BASIC ELECTRONICS
ASSIGNMENT

Submitted by
Muhammad Ahsan Akbar
Cms : 284918
Section : BESE-10A

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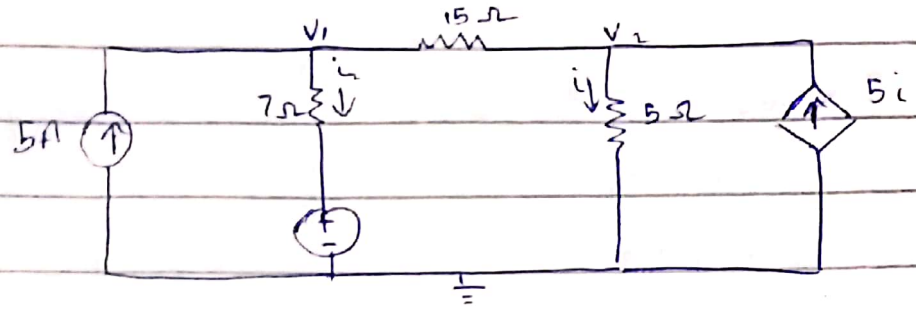
Question - 1

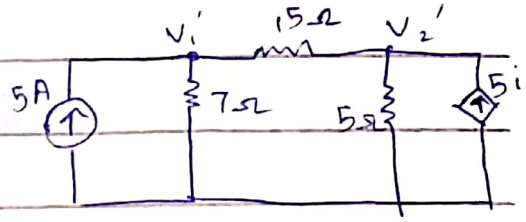


We will apply Superposition theorem
First we will only consider current source of 5A & ignore voltage source

At node V_1' :-

$$I_1 + I_2 + I_3 = 0$$

$$-5 + \frac{V_1' - 0}{7} + \frac{V_1' - V_2'}{15} = 0$$



$$\frac{-525 + 15V_1' + 7V_1' - 7V_2'}{105} = 0$$

$$22V_1' - 7V_2' - 525 = 0 \quad -i$$

At node V_2' :-

$$-5i + \frac{V_2'}{5} + \frac{V_2' - V_1'}{15} = 0 \quad -\alpha$$

As $i = V_2/5$ put in α

$$-5\left(\frac{V_2'}{5}\right) + \frac{V_2'}{5} + \frac{V_2' - V_1'}{15}$$

$$\frac{-15V_2' + 3V_2' + V_2' - V_1'}{15} = 0$$

$$-11v_2' - v_1' = 0 \quad -(ii)$$

Put in (i)

$$-242v_2' - 7v_2' - 525 = 0$$

$$-249v_2' - 525 = 0$$

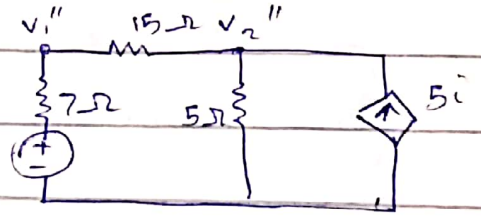
$$v_2' = -2.1084\ V$$

Put in (ii)

$$-11(-2.1084) - v_1' = 0$$

$$v_1' = 23.1924\ V$$

Now, consider only voltage source & ignore current source



At node v_1'' :-

$$I_1 + I_2 + I_3 = 0$$

$$\frac{v_1'' - 4}{7} + \frac{v_1' - v_2'}{15} = 0$$

$$15v_1'' - 60 + 7v_1'' - 7v_2'' = 0$$

$$22v_1'' - 7v_2'' - 60 = 0 \quad -(iii)$$

At node v_2'' :-

$$I_1 + I_2 + I_3 = 0$$

$$-5i + \frac{v_2''}{5} + \frac{v_2'' - v_1''}{15} = 0$$

$$v_1'' = -11v_2'' \quad -(iv)$$ put in (iii)

$$-242v_2'' - 7v_2'' - 60 = 0$$

$$v_2'' = -0.2409\ V$$

put in (iv)

$v_1'' = -11(-0.2409)$

$v_1'' = 2.6506$

Add v_1' & v_1'' to get v_1

$v_1 = v_1' + v_1''$

$= 23.1924 + 2.6506$

$v_1 = 25.8430\ V$

Add v_2' & v_2'' to get v_2

$v_2 = v_2' + v_2''$

$= -2.1084 - 0.2409$

$v_2 = -2.3493\ V$

For i :-

$i = \frac{v_2}{5} = \frac{-2.3493}{5}$

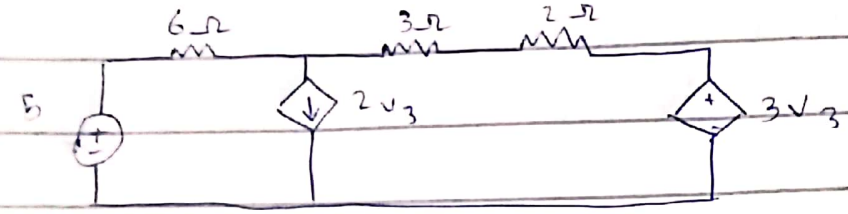
$i = -0.46986$

For i_2 :-

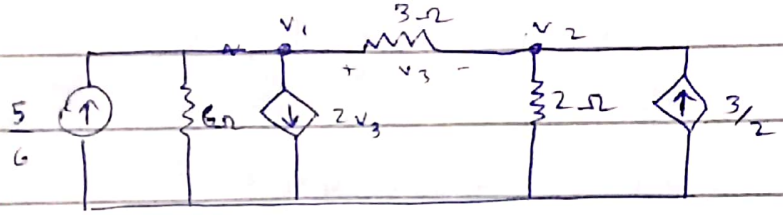
$i_2 = \frac{v_1 - 4}{7} = \frac{25.8430 - 4}{7}$

$i_2 = 3.1204\ A$

Question - 2



Converting voltage sources to current sources



At node v_1 :-

$$-\frac{5}{6} + \frac{v_1}{6} + 2v_3 + \frac{v_1 - v_2}{3} = 0$$

$$\frac{-5 + v_1 + 12v_3 + 2v_1 - 2v_2}{6} = 0$$

$$-5 + v_1 + 12v_3 + 2v_1 - 2v_2 = 0 \qquad \therefore v_3 = v_1 - v_2$$

$$15v_1 - 14v_2 - 5 = 0 \quad -(1)$$

At node v_2 :-

$$-\frac{3}{2}v_3 + \frac{v_2}{2} + \frac{v_2 - v_1}{3} = 0$$

$$-9v_3 + 3v_2 + 2v_2 - 24 = 0$$

$$\therefore v_3 = v_1 - v_2$$

$$-9v_1 + 9v_2 + 3v_2 + 2v_2 - 24 = 0$$

$$-11v_1 + 14v_2 = 0$$

$$v_2 = \frac{11}{14}v_1 \quad -(2)$$

put v_2 in ①

$$15v_1 - 14\left(\frac{11}{14}v_1\right) - 5 = 0$$

$$15v_1 - 11v_1 - 5 = 0$$

$$4v_1 = 5$$

$$v_1 = \frac{5}{4} = 1.25$$

put v_1 in ②

$$v_2 = \frac{11}{14} \times \frac{5}{4}$$

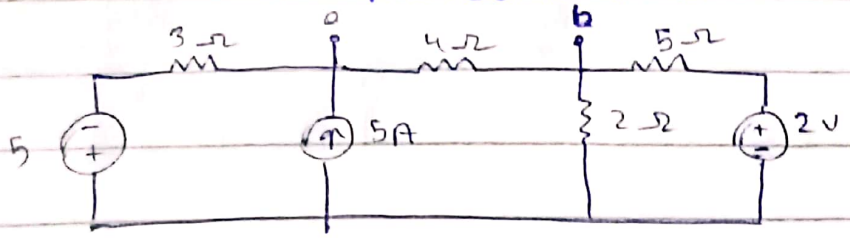
$$v_2 = 0.9821$$

as $v_3 = v_1 - v_2$

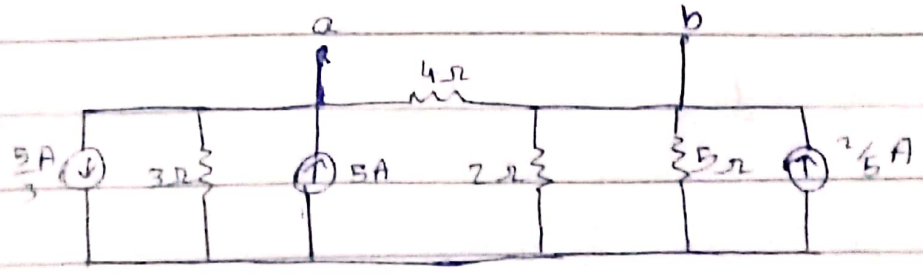
$$v_3 = 1.25 - 0.9821$$

$$\boxed{v_3 = 0.2679}$$

Question - 3



Converting voltage sources to current sources



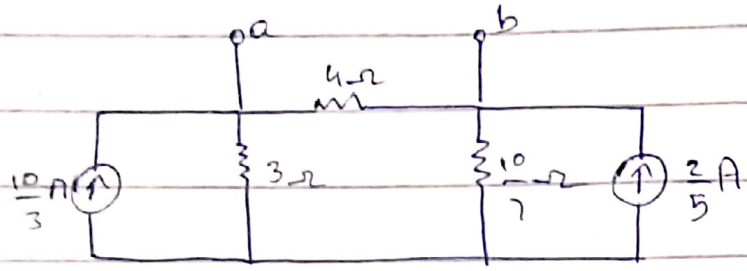
Combining 5A & 5/3 A currents

$$I = 5 - \frac{5}{3} = \frac{10}{3} A$$

Combining 5Ω & 2Ω resistors

$$R = \frac{5 \times 2}{5+2} = \frac{10}{7} \Omega$$

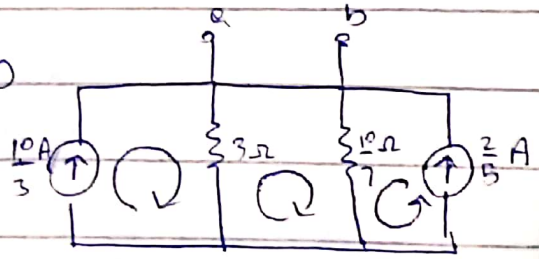
Modified circuit is



Apply Norton's Theorem

For I_{ab} :-

$$I_{ab}\left(3 + \frac{10}{7}\right) = \frac{10}{3} \times 3 + \frac{10}{7} \times \frac{2}{5}$$



$$I_{ab}\left(\frac{31}{7}\right) - 10 + \frac{4}{7} = 0$$

$$I_{ab} = \frac{66}{7} \times \frac{7}{31}$$

$$I_{ab} = 2.1290 A$$

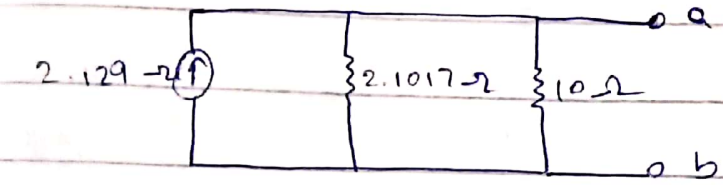
For equivalent resistence

$$R_n = 4 M \left(3 + \frac{10}{7}\right)$$

$$= 4 // \frac{31}{7}$$

$R_n = 2.1017\ \Omega$

For 10Ω resistor norton's circuit is



For current across 10Ω resistor

$$I_{10} = \frac{2.1017}{2.1017+10} \times 2.1290$$

$$I = 0.3697\ A$$

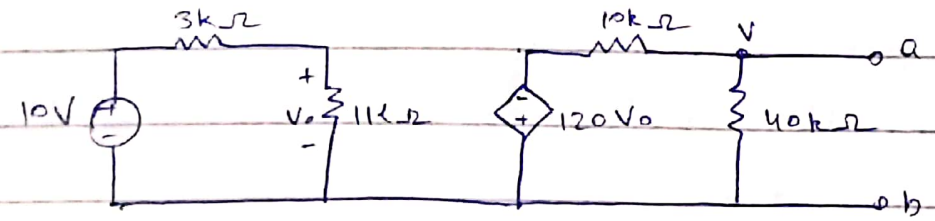
For Power absorbed

$$P = I^2R$$

$$= (0.3697)^2 \times 10$$

$$P = 1.3697\ W$$

Question - 4



Part (a) :-

For V_o :-

Apply voltage divider rule

$$V_o = 10 \times \frac{1}{1+3}$$

$$V_o = \frac{5}{2} V = 2.5 V$$

At node V :-

$$I_1 + I_2 = 0$$

$$\frac{V - 120V_o}{10000} + \frac{V}{40000} = 0 \quad - (1)$$

Put value of V_o in (1)

$$\frac{V - 120(5/2)}{10000} + \frac{V}{40000} = 0$$

$$\frac{V - 300}{10000} + \frac{V}{40000} = 0$$

$$\frac{4V - 1200 + V}{40000} = 0$$

$$5V - 1200 = 0$$

$$V = \frac{1200}{5}$$

$$\boxed{V = 240V}$$

For short circuit :-

$$I = \frac{120 \times 5/2}{10000}$$

$$I = \frac{300}{10000} = \frac{3}{100}$$

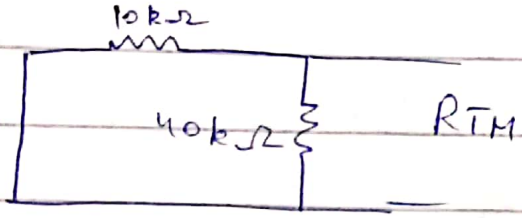
For R_{TH}

$$R_{TH} = \frac{V}{I} = \frac{240}{0.03}$$

$$\boxed{R_{TH} = 8k\Omega}$$

Part (b) :-

We will remove 10V independent voltage source, Due to this 'Vo' has zero voltage, As dependent voltage source is equal to 120 Vo so it also becomes zero. Final circuit is



For RTH:

$$R_{TH} = \frac{40000 \times 10000}{40000 + 10000}$$

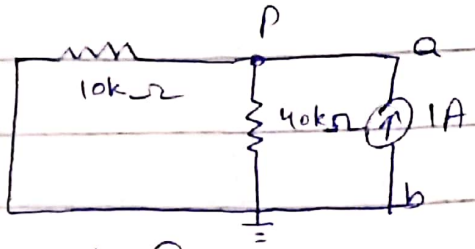
$$= \frac{400000000}{50000}$$

$$R_{TH} = 8000\ \Omega$$

$$R_{TH} = 8\ K\Omega$$

Part (c) :-

As all independent sources are set to zero so Vo is also zero due to which dependent source has no effect we will attach 1A current b/w a & b. Final circuit will be as shown



At point P :-

$$\frac{P}{10k} + \frac{P}{40k} = 1$$

$$\frac{4P + P}{40k} = 1$$

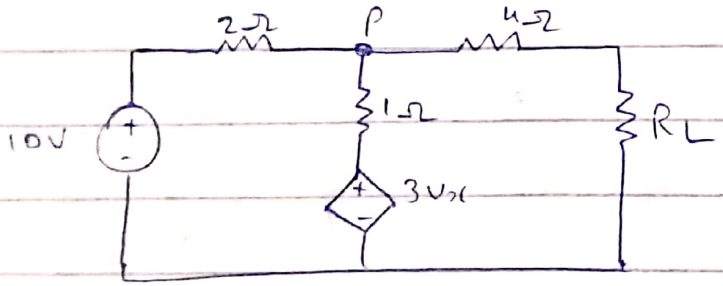
$$P = \frac{40k}{5} = 8kV$$

For R_{TH} :-

$$R_{TH} = \frac{P}{I} = \frac{8kV}{1A}$$

$$R_{TH} = 8k\Omega$$

Question - 5



We have to find maximum power for load R_L. As we know

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

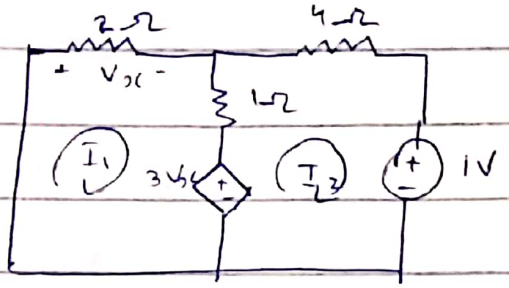
So we will find V_{TH} & R_{TH} by R_L

For R_{TH}, we will replace R_L by 1V voltage source & ignore 10V independent voltage source, Modified circuit will be

Apply mesh analysis

It is clear that

$$V_x = 2I_1$$



For mesh: 1

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

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

$$9I_1 - I_2 = 0$$

$$I_2 = 9I_1 \quad -①$$

For mesh 2 :

$$5I_2 + 1 - 3V_x - I_1 = 0$$

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

$$5I_2 + 1 - 7I_1 = 0$$

From eq ① $I_2 = 9I_1$

$$5(9I_1) + 1 - 7I_1 = 0$$

$$I_1 = -0.0263$$

$$I_2 = -0.2368$$

For R_{TH}

$$R_{TH} = \frac{V}{I_2} = \frac{1}{0.2368} = 4.22\,\Omega$$

$$\boxed{R_{TH} = 4.22\,\Omega}$$

For circuit in mesh 1

$$-10 + 3I_1 + 3V_x = 0$$

$$-10 + 3I_1 + 3(2I_1) = 0$$

$$9I_1 = 10$$

$$I_1 = \frac{10}{9} = 1.11\,A$$

As $V_{oc} = 10 - P$

$$I_1 = \frac{V_{oc}}{R_{2\Omega}}$$

$$1.11 = \frac{10 - P}{2}$$

$$\boxed{P = 7.78\,V}$$

For P_{max} :-

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

$$= \frac{(7.78)^2}{4 \times 4.22}$$

$$\boxed{P_{max} = 3.5858\,W}$$