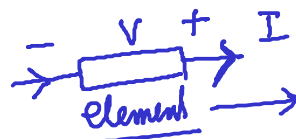


Absorbing power

$$= VI \cdot 10 \times 6$$

Network Analysis

KVL & KCL



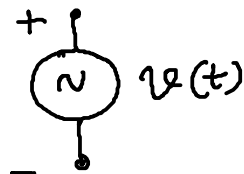
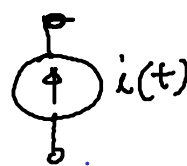
delivering power = $V \cdot I$

R, L, C Circuit elements

dec-1

Sources:- Voltage source, $\frac{+}{-} \frac{1}{10V}$ Current source $\uparrow$ I

time varying source



$$\frac{6 \times 4}{10} = 2.4 \Omega$$

Battery is delivering power = $30 \times 10 = 300W$

$$P = 6 \times 10 = 60W \text{ (absorbed)}$$

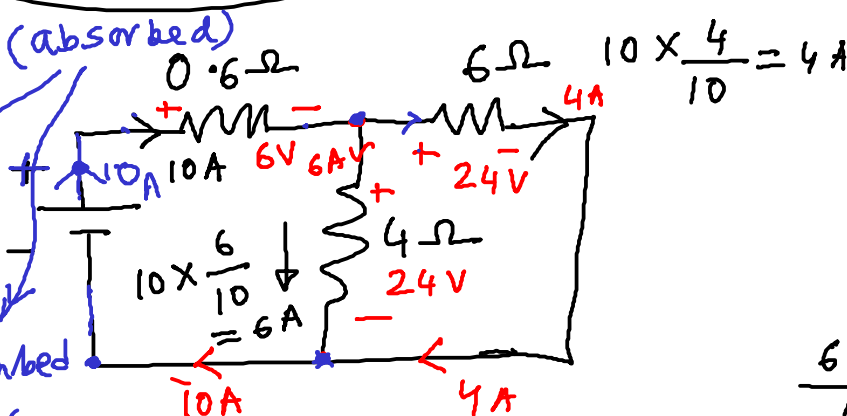
$$P = 24 \times 6 = 144W$$

$$P = 24 \times 4 = 96W$$

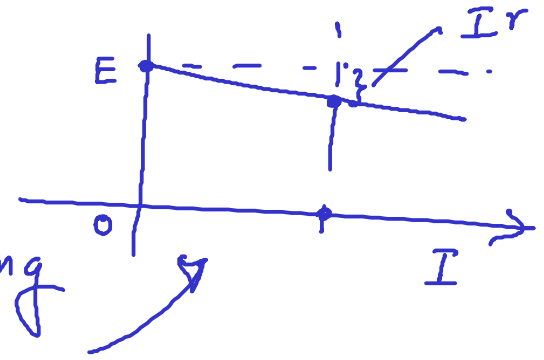
$$\text{Total power absorbed} = 60 + 144 + 96 = 300W$$

$$30 - 6 - 24 = 0 \text{ KVA}$$

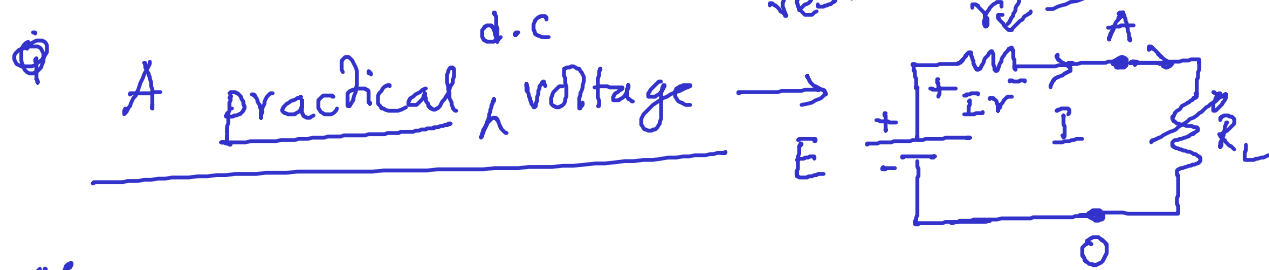
$$30 - 6 - 24 = 0$$



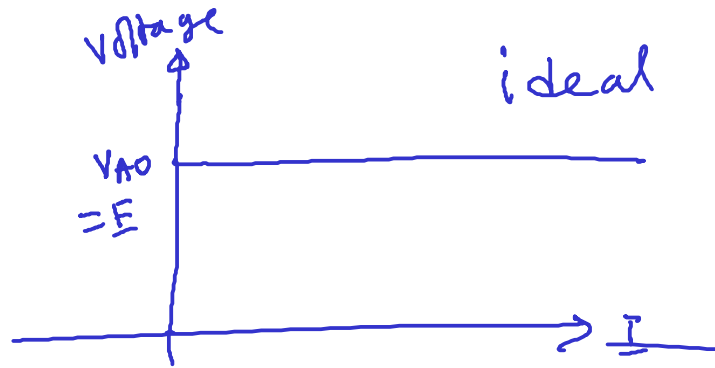
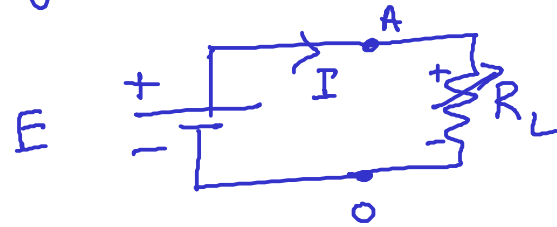
Sources: Voltage sources
 current source (?)



$$V_{AO} = E - Ir$$

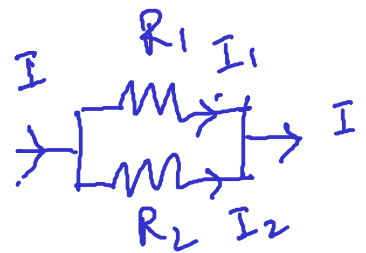


ideal voltage source internal resistance $r=0$



$$V_{AO} = E$$

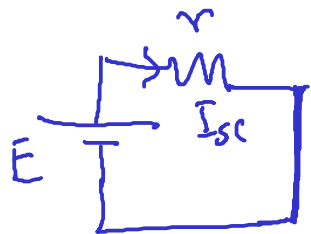
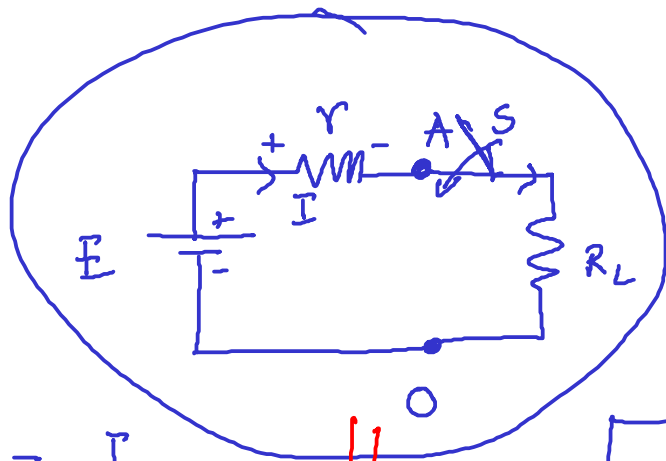
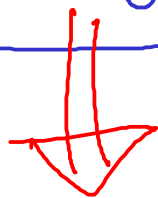
Current source :-



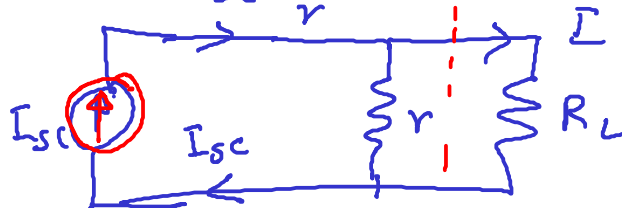
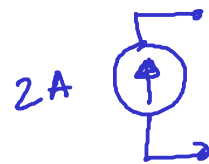
$$I_1 = I \frac{R_2}{R_1 + R_2}$$

def

$$\frac{E}{r} = I_{sc}$$



$$I_{sc} = \frac{E}{r}$$



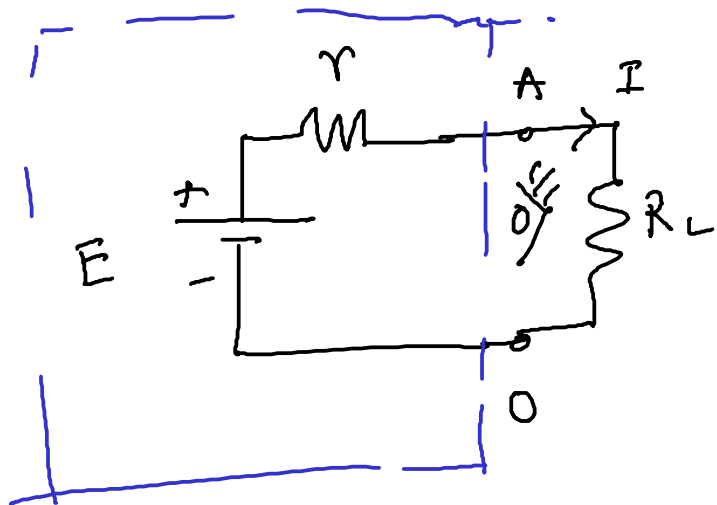
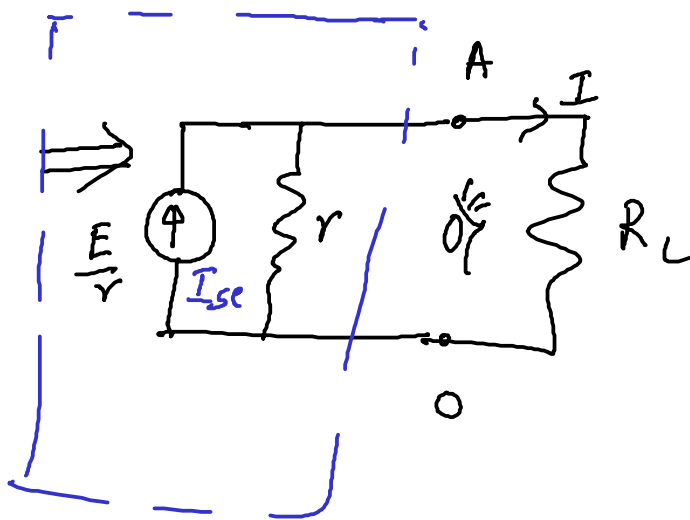
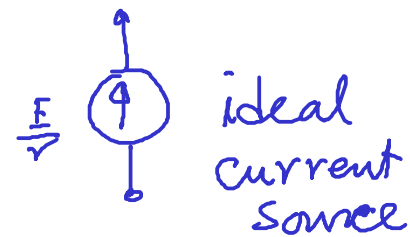
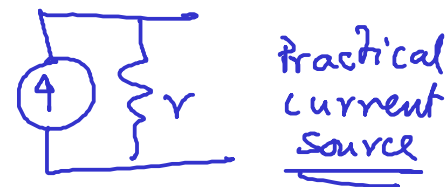
$V_{A0} = E$ with S opened.
with S closed

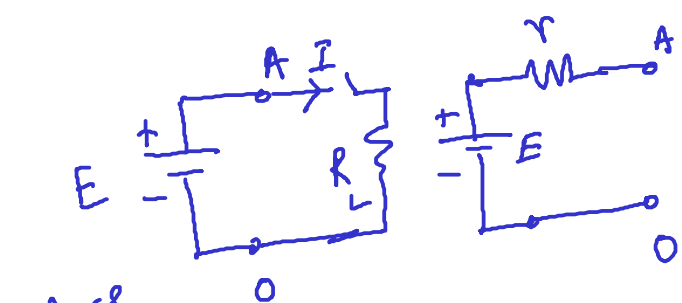
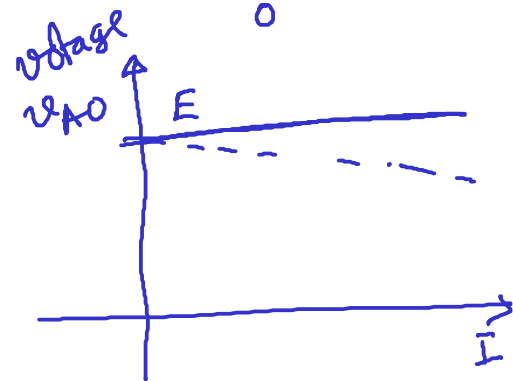
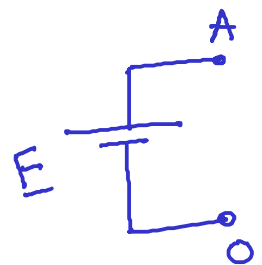
$$V_{A0} = E - I r$$

$$I = \frac{E}{r + R_L}$$

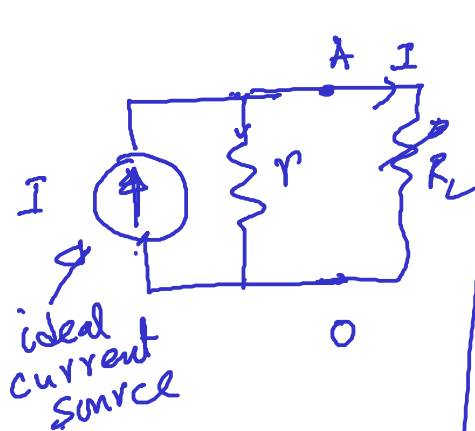
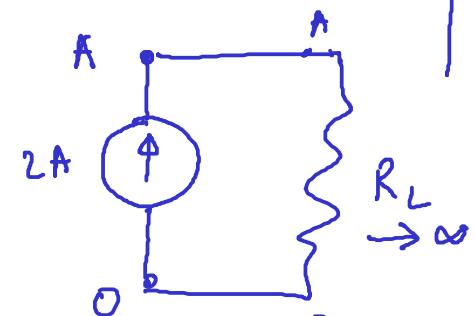
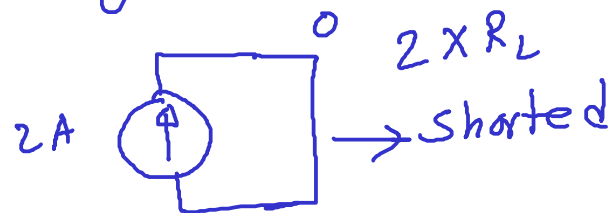
$$I = \frac{E}{r + R_L} = \frac{\left(\frac{E}{r} \right) \downarrow I_{sc}}{(r + R_L)/r} \quad \because r \neq 0$$

$$I = I_{sc} \frac{r}{(r + R_L)}$$





Open circuited when not in use

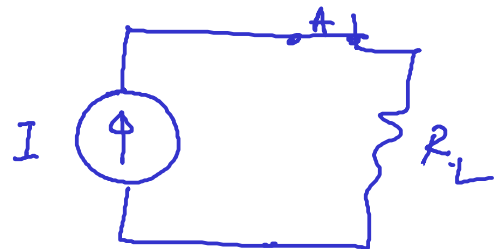
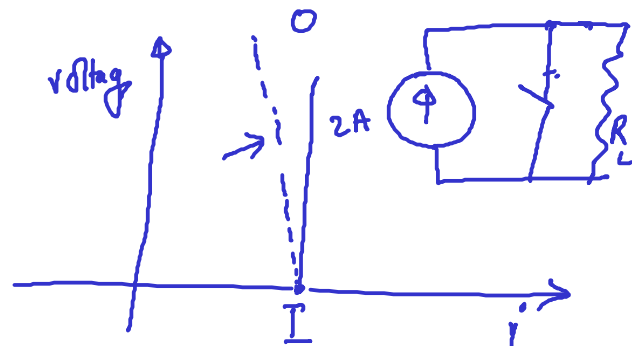
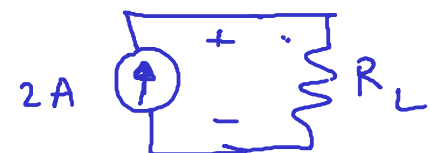


$2 \times R_L$

→ Shorted

when not in use

dec-3



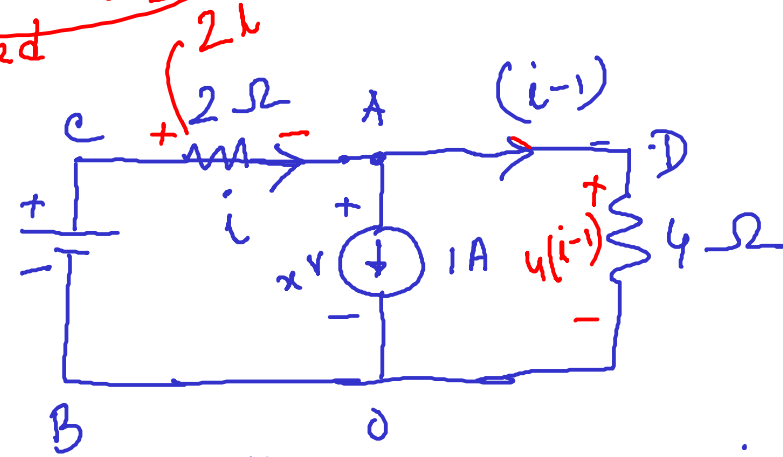
$$10V \rightarrow 10 \times 2.33 = 23.3V \quad (\text{delivering})$$

Power absorbed
by resistances

$$4.67 \times 2.33$$

$$+ 5.33 \times 1.33$$

$$= \underline{18W}$$



Current source

$$\text{absorbs} = 5.33 \times 1 = \underline{5.33W}$$

To find

Take loop OBCADO

and write down KVL:

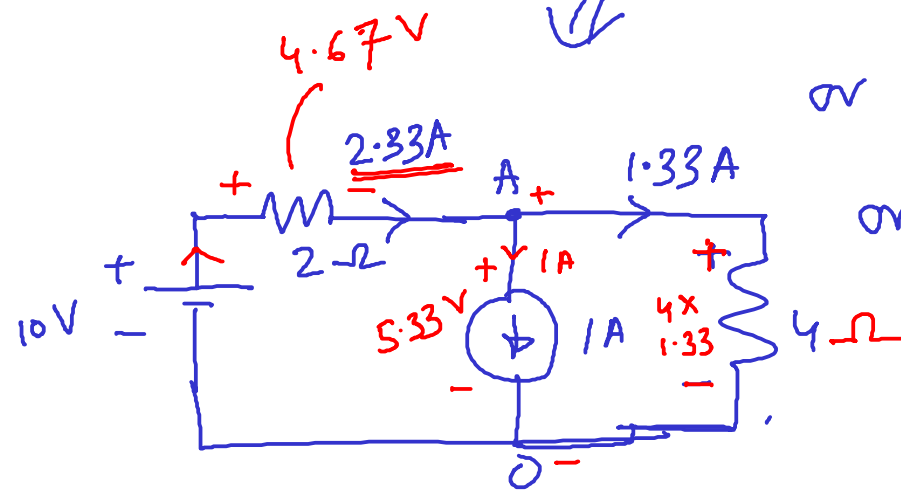
$$10 - 2i - 4(i-1) = 0$$

$$\text{or } 10 - 6i + 4 = 0$$

$$\text{or } 6i = 14 \quad \text{or } i = \frac{14}{6} A = 2.33A$$

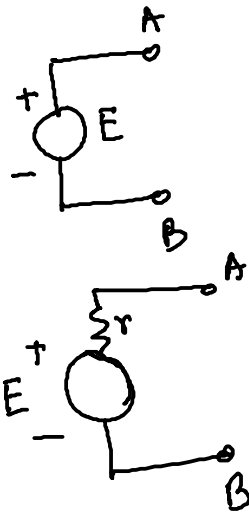
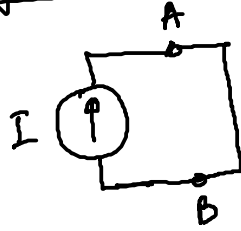
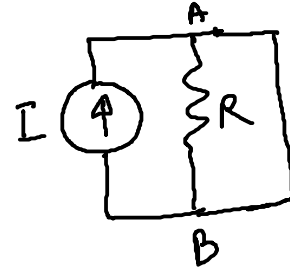
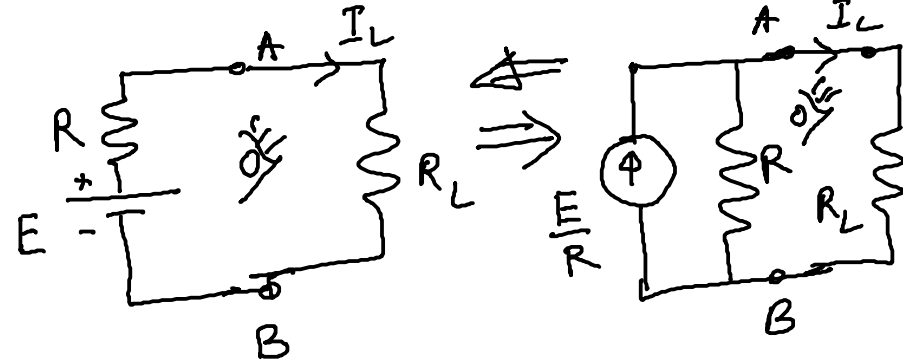
$$V_{AO} = 4 \times 1.33 = \underline{5.33V}$$

$$\text{Total power absorbed} = 18 + 5.33 = \underline{23.33W}$$

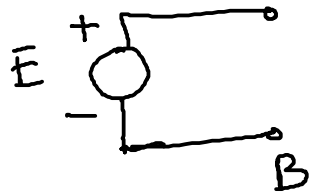
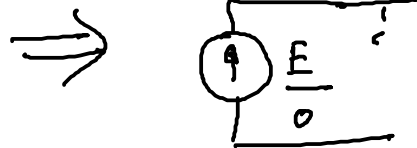
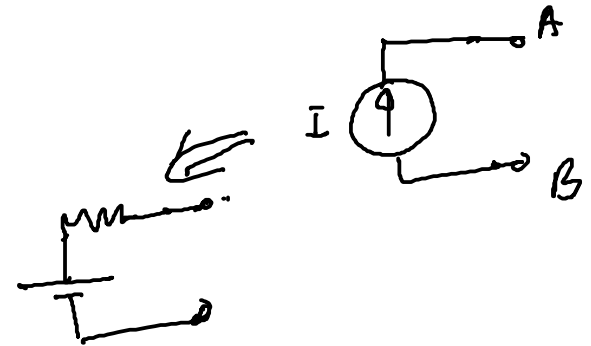


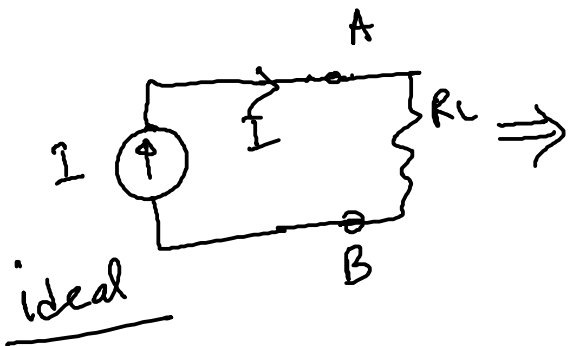
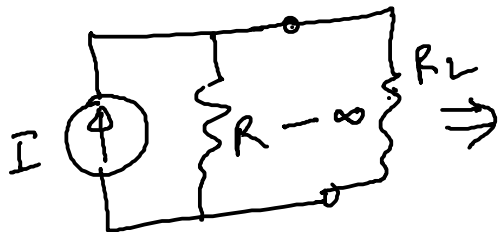
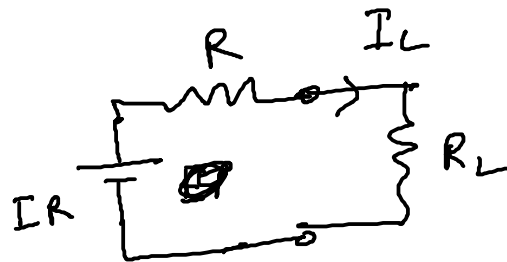
Network Analysis

Lec-4



$\leftarrow A \quad R=0$

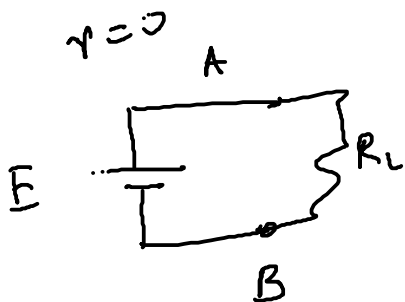
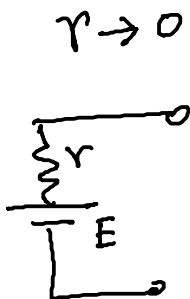
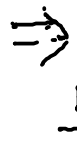
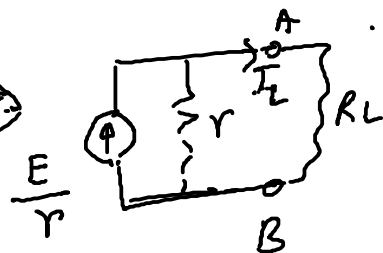




$$\lim_{R \rightarrow \infty}$$

$$I_L = \frac{IR}{R + R_L}$$

$$\frac{IR}{R} = I \quad \text{as } R \rightarrow \infty$$



$$I_L = \frac{E}{r} \times \frac{r}{R_L + r} \quad \lim_{r \rightarrow 0}$$

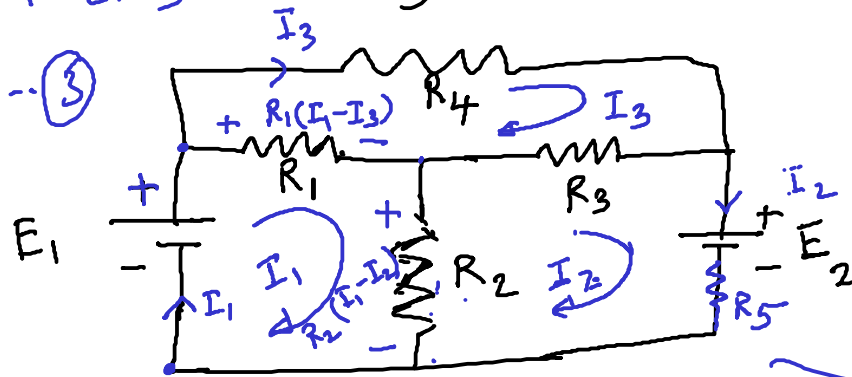
$$= \frac{E}{r} \times \frac{r}{R_L} \quad \lim_{r \rightarrow 0} = \frac{E}{R_L}$$

Mesh Analysis / Node Analysis

Sources $\rightarrow$ constant DC values
only resistances

KVL mesh 3

$$-R_1 I_1 + R_3 I_2 + (R_1 + R_4 + R_3) I_3 = 0 \quad \text{--- (3)}$$



loop
mesh

KVL in mesh 1

$$E_1 - R_1 (I_1 - I_3) - R_2 (I_1 - I_2) = 0$$

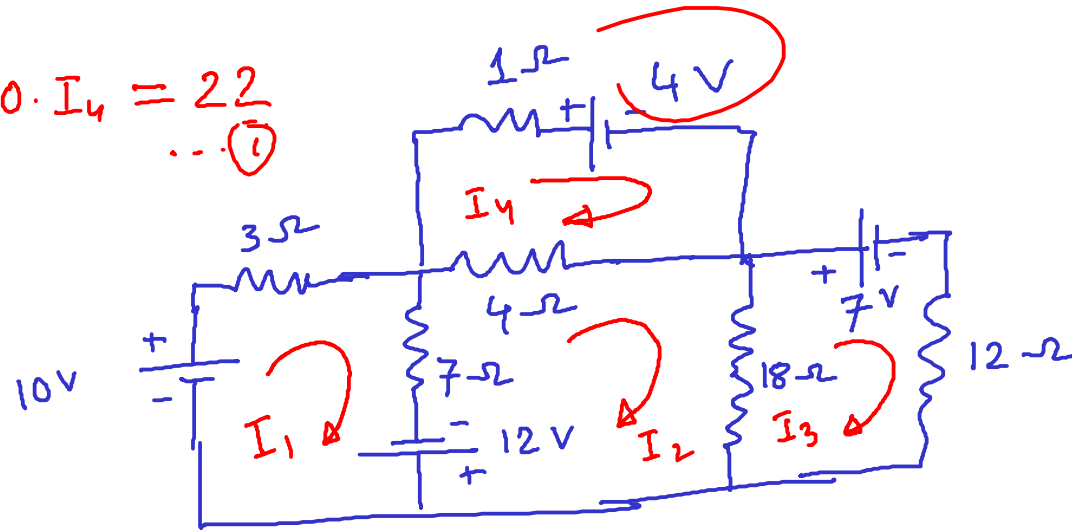
$$\text{or } (R_1 + R_2) I_1 - R_1 I_3 - R_2 I_2 = +E_1 \quad \text{--- (1)}$$

KVL eqnⁿ in mesh 2

$$\rightarrow -R_2 I_1 + (R_2 + R_3 + R_5) I_2 - R_3 I_3 = -E_2 \quad \text{--- (2)}$$

Mesh-I KVL

$$10I_1 - 7I_2 + 0 \cdot I_3 + 0 \cdot I_4 = 22 \quad \dots \textcircled{1}$$



Dec-5

Mesh 2

$$-7I_1 + 29I_2 - 18I_3 - 4I_4 = -12 \quad \dots \textcircled{2}$$

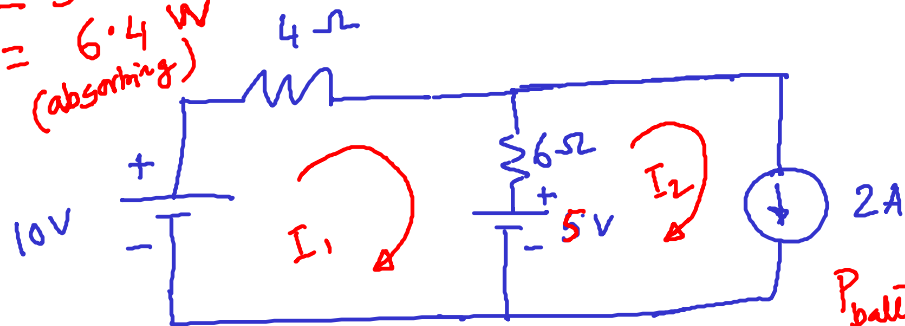
mesh 3

$$0 \times I_1 - 18I_2 + 30I_3 + 0 \times I_4 = -7 \quad \dots \textcircled{3}$$

mesh 4

$$-0 \times I_1 - 4I_2 - 0 \times I_3 + 5I_4 = -4 \quad \dots \textcircled{4}$$

$P_{\text{current source}} = 3.2 \times 2 = 6.4 \text{ W}$
 (absorbing)



KVL in mesh 1:

$$10I_1 - 6I_2 = 10 - 5 = 5$$

$$10I_1 - 12 = 5$$

$$I_1 - I_2 \downarrow$$

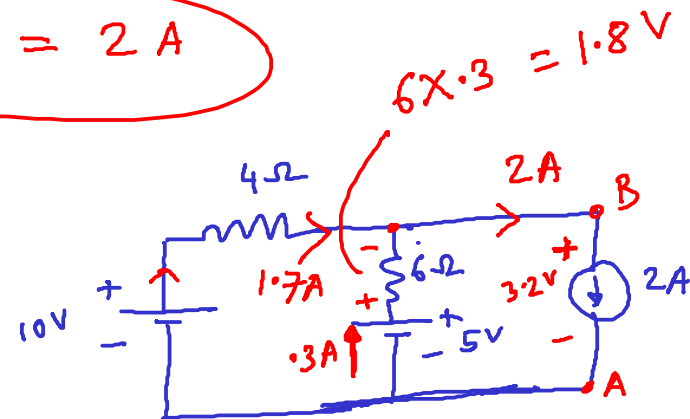
$$1.7 - 2 = -0.3 \text{ A}$$

~~P_{battery}~~ $1.5 + 1.7 = 1.7 \times 4 + 3 \times 6 + 6.4$

$$I_2 = 2 \text{ A}$$

$$P_{\text{battery}} = 1.7 \times 10 = 17 \text{ W}$$

 (delivering)



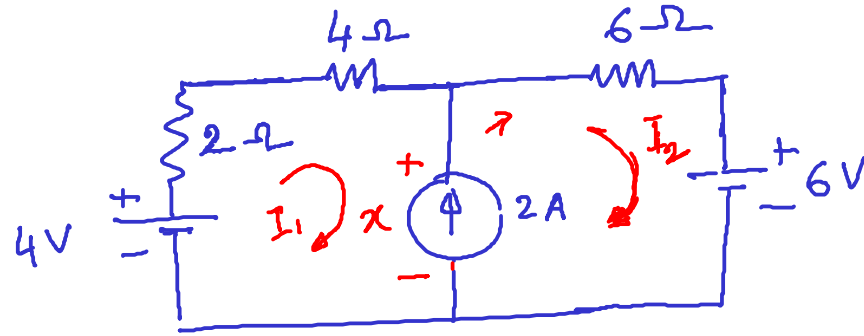
$$P_{\text{battery}} = 5 \times 0.3 = 1.5 \text{ W}$$

 (delivering)

$$V_{AB} = 6 \times 0.3 - 5 = 1.8 - 5 = -3.2 \text{ V}$$

$$\therefore V_{BA} = -V_{AB} = 3.2$$

Mesh Analysis:



dec-6

$$I_2 - I_1 = 2 \quad \text{--- (1)}$$

KVL in mesh 1:

$$6I_1 - 0xI_2$$

$$= 4 - x$$

assumed
voltage
across
current
source

$$6I_1 = 4 - x \quad \text{--- (2)}$$

KVL mesh 2:

$$0xI_1 + 6I_2 = -6 + x \quad \text{--- (3)}$$

Nodal Method for solving network problem.

$$X \xrightarrow{I} Y$$

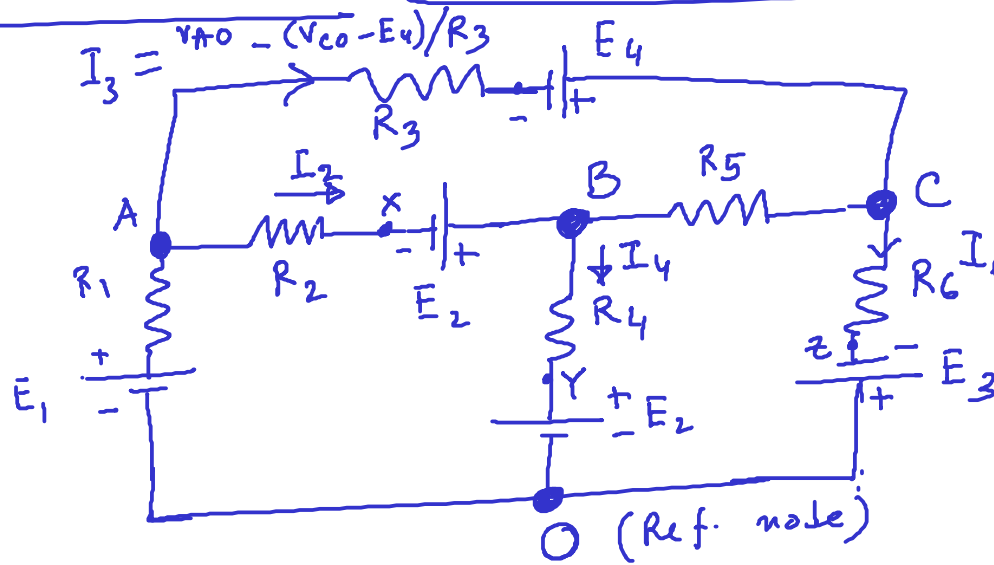
$$R$$

$$I = \frac{V_{XY}}{R}$$

$$I_4 = \frac{V_{BY}}{R_4}$$

$$= \frac{V_{B0} - V_{Y0}}{R_4}$$

$$= \frac{V_{B0} - E_2}{R_4}$$



$$I_2 = \frac{V_{AX}}{R_2} = \frac{V_{A0} - V_{X0}}{R_2}$$

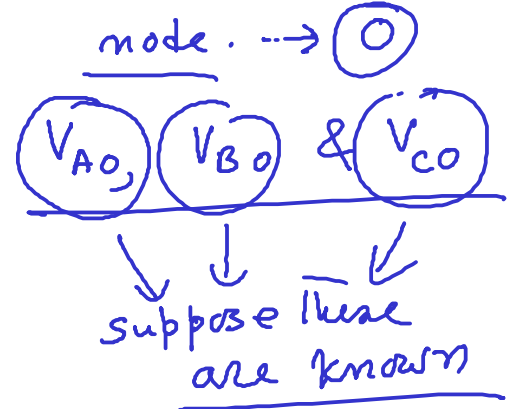
$$= \frac{V_{A0} - (V_{B0} - E_2)}{R_2} \quad \text{now } V_{X0} = (V_{B0} - E_2)$$

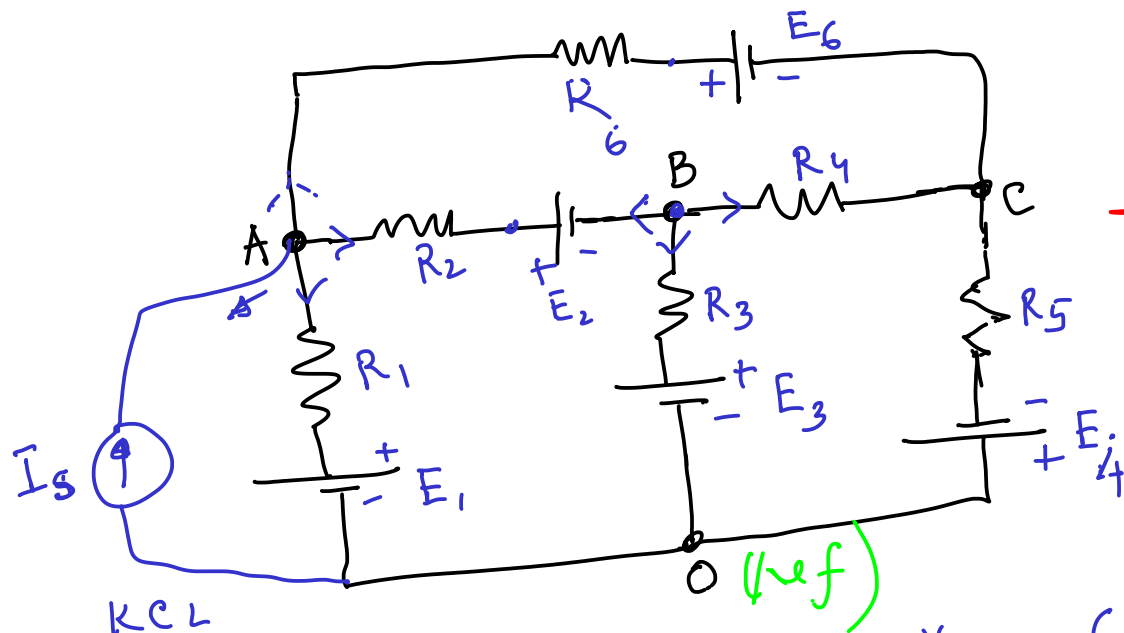
$$= \frac{V_{A0} - V_{B0} + E_2}{R_2}$$

no. of nodes

$$V_{C0} - (-E_3) = n = 4$$

choose a ref. node. $\rightarrow \bigcirc$





dec-7

KCL
At node C

$$-\frac{1}{R_6} V_{A0} - \frac{1}{R_4} V_{B0} + \left(\frac{1}{R_6} + \frac{1}{R_4} + \frac{1}{R_5} \right) V_{C0} = -\frac{E_6}{R_6} - \frac{E_4}{R_5} \quad \text{--- (3)}$$

If n = total no. of nodes
• solve $(n-1)$ eqns.

KCL

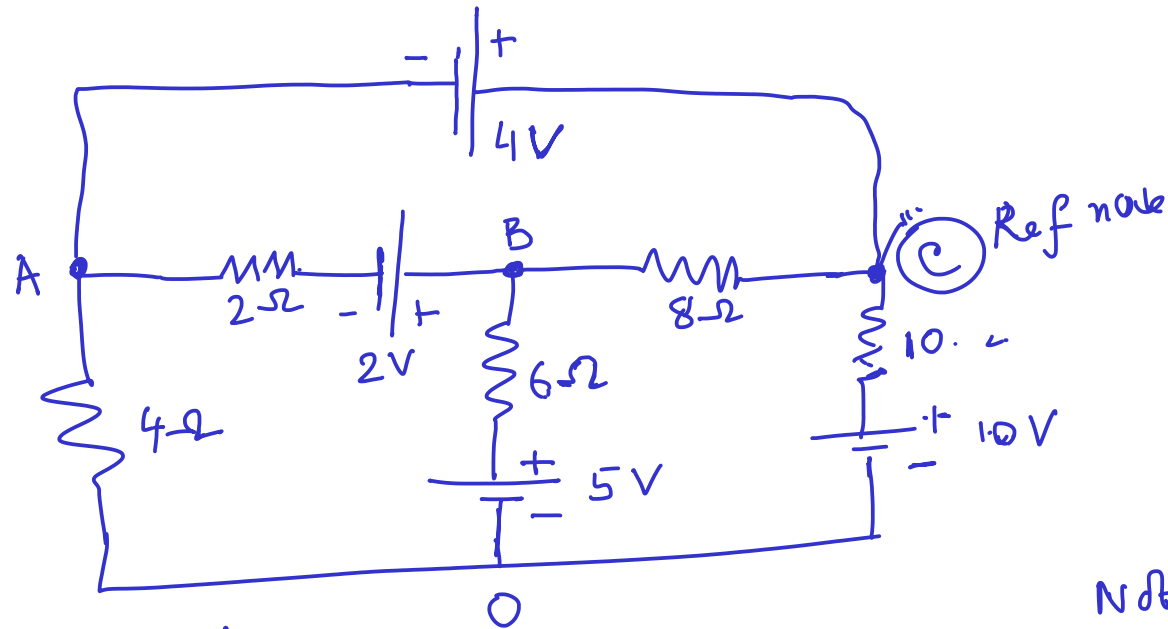
at node (A):

$$\frac{V_{A0} - E_1}{R_1} + \frac{V_{A0} - (V_{B0} + E_2)}{R_2} + \frac{(V_{A0} - (E_6 + V_{C0}))}{R_6} - I_s = 0$$

$$\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_6} \right) V_{A0} - \frac{1}{R_2} V_{B0} - \frac{1}{R_6} V_{C0} = \frac{E_1}{R_1} + \frac{E_2}{R_2} + \frac{E_6}{R_6} + I_s \quad \text{--- (1)}$$

at node (B) :-

$$-\frac{1}{R_2} V_{A0} + \left(\frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4} \right) V_{B0} - \frac{1}{R_4} V_{C0} = \frac{E_3}{R_3} - \frac{E_2}{R_2} \quad \text{--- (2)}$$



KCL at node B

$$-\frac{1}{2} \times (-4) + V_{Bc} \left(\frac{1}{6} + \frac{1}{8} + \frac{1}{2} \right) - \frac{1}{6} V_{oc} = \frac{2}{2} + \frac{5}{6} \quad \text{--- (1)}$$

KCL at node 0 :-

$$-\frac{1}{4} (V_{Ac} = -4) + V_{oc} \left(\frac{1}{6} + \frac{1}{4} + \frac{1}{10} \right) - \frac{1}{6} V_{Bc} = -\frac{5}{6} - \frac{10}{10} \quad \text{--- (2)}$$

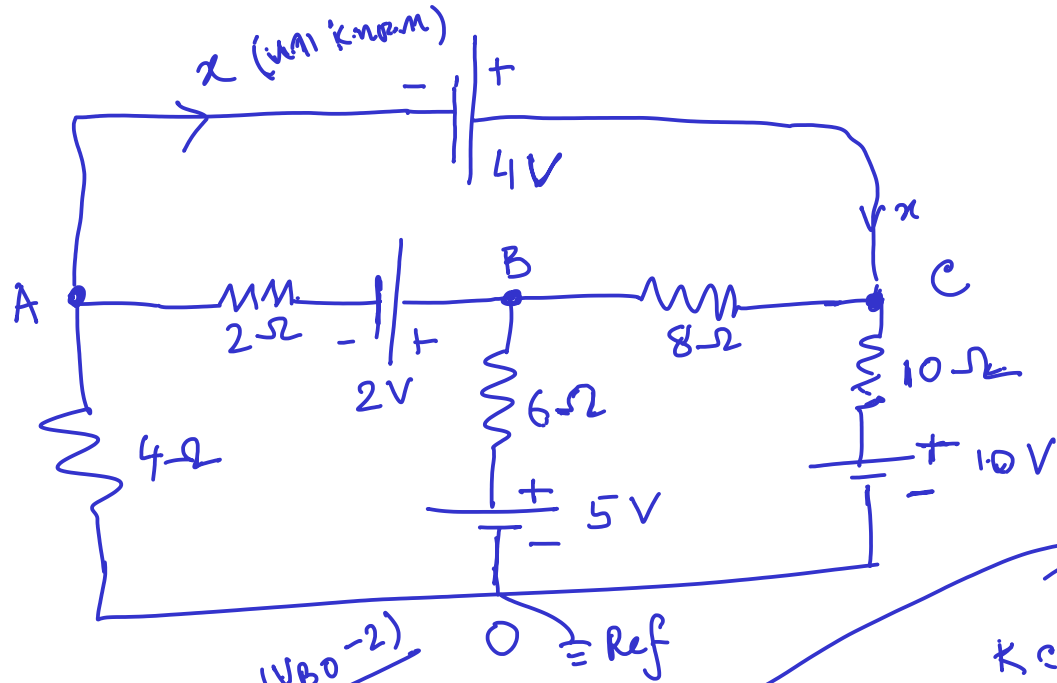
KCL at node A

Choose (C) as ref. node.

V_{Ac} , V_{Bc} and V_{oc}

$V_{Ac} = -4V$ known

Not necessary to write KCL at node A.



V_{A0}, V_{B0}, V_{C0} Ques 8

$$V_{A0} = V_{C0} - 4 \quad \text{--- (1)}$$

at node A

KCL

$$\left(\frac{1}{4} + \frac{1}{2}\right)V_{A0} - \frac{1}{2}V_{B0} = -\frac{2}{2} - x \quad \text{--- (2)}$$

KCL at node B

$$\frac{V_{A0}}{4} + \frac{V_{A0} - (V_{B0} - 2)}{2} - \frac{1}{2}V_{A0} + V_{B0} \left(\frac{1}{6} + \frac{1}{8} + \frac{1}{2}\right) - \frac{1}{8}V_{C0} = \frac{2}{4} + \frac{5}{6} \quad \text{--- (3)}$$

KCL at node C

$$-\frac{1}{8}V_{B0} + V_{C0} \left(\frac{1}{10} + \frac{1}{8}\right) = \frac{10}{10} + x \quad \text{--- (4)}$$