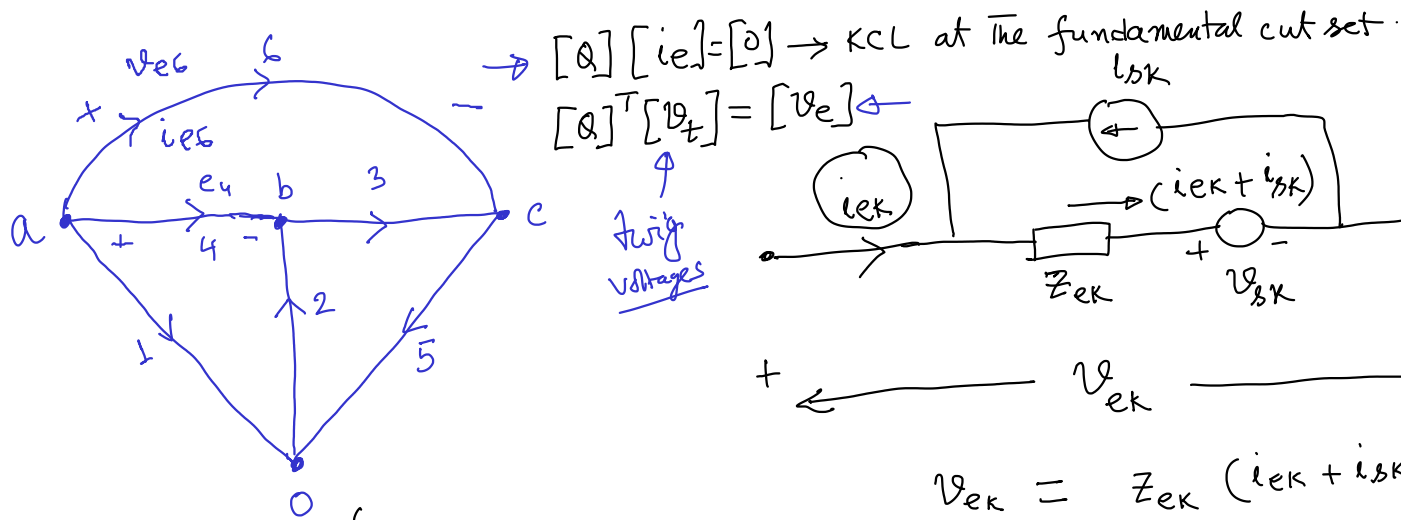
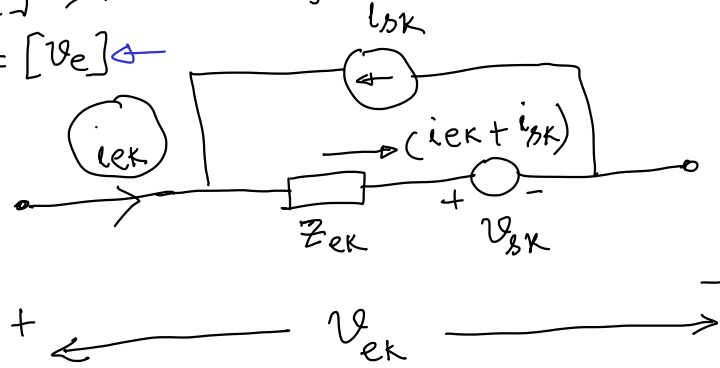




dec-66
Solving ckt
by cut-set method
or using [Q] matrix

$$v_{ek} = Z_{ek} (i_{ek} + i_{sk}) + v_{sk} = Z_{ek} i_{ek} + Z_{ek} i_{sk} + v_{sk}$$

$$\text{or } Z_{ek} i_{ek} = v_{ek} - Z_{ek} i_{sk} - v_{sk}$$

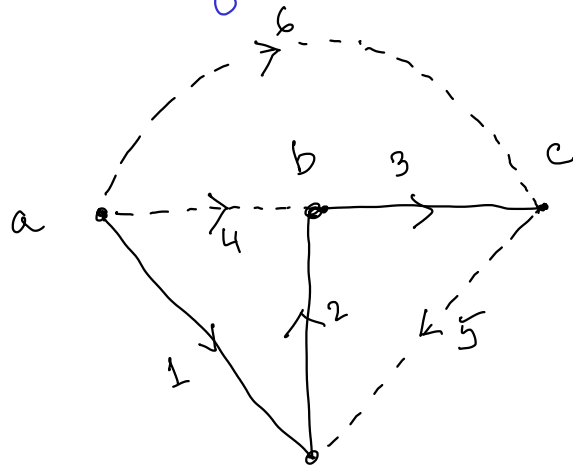
$$\text{or } i_{ek} = \frac{1}{Z_{ek}} v_{ek} - i_{sk} - \frac{1}{Z_{ek}} v_{sk}$$

$$\text{or } i_{ek} = Y_{ek} v_{ek} - i_{sk} - Y_{ek} v_{sk}$$

$$[i_e] = [Y][v_e] - [i_s] - [Y][v_s]$$

$$[Q][i_e] = [Q][Y][v_e] - [Q][i_s] - [Q][Y][v_s] = [0]$$

$$\text{or } [0] = [Q][Y][Q]^T[v_t] - [Q][i_s] - [Q][Y][v_s]$$



$$[Q][Y][Q]^T [\overset{\downarrow}{V}_t] - [Q][i_s] - [Q][Y][V_s] = [0]$$

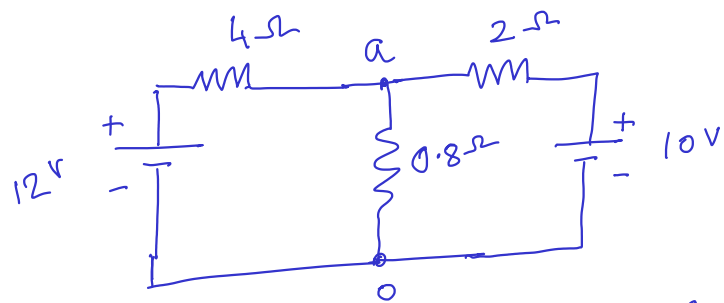
$$\text{or } \underline{[Q][Y][Q]^T [V_t]} = [Q][i_s] + [Q][Y][V_s] \leftarrow$$

Previously
got

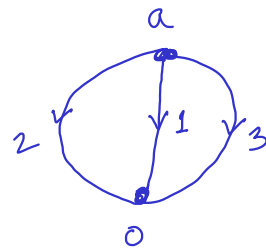
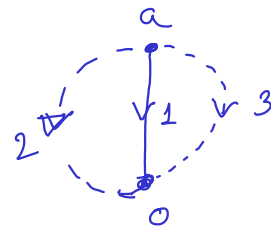
$\therefore$ Tree voltages can be calculated.

$$[A][Y][A]^T [V_N] = [A][i_s] + [A][Y][V_s] \rightarrow \text{to calculate node voltages}$$

$$[B][Z][B]^T [i_L] = -[B][Z][\underset{\uparrow}{i_s}] - [B][V_s] \rightarrow \text{to calculate fundamental loop currents.}$$



$$\underline{[B][Z][B]^T} [i_L] = -[B][Z][i_s] - [B][v_s]$$



Want to solve for fundamental
loop currents

$$[B] = \begin{matrix} & \begin{matrix} 1 & 2 & 3 \end{matrix} \\ \begin{matrix} L_2 \\ L_3 \end{matrix} & \begin{bmatrix} -1 & 1 & 0 \\ -1 & 0 & 1 \end{bmatrix} \end{matrix}$$

$$[Z] = \begin{bmatrix} 0.8 & 0 & 0 \\ 0 & 4 & 0 \\ 0 & 0 & 2 \end{bmatrix}$$

$$[v_s] = \begin{bmatrix} 0 \\ 12 \\ 10 \end{bmatrix}; \quad [i_s] = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$

$$\therefore [B][Z][B]^T$$

$$\downarrow$$

$$\begin{bmatrix} -1 & 1 & 0 \\ -1 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0.8 & 0 & 0 \\ 0 & 4 & 0 \\ 0 & 0 & 2 \end{bmatrix} \begin{bmatrix} -1 & -1 \\ 1 & 0 \\ 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 4.8 & 0.8 \\ 0.8 & 2.8 \end{bmatrix}$$

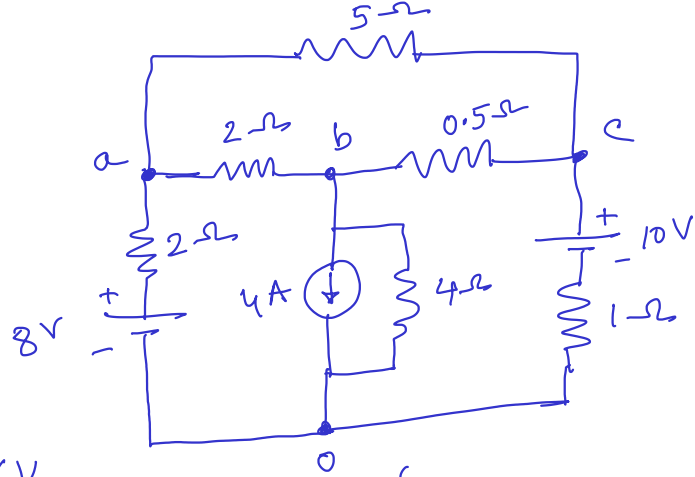
$$\therefore \begin{bmatrix} 4.8 & 0.8 \\ 0.8 & 2.8 \end{bmatrix} [i_L] = - \begin{bmatrix} -1 & 1 & 0 \\ -1 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 \\ 12 \\ 10 \end{bmatrix}$$

$$= \begin{bmatrix} -12 \\ -10 \end{bmatrix}$$

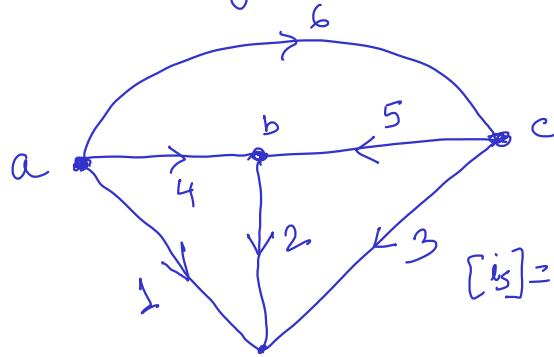
$$\therefore [i_L] = \begin{bmatrix} 4.8 & 0.8 \\ 0.8 & 2.8 \end{bmatrix}^{-1} \begin{bmatrix} -12 \\ -10 \end{bmatrix} = \begin{bmatrix} -2 \\ -3 \end{bmatrix}$$

Dec 67

Find out the node voltage
 $[v_N] = \begin{bmatrix} v_{ao} \\ v_{bo} \\ v_{co} \end{bmatrix}$



$$\begin{aligned} v_{ao} &= 6V \\ v_{bo} &= 4V \\ v_{co} &= 6V \end{aligned}$$



$$[i_s] = \begin{bmatrix} 0 \\ -4 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

$$\therefore [v_N] = \begin{bmatrix} 1.2 & -0.5 & -0.2 \\ -0.5 & 2.75 & -2 \\ -0.2 & -2 & 3.2 \end{bmatrix}^{-1} \begin{bmatrix} 4 \\ -4 \\ 10 \end{bmatrix} = \begin{bmatrix} 6 \\ 4 \\ 6 \end{bmatrix}$$

$$[A][Y][A]^T [v_N] = [A][i_s] + [A][Y][v_s]$$

$$[A] = \begin{matrix} & \begin{matrix} 1 & 2 & 3 & 4 & 5 & 6 \end{matrix} \\ \begin{matrix} a \\ b \\ c \end{matrix} & \begin{bmatrix} 1 & 0 & 0 & 1 & 0 & 1 \\ 0 & 1 & 0 & -1 & -1 & 0 \\ 0 & 0 & 1 & 0 & 1 & -1 \end{bmatrix} \end{matrix}$$

$$[Y] = \begin{bmatrix} 1/2 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1/4 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1/2 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1/5 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1/5 \end{bmatrix}$$

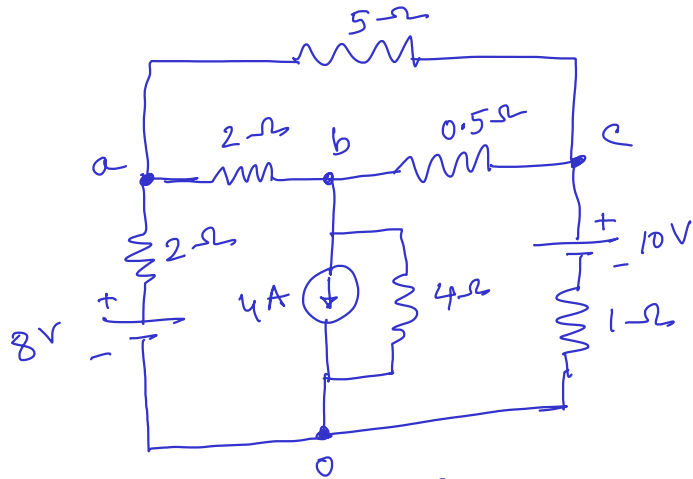
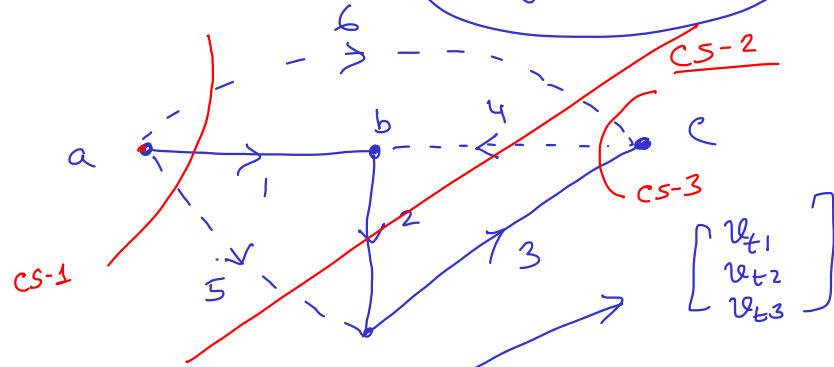
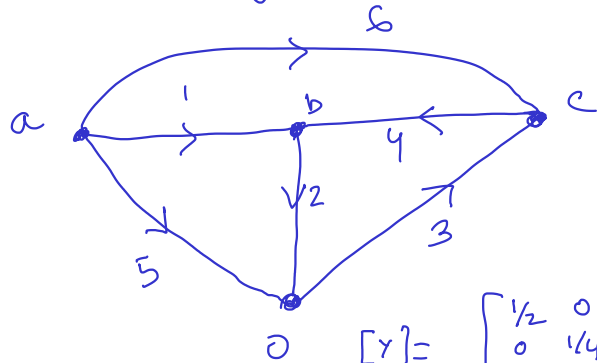
$$[A][Y][A]^T x$$

$$[v_s] = \begin{bmatrix} 8 \\ 0 \\ 10 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} 1.2 & -0.5 & -0.2 \\ -0.5 & 2.75 & -2 \\ -0.2 & -2 & 3.2 \end{bmatrix} \begin{bmatrix} v_{ao} \\ v_{bo} \\ v_{co} \end{bmatrix} = \begin{bmatrix} 0 \\ -4 \\ 6 \end{bmatrix} + \begin{bmatrix} 4 \\ 0 \\ 10 \end{bmatrix}$$

$$= \begin{bmatrix} 4 \\ -8 \\ 16 \end{bmatrix}$$

Solve for the twig voltages.



$$[Y] = \begin{bmatrix} 1/2 & 0 & 0 & 0 & 0 \\ 0 & 1/4 & 0 & 0 & 0 \\ 0 & 0 & 1/1 & 0 & 0 \\ 0 & 0 & 0 & 1/5 & 0 \\ 0 & 0 & 0 & 0 & 1/2 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1/5 \end{bmatrix}$$

$$[Q][Y][Q]^T [v_t] = [Q][i_s] + [Q][Y][v_s]$$

$$[Q] = \begin{matrix} & \begin{matrix} 1 & 2 & 3 & 4 & 5 & 6 \end{matrix} \\ \begin{matrix} CS-1 \\ CS-2 \\ CS-3 \end{matrix} & \begin{bmatrix} 1 & 0 & 0 & 0 & 1 & 1 \\ 0 & 1 & 0 & -1 & 1 & 1 \\ 0 & 0 & 1 & -1 & 0 & 1 \end{bmatrix} \end{matrix}$$

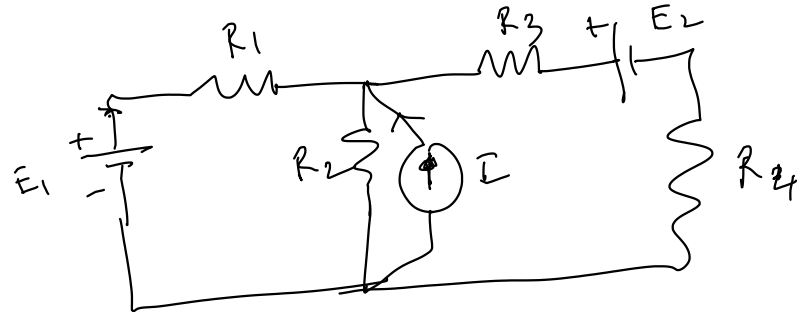
$$\text{Let } [i_s] = \begin{bmatrix} 0 \\ -4 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

$$[Q]^T [v_t] = [v_e]$$

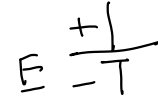
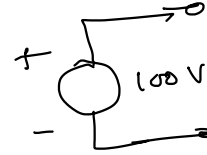
$$[v_s] = \begin{bmatrix} 0 \\ 0 \\ -10 \\ 0 \\ +8 \\ 0 \end{bmatrix}$$

Circuits or Networks having independent voltage / current sources.

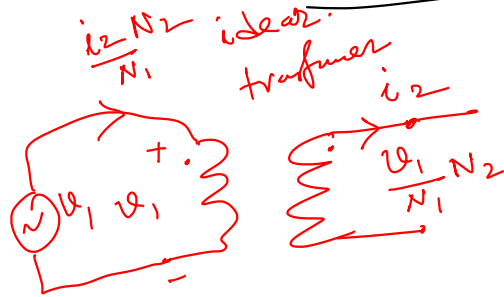
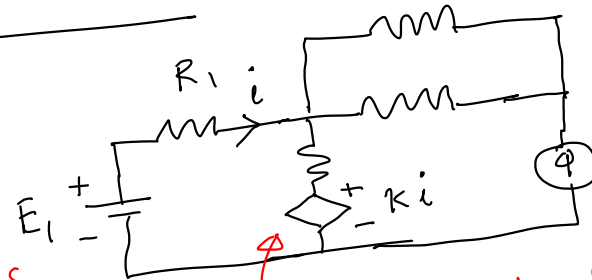
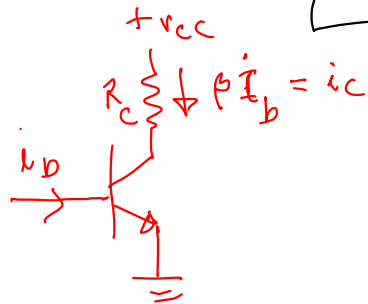
dec-68



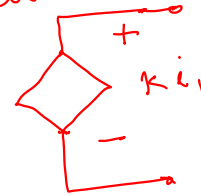
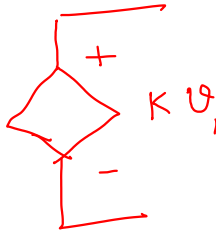
independent sources.



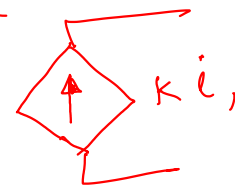
Dependent sources:



dependent voltage sources



dependent current sources.



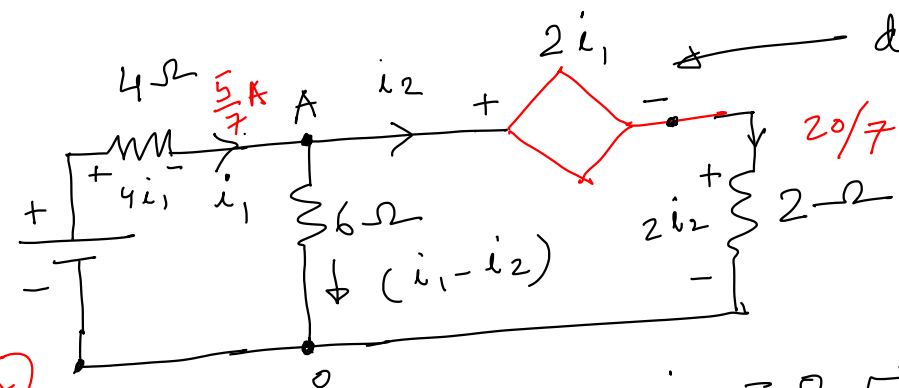
dependent voltage source.

from eqnⁿ ①

$$6i_1 + 2i_2 = 10$$

$$12i_2 + 2i_2 = 10$$

$$\text{or } i_2 = \frac{10}{14} = \frac{5}{7} \text{ A}$$



dependent source

$$8i_2 = 4i_1$$

$$\text{or } 2i_2 = i_1$$

$$10 - 4i_1 - 2i_1 - 2i_2 = 0$$

$$10 - 4i_1 - 6(i_1 - i_2) = 0$$

$$\text{or } 10 - 10i_1 + 6i_2 = 0 \quad \text{--- ②}$$

at A KCL

$$\rightarrow \frac{v_{A0} - 10}{4} + \frac{v_{A0}}{6} + \frac{v_{A0} - 2i_1}{2} = 0$$

$$\text{or } 6i_1 + 2i_2 = 10 \quad \text{--- ①} \checkmark$$

$$-10i_1 + 6i_2 = -10 \quad \text{--- ②} \checkmark$$

$$-4i_1 + 8i_2 = 0$$

$$6i_1 + 2i_2 = -10i_1 + 6i_2$$

$$\text{or } 16i_1 = 4i_2$$

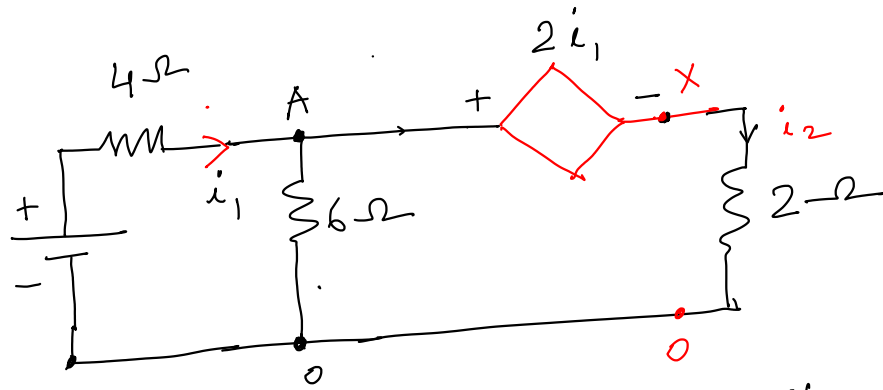
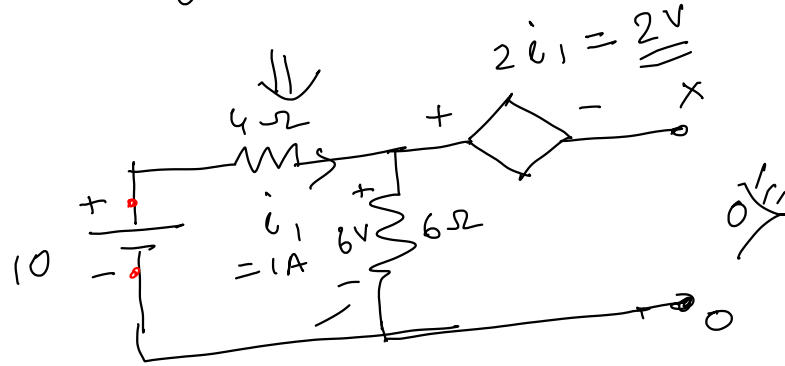
$$\text{or } 4i_1 = i_2$$

$$6i_1 + 2 \times 4i_1 = 10$$

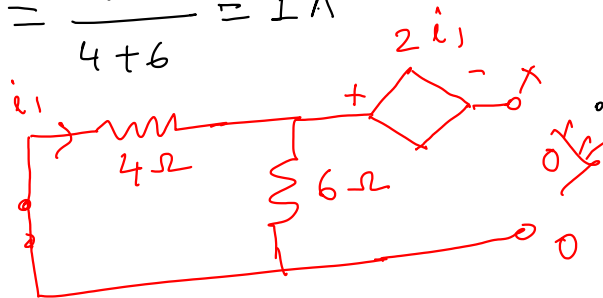
$$14i_1 = 10 \quad \text{or } i_1 = \frac{10}{14} = \frac{5}{7} \text{ A}$$

$$i_2 = 4i_1 = \frac{20}{7} \text{ A}$$

10V



$$i_1 = \frac{10}{4+6} = 1A$$



Circuit analysis with dependent & independent sources.

dec - 69

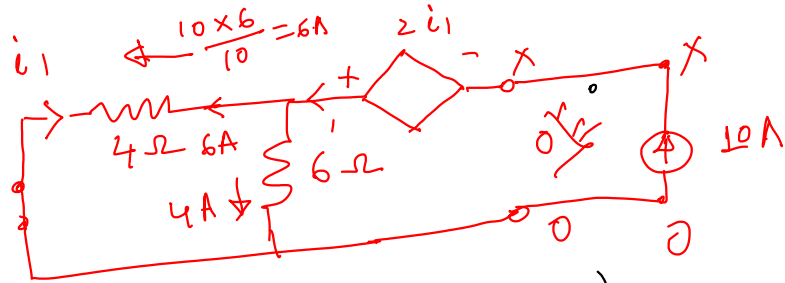
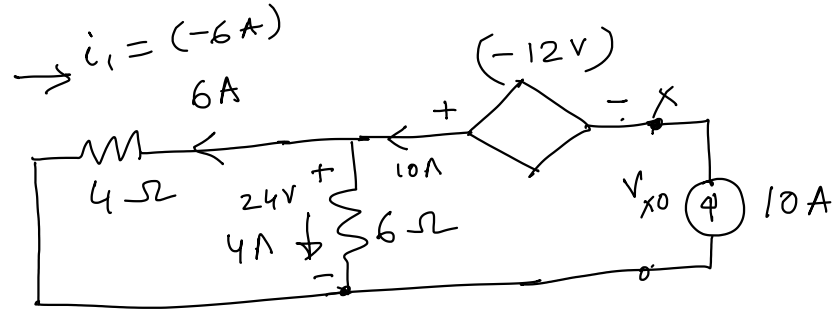
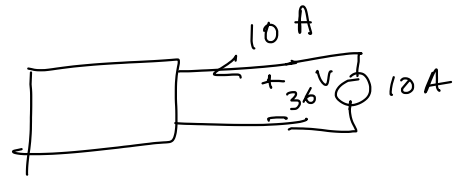
Find out current in 2Ω resistor by applying Thevenin Theorem.

$$V_{Th} = V_{x0} = \text{o.c voltage}$$

$$V_{Th} = 6 - 2 = 4V$$

To find out R_{Th} :-

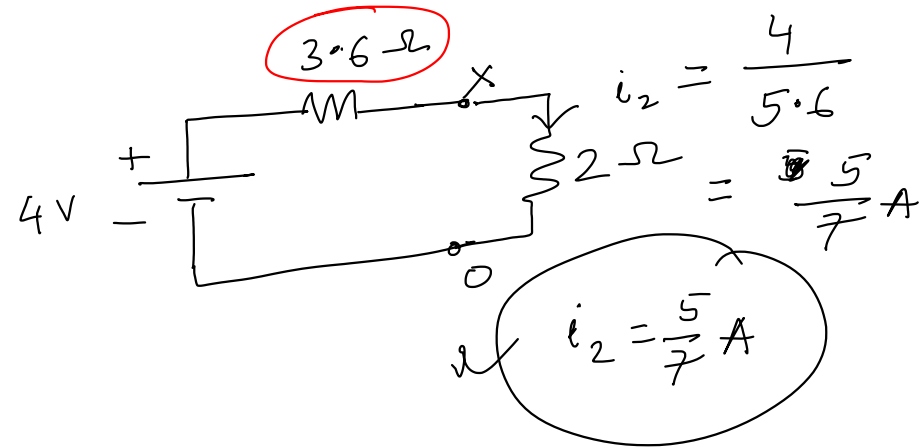
- Replace the independent sources by their internal impedances.
- Keep the dependent sources (i.e., Don't remove them)

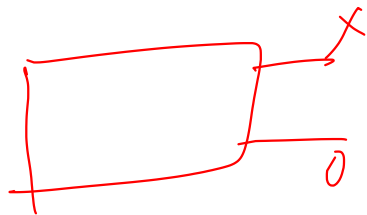
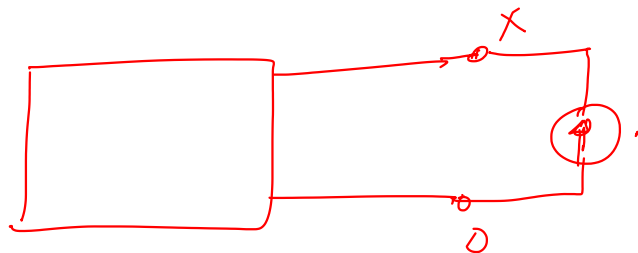


$$V_{XO} = 24V - (-12)$$

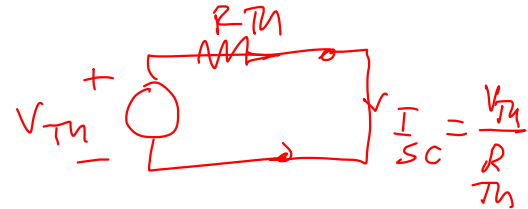
$$V_{XO} = 36V$$

$$R_{Th} = \frac{36}{10} = 3.6\Omega$$

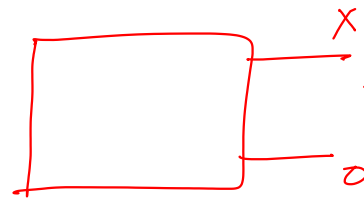




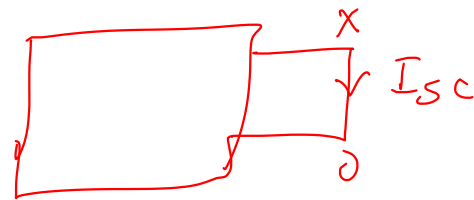
$$V_{Th} = V_{X0} \text{ (o.c.)}$$



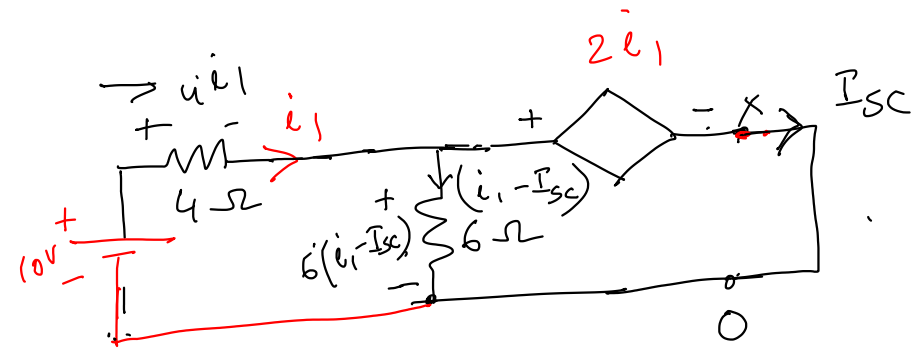
$$R_{Th} = \frac{V_{Th}}{I_{sc}}$$



$$V_{Th} = V_{o.c.}$$



$$R_{Th} = \frac{V_{Th}}{I_{sc}}$$



$$V_{Th} = 4V$$

Calculate

$$10 - 4i_1 - 6(i_1 - I_{sc}) = 0 \quad (1)$$



$$10 - 4i_1 - 6(i_1 - I_{sc}) = 0$$

$$\text{or } 6i_1 = 10$$

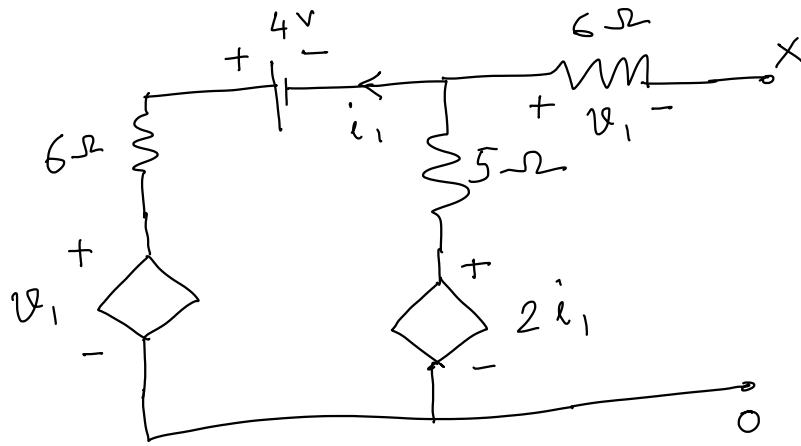
$$\text{or } i_1 = \frac{10}{6} = \frac{5}{3} A$$

$$\text{or } 6I_{sc} = \frac{50}{3} - 10 = \frac{20}{3}$$

$$\text{or } I_{sc} = \frac{20}{3 \times 6} = \frac{10}{9} A$$

$$R_{Th} = \frac{V_{Th}}{I_{sc}} = \frac{4}{10/9} = \frac{36}{10} = \underline{\underline{3.6 \Omega}}$$

Ex-2



$$i_1 = \frac{2i_1 + 4}{11} \Rightarrow 9i_1 = 4 \Rightarrow i_1 = \frac{4}{9} \text{ A}$$

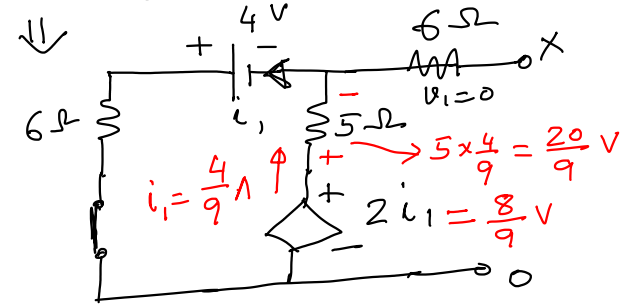
$$V_{Th} = V_{X0} = 2i_1 - 5i_1 = -3i_1 = -\frac{12}{9} \text{ V}$$

(o.c.) $V_{Th} = -\frac{4}{3} \text{ Volts}$

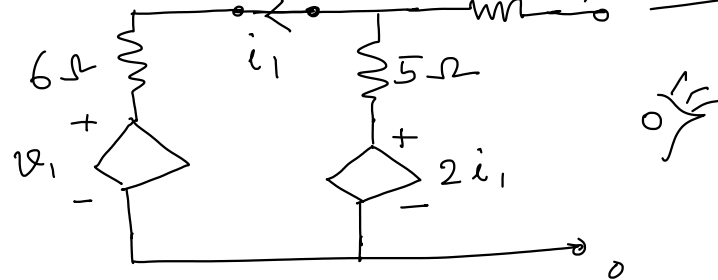
dec-70

Thevenin
Equivalent ckt
across X & 0 Terminals

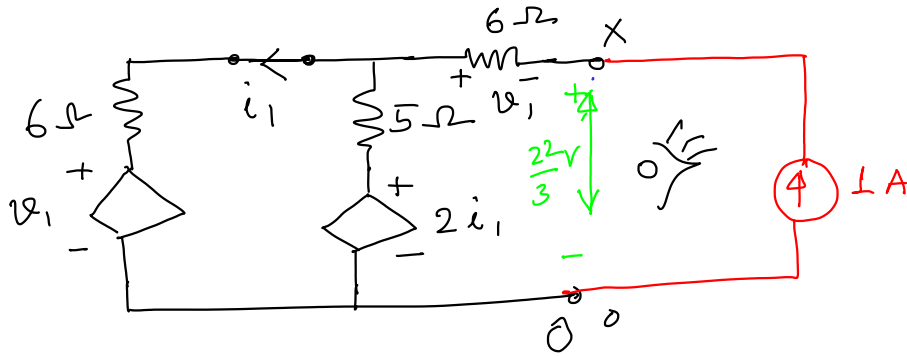
$$V_{X0} \text{ (o.c.)} = V_{Th}$$



To find R_{Th} : Replace ~~the~~ 4V by S.C
Keep all the dependent
source in the circuit



Equiv.
Ther. ckt
across xo
is



Excite the network from
 x & o terminal by $1A$ current.

Calculate V_{xo} now

Then $R_{Th} = \frac{V_{xo}}{1A}$

KVA

$$2i_1 + 5(1-i_1) - 6i_1 + 6 = 0$$

$$-9i_1 + 11 = 0 \quad \therefore i_1 = \frac{11}{9} A$$

$$V_{xo} = 2i_1 + 5(1-i_1) + 6$$

$$= -3i_1 + 11$$

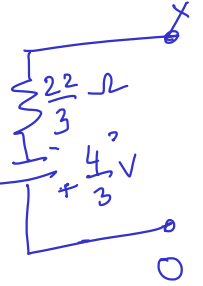
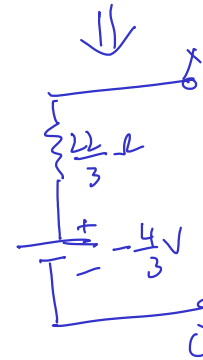
$$= 11 - 3i_1 = 11 - \frac{33}{9} = 11 - \frac{11}{3}$$

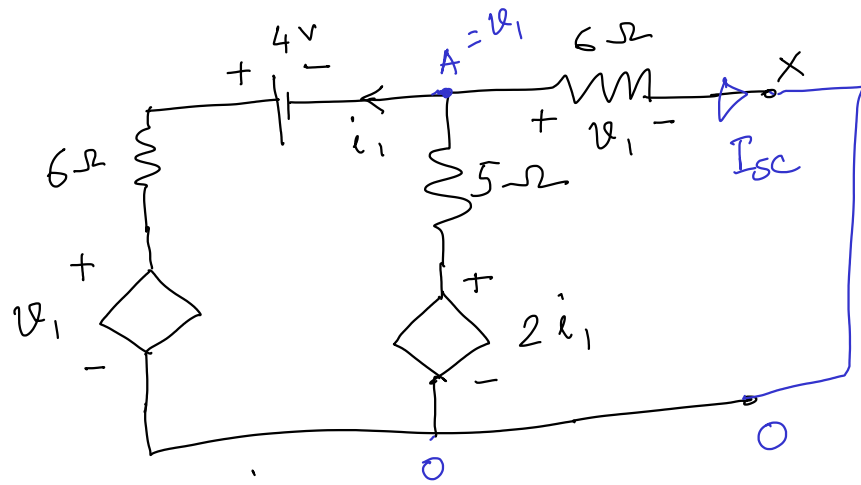
$$= + \frac{22}{3} \text{ volts.}$$

$$\therefore R_{Th} = \frac{V_{xo}}{1} = \frac{22/3}{1} = \frac{22}{3} \Omega$$

V_{Th} already calculated

$$V_{Th} = V_{xo} \text{ (o.c)} = -\frac{4}{3} V$$





What is s.c. current

$$v_{Ao} = v_1$$

$$I_{sc} = \frac{v_1}{6}$$

KCL at A

$$\frac{v_1 + 4 - v_1}{6} = i_1 \quad \therefore i_1 = \frac{4}{6} \text{ A}$$

$$\boxed{i_1 = \frac{2}{3} \text{ A}}$$

KCL at A :-

$$\frac{2}{3} + \frac{v_1 - 2i_1}{5} + \frac{v_1}{6} = 0$$

$$\text{or } \frac{2}{3} + \frac{v_1 - \frac{4}{3}}{5} + \frac{v_1}{6} = 0$$

$$\text{or } 20 + 6v_1 - \frac{4}{3} \times 6 + 5v_1 = 0$$

$$\rightarrow 11v_1 = -20 + 8$$

$$\text{or } v_1 = -\frac{12}{11} \text{ V (Th)}$$

$$I_{sc} = -\frac{12}{11 \times 6} = -\frac{2}{11} \text{ A}$$

$$R_{Th} = \frac{V_{x \text{ (o.c.)}}}{I_{sc}} = \frac{V_{Th}}{I_{sc}} = \frac{-4/3}{-2/11} = \frac{22}{3} \Omega$$