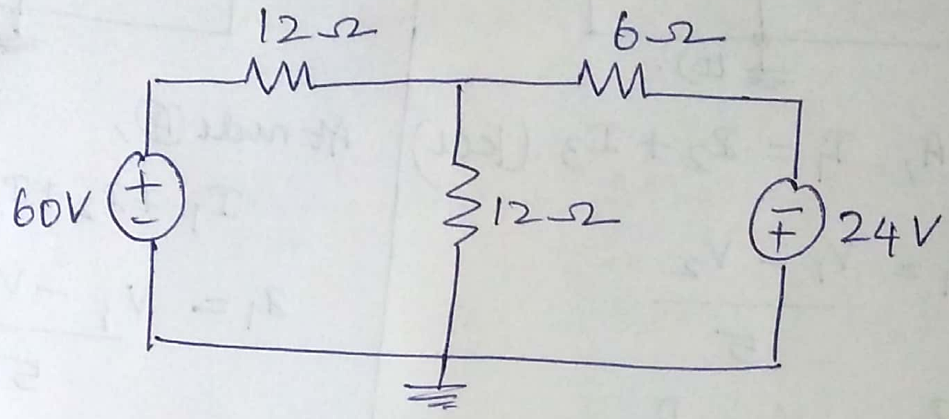
NODAL ANALYSIS

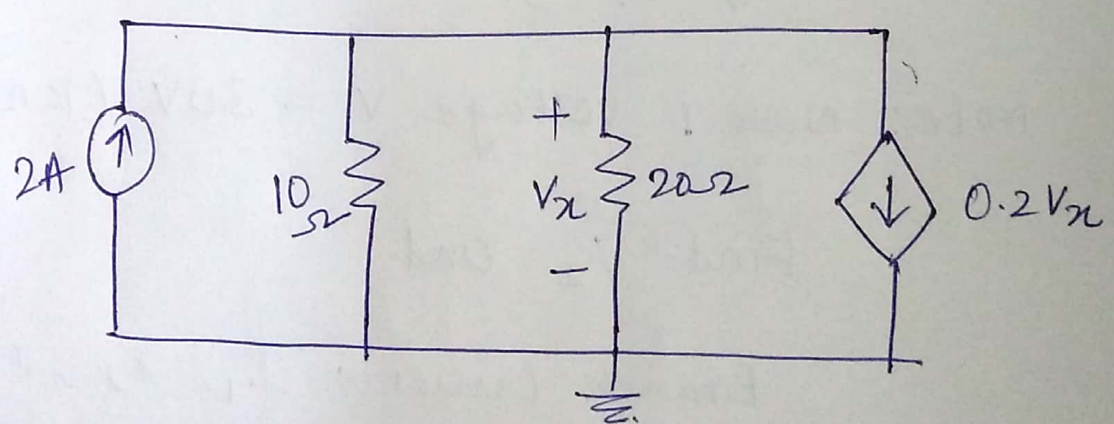
PRACTICE PROBLEMS

(1)



Identify the nodes with unknown nodal voltages and solve using nodal analysis. Find the power dissipated in all resistors.

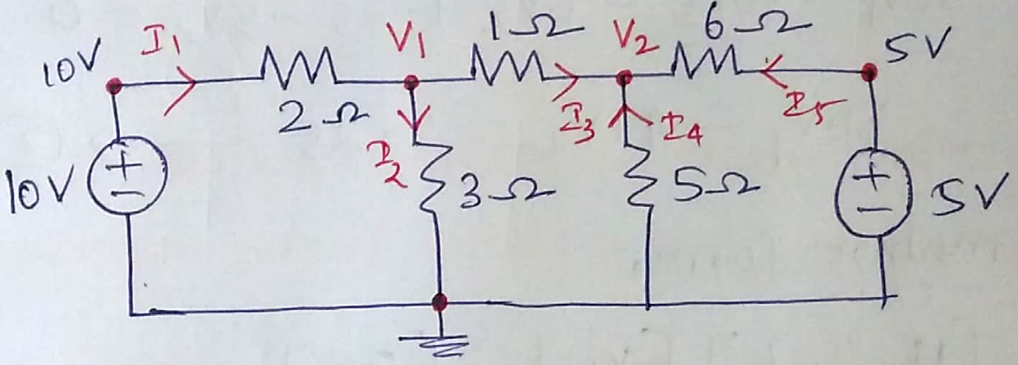
(2) Solve to find V_x using nodal analysis.



NODAL ANALYSIS

- USING KCL & OHMS LAW
- Find unknown nodal voltages.

①



number of nodes = 5.

unknown nodal voltages = V_1, V_2

- mark arbitary current direction in all branches.
- current flow $V_A \xrightarrow{I} R \rightarrow V_B$

then $I = \dfrac{V_A - V_B}{R}$.

At node (V_1),

KCL ⇒ $I_1 = I_2 + I_3$, represent I in terms of V,

$$\frac{10 - V_1}{2} = \frac{V_1 - 0}{3} + \frac{V_1 - V_2}{1}$$

$\times 6$

$$30 - 3V_1 = 2V_1 + 6V_1 - 6V_2$$

$$11V_1 - 6V_2 = 30 \longrightarrow ①$$

At node V_2,

$$I_3 + I_4 + I_5 = 0.$$

$$\frac{V_1 - V_2}{1} + \frac{0 - V_2}{5} + \frac{5 - V_2}{6} = 0.$$

$\times 30$

$$30V_1 - 30V_2 - 6V_2 + 25 - 5V_2 = 0.$$

$$30V_1 - 41V_2 = -25 \longrightarrow (2).$$

In matrix form,

$$\begin{bmatrix} 11 & -6 \\ 30 & -41 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} 30 \\ -25 \end{bmatrix}$$

$$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} 5.0922 \\ 4.3357 \end{bmatrix} V$$

Solve simultaneous equations (1), (2)

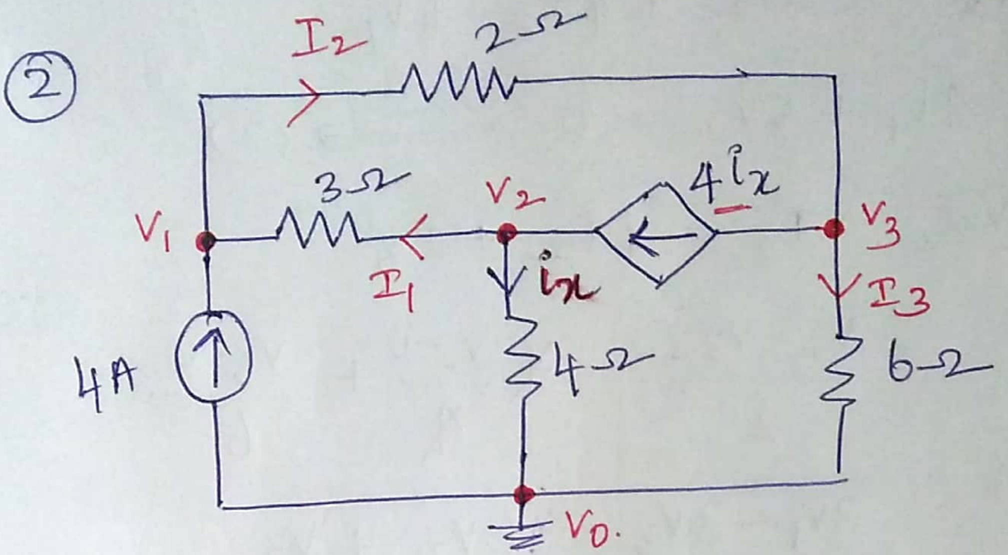
(or) solve in matrix form taking inverse

(or) using cramers rule.

Knowing V_1, V_2 we can find current in all branches as example (verify KCL at node V_1)

$$I_1 = \frac{10 - V_1}{2} = 2.4539\text{ A} \qquad I_2 = \frac{V_1}{3} = 1.6974\text{ A} \qquad I_3 = \frac{V_1 - V_2}{1} = 0.7565$$

2



no. of nodes = 4 (including reference node $V_0 = 0$)

unknown nodal voltages are. → V_1, V_2, V_3.

— mark current direction in all branches and assign currents names.

— note: $4i_x$ is a dependent current source.

At node (V_1),

apply KCL, $4 + I_1 = I_2$.

rep I as $\frac{V}{R}$, $4 + \frac{V_2 - V_1}{3} = \frac{V_1 - V_3}{2}$

× 6

$$24 + 2V_2 - 2V_1 = 3V_1 - 3V_3$$

$$5V_1 - 2V_2 - 3V_3 = 24 \longrightarrow (1)$$

At node (2),

$4i_x = i_x + I_1$, i.

$$\cancel{4}\,\frac{V_2 - 0}{\cancel{4}} = \frac{V_2 - 0}{4} + \frac{V_2 - V_1}{3}$$

$$V_2 = \frac{V_2}{4} + \frac{V_2 - V_1}{3}$$

(A)

$$12V_2 = 3V_2 + 4V_2 - 4V_1$$

$$4V_1 + 5V_2 = 0 \longrightarrow (2)$$

At node (V_3), $I_2 = 4i_x + I_3$

$$\frac{V_1 - V_3}{2} = \cancel{4}\frac{V_2 - 0}{\cancel{4}} + \frac{V_3 - 0}{6}$$

$\times 6$

$$3V_1 - 3V_3 = 6V_2 + V_3$$

$$3V_1 - 6V_2 - 4V_3 = 0 \longrightarrow (3)$$

$$\begin{bmatrix} 5 & -2 & -3 \\ 4 & 5 & 0 \\ 3 & -6 & -4 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix} = \begin{bmatrix} 24 \\ 0 \\ 0 \end{bmatrix}$$

ANS: $V_1 = 32V$, $V_2 = -25.6V$, $V_3 = 62.4V$

using V, find I and verify KCL at nodes,

eg. at node V_2

$$i_x = \frac{V_2}{4} = -6.4A$$

$$4i_x = -25.6A$$

$$I_1 = \frac{V_2 - V_1}{3} = -19.2A$$

$$4i_x = i_x + I_1.$$

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