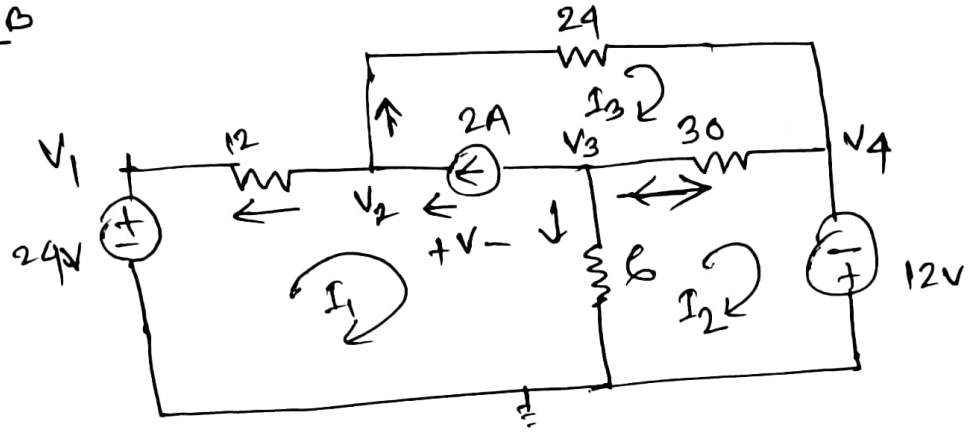
Q.1

Part A

$$R = 20\ K\Omega$$

Part - B

i)



Nodal Analysis

$$V_1 = 24\ V$$

$$V_4 = -12\ V$$

At node-2 (V_2)

$$-2 + \frac{V_2 - 24}{12} + \frac{V_2 + 24}{24} = 0$$

$$\Rightarrow \quad V_2 = 28\ V$$

At node-3 (V_3)

$$2 + \frac{V_3}{6} + \frac{V_3 + 12}{36} = 0$$

$$\Rightarrow \quad V_3 = -12\ V$$

Mesh Analysis

(iii)

for loop-1

$$\boxed{-24 + 12I_1 + V + 6(I_1 - I_2) = 0}$$

$$\Rightarrow \quad 18I_1 - 6I_2 + V = 24 \quad \text{——— (i)}$$

for loop-2

$$6(I_2 - I_1) + 30(I_2 - I_3) - 12 = 0$$

$$\Rightarrow \boxed{-6I_1 + 36I_2 - 30I_3 = +12}$$

for loop-3

$$\boxed{-V + 24I_3 + 30(I_3 - I_2) = 0} \quad \text{——— (ii)}$$

(i) + (ii) $\Rightarrow$

$$18I_1 - 6I_2 - 30I_2 + 54I_3 = 24$$

$$\Rightarrow \boxed{18I_1 - 36I_2 + 54I_3 = 24}$$

from supermesh

$$\boxed{-I_1 + I_3 = 2}$$

$$\boxed{\begin{aligned} I_1 &= -V_3 = -0.33\,A \\ I_2 &= 5/3 = 1.667\,A \\ I_3 &= 5/3 = 1.667\,A \end{aligned}}$$

ii)

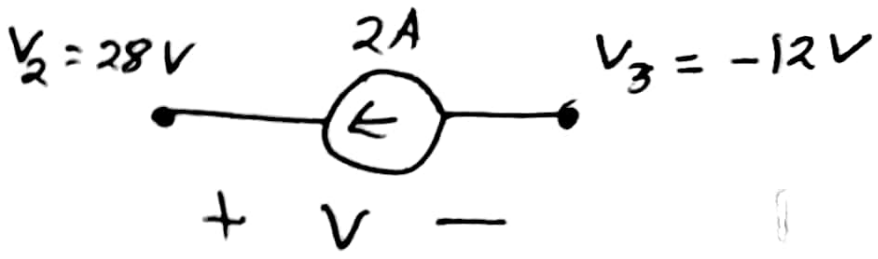
$P = VI$

$= -(V_2 - V_3) \times 2$

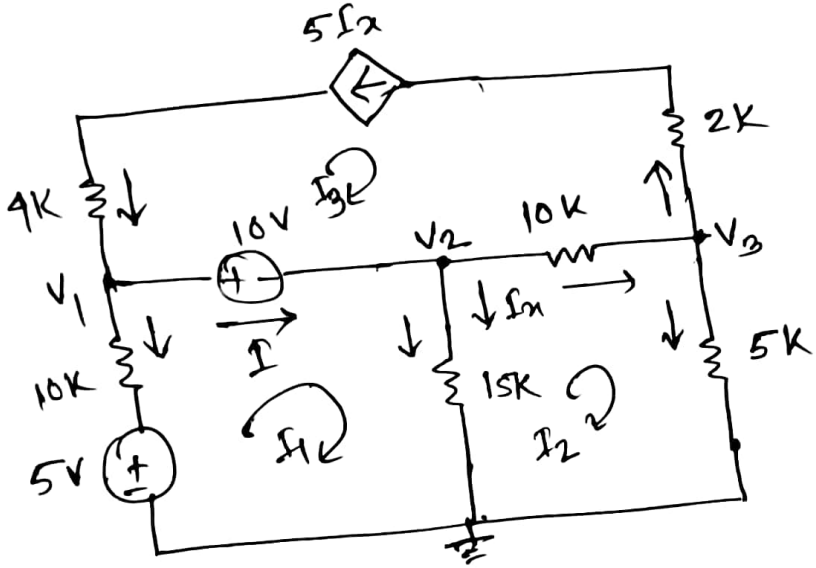
$= -\{28 - (-12)\} \times 2$

$= -80\ W$

↖ supplying



Q.2



Nodal Analysis

At node-1 (V_1)

$$\frac{V_1 - 5}{10K} + I - 5I_x = 0$$

$$\Rightarrow \frac{V_1 - 5}{10K} + I - 5 \times \frac{V_2}{15K} = 0 \qquad \left[I_x = \frac{V_2}{15K} \right]$$

$$\Rightarrow \frac{V_1 - 5}{10K} + I - \frac{V_2}{3K} = 0 \quad \text{——— (1)}$$

At node-2 (V_2)

$$\boxed{-I + \frac{V_2}{15K} + \frac{V_2 - V_3}{10K} = 0} \quad \text{——— (1)}$$

(1) + (1) ⇒

$$\frac{V_1 - 5}{10K} - \frac{V_2}{3K} + \frac{V_2}{15K} + \frac{V_2 - V_3}{10K} = 0$$

$$\Rightarrow \boxed{3V_1 - 5V_2 - 3V_3 = 15}$$

At node-3 (V_3)

$$\boxed{+5I_x + \frac{V_3}{5K} - \frac{V_2 - V_3}{10K} = 0}$$

$$\Rightarrow 5 \times \frac{V_2}{15K} + \frac{V_3}{5K} - \frac{V_2 - V_3}{10K} = 0$$

$$\Rightarrow \boxed{7V_2 + 9V_3 = 0}$$

At super node

$$\boxed{V_1 - V_2 = 10}$$

$$\boxed{\begin{aligned} V_1 &= -35\,V \\ V_2 &= -45\,V \\ V_3 &= 35\,V \end{aligned}}$$

Mesh Analysis

Loop 1

$$-5 + 10K I_1 + 10 + 15K(I_1 - I_2) = 0$$

$$\Rightarrow \quad 25K I_1 - 15K I_2 = -5$$

for Loop-2

$$15K(I_2 - I_1) + 10K(I_2 - I_3) + 5K I_2 = 0$$

$$\Rightarrow \quad -15K I_1 + 30K I_2 - 10K I_3 = 0$$

for Loop-3

$$I_3 = -5 I_x$$

$$\Rightarrow \quad I_3 = -5(I_1 - I_2) \qquad [\because I_x = I_1 - I_2]$$

$$\Rightarrow \quad 5 I_1 - 5 I_2 + I_3 = 0$$

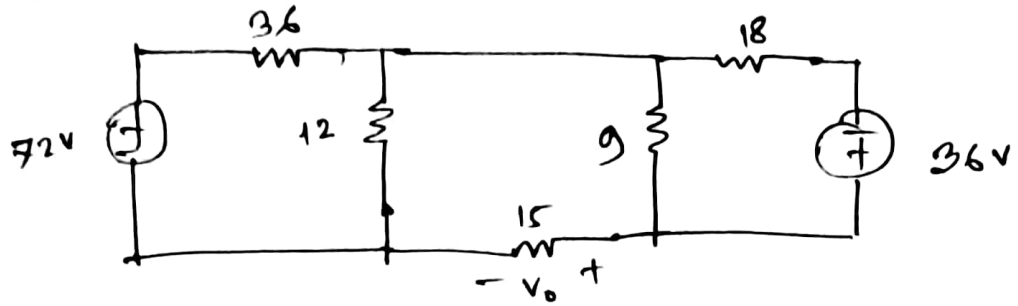
$$I_1 = 4\,mA$$
$$I_2 = 7\,mA$$
$$I_3 = 15\,mA$$

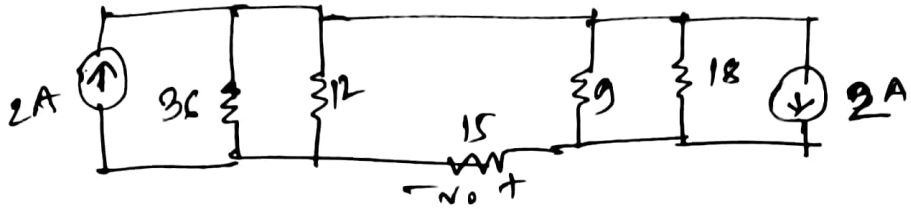
ii)

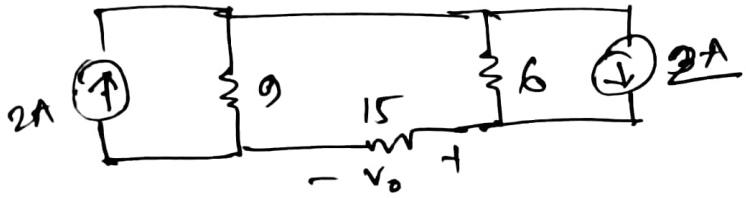
$$I_x = -3\,mA$$

$$I_{10V} = 11\,mA$$

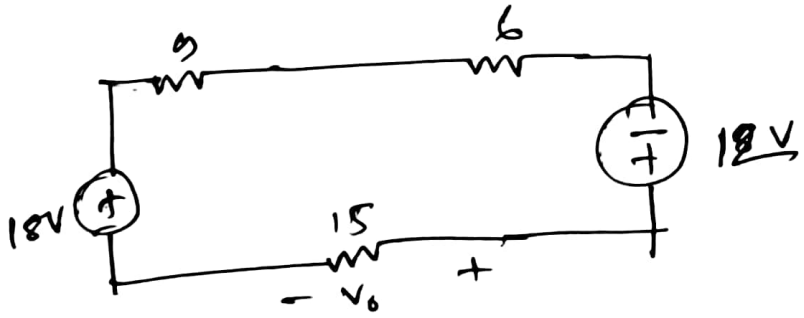
Set -1


36
18
72V
12
9
36V
15
− V₀ +


2A
36
12
9
18
2A
15
− V₀ +


2A
9
15
6
2A
− V₀ +

$V_0 = 15V$


9
6
18V
18V
15
− V₀ +