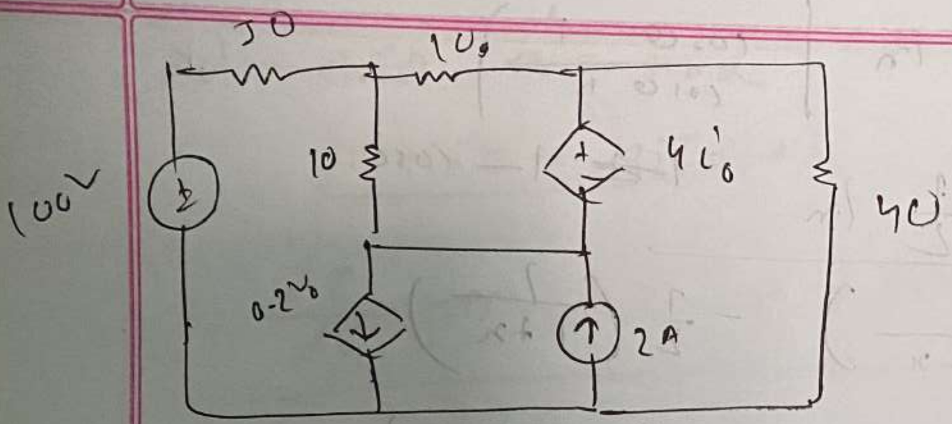
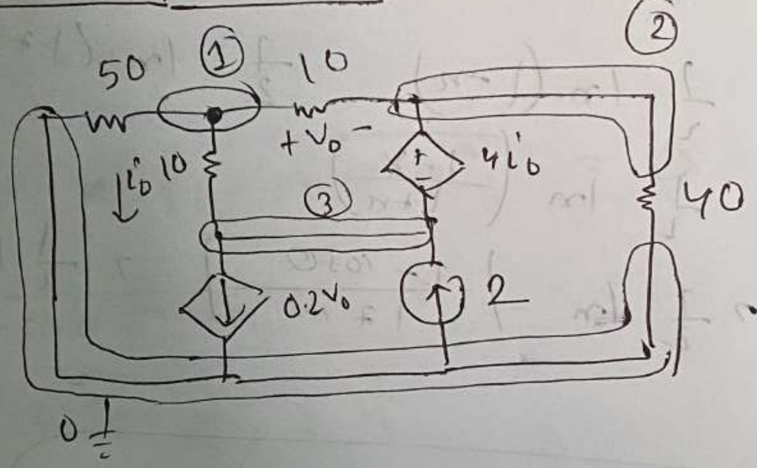
Superposition



(4) 2A on :



$$v_1\left(\frac{1}{50}+\frac{1}{10}+\frac{1}{10}\right) - v_2\left(\frac{1}{10}\right) - v_3\left(\frac{1}{10}\right) = 0 \quad \text{— (i)}$$

$$v_2 - v_3 = 4i_0 = \frac{v_1 - v_3}{10}$$

$$\Rightarrow 10(v_2 - v_3) = v_1 - v_3 \quad \text{— (ii)}$$

$$v_2\left(\frac{1}{10}+\frac{1}{40}\right) - v_1\left(\frac{1}{10}\right) + \underset{(v_1 - v_2)}{0.2v_0} - 2 = 0 \quad \text{— (iii)}$$

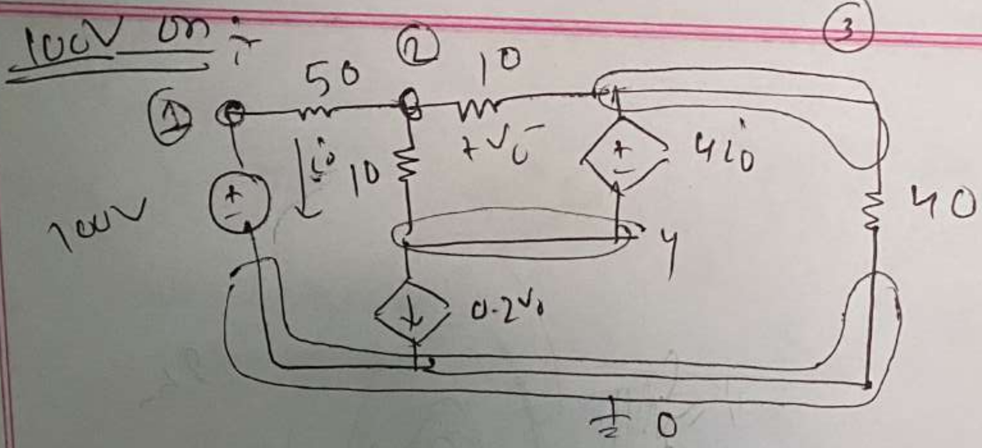
(i), (ii), (iii) $\Rightarrow$

$v_1 = 111.76\text{ V}$, $v_2 = 122.35\text{ V}$, $v_3 = 123.529\text{ V}$

$$\boxed{\therefore v_{o_1} = -10.59\text{ V}}$$

3

100V on :



$v_1 = 100$ — (i)

$v_2\left(\frac{1}{50}+\frac{1}{10}+\frac{1}{10}\right) - v_1\left(\frac{1}{50}\right) - v_3\left(\frac{1}{10}\right) - v_4\left(\frac{1}{10}\right) = 0$ — (ii)

$v_3 - v_4 = 4i_0 = 4 \times \left(\frac{v_2 - v_4}{10}\right)$ — (iii)

$v_3\left(\frac{1}{10}+\frac{1}{40}\right) - v_2\left(\frac{1}{10}\right) + v_4\left(\frac{1}{10}\right) - v_2\left(\frac{1}{10}\right) \cancel{+0.2v_0} + 0.2(v_2 - v_3) = 0$

(i), (ii), (iii) $\Rightarrow$

$v_1 = 100$, $v_2 = 21.56$, $v_3 = 15.68$, $v_4 = 11.76$

$\therefore v_{o_2} = v_2 - v_3$

$= 5.88\,V$

$\therefore v_0 = v_{o_1} + v_{o_2}$

$= -10.59 + 5.88$

$\boxed{v_0 = -4.71}$ (Ans.)

$$i(t) = \frac{V_s}{R} e^{-t/\tau}, \quad t \geq 0$$
$$\tau = RC$$

Transient

1

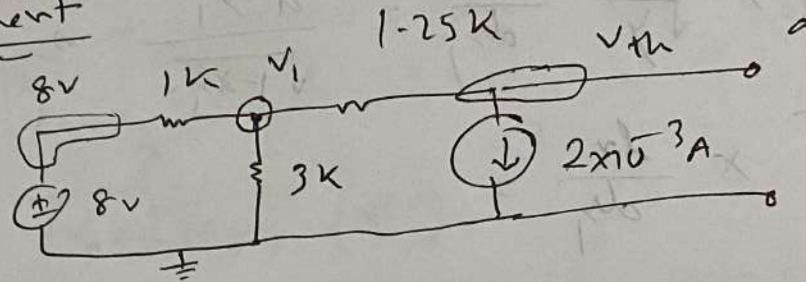
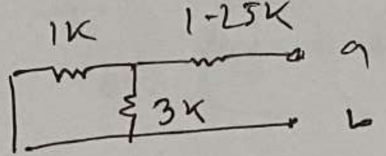


Fig: 1

Thevenin R:



$$\boxed{\therefore R_{th} = 2K}$$

Thevenin V:

= from Fig: 1

$$v_1\left(\frac{1}{1} + \frac{1}{3} + \frac{1}{1.25}\right) - 8\left(\frac{1}{1}\right) - V_{th}\left(\frac{1}{1.25}\right) = 0$$

$$\Rightarrow \boxed{(2.133)v_1 + (-0.8)V_{th} = 8} \quad \text{— (i)}$$

$$V_{th}\left(\frac{1}{1.25\times10^3}\right) - v_1\left(\frac{1}{1.25\times10^3}\right) + 2\times10^{-3} = 0$$

$$\Rightarrow \boxed{(-0.8)v_1 + (0.8)V_{th} = -2} \quad \text{— (ii)}$$

$v_1 = 4.5$, $\boxed{V_{th} \approx 2}$

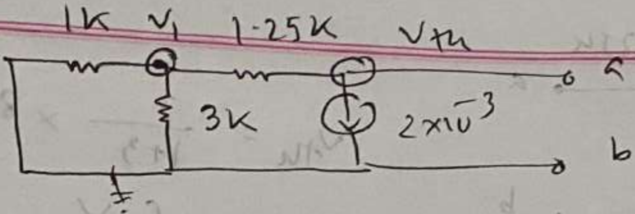
Now, $\tau = RC = R_{th}C$

$= 2\times10^{-3}$ s

$$\therefore i(t) = \cancel{V_s}\ \frac{V_{th}}{R_{th}} e^{-t/\tau}$$

$$\boxed{i(t) = 10^{-3} e^{-\frac{t}{2\times10^{-3}}}}$$

(2)



v_{th} :

$$v_1\left(\frac{1}{1}+\frac{1}{1.25}+\frac{1}{3}\right) - v_{th}\left(\frac{1}{1.25}\right) = 0$$

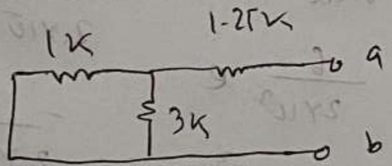
$$\Rightarrow (2.133)v_1 + (-0.8)v_{th} = 0 \quad \text{--- (i)}$$

$$v_{th}\left(\frac{1}{1.25\times10^3}\right) - v_1\left(\frac{1}{1.25\times10^3}\right) + 2\times10^{-3} = 0$$

$$\Rightarrow (-0.8)v_1 + (0.8)v_{th} = -2 \quad \text{--- (ii)}$$

$$\boxed{v_{th} = -4}$$

R_{th} :



$$\therefore R_{th} = (1^{-1}+3^{-1})^{-1} + 1.25$$

$$\boxed{R_{th} = 2K}$$

$$\therefore \tau = R_{th}C$$

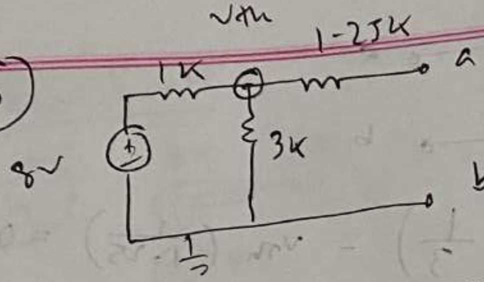
$$= 2\times10^{3} \times 10^{-6}$$

$$\therefore \tau = 2\times10^{-3}$$

$$\therefore i_1(t) = \frac{v_{th}}{R_{th}} e^{-t/\tau}$$

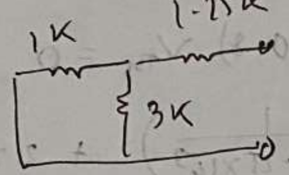
$$i_1(t) = -2\times10^{-3} e^{-\frac{t}{2\times10^{-3}}} \text{ A}$$

(3)



$$V_{th} = \frac{3}{1+3} \times 8$$
$$= 6\ V$$

R_{th}:



$$R_{th} = 2\ K$$

$$\tau = R_{th} C = 2 \times 10^{-3}$$

$$\therefore i_2(t) = \frac{V_{th}}{R_{th}} e^{-t/\tau}$$
$$= \frac{6}{2 \times 10^{3}} e^{-\frac{t}{2\times10^{-3}}}$$
$$= 3 \times 10^{-3} e^{-\frac{t}{2\times10^{-3}}}$$

Now,

$$i_1(t) + i_2(t) = (-2\times10^{-3} + 3\times10^{-3}) e^{-\frac{t}{2\times10^{-3}}}$$
$$= 10^{-3} e$$
$$= i(t)$$

$\therefore$ Superposition principle works here.