## Series - Parallel

1/ $Req = 25 + \{(180 + 60) \text{ of } 60\}$

$= 25 + (240 \text{ of } 60)$

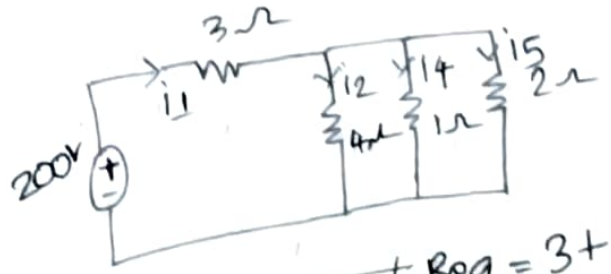
$= 25 + \{(240 \times 60) \div (240 + 60)\}$

$= 25 + (14400 \div 300)$

$= 25 + 48$

$= 73\ \Omega$ Ans

2/ Simplifying




$i_1 = \frac{200}{Req} = \frac{200}{25} \times 7 = 56A$ Ans

$Req = 3 + (4^{-1} + 1^{-1} + 2^{-1})^{-1}$

$= 3 + 4/7$

$= \frac{25}{7}\ \Omega$

$i_5 = 56\left(\frac{4/5}{2 + 4/5}\right) = 56\left(\frac{2}{7}\right)$

$= 16A$ Ans

3/ 20Ω & 60Ω are parallel,

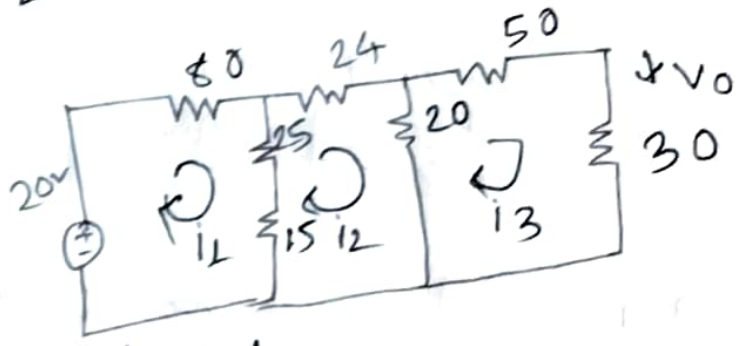
$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{60} + \frac{1}{20}$$

$$= \frac{4}{60}$$

$$= \frac{1}{15}$$

$\therefore R_{eq} = 15$

Simplifying,




Applying KVL in loop 1,

$$20 = 80i_1 + 25(i_1 - i_2) + 15(i_1 - i_2)$$

$$20 = 120\,i_1 - 40i_2 \quad \text{— (1)}$$

loop 2,

$$0 = 24i_2 + 20(i_2 - i_1) + 25(i_2 - i_1) + 15(i_2 - i_1)$$

$$\Rightarrow 0 = -40i_1 + 84i_2 - 20i_3 \quad \text{— (II)}$$

loop 3,

$$0 = 50i_3 + 30i_3 + 20(i_3 - i_2)$$

$$0 = -20i_2 + 100i_3 \quad \text{— (III)}$$

Using calc we get,

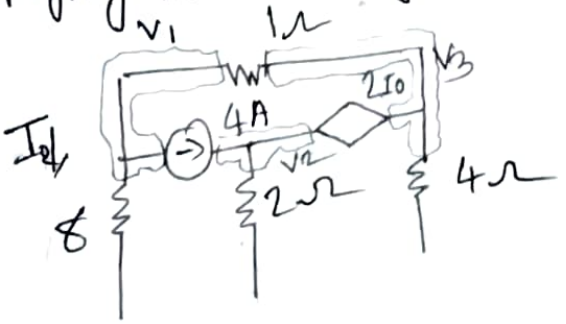
$i_1 = 0.2A$ , $i_2 = 0.1A$ & $i_3 = 0.02A$

From the circuit we get,

$i = i_1 = \boxed{0.2A}$ Ans

$V_o = I_3 R = (0.02) \times 30 = \boxed{0.6V}$ Ans

4/ Applying nodal analysis,




3 nodes are $V_1$, $V_2$ & $V_3$

$I_o = \frac{V_1}{8}$

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

$\Rightarrow V_1 (1 + 1/8) - V_3 = -4$ — (1)

At $V_2$, $-4 + 2\left(\frac{V_1}{8}\right) + \frac{V_2}{2} = 0$

$\Rightarrow \frac{V_1}{4} + \frac{V_2}{2} = 4$ — (11)

At $V_3$ $-2\left(\frac{V_1}{8}\right) + \frac{V_3 - V_1}{1} + \frac{V_3}{4} = 0$

$V_1 \left(-1 - \frac{1}{4}\right) + V_3 \left(1 + 1/4\right) = 0$ — (111)

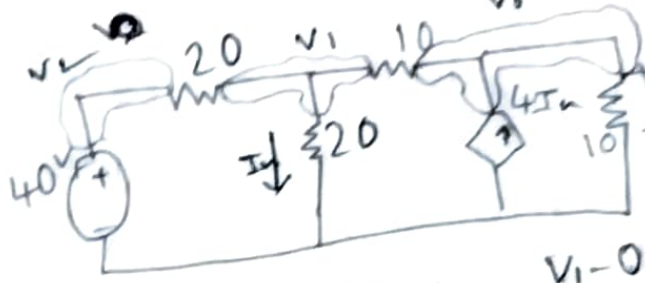
Using calc,

$V_1 = \boxed{-32\ V}$, $V_2 = \boxed{24V}$ & $V_3 = \boxed{-32V}$

$$I_0 = \frac{V_1}{8} = \frac{-32}{8} = \boxed{-4A}$$

Ans

5/ Hence, ~~the~~ using nodal analysis,




$I_n = \frac{V_1}{20}$

at $V_1$, $\frac{V_1 - 40}{20} + \frac{V_1 - 0}{20} + \frac{V_1 - V_0}{10} = 0$ — (1)

$\Rightarrow 0.2V_1 - 0.1V_0 = 2$

at $V_2$ $\frac{V_0 - V_1}{10} - 4I_n + \frac{V_0 - 0}{10} = 0$

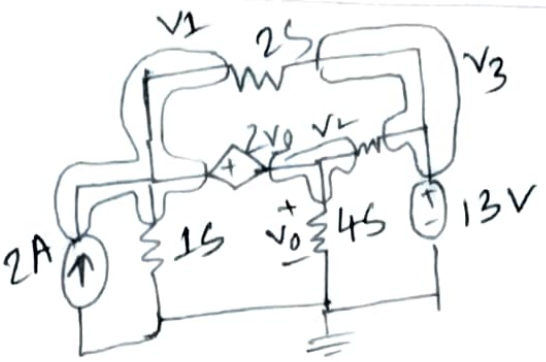
$\Rightarrow -0.8V_1 + 0.2V_0 = 0$ — (II)

Using calc, $V_1 = (2/3)V_0$, $V_0 = \boxed{60V}$

$\therefore V_1 = 2/3 \times 60 = \boxed{40\ V}$

Ans

6/




$V_0 = V_2$

Supernode

$$V_1 - V_2 = 2V_0 \quad \text{— (1)}$$

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

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

$$V_3 = 13.V$$

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

$$3V + 12V_2 = 2 + 130$$

From (1),

$$V_1 - V_2 = 2V_0$$

$$\Rightarrow V_1 - 3V_2 = 0 \quad \text{— (III)}$$

$$3V_1 + 12V_2 = 132 \quad \text{— (IV)}$$

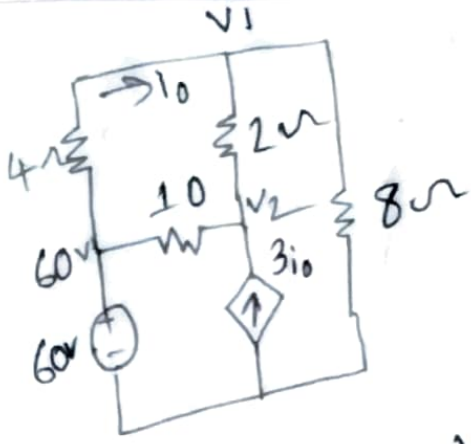
From calc,

$V_1 = \boxed{18.56V}$,

$V_2 = \boxed{6.286V}$. &

$V_3 = \boxed{13V}$ Ans

7/




at $v_1$

$$\frac{v_1 - 60}{4} + \frac{v_1}{8} + \frac{v_1 - v_2}{2} = 0$$

$$2v_1 - 120 + v_1 + 4v_1 - 4v_2 = 0$$

$$7v_1 - 4v_2 = 120 \quad \text{— (1)}$$

at $v_2$ $\quad 3i_o = \frac{v_2 - 60}{10} + \frac{v_2 - v_1}{2}$

$$\Rightarrow i_o = \frac{60 - v_1}{4}$$

$$\frac{3(60 - v_1)}{4} + \frac{60 - v_2}{10} + \frac{v_1 - v_2}{2} = 0$$

$$1020 = 5v_1 - 12v_2 \quad \text{— (II)}$$

from calc,

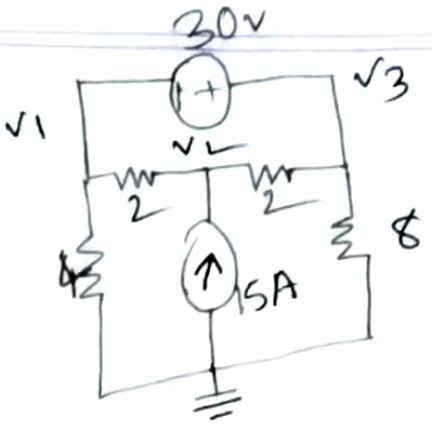
$$v_1 = \boxed{53.08\ V}$$

$$i_o = \frac{60 - v_1}{4} = \frac{60 - 53.08}{4}$$

$$= \boxed{1.73\ A}$$

Ans

8/




Using nodal analysis,

supernode

$$\frac{V_1}{4} + \frac{V_1 - V_2}{2} + \frac{V_3}{8} + \frac{V_3 - V_2}{2} = 0$$

$$\Rightarrow 6V_1 - 8V_2 + 5V_3 = 0 \quad \text{— (1)}$$

Using cale

$$V_3 - V_1 = 30 \quad \text{— (11)}$$

at $V_2$

$$\frac{V_2 - V_1}{2} - 15 + \frac{V_2 - V_3}{2} = 0$$

$$\frac{V_2 - V_1 - 30 + V_2 - V_3}{2} = 0$$

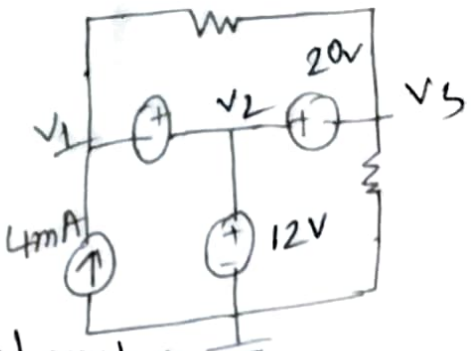
$$2V_2 - V_1 - V_3 = 30 \quad \text{— (111)}$$

Using calculator,

$V_1 = \boxed{30V}$, $V_2 = \boxed{60V}$ & $V_3 = \boxed{60V}$

Ans

Q1




Using nodal analysis,

$\therefore \boxed{V_2 = 10V}$

$V_2 - V_3 = 20$

$\Rightarrow 12 - V_3 = 20$

$\Rightarrow 12 - 20 = V_3$

$\therefore \boxed{V_3 = -8V}$

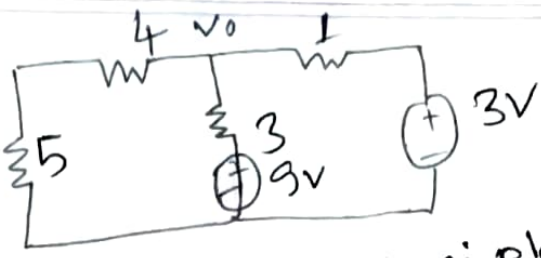
& $V_2 - V_1 = 10V$

$12 - V_1 = 10$

$\Rightarrow \boxed{V_1 = 2V}$

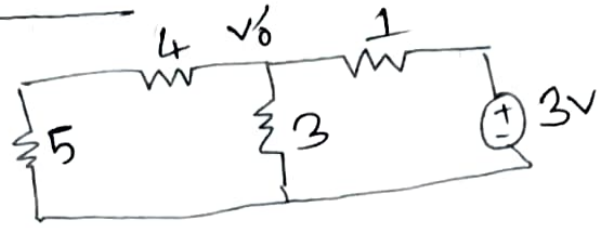
Ans

10/




By superposition principle considering

3v source,



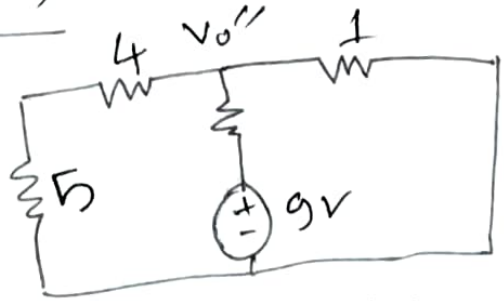

Applying KCL,

$$\frac{v_o'}{5} + \frac{v_o'}{3} + \frac{v_o'-3}{1} = 0$$

$$\Rightarrow v_o' = 3/1.44$$

$$\therefore v_o' = 2.076V$$

For 9v source,




Applying KCL,

$$\frac{v_o''}{5} + \frac{v_o''-9}{3} + \frac{v_o''}{1} = 0$$

$$\Rightarrow v_o''(1/5 + 1 + 1/3) = 3$$

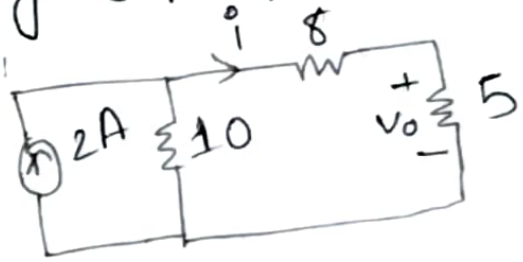
$$\therefore v_o'' = 2.076V$$

By superposition theorem,

$$V_o = V_o' + V_o''$$
$$= 2.076 + 2.076$$
$$\therefore V_o = \boxed{4.157\ V} \quad \text{Ans}$$

11| Applying superposition Principle,

For ~~4A source~~ power

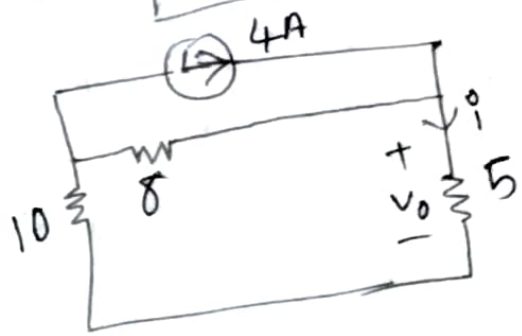



For 2A current source:

applying current division,

$$i = \frac{2 \times 10}{10+8+5}$$
$$= 0.869$$
$$V_1 = i \times 5 = 0.869 \times 5$$
$$\therefore V_1 = \boxed{4.347\ V} \quad \text{Ans}$$

For 4A:

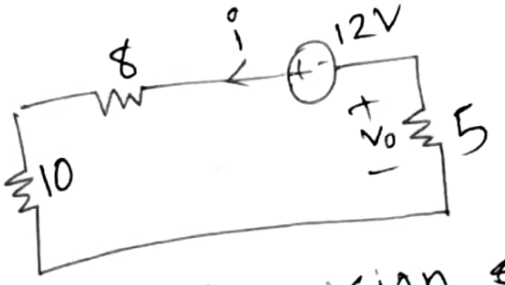


applying current division rule,

$$i = \frac{4 \times 8}{10+8+5} = 1.391 \text{ A}$$

$$V_2 = 5 \times i = \boxed{6.518 \text{ V}} \quad \text{Ans}$$

For 12V source:




applying current division rule,

$$i = \frac{12}{10+8+5}$$

$$= 0.521 \text{ A}$$

$$V_3 = -i \times 5$$

$$= \boxed{-2.608 \text{ V}}$$

Total voltage.

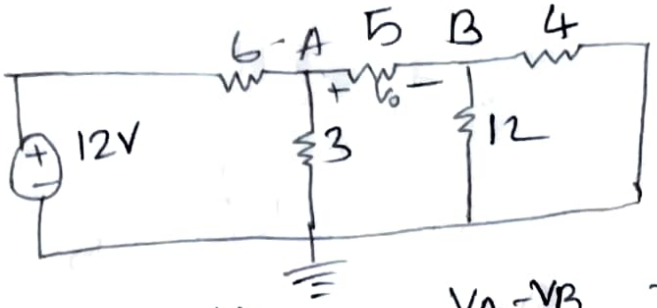
$$V_0 = V_1 + V_2 + V_3$$

$$= 4.347 + 6.918 - 2.608$$

$$\therefore V_0 = \boxed{8.695 \text{ V}} \quad \text{Ans}$$

12| Using superposition principle,

For 12V source:




$$30 \times \left( \frac{12 - V_A}{6} = \frac{V_A}{3} + \frac{V_A - V_B}{5} \right)$$

$$\Rightarrow 60 - 5V_A = 10V_A + 6V_A - 6V_B$$

$$\Rightarrow 60 = 21V_A - 6V_B$$

$$\Rightarrow 20 = 7V_A - 2V_B \quad \text{—— (1)}$$

$$\left( \frac{V_A - V_B}{5} = \frac{V_B}{12} + \frac{V_B}{4} \right) \times 60$$

$$\Rightarrow 12V_A - 12V_B = 5V_B + 15V_B$$

$$\Rightarrow 12V_A = 32V_B$$

$$\Rightarrow 3V_A = 8V_B$$

$$\Rightarrow 3V_A - 8V_B = 0 \quad \text{—— (11)}$$

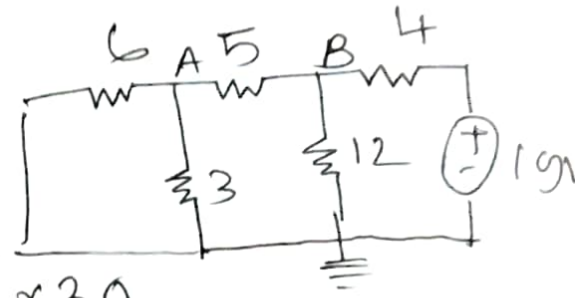
From Calc, $V_A = 3.2\ V$

$V_B = 1.2\ V$

$V_o' = V_A - V_B$

$\Rightarrow V_o' = 3.2 - 1.2$

$\Rightarrow V_o' = \boxed{2V}$




For 19V Source:

$$\left(\frac{0 - V_A}{6} = \frac{V_A}{3} + \frac{V_A - V_B}{5}\right) \times 30$$

$\Rightarrow -5V_A = 10V_A + 6V_A - 6V_B$

$\Rightarrow V_A - 2V_B = 0$ ——— (1)

$$60 \times \left(\frac{V_A - V_B}{5} = \frac{V_B}{12} + \frac{V_B - 19}{4}\right)$$

$\Rightarrow 12V_A - 12V_B = 5V_B + 15V_B - 15 = 19$

$\Rightarrow V_A = 2.85\ V$ [Putting $V_B$ value from (1) using calculator]

Now

$\therefore V_B = \frac{7}{2} V_A$

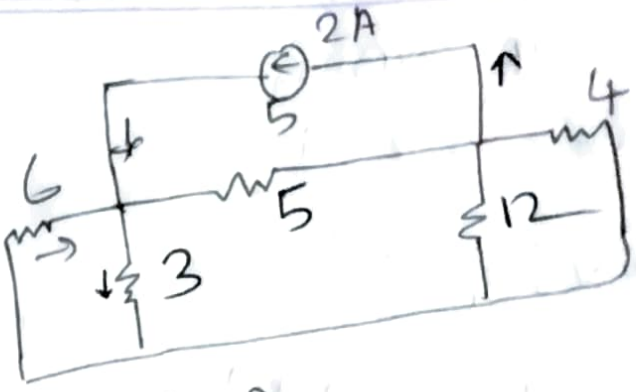
$\therefore V_B = 9.975\ V$

$V_o'' = V_A - V_B$

$= 2.85 - 9.975$

$= \boxed{7.125V}$

For 2 A source :




$$\left(\frac{0-V_A}{6}+2=\frac{V_A}{3}+\frac{V_A-V_B}{5}\right)\times 30$$

$$\Rightarrow -5V_A+60=10V_A+6V_A-6V_B$$

$$\Rightarrow 20=7V_A-2V_B \quad \text{—— (I)}$$

$$\left(\frac{V_A-V_B}{5}=2+\frac{V_B}{12}+\frac{V_B}{4}\right)\times 60$$

$$\Rightarrow 12V_A-12V_B=120+5V_B+15V_B$$

$$\Rightarrow 3V_A-8V_B=30 \quad \text{—— (II)}$$

Using calc,

$$V_B=-3V \;\&\; V_A=2$$

$$V_o''' = V_A - V_B$$

$$= 2+3$$

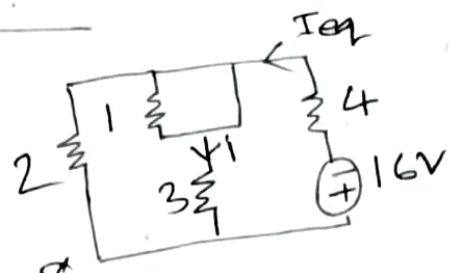
$$\therefore V_o''' = \boxed{5V}$$

Therefore,

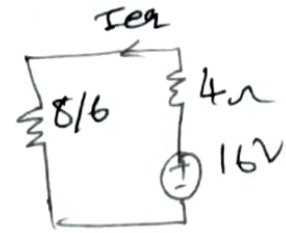
$$V_o = V_o' + V_o'' + V_o'''$$
$$= 2 + (-7.125) + 5$$
$$= \boxed{-0.125\,V} \quad \text{Ans}$$

13) Using superposition Principle,

For 16V source:




$$\Rightarrow \frac{2\times 4}{6} = \frac{8}{6}$$



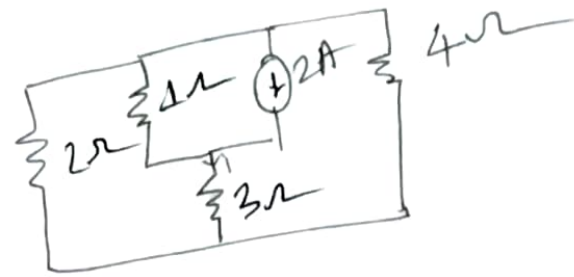

$$I_{eq} = \frac{16}{4 + 8/6}$$
$$= 3A$$

$$i_1 = \frac{2}{2+3+1} \times I_{eq}$$
$$= \frac{2}{6} \times 3$$
$$= \boxed{1A}$$

∴ Current flowing through 3Ω = 1A

For 2A source:

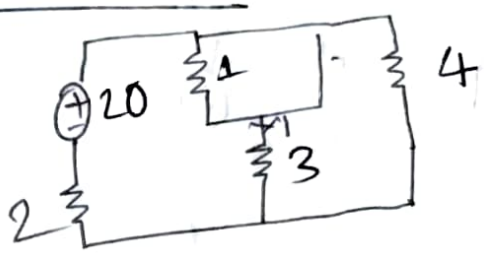
$$(2^{-1} + 4^{-1})^{-1}$$
$$= 8/6\,\Omega$$



$3 + 8/6 = 26/6 = 13/3\ \Omega$

$$i_2 = 2 \times \frac{1}{(1+13/3)} = \boxed{3/8\ A}$$

For 20v source :




$(2^{-1}+4+1)^{-1} + (1+3)$


$(4^{-1}+4^{-1})^{-1} = 2$

$$i_0 = \frac{20}{2+2} = 5\ A$$

$$i_3 = \frac{4 \times 5}{4+4} = \boxed{2.5\ A}$$

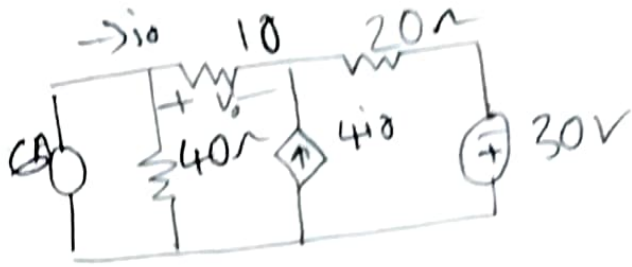
Using superposition theorem,

$$i = i_1 + i_2 + i_3$$
$$= 1 + 3/8 + 2.5$$
$$\therefore i = \boxed{3.675\ A}\ \text{Ans}$$

Power = $i^2R$ = 45.0 468

$\therefore$ P = 45.05W Ans

14/ Using superposition principle,




$V_o = V_{o1} + V_{o2}$

$i = i_{o1} + i_{o2}$

Applying nodal analysis,

node1 $\quad -6 + \frac{v_1}{40} + \frac{v_1 - v_2}{10} = 0$

$v_1(0.125) - (0.1)v_2 = 6 \quad \text{—} (1)$

node2 $\quad -4i_{o1} + \left(\frac{v_2}{20}\right) + \left(\frac{v_2 - v_1}{10}\right) = 0$

but, $i_{o1} = \frac{4 - v_2}{10}$

So, $\left(\frac{v_1 - v_2}{10}\right)\alpha - 4 + (0.15)v_2 - 0.1v_1 = 0$

$\Rightarrow v_1 = \frac{0.55v_2}{0.5}$

$\therefore v_1 = 1.1v_2$

Now,

$$0.125 \times 1.1\, V_2 - 0.1 V_2 = 6$$

$$\Rightarrow V_2 = \frac{6}{0.0375}$$

$$\therefore V_2 = \boxed{160\,V}$$

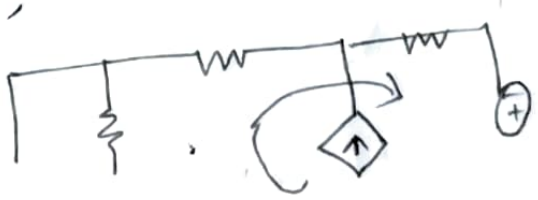
$$\& \quad V_1 = (1.1)\times(160)$$

$$\therefore V_1 = \boxed{16\,V}$$

Also, $i_{o1} = \frac{V_{o1}}{10} = 16/10$

$$\therefore i_{o1} = \boxed{1.6A}$$

to find $v_{o2}$ & $i_{o2}$ open circuit source,



Applyin KVL in the loop,

$$i_{o2} + 4i_{o2} = 5i_{o2}$$

$$(40+10)\, i_{o2} + (20)(5)\, i_{o2} - 30 = 0$$

$$\Rightarrow i_{o2} = \frac{150}{30}$$

$$\therefore i_{o2} = \boxed{0.2A}$$

$\therefore V_{O2} = 10 \times i_{O2}$

$= 10 \times 0.2$

$\therefore V_{O2} = \boxed{2V}$

Now, $V_O = V_{O1} + V_{O2} = 16 + 2 = \boxed{18V}$

$i_O = i_{O1} + i_{O2} = 1.6 + 0.2 = \boxed{1.8A}$

Ans