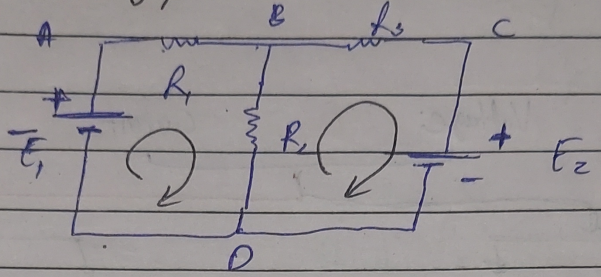
Unit - 2 DC circuit

* Network Terminology :-



(i) Active Elements :-
Those elements in the network which supplies energy to the circuit. E_1 and E_2 are inactive elements.

(ii) Passive elements :-
Which consumes energy or receive energy to the circuit is called passi.

(iii) Node :- A point in a network where two or more elements join. {A, B, C, D} are nodes

(iv) Junction :- A point in a network where 3 or more elements join. (B and D)

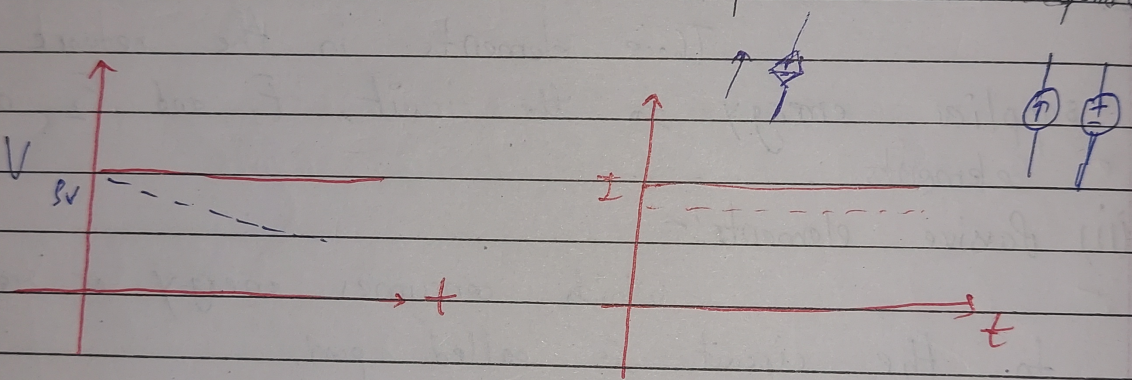
(v) Loop :- The closed path of a network.
2 ABD 2 ABCD 2 BCD

* Mesh :- The most elementary form of a loop that can't be further divided.
2 ABD 2 BCD

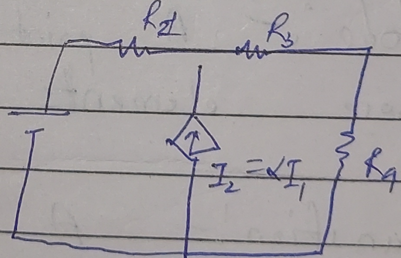
Branch :- The path of a network which lies b/w two junction points.

Sources :-

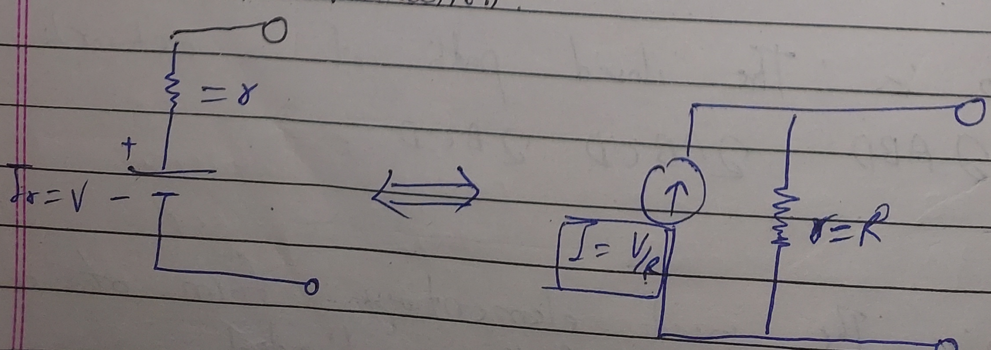
- Voltage, Current
  - Ideal
  - Practical
  - Dependent
  - Independent



- Voltage Depen. Voltage Source :- (VDVS)
- CDVS
- VDCS
- CDCS

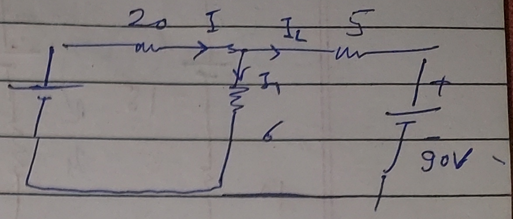


Source Transformation :-



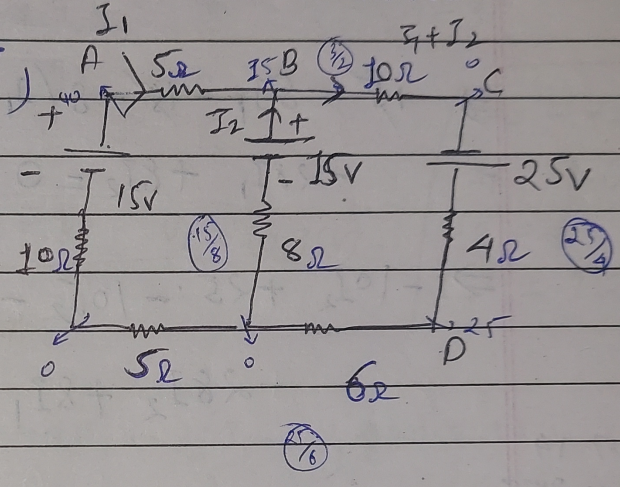
Kirchoff's law :-

(i)



Find I and P in $6\,\Omega$ resistance.

(ii)

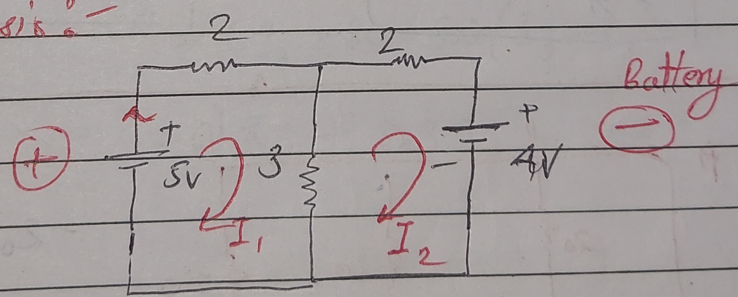


$I_1 = 0.44$

$I_2 = 1.11$

$I_1 + I_2 = 1.55$

Mesh Analysis :-



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

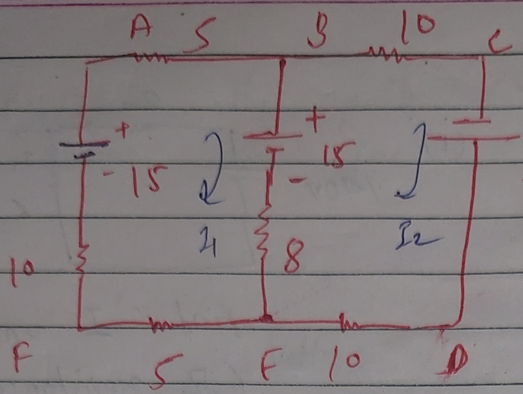
⇒ $5 - 2I_1 - 3I_1 + 3I_2 = 0$ ⇒ $-2I_2 - 4 - 3I_2 + 3I_1 = 0$

⇒ $(5 - 5I_1 + 3I_2 = 0)3$

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

$I_1 = +\frac{13}{16}$

$I_2 = -5$



Sol:-

$\Rightarrow$ $\cancel{15} - 5I_1 - \cancel{15} - 8(I_1 - I_2) - 5I_1 - 10I_1 = 0$

$-28I_1 + 8I_2 = 0$ $\qquad 8I_2 = 28I_1$

$\Rightarrow$ $-10I_2 + 25 - 10I_2 - 8(I_2 - I_1) + 15 = 0$

$-28I_2 + 8I_1 + 40 = 0$

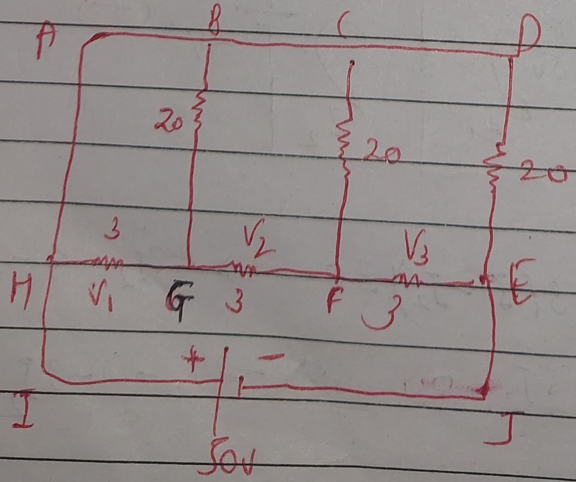
$\cancel{-28} \times \frac{\cancel{28}}{8} I_1$

$14 \times 7 = I_1$

$\frac{14 \times 7 \times 28}{8} = I_2$

$I_1 = 0.44\ A.$

$I_2 = 1.54\ A.$



$-20(I_1 - I_2)$

$-3(I_1 - I_4) = 0$

$\Rightarrow$ $-20(I_2 - I_1)$

$-20(I_2 - I_3)$

$-3(I_2 - I_4)$

$\Rightarrow$ $-20I_3 - 3(I_3 - I_4) - 20(I_3 - I_2) = 0$

PAGE

$$-3(I_4 - I_1) - 3(I_4 - I_2) - 3(I_4 - I_3) + 50 = 0$$

$\Longrightarrow$

$$-23I_1 + 20I_2 + 3I_4 = 0$$

$$+20I_1 - 43I_2 + 20I_3 + 3I_4 = 0 \qquad 1-2$$

$$20I_2 - 43I_3 + 3I_4 = 0 \qquad 2-3$$

$$3I_1 + 3I_2 + 3I_3 - 9I_4 + 50 = 0 \qquad 4-3$$

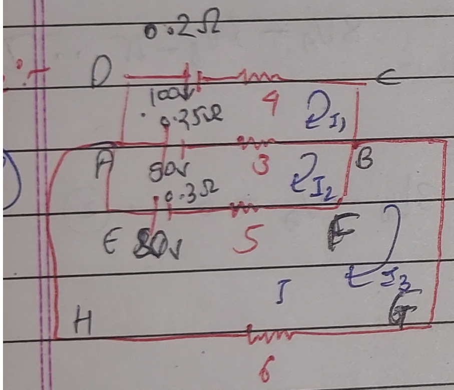
$I_3 = 2.8$

$I_1 = 4.6$

$I_2 = 4.$

$I_4 = 9.27A$

$V_1 = 13.82V \quad V_2 = 15.83 \quad V_3 = 20.35V$



① $-100 - 4.2I_1 - 3.25(I_1 - I_2) + 90 = 0$

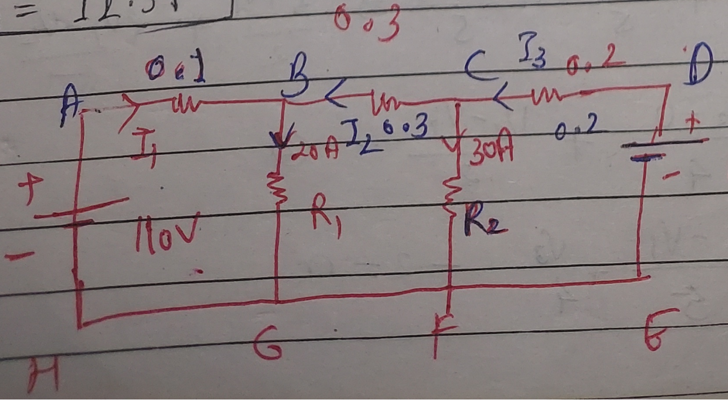
② $-90 - 3.25(I_2 - I_1) - (5.3)I_2 + 80 = 0$

③ $-6I_3 - 80 - 5.3(I_3 - I_2) = 0$

$$-11.3I_3 + 5.3I_2 - 80 = 0$$

$I_1 = 6.21$
$I_2 = 11.16$
$I_3 = 12.31$

I_n 3Ω (4.95) $(I_2 - I_1)$



$R_1 \rightarrow 5.45\ \Omega$

$R_2 \rightarrow 3.73\ \Omega$

~~$I_1 \rightarrow 10A$~~

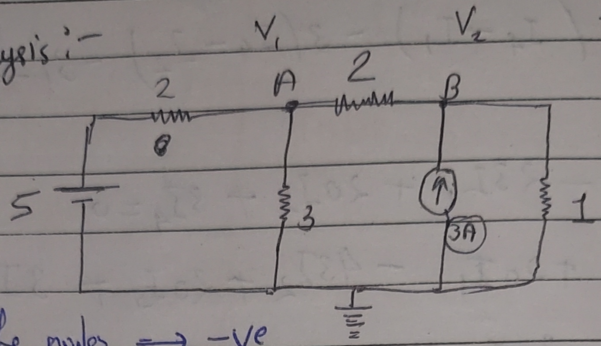
~~$I_2 = 10A$~~

$I_3 = 40A$

DATE
PAGE

Nodal Analysis :-

Que.



Towards the nodes ⟹ -ve
Always from node → +ve

- KCL at node A

$$\frac{V_A - 5}{2} + \frac{V_A - 0}{3} + \frac{V_A - V_B}{2} = 0 \Rightarrow 3V_A - 15 + 2V_A + 3V_A - 3V_B = 0$$

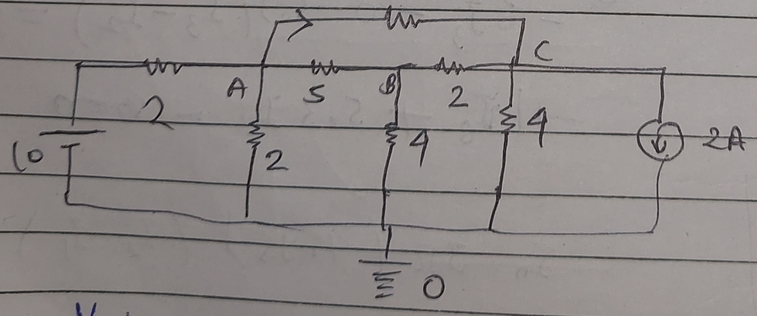
$$8V_A - 3V_B = 15 \quad \ldots (1)$$

- KCL at node B.

$$\frac{V_B - V_A}{2} + \frac{V_B - 0}{1} - 3 = 0 \Rightarrow 3V_B - V_A = 6 \quad \ldots (2)$$

Solⁿ:- $\boxed{V_A = 3}$ $V_B = 3.$

Que



$$\frac{V_A - 10}{2} + \frac{V_1 - 0}{2} + \frac{V_1 - V_2}{5} + \frac{V_1 - V_3}{5} \Rightarrow \frac{V_1 + V_1}{2} + \frac{2V_1 - V_2}{5} \quad \ldots (1)$$

$$\frac{V_2 - V_1}{5} + \frac{V_2 - 0}{4} + \frac{V_2 - V_3}{2} \quad \ldots (2)$$

$$\frac{V_3 - V_2}{4} + \frac{V_3 - V_1}{5} + \frac{V_3}{4} + 2 = 0$$

DATE
PAGE

$$\frac{4V_2 - 4V_1 + 5V_2}{20} + \frac{10(V_2 - V_3)}{1}$$

$V_A = 3.36 \quad V_B = -0.036, \quad V_C = -1.416$

~~Newton~~ Network Theorem :-

Thevenin's theorem :-

~~Any~~ 2 ~~terminal~~ of an electrical networks consistence of ~~active~~ elements can be replaced by an equivalent voltage source and equivalence.

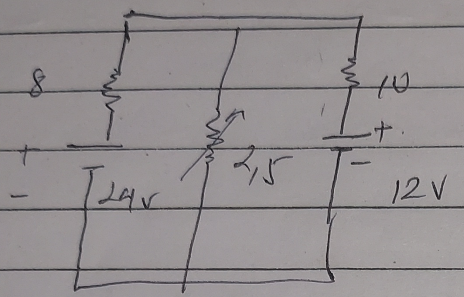
The voltage source :- The open circuit voltage btwn the tutorial caused by the active network

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

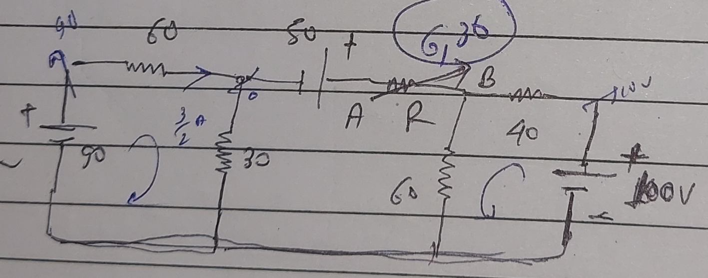
Unit - 2 DC circuit.

Sol^n:-

Q.



Q2

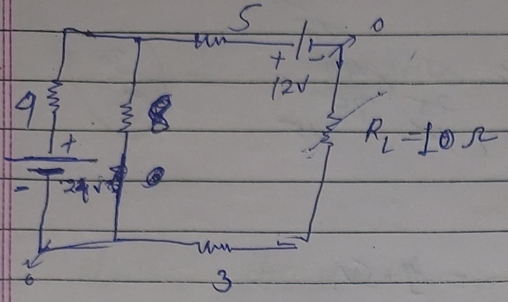


$I_L = \frac{V_{TH}}{R_{TH} + R_L}$

DATE
PAGE

Sol^n -

Qn.



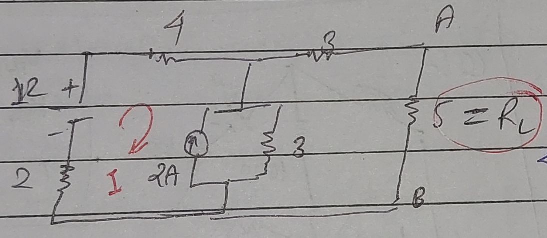
$$24 - 4(I_1 + I_2) - 8(I_1) = 0$$

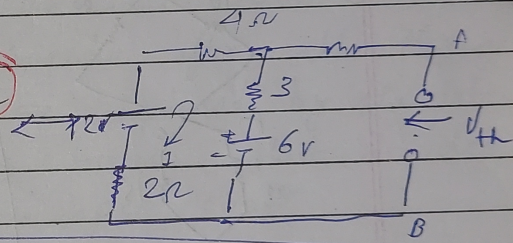
$$-5I_2 + 12 - I_2(10).$$

$$V_{Th} = 0 + 16 + 0 + -12 = 0 = 4V$$

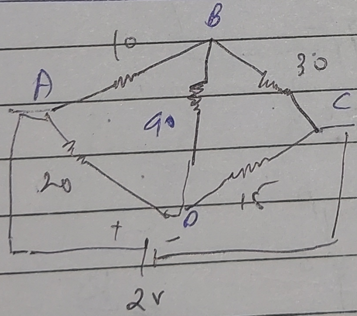
$$R_{Th} = 10.67$$

$$5 + 3 + (4 \| 8)$$





find V_{BC} V_{DC}



$\begin{bmatrix} 40 \\ 35 \end{bmatrix}$

$8 \quad \frac{40 \times 35}{75} \quad 7$

$15 \quad 3$

$R \Rightarrow \boxed{\frac{56}{3}}$

$V = \frac{2 \times 3}{28}$

$\frac{3}{28} =$

$$I_1 = \frac{30}{28} \times \frac{40}{75} \times \frac{2}{40} = \frac{1}{20}$$

$V_{Th} =$

$$I_2 = \frac{3}{28} \times \frac{35}{75} \quad \frac{2}{35}$$

$$V_1 = 2 \times \frac{40}{75}$$

$$V_2 = 2 \times \frac{35}{75}$$

$V_{BC} = 30 \times \frac{5}{28} \times \frac{40}{75} = \frac{30}{7}$

$= 30 \times I_1$

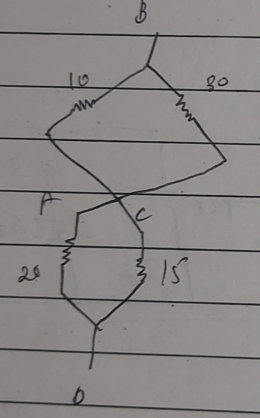
$= 30 \times \frac{V}{40} = 1.5V$

$V_{DC} = 15 I_2 = 15 \times \frac{V_2}{35} = 0.857V$

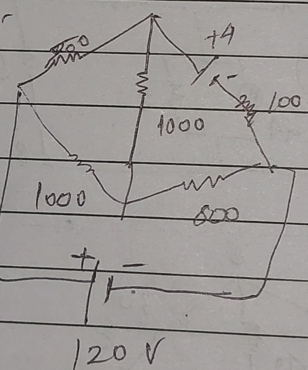
$V_{BD} = V_B - V_D = V_{Th} = 1.5 - 0.857$

$= 0.642 \; V.$

$I = 0.1$



Q:-

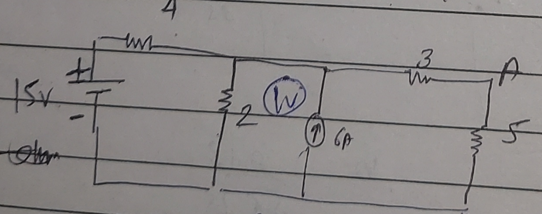


$V_{TH} = 2.2$

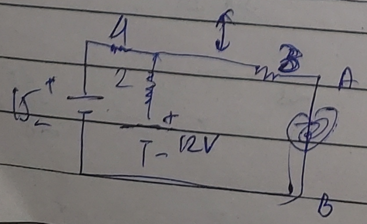
$R_{TH} = 527.72$

$I = 1.5mA$

Q:-



$= \frac{125}{28}$



$3 - 6I = 0$

$0.5 = I$

$V_{TH} = 13$

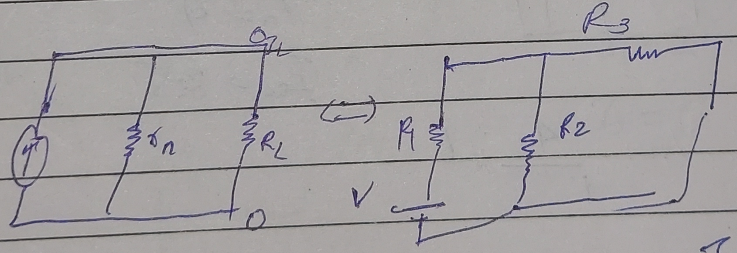
$R_{TH} = 4.33$

$R_{TH} = 3 + (4 \| 2)$

$\frac{14}{3} \times 2$ $\frac{20}{3}$

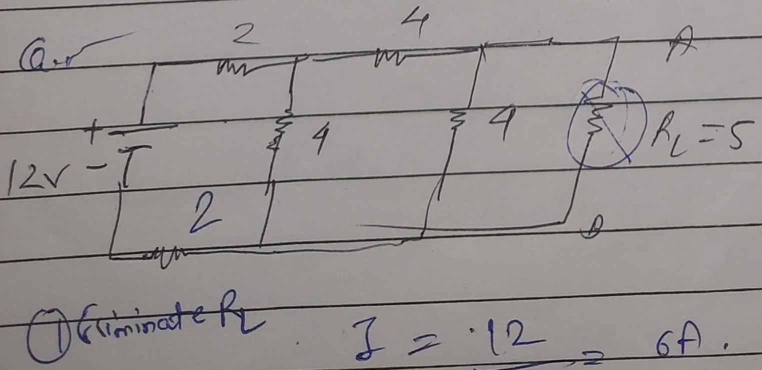
$I_L = 1.39A$ $I_L = \frac{V_{Th}}{R_{Th} + R_L}$

Norton's theorem :— Any two terminal network consisting of voltage sources and resistances can be converted a constant source and a parallel resistance. The magnitude of constant current is equal to the current which will flow when two terminals are short circuited and parallel resistance is the equivalent resistance of the whole network ~~whipe~~ viewed from open circuited terminals after all the voltage and current source are replaced by the int resistance or voltage source becomes short circuited and current source become open circuit.



$I_L = \frac{r_n}{r_n + R_L} \times I_{SC}$

Q.

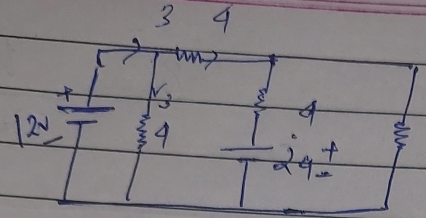


$I_{SC} = 1A$

① Eliminate R_L $I = \frac{12}{2+8+2} = 6A$. $r_n = 2.4$ (By removing battery)

$\frac{2.4}{8.4} \times 1 = I_L$

Qu



$I_L = \frac{2}{2+8} \times 9$

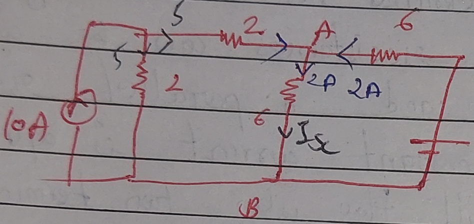
$I_x = \frac{24}{4} = 6 + 3 = 9$

$r_n = 2$

$= \frac{2}{7} \times 9$

$\Rightarrow \frac{18}{7} = 2.55$

Que



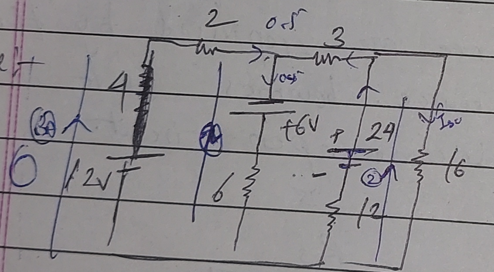
$I_L = \frac{2.4}{2.4+8} \times 7$

Sol

$\frac{12}{6} = 2A$

$I_L = \frac{2.4}{8.4} \times 7 = 2A$

Que



Show that I flowing through resistor 6 is 0.5 A

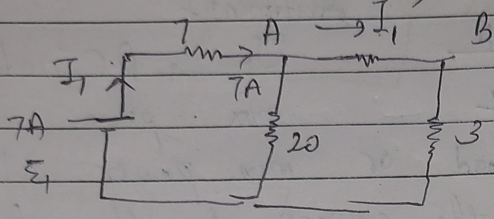
$r_n = 4$

$I_{sc} = 2.5$

10

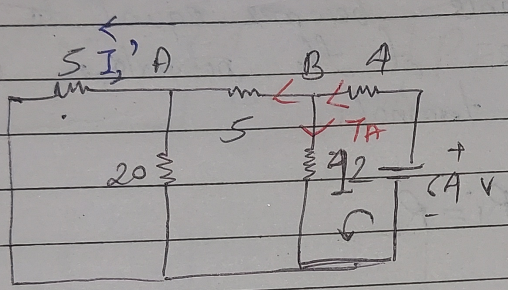
$\frac{4}{i} \times i$

★ Superposition theorem :-



$$I_1' = \frac{7 \times 20}{20+5+3}$$

$I_1' = 5A$ (A to B)



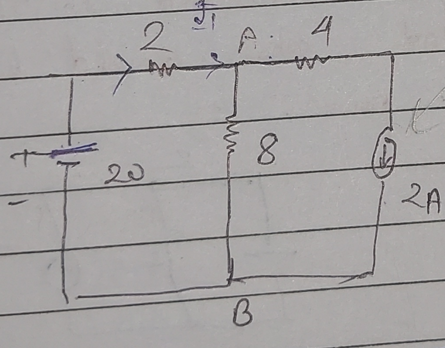
$I_2 = 7A$

$$I_2' = 7 \times \frac{12}{12+5+4} = 4(A)$$

[B to A]

$I_2 = 5 - 4$ Ans

Qu.

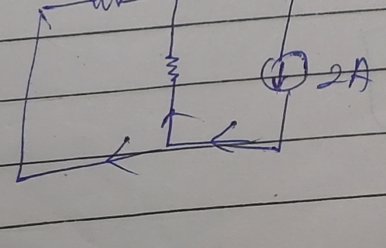


If we open this circuit?

$I_1 = 2$

$I_2 = 0$

Sol



$$I_2 = \frac{2 \times 2}{2+8} = \frac{2 \times 2}{10} = 0.4A$$

$I_{AB} = I_1 - I_2 = 2 - 0.4 = 1.6$ A

* Max^m Power transfer :- $R_L = R_{TH}$

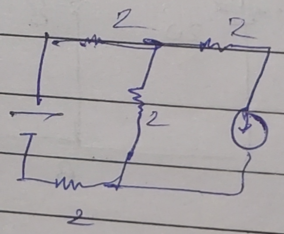
$$P_{max} = \frac{V_{TH}^2}{4R_L}$$

Statement :-

In a D.C network, max. power will be consumed by the load or max. power will be transferred from the source to the load, the the load resistance becomes equal to the internal resistance of the network, as viewed from the load terminals.

$$R_{TH} = R_i = R_L$$

Q:- A 12 v battery is supplying power to resistive load R_L to as shown in network. Calculate at what value power transferred to the load will be max. and what would be the value of that max. power.

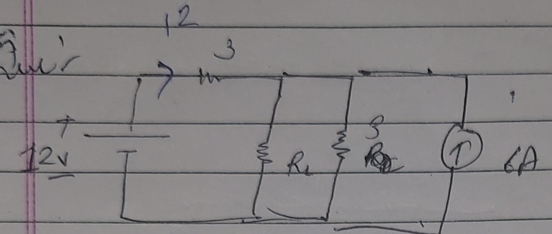


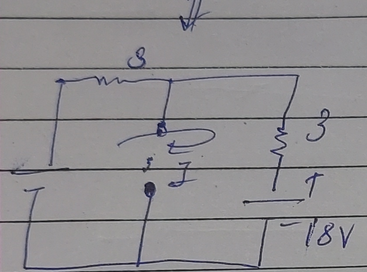
$I = \frac{12}{6} = 2A$ $\quad V_{TH} = 2 \times 2$, 2Ω

$V_{th} = 4v$

$R_{th} = 5.33\Omega = R_i = R_L$

Que:





Sol^n:-

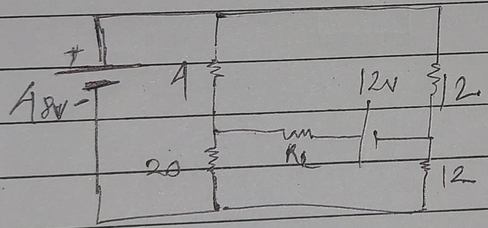
$I = [2 - 3I \ldots - 3I]$

$I_A = 1A$

$V_{Th} = 15V$

$P = 37.5\ W$

Qu.



Sol^n:

$V_{TH} = 4.4$

$R_{TH} = 9.33$

$p = 0.42\ W$