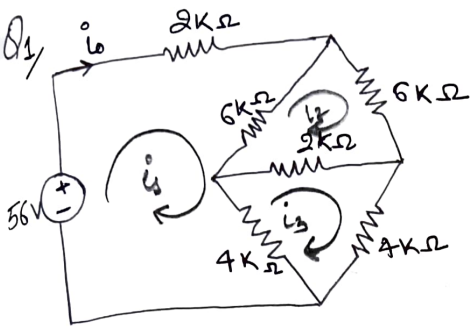
Mesh Analysis :

Q1/



find I_o ?

Assume all current in mA.

mesh 1 :

$$-56V + (2+6+4)i_1 - 6i_2 - 4i_3 = 0$$

$$12i_1 - 6i_2 - 4i_3 = 56$$

$$6i_1 - 3i_2 - 2i_3 = 28 \quad \text{— (i)}$$

mesh 2 :

$$(6+2+6)i_2 - 2i_3 - 6i_1 = 0$$

$$14i_2 - 2i_3 - 6i_1 = 0$$

$$3i_1 - 7i_2 + i_3 = 0 \quad \text{— (ii)}$$

mesh 3 :

$$(4+4+2)i_3 - 2i_2 - 4i_1 = 0$$

$$4i_1 + 2i_2 - 10i_3 = 0$$

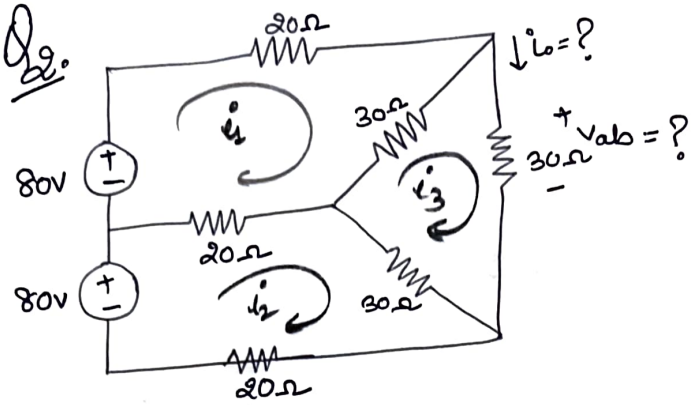
$$2i_1 + i_2 - 5i_3 = 0 \quad \text{— (iii)}$$

On solving equation i, ii and iii :

$$i_1 = 8mA$$
$$i_2 = 4mA$$
$$i_3 = 4mA$$

$\therefore \boxed{i_o = i_1 = 8mA}$ Ans

Q2.



mesh 1 :

$$-80 + (20+30+20)\,i_1 - 30\,i_3 - 20\,i_2 = 0$$

$$7\,i_1 - 2\,i_2 - 3\,i_3 = 8 \quad \text{—— (1)}$$

mesh 2 :

$$-80 + (20+20+30)\,i_2 - 20\,i_1 - 30\,i_3 = 0$$

$$2\,i_1 - 7\,i_2 + 3\,i_3 = (-8) \quad \text{—— (2)}$$

mesh 3 :

$$(30+30+30)\,i_3 - 30\,i_1 - 30\,i_2 = 0$$

$$i_1 + i_2 - 3\,i_3 = 0 \quad \text{— (3)}$$

On solving (1), (2) and (3) equation :

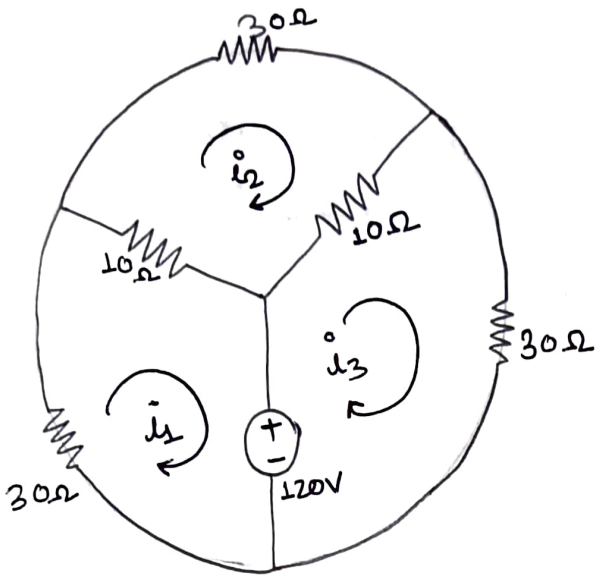
$$i_1 = i_2 = 8/3 = 2.667\ A$$

$$i_3 = 16/9 = 1.7778\ A$$

$$\boxed{i_o = i_3 = 1.7778\ A}$$

$$V_{ab} = i_o \times R_{ab} = \frac{16}{9} \times 30 = 53.33\,V$$

Q3.



mesh 1 :

$$120 + (30+10)\,i_1 + (-10\,i_2) = 0$$

$$4i_1 - i_2 = -12 \quad \text{— (i)}$$

mesh 2 :

$$(10+30+10)\,i_2 - 10i_1 - 10i_3 = 0$$

$$i_1 - 5i_2 + i_3 = 0 \quad \text{— (ii)}$$

mesh 3 :

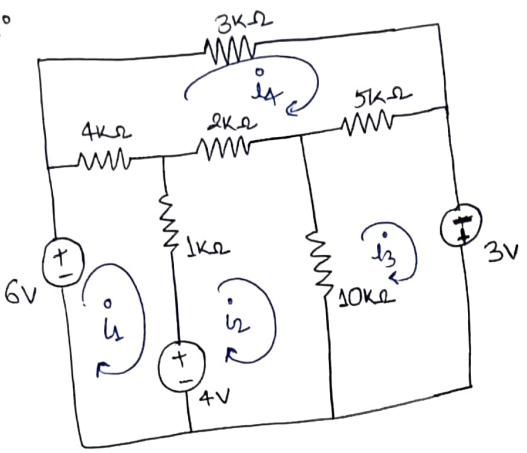
$$-120 + (10+30)\,i_3 - 10i_2 = 0$$

$$i_2 - 4i_3 = -12 \quad \text{— (iii)}$$

Solve i, ii and iii equation :

$$\left.\begin{aligned} i_1 &= -3A \\ i_2 &= 0A \\ i_3 &= 3A \end{aligned}\right\} \text{Ans}$$

Q4.



mesh 1:

$$-6+4+(4+1)i_1-4i_4-i_2=0$$

$$5i_1-i_2-4i_4=2 \quad \text{—(1)}$$

mesh 2:

$$-4+(1+2+10)i_2-i_1-2i_4-10i_3=0$$

$$i_1-13i_2+10i_3+2i_4=(-4) \quad \text{—(2)}$$

mesh 3:

$$-3+(10+5)i_3-5i_4-10i_2=0$$

$$10i_2-15i_3+5i_4=(-3) \quad \text{—(3)}$$

mesh 4:

$$(4+2+3+5)i_4-4i_1-2i_2-5i_3=0$$

$$4i_1+2i_2+5i_3-14i_4=0 \quad \text{—(4)}$$

On solving 1, 2, 3 and 4 equation:

$$\left.\begin{aligned} i_1 &= 3.608\ A \\ i_2 &= 4.043\ A \\ i_3 &= 3.895\ A \\ i_4 &= 3\ A \end{aligned}\right\}$$

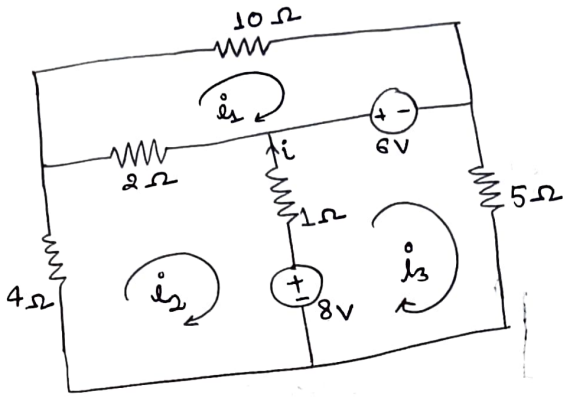
Current through 10kΩ $\Rightarrow (i_2-i_3)$

$= 4.043 - 3.895$

$= 0.148\ A$

$= 148\ mA$

Q5//



mesh 1 :

$$-6 + (2+10)i_1 - 2i_2 = 0$$

$$12i_1 - 2i_2 = 6$$

$$6i_1 - i_2 = 3 \quad \text{— (I)}$$

mesh 2 :

$$8 + (2+4+1)i_2 - 2i_1 - i_3 = 0$$

$$2i_1 - 7i_2 + i_3 = +8 \quad \text{— (II)}$$

mesh 3 :

$$-8 + 6 + (1+5)i_3 - i_2 = 0$$

$$i_2 - 6i_3 = (-2) \quad \text{— (III)}$$

On Solving (I), (II) and (III) Equation :

$$\left.\begin{aligned} i_1 &= 0.3291 \\ i_2 &= -1.0256 \\ i_3 &= 0.1624 \end{aligned}\right\}$$

$$i_o = (i_3 - i_2)$$

$$= 0.1624 - (-1.0256)$$

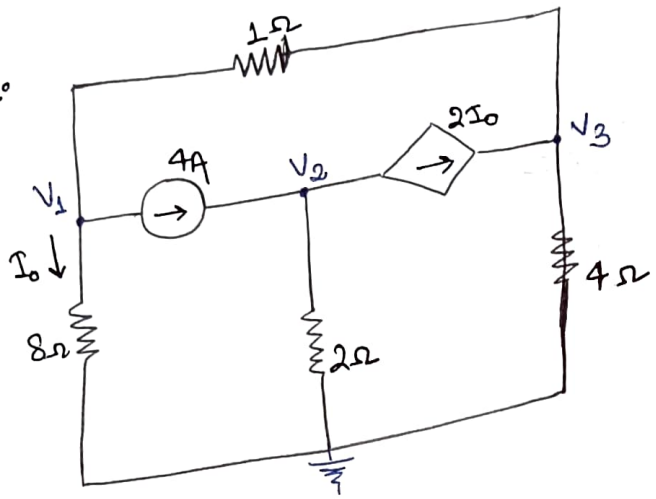
$$= 0.1624 + 1.0256$$

$$\boxed{i_o = 1.188\ A}$$

Ans

Nodal Analysis !

Q1.



@ node 1 :

$$\frac{V_1-0}{8} + \frac{V_1-V_3}{1} + 4 = 0$$

$$9V_1 - 8V_3 + 32 = 0 \quad \text{— (I)}$$

@ node 2 :

$$-4 + \frac{V_2-0}{2} + 2I_0 = 0$$

$$-4 + \frac{V_2}{2} + 2 \times \frac{V_1}{8} = 0$$

$$V_1 + 2V_2 - 16 = 0 \quad \text{— (II)}$$

$$\frac{V_1}{8} = I_0 \quad \text{— eq (IV)}$$

@ node 3 :

$$\frac{V_3-0}{4} + \frac{V_3-V_1}{1} - 2I_0 = 0$$

$$5V_3 - 4V_1 - 8I_0 = 0$$

$$-4V_1 - V_1 + 5V_3 = 0$$

$$-5V_1 + 5V_3 = 0$$

$$V_3 - V_1 = 0$$

$$V_3 = V_1 \quad \text{— (III)}$$

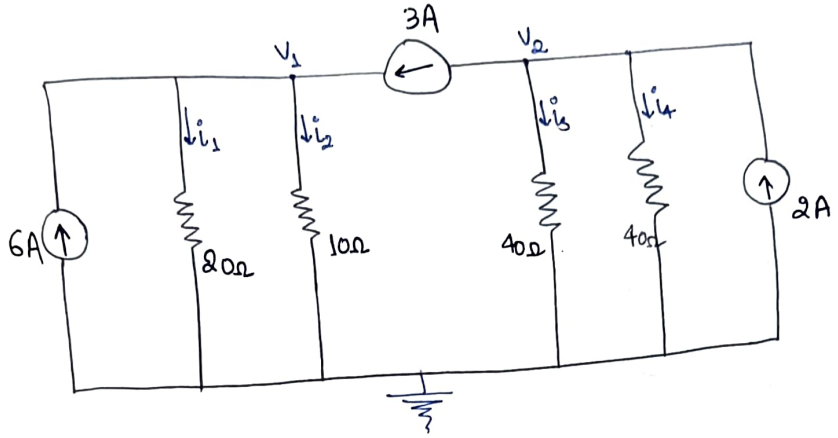
from eqn (I) and (II)

$$9V_1 - 8(V_1) + 32 = 0$$

$$V_1 = -32\ V$$

from eqn (IV) $\frac{V_1}{8} = I_0 \Rightarrow I_0 = \frac{-32}{8} = -4$ Amps

Q2.



@ node 1:

$$\frac{V_1-0}{10}+\frac{V_1-0}{20}-6-3=0$$

$$\frac{3V_1}{20}-9=0$$

$$V_1 = 3\times 20 = 60V$$

@ node 2:

$$\frac{V_2-0}{40}+\frac{V_2-0}{40}-2+3=0$$

$$\frac{V_2}{20}=-1$$

$$V_2=-20V$$

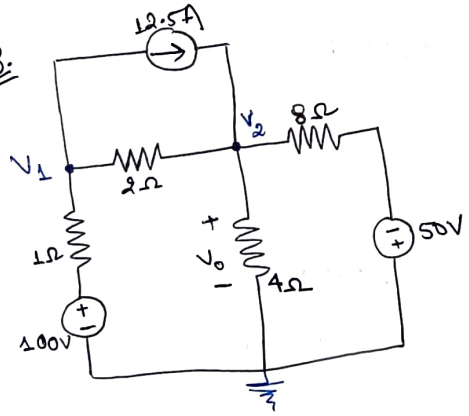
$$i_1=\frac{V_1-0}{20}=\frac{60}{20}=3A$$

$$i_2=\frac{V_1-0}{10}=\frac{60}{10}=6A$$

$$i_3=\frac{V_2-0}{40}=\frac{-20}{40}=-500mA$$

$$i_4=\frac{V_2-0}{40}=-500mA$$

Q3.



@ node V_1:

$$\frac{V_1-100}{1}+\frac{V_1-V_2}{2}+12.5=0$$

$$3V_1-V_2=175 \quad -(1)$$

@ node V_2:

$$\frac{V_2+50}{8}+\frac{V_2-0}{4}+\frac{V_2-V_1}{2}=12.5$$

$$-7V_2-4V_1=50 \quad -(11)$$

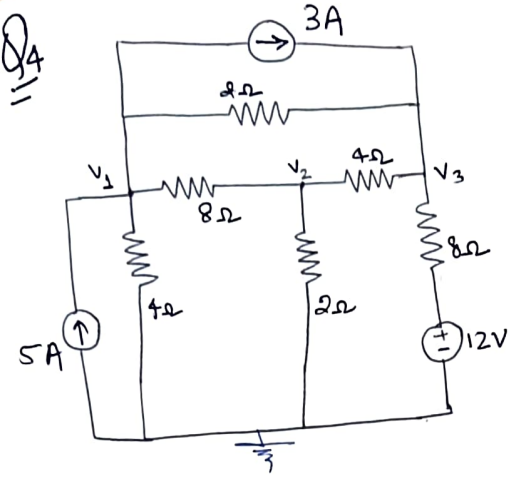
On solving (1) and (11)

$V_1 = 75V$

$V_2 = 50V$

$\therefore V_2 = V_o = 50V$ Ans

Q4



@ node 1 :

$$\frac{V_1-V_2}{8}+\frac{V_1-0}{4}+\frac{V_1-V_3}{2}+3=5 \Rightarrow \quad 7V_1-V_2-4V_3=16 \quad -(1)$$

@ node 2 :

$$\frac{V_2-V_1}{8}+\frac{V_2-0}{2}+\frac{V_2-V_3}{4}=0 \Rightarrow \quad 7V_2-V_1-2V_3=0 \quad -(11)$$

@ node 3:

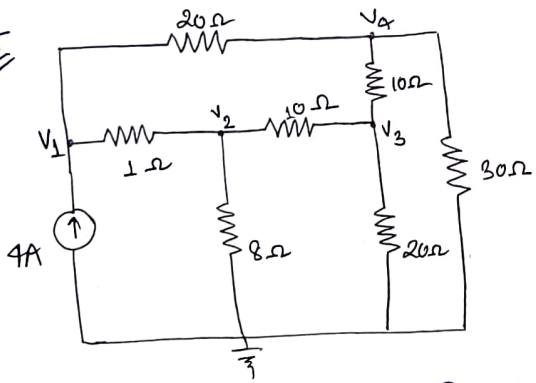
$$\frac{V_3-V_2}{4}+\frac{V_3-12}{8}+\frac{V_3-V_1}{2}=3 \Rightarrow \quad 4V_1+2V_2-7V_3=36 \quad -(111)$$

On solving eqn (1), (11) and (111) :

$V_1 = -2V$ $\qquad$ $V_3 = -6.93V$

$V_2 = -2.267V$

Q5



@ node 1 :

$$\frac{V_1-V_2}{1}+\frac{V_1-V_4}{20}=4$$

$$21V_1-20V_2-V_4=80 \quad -(1)$$

@ node 2 :

$$\frac{V_2-V_1}{1}+\frac{V_2-V_3}{10}+\frac{V_2}{8}=0$$

$$80V_1-98V_2+8V_3=0 \quad -(11)$$

@ node 3 :

$$\frac{V_3-V_2}{10}+\frac{V_3-V_4}{10}+\frac{V_3-0}{20}=0 \Rightarrow 2V_2-5V_3+2V_4=0 \quad -(111)$$

@ node 4 :

$$\frac{V_4-V_1}{20}+\frac{V_4-V_3}{10}+\frac{V_4-0}{30}=0 \Rightarrow 3V_1+6V_3-11V_4=0 \quad -(IV)$$

Q5

from eqn (i), (ii), (iii) and (iv):

$V_1 = 25.52V$

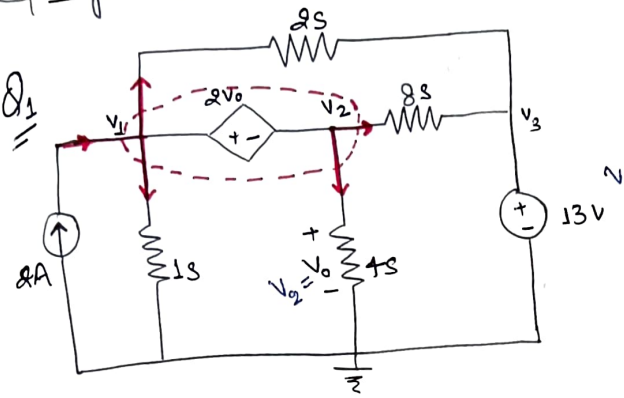
$V_2 = 22.05V$

$V_3 = 14.842V$

$V_4 = 15.056V$

Super node :

Q1 =



$V_3 = 13V$

@ supernode :

$$2(V_1 - V_3) + (V_2 - V_3)8 + (V_2 - 0)4 + (V_1 - 0)1 = 2$$

$$3V_1 + 12V_2 - 10V_3 = 2 \quad \text{—(1)}$$

also; $(V_1 - V_2) = 2V_0$

$V_1 = V_2 + 2V_0$

$\frac{(V_2 - 0)}{1/4} = V_0 \rightarrow V_2 = \frac{1}{4}V_0$

$\hookrightarrow V_1 = 3V_0$ or $V_1 = 3V_2$

$V_3 = 13V$

$V_1 = 3V_2$

$3V_1 + 12V_2 - 10V_3 = 2$

$3(3V_2) + 12V_2 - 10 \times 13 = 2$

$21V_2 = 132$

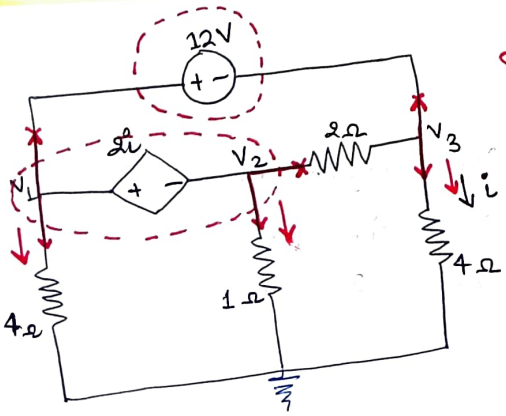
$V_2 = 6.286V$

$V_1 = 3V_2 = 3 \times 6.286\ V$

$V_1 = 18.857V$

$V_1 = 18.857\ V$ $\quad V_2 = 6.286\ V$ $\quad V_3 = 13V$

Q2 =



Super nodes (1 and 2) & (1 and 3)

@ Super node :

$$\frac{V_1 - 0}{4} + \frac{V_2 - 0}{1} + \frac{V_3 - 0}{4} = 0$$

$$V_1 + 4V_2 + V_3 = 0 \quad \text{—(1)}$$

also $V_1 - V_3 = 12 \Rightarrow V_1 = V_3 + 12$ —(11)

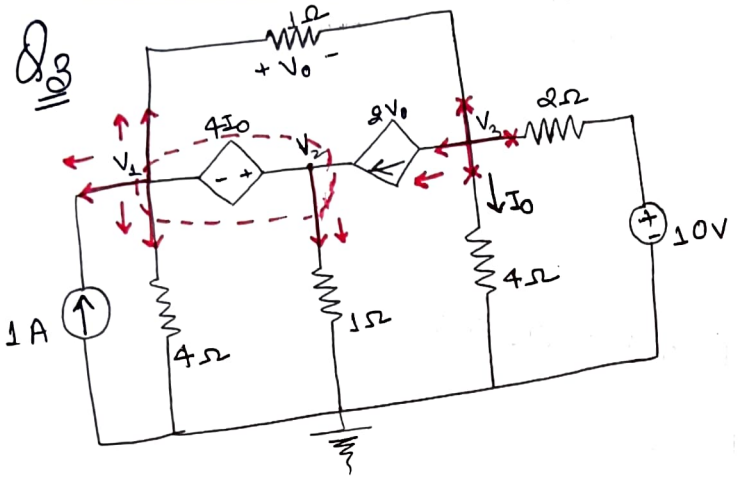
$V_1 - V_2 = 2i$ and $\frac{V_3}{4} = i \Rightarrow V_1 - V_2 = 2\frac{V_3}{4} \Rightarrow 2(V_1 - V_2) = V_3$ —(111)

$$V_1 + 4V_2 + V_3 = 0$$
$$V_1 - V_3 = 12$$
$$2V_1 - 2V_2 - V_3 = 0$$

$$V_1 = (-3)V$$
$$V_2 = 4.5V$$
$$V_3 = (-15)V$$

Ans

Q3



$$V_0 = V_1 - V_3$$

$$V_2 - V_1 = 4i_0$$
$$i_0 = \frac{V_3}{4}$$

$$V_2 - V_1 = V_3$$
$$V_1 - V_2 + V_3 = 0 \quad (iii)$$

(a) Super node: $\frac{V_1 - 0}{4} + \frac{V_2 - 0}{1} + \frac{V_1 - V_3}{1} = 1 + 2V_0$

$$5V_1 + 4V_2 - 4V_3 = (1 + 2V_0)4$$

$$5V_1 + 4V_2 - 4V_3 = [1 + 2(V_1 - V_3)]4$$

$$-3V_1 + 4V_2 + 4V_3 = 4 \quad \text{—(1)}$$

(a) node V_3:

$$\frac{V_3 - 10}{2} + \frac{V_3 - V_1}{1} + \frac{V_3 - 0}{4} + 2V_0 = 0 \qquad V_0 = V_1 - V_3$$

$$\Rightarrow \quad 2(V_3 - 10) + 4(V_3 - V_1) + V_3 + 8(V_1 - V_3) = 0$$

$$4V_1 - V_3 = 20 \quad \text{—(2)}$$

we have:

$$-3V_1 + 4V_2 + 4V_3 = 4$$
$$4V_1 - V_3 = 20$$
$$V_1 - V_2 + V_3 = 0$$

$$V_1 = 4.97V$$
$$V_2 = 4.85V$$
$$V_3 = -0.12V$$