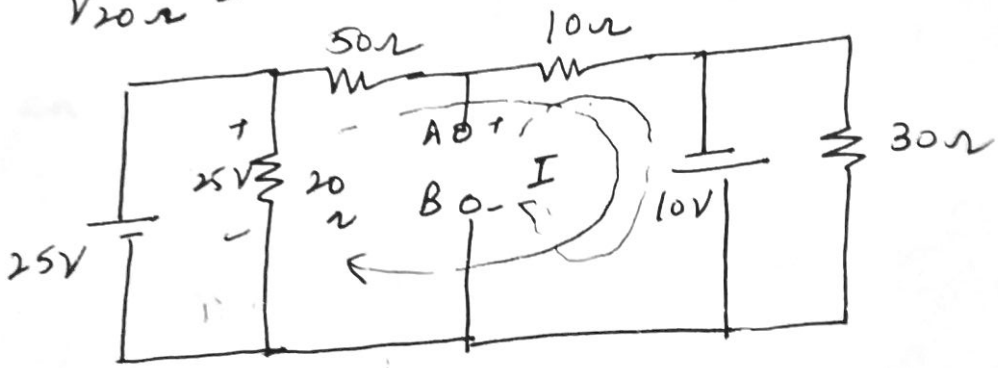


Solution :-

Step I :- Calculation of V_{TH}

Now 20Ω resistor is in parallel with 25V source

$\therefore V_{20\Omega} = 25\ V$



$$50I + 10I - 10 - 25 = 0$$

$$60I = 35$$

$$I = 0.53\ A$$

$$10I - 10 - V_{TH} = 0$$

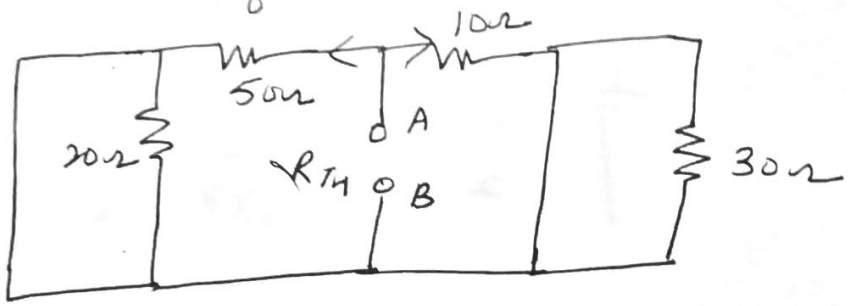
$$10(0.53) - 10 = V_{TH}$$

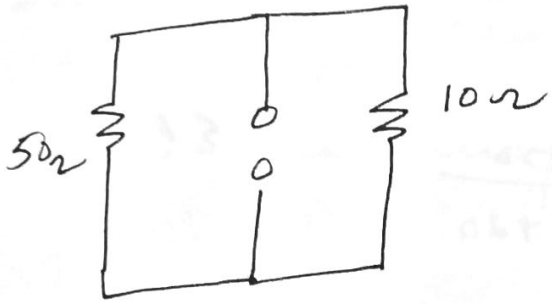
$$5.3 - 10 = V_{TH}$$

$$-4.7 = V_{TH} \quad [\because A \text{ is -ve}, B \text{ is +ve}]$$

Step II :- Calculation of R_{TH}

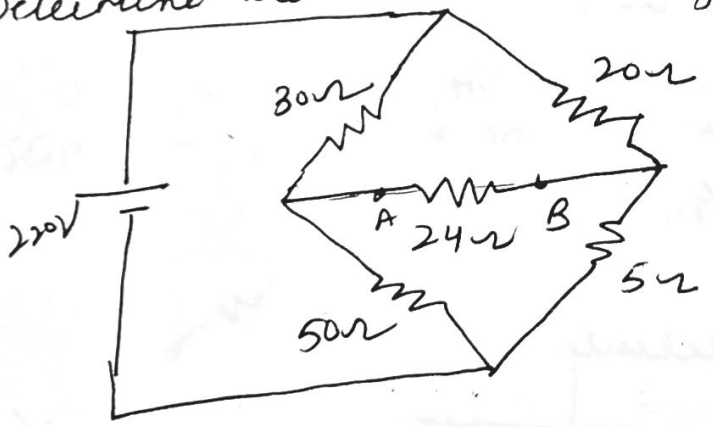
Step II :- Calculation of R_{TH}



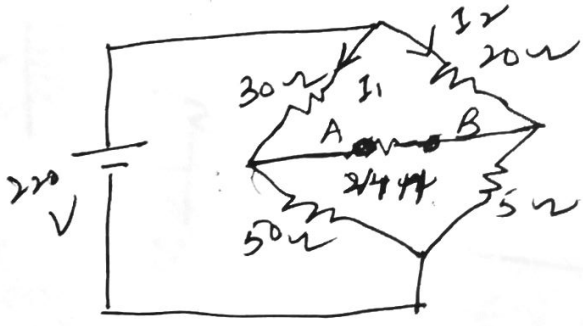


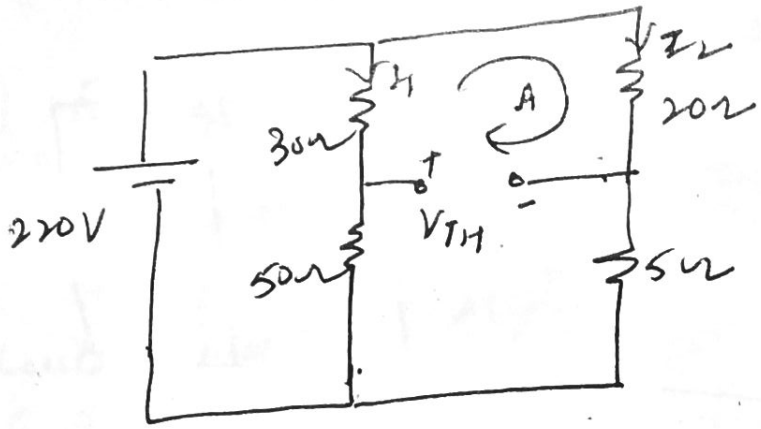
$$R_{TH} = 50 \,||\, 10$$
$$= \frac{50 \times 10}{50 + 10}$$
$$= 8.33\,\Omega$$

Ques-7 :- Determine the current through the 24Ω resistor



Solution :- Calculation of V_{TH}





$$I_1 = \frac{220}{30+20} = 2.75\ A$$

$$I_2 = \frac{220}{25} = 8.8\ A$$

In Mesh A

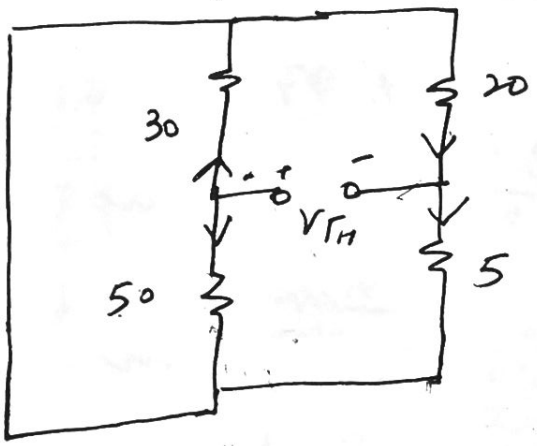
$$-30I_1 + 20I_2 - V_{TH} = 0$$

$$-30(2.75) + 20(8.8) = V_{TH}$$

$$-82.5 + 176 = V_{TH}$$

$$V_{TH} = 93.5\ V$$

Step II :- To calculate R_{TH}



$$R_{TH} = (30 \| 50) + 20 \| 5$$

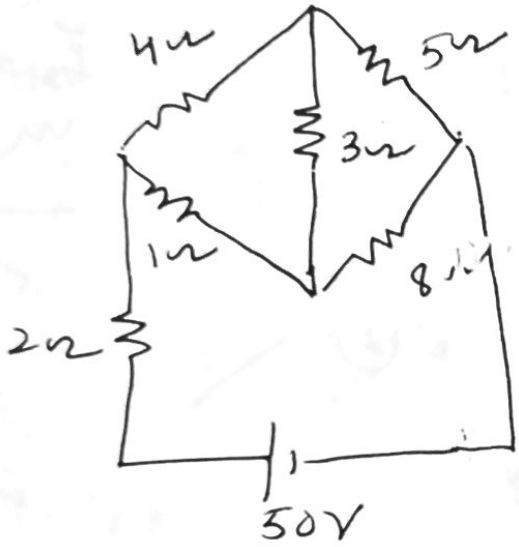
$$= 22.75\ \Omega$$

Step III Calculation of I_L

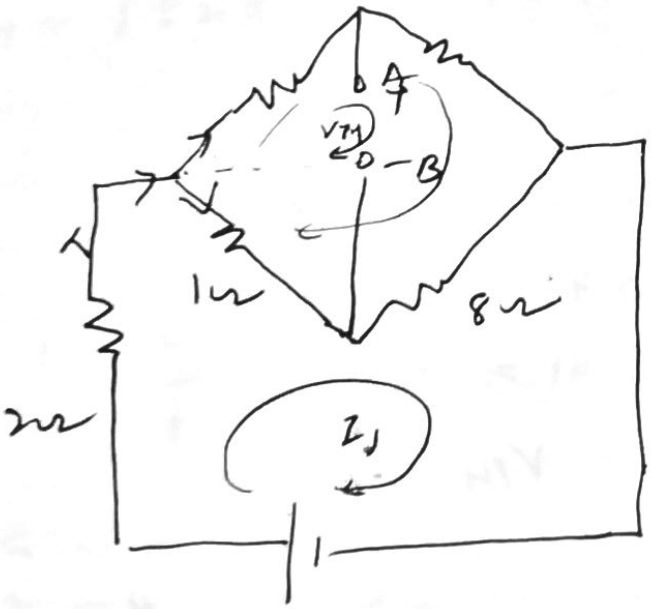
$$I_L = \frac{93.5}{22.75 + 24}$$

$$= 2A$$

Numerical-8 :- Find the current through the 3Ω resistor



Solution :- Step 1 :- open ckt voltage calculation



Using KVL in mesh 1

$$20I_1 + 1(I_1 - I_2) + 8(I_1 - I_2) - 50 = 0$$

$$20I_1 + I_1 - I_2 + 8I_1 - 8I_2 - 50 = 0$$

$$\boxed{11I_1 - 9I_2 = 50} \quad -(1)$$

Using KVL in Mesh (2)

$$4I_2 + 5I_2 - 8(I_1 - I_2) - (I_1 - I_2) = 0$$

$$4I_2 + 5I_2 - 8I_1 + 8I_2 - I_1 + I_2 = 0$$

$$\boxed{18I_2 - 9I_1 = 0}$$

After solving eqn (1) & (2)

$$I_1 = 7.69\ A$$

$$I_2 = 3.85\ A$$

For V_{TH}

$$5I_2 - 8(I_1 - I_2) - V_{TH} = 0$$

$$5I_2 - 8(7.69 - 3.85) = V_{TH}$$

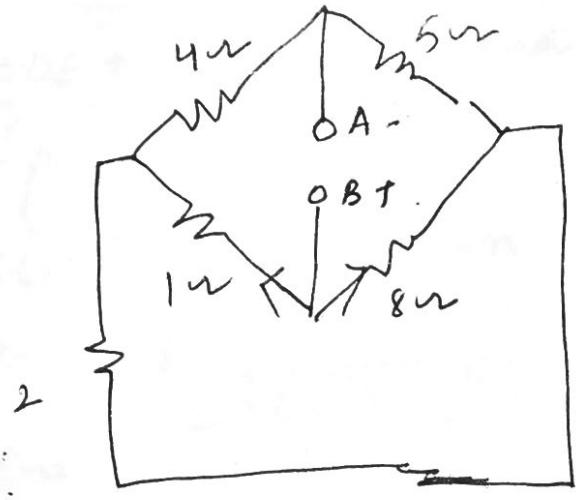
$$5(3.85) - 8(3.84) = V_{TH}$$

$$19.25 - 30.72 = V_{TH}$$

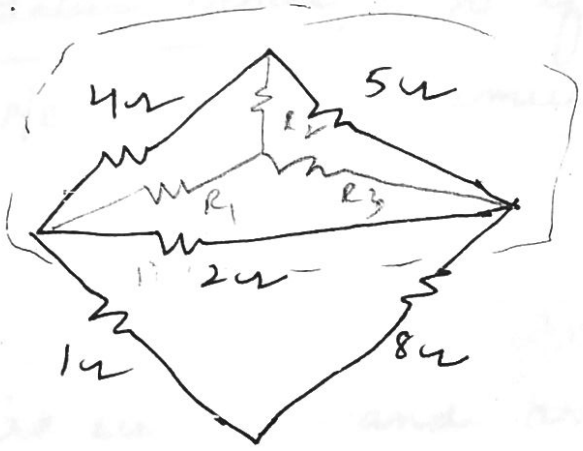
$$-11.47 = V_{TH}$$

$$V_{TH} = 11.47 \quad \begin{matrix} [\text{i.e. A is -ve} \\ \text{B = +ve}] \end{matrix}$$

Step II :- Calculation of R_{TH}



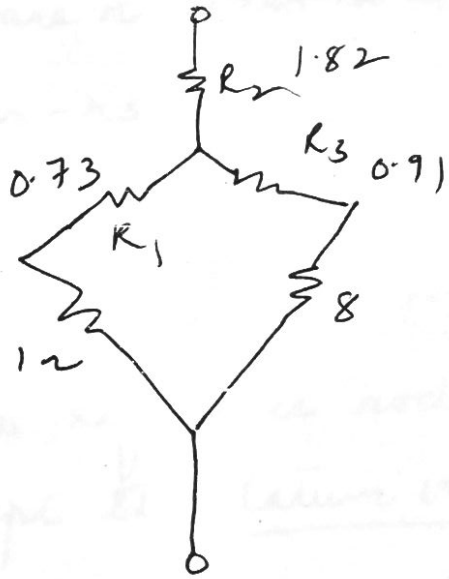
OR



$R_1 = \frac{4 \times 2}{4+2+5}$

$R_2 = \frac{4 \times 5}{4+5+2}$

$R_3 = \frac{5 \times 2}{4+2+5}$ converting upper delta into star.



$$R_{TH} = 1.82 + (1.73 \parallel 8.91)$$

$$= 3.27\Omega$$

Step III :-

$$I_L = \frac{11.47}{3.27 + 3}$$

$$= 1.83\,A$$