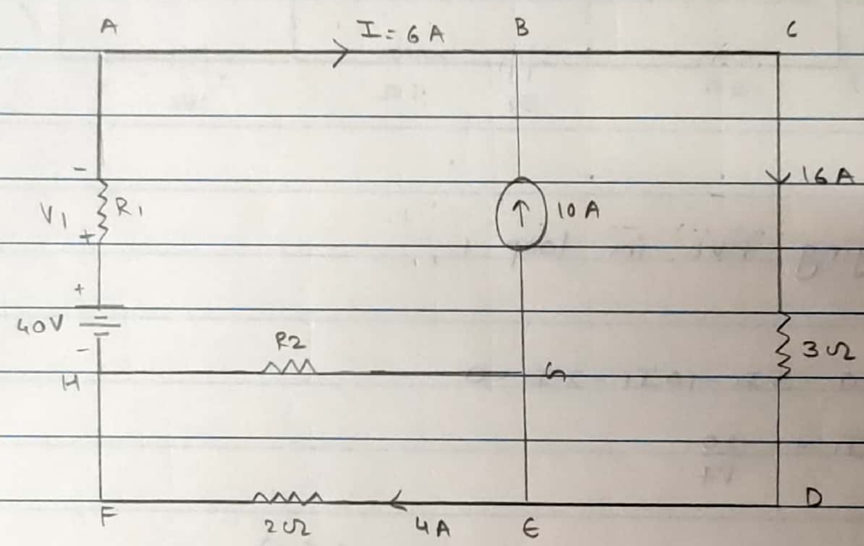
SAP ID - 60004200132
Name - Ayush Jain
Div - J

MAEER's MIT

BEE

Term Test 1 Assignment.

1.) Find the unknown voltage V_1 in the circuit.



Applying KCL at B,

$\therefore \quad I + 10 - 16 = 0$

$\therefore \quad I = 6\ A$

Now,

Applying KVL in ABCDEFA

$40 - 6R_1 - 16(3) - 4(2) = 0$

$\therefore -6R_1 - 16 = 0$

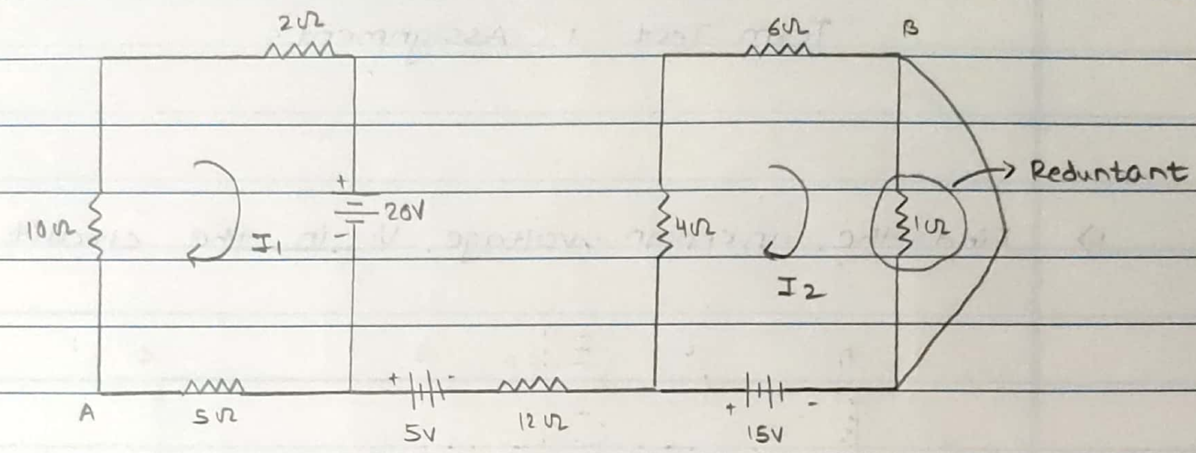
$\therefore 6R_1 = -16$

$\therefore V_1 = -16\ V \quad \therefore [V_1 = IR_1 = 6R_1]$

$\therefore$ The unknown voltage V_1 in the circuit is -16 V.

MAEER's MIT

2)



Applying KVL in loop 1,

$$-20 - 5I_1 - 10I_1 - 2I_1 = 0$$

$$\therefore \quad I_1 = \frac{-20}{17}$$

$$\therefore \quad I_1 = -1.176\ A = 1.176A\ (\circlearrowleft)$$

Applying KVL in loop 2,

$$15 - 4I_2 - 6I_2 = 0$$

$$\therefore \quad I_2 = \frac{15}{10}$$

$$\therefore \quad I_2 = 1.5\ A\ (\circlearrowright)$$

Now,

Applying KVL from A to B,

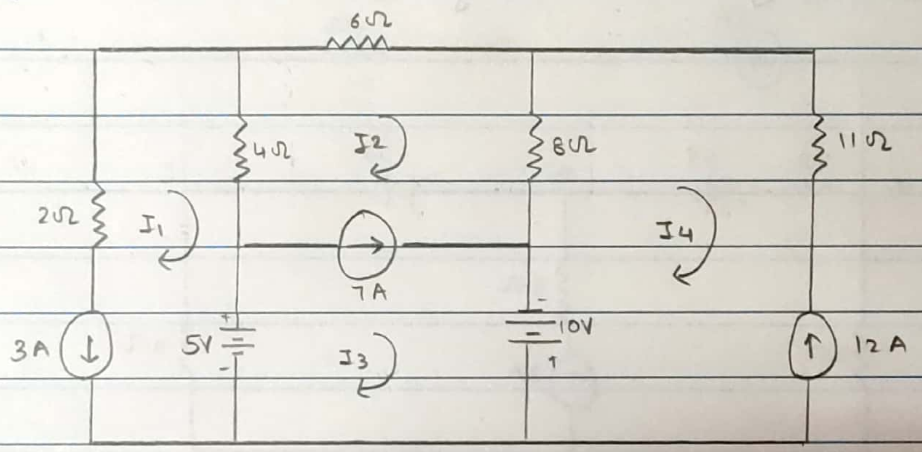
$$V_A - 5(I_1) - 5 - 4I_2 - 6I_2 - V_B = 0$$

$$\therefore \quad V_A - V_B = 5I_1 + 10I_2 + 5$$

$$\therefore \quad V_{AB} = 5(1.176) + 10(1.5) + 5 = 25.88\ V$$

$\therefore$ The voltage V_{AB} is $25.88\ V$.

3) Find current through the 8Ω resistance using mesh analysis.



∴ ~~For~~ From given circuit,

$I_1 = -3\text{ A}$, $I_4 = -12\text{ A}$

Apply KVL at supermesh,

$-4I_2 - 6I_2 - 8I_2 + 10 + 5 + 4I_1 + 8I_4 = 0$

$-18I_2 + 15 + 4(-3) + 8(-12) = 0$

∴ $-18I_2 + 15 - 12 - 96 = 0$

∴ $-18I_2 - 93 = 0$

∴ $I_2 = \frac{-93}{18} = -5.167\text{ A}$

∴ $I_2 = 5.167\text{ A}$ (↺)

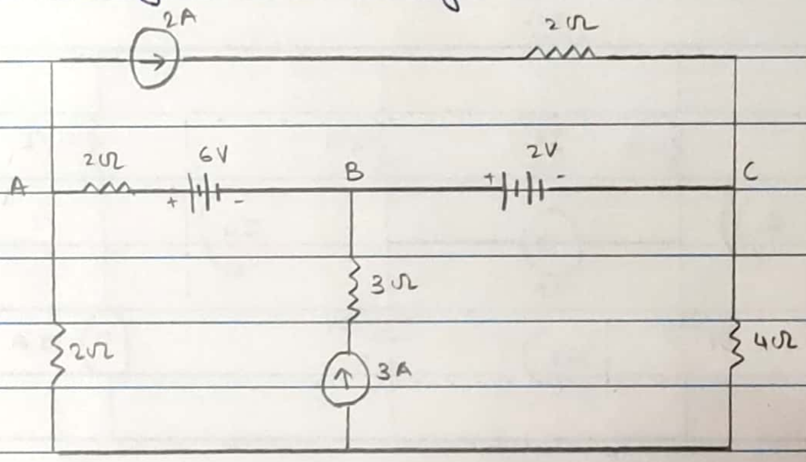
Now,

$I_{8\Omega} = I_4 - I_2$

$= 12 - 5.167 = 6.833\text{ A}$

∴ Current through 8Ω resistance is 6.833 A.

4) Find the current through 4Ω resistor in the network shown using nodal analysis.



$V_B - V_C = 2$ — (i)

Applying KCL at node A,

$\therefore \frac{V_A}{2} + \frac{V_A - 6 - V_B}{2} + 2 = 0$

$\therefore 2V_A - V_B = 2$ — (ii)

Applying KCL at supernode,

$\frac{V_B + 6 - V_A}{2} - 3 + \frac{V_C}{4} - 2 = 0$

$\therefore -2V_A + 2V_B + V_C = 8$ — (iii)

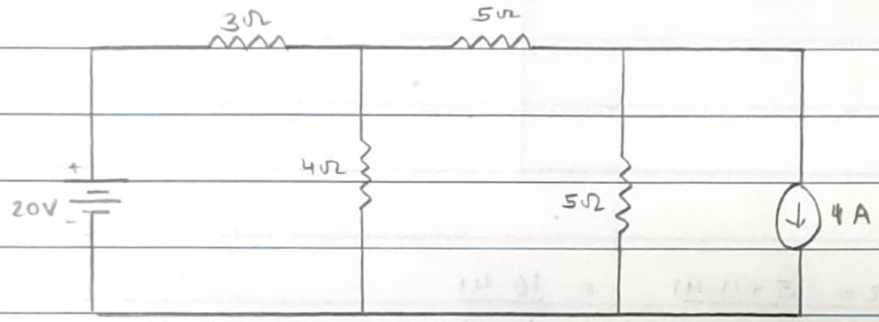
$\therefore$ On solving (i), (ii) and (iii)

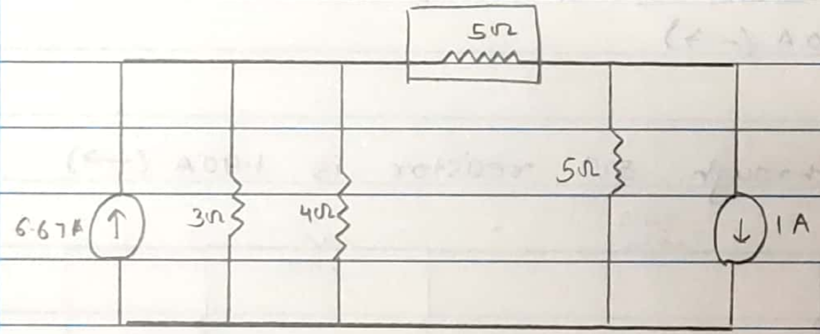
$\therefore V_A = 4V, \quad V_B = 6V, \quad V_C = 4V$

$\therefore I_{4\Omega} = \frac{V_C}{4} = \frac{4}{4} = 1A (\downarrow)$

$\therefore$ Current through 4Ω resistor is 1A.

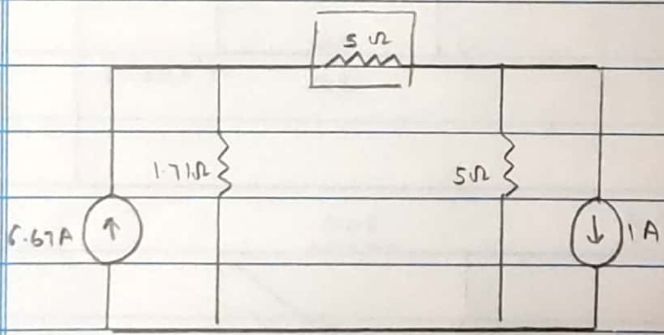
5) Calculate the direction and magnitude of the current through 5Ω resistor using source transformation.

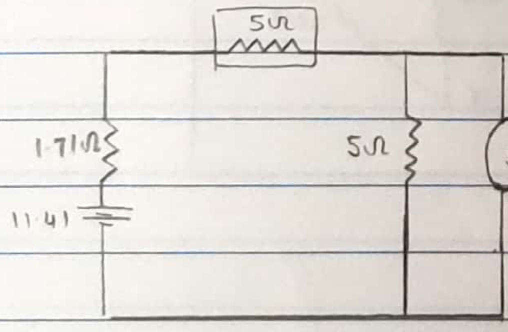


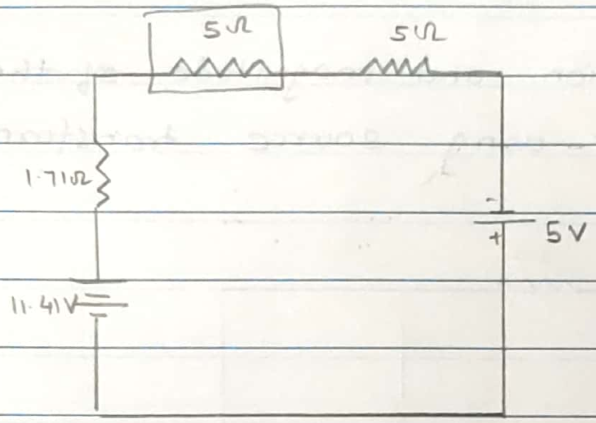


Now, 3Ω is parallel to 4Ω

$\therefore 3 \| 4 = 1.71\Omega$





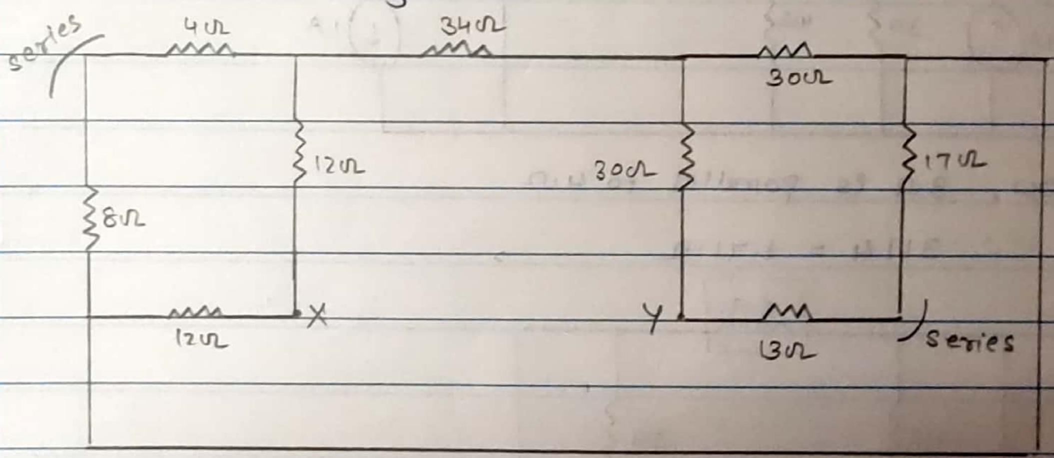


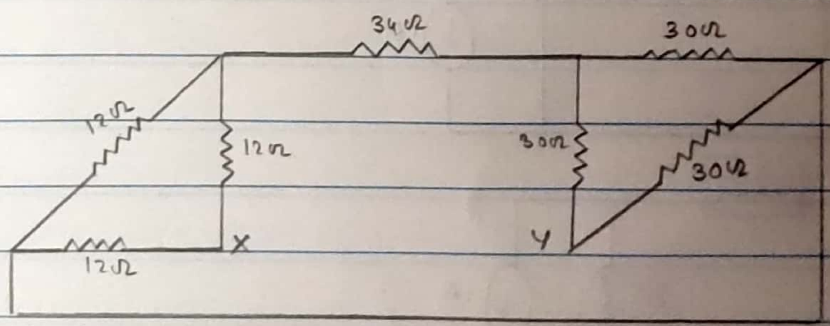
$$\therefore\ I_{5\Omega} = \frac{5+11.41}{5+5+1.71} = \frac{16.41}{11.71}$$

$$\therefore\ I_{5\Omega} = 1.40\,A\ (\rightarrow)$$

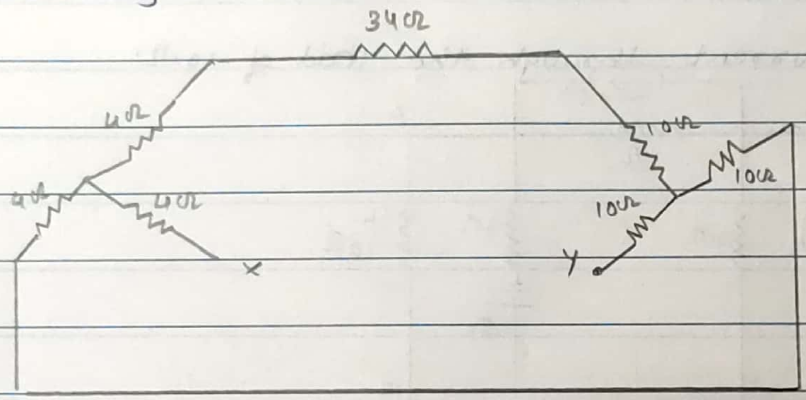
∴ Current through 5Ω resistor is 1.40A (→)

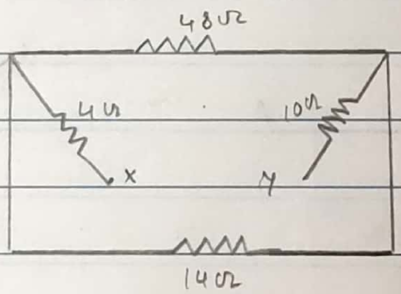
6)



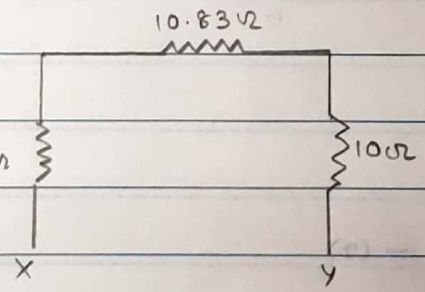


Converting the deltas into star network,





Now, $(48 \parallel 14)\Omega$ $\therefore$ $48 \parallel 14 = 10.83\Omega$

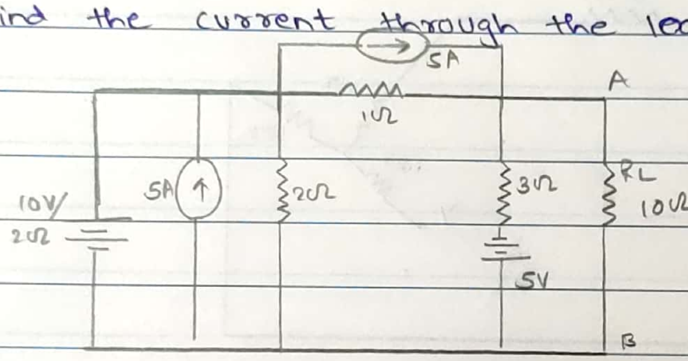


$\therefore \quad R_{xy} = 4 + 10.83 + 10$

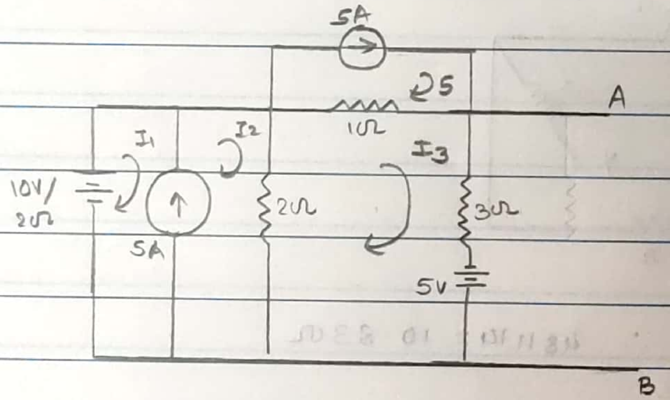
$\therefore R_{xy} = 24.83\Omega$

$\therefore$ Equivalent network resistance between terminals x and y is 24.83Ω.

7) Find the Thevenin's equivalent circuit across a-b and hence find the current through the load of 10Ω.



→



$\therefore$ $I_2 - I_1 = 5$ — (i)

$\therefore$ KVL in supermesh,

$10 - 2I_1 - 2I_2 + 2I_3 = 0$ — (2)

KVL in loop 3,

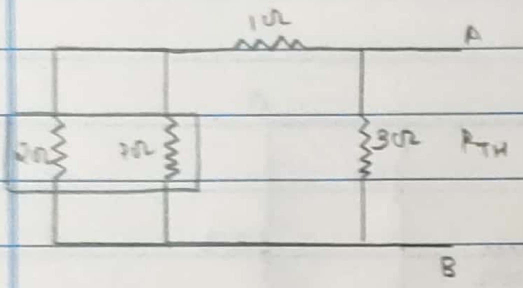
$10 - 6I_3 + 2I_2 = 0$

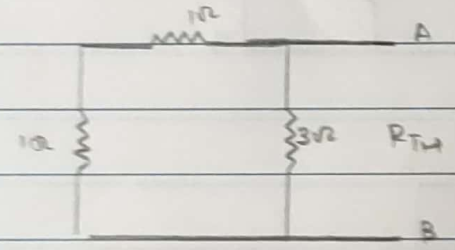
$\therefore$ $I_2 - 3I_3 + 5 = 0$ — (3)

On solving (i), (ii) and (iii)

$I_1 = 2A$, $I_2 = 7A$, $I_3 = 4A$.

For R_{TH},





$R_{TH} = (1+1) \| 3 = 2 \| 3 = 1.2\Omega$

$\therefore R_{AB} = 1.2\Omega$

Now,

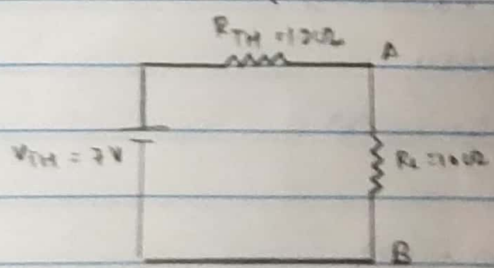
Applying KVL from A to B,

$V_A - 3\times4 + 5 - V_B = 0$

$V_{AB} = 7V$

$\therefore V_{TH} = 7V$

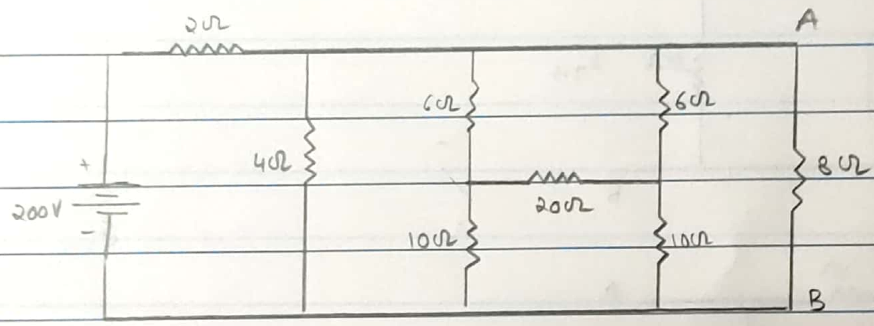
$\therefore$ Thevenin's equivalent circuit,

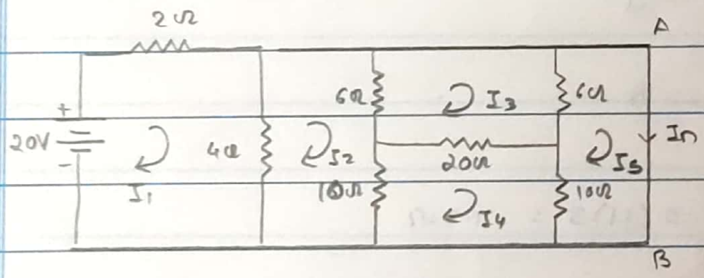


$\therefore I_{10\Omega} = \frac{7}{1.2+10} = \frac{7}{11.2} = 0.625\,A\ (\downarrow)$

$\therefore$ Current through load of 10Ω is $0.625A\ (\downarrow)$

8) Find the current through Norton's theorem through a load of 8 Ω.





KVL in loop 1,

$200 - 6I_1 + 4I_2 = 0$

$\therefore 3I_1 - 2I_2 = 100 \quad -(i)$

KVL in loop 2,

$-20I_2 + 4I_1 + 6I_3 + 10I_4 = 0$

$-20I_2 + 4\left(\frac{2I_2 + 100}{3}\right) + 6I_3 + 10I_4 = 0$

$-60I_2 + 8I_2 + 400 + 18I_3 + 30I_4 = 0$

$\therefore 52I_2 = 400 + 18I_3 + 30I_4$

$\therefore 26I_2 = 200 + 9I_3 + 15I_4 \quad -(2)$

KVL in loop 3,

$-32I_3 + 6I_2 + 20I_4 + 6I_5 = 0 \quad -(3)$

KVL in loop 4,

$-40I_4 + 10I_2 + 20I_3 + 10I_5 = 0 \quad -(4)$

KVL in loop 5,

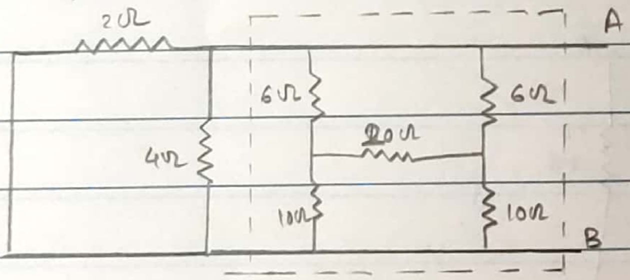
$-16 I_5 + 10 I_4 + 6 I_3 = 0 \quad -(5)$

On solving equation (2), (3), (4) and (5),

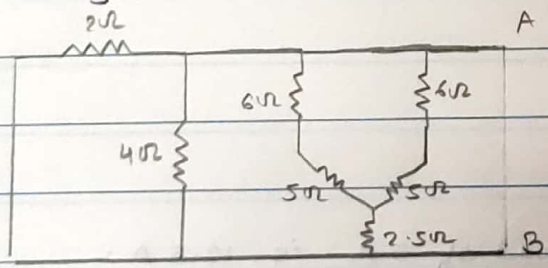
$I_3 = 100A$, $I_4 = 100A$, $I_5 = 100A$

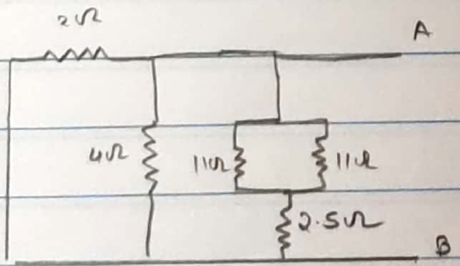
$\therefore I_N = I_5 = 100A$.

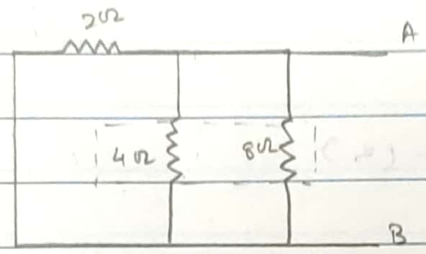
For RTH,



Converting the delta into star network,





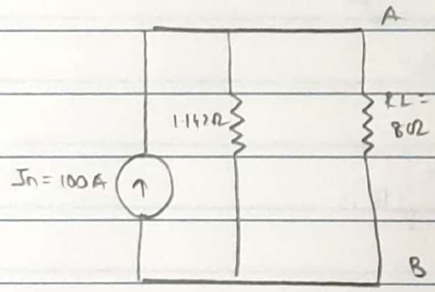


$\therefore R_{AB} = (8 || 4) || 2$

$\therefore R_{AB} = 1.142\,\Omega$

$\therefore R_N = 1.142\,\Omega$

$\therefore$ Norton's Equivalent circuit.

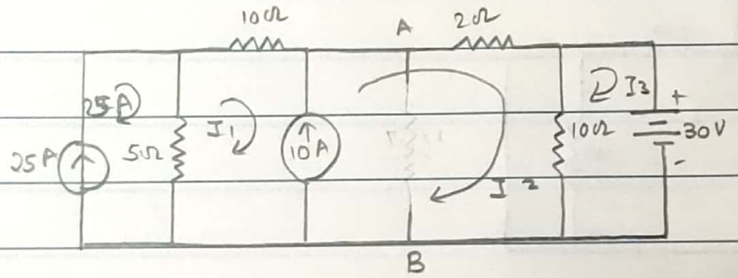


$$\therefore I_{8\Omega} = \frac{100 \times 1.142}{8 + 1.142}$$

$$I_{8\Omega} = 12.5\ A$$

$\therefore$ Current through a load of $8\,\Omega$ is $12.5\ A$.

9) Determine the maximum power delivered to R_L.



$I_1 - I_2 = 10 \quad \text{—(i)}$

Applying KVL in supermesh,

$-15I_1 - 12I_2 + 10I_3 + 5(25) = 0$

$\therefore 15I_1 + 12I_2 - 10I_3 = 125 \quad \text{— (2)}$

Applying KVL in loop,

$-30 - 10I_3 + 10I_2 = 0$

$\therefore 10I_2 - 10I_3 = 30 \quad \text{— (3)}$

$\therefore$ On solving (i), (ii) and (3)

$I_1 = 4.41A$, $I_2 = 14.41A$, $I_3 = 11.41A$

Now,

Applying KVL from A to B,

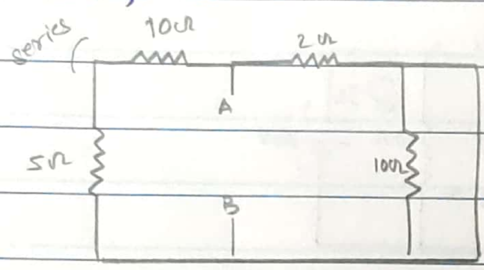
$V_A - 2I_2 - 10I_2 + 10I_3 - V_B = 0$

$V_{AB} = 12I_2 - 10I_3$

$\therefore V_{AB} = 58.822\ V$

$\therefore V_{TH} = 58.822\ V$

For R_{TH},



$\therefore R_{AB} = (10+5) \| 2 = \cancel{(15 \|)2}\ 15 \| 2$

$\therefore R_{AB} = 1.764\,\Omega$

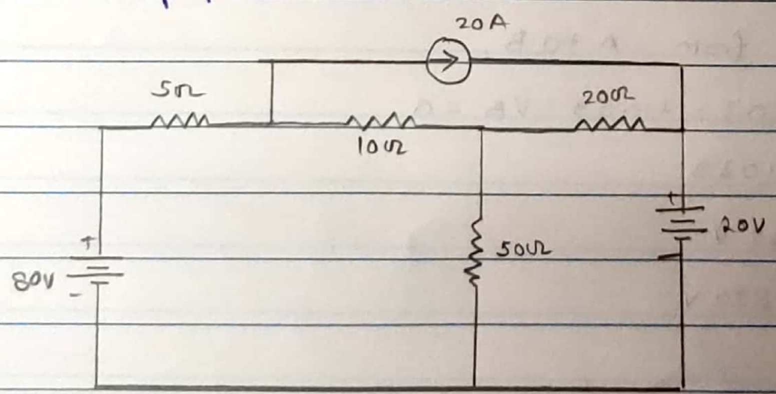
$\therefore R_{TH} = 1.764\,\Omega$

$$\therefore P_{max} = \frac{V_{TH}^2}{4R_{TH}} = \frac{(58.822)^2}{4(1.764)}$$

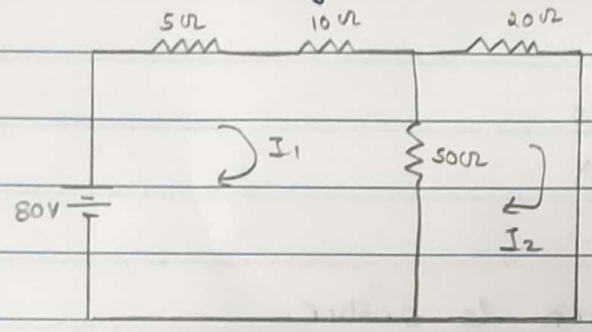
$\therefore P_{max} = 490.366\ W$

$\therefore$ Maximum Power delivered to load R_L is 490.366 W.

10) Determine the current through 10Ω resistor in the network shown superposition theorem.



Case 1 : when only 80 V source is active.



KVL in loop 1,

$80 - 65I_1 + 50I_2 = 0$

$\therefore 65I_1 - 50I_2 = 80$ — (i)

KVL in loop 2,

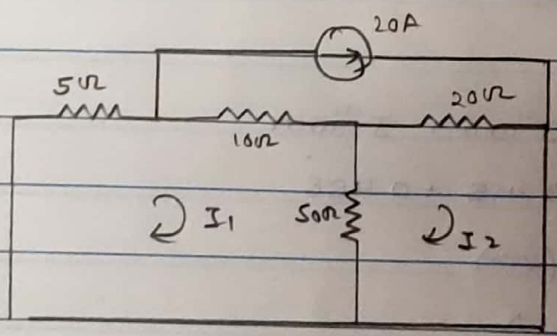
$50I_1 - 70I_2 = 0$ — (2)

On solving equations (i) and (ii),

$I_1 = 2.73$ A , $I_2 = 1.95$ A

$\therefore I_{10\Omega}' = 2.73$ A ($\longrightarrow$)

Case 2: When 20 A current source is active.



KVL in loop 1,

$65I_1 - 50I_2 = 200$ — (i)

KVL in loop 2,

$50I_1 - 70I_2 = -400$ — (2)

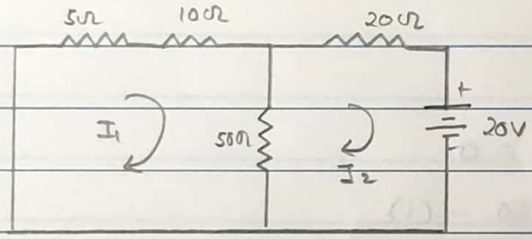
On solving,

$I_1 = 16.585\,A$, $I_2 = 17.561\,A$

$\therefore I''_{10\Omega} = 20 - 16.585$

$I''_{10\Omega} = 3.415\,A\ (\leftarrow)$

Case 3 : When 20V source is active.



KVL in loop 1,

$-65 I_1 + 50 I_2 = 0 \quad -(i)$

KVL in loop 2,

$-70 I_2 + 50 I_1 = 20 \quad -(2)$

On solving,

$I_1 = -0.488\,A$, $I_2 = -0.634\,A$

$\therefore I'''_{10\Omega} = 0.488\,A\ (\leftarrow)$

$\therefore I_{10\Omega} = I'_{10\Omega} + I''_{10\Omega} + I'''_{10\Omega}$

$= -2.73 + 3.415 + 0.488$

~~$I_{10\Omega} = 1.173A\ (\leftarrow)$~~

$I_{10\Omega} = 1.171\,A\ (\leftarrow)$

$\therefore$ Current through 10 Ω resistor is 1.171A (←)