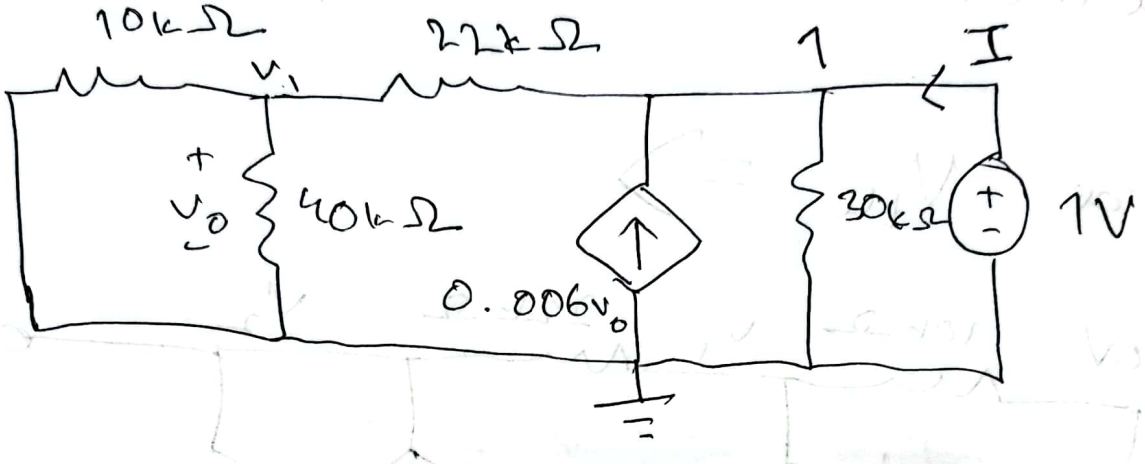
Assignment - 03

1) For R_{th} =>



$$\frac{v_1}{10} + \frac{v_1}{40} + \frac{v_1 - 1}{22} = 0$$

or, $v_1 = 0.267$

$$I = \frac{1}{30} + \frac{1 - v_1}{22} - 0.006v_1$$

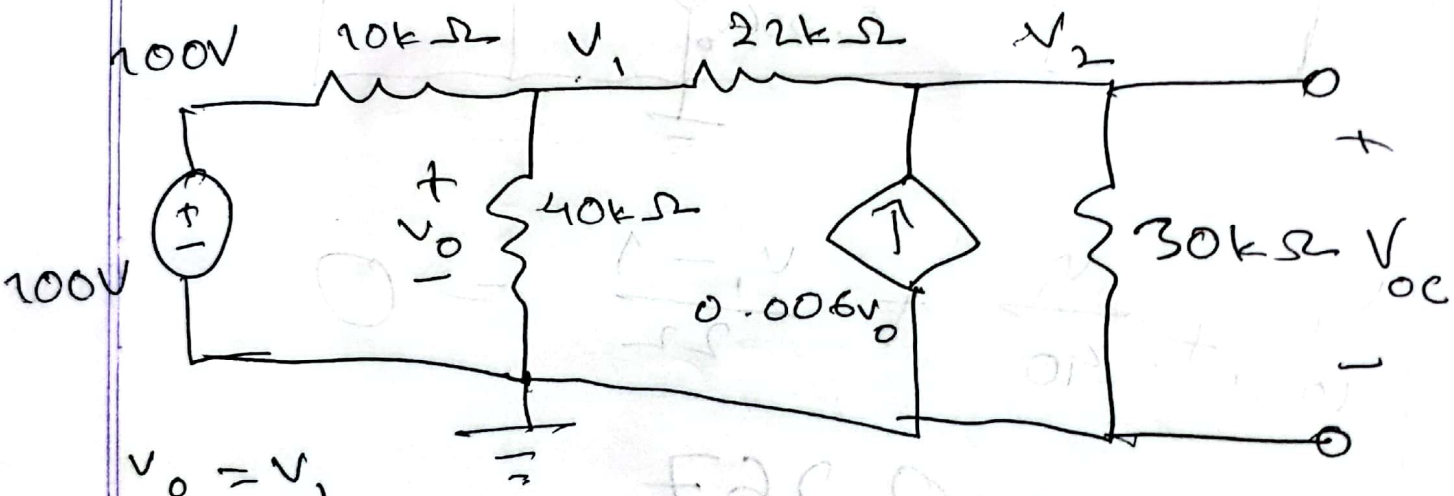
$$= 0.065 mA$$

$$\therefore R_{th} = \frac{1}{I} = 15.38 k\Omega$$

simple circuit shown

$R = 15.38\,k\Omega$ for maximum power

For V_{th} =>



$v_o = v_1$

$$\frac{v_1 - 100}{10} + \frac{v_1}{40} + \frac{v_1 - v_2}{22} = 0$$

or, $0.17v_1 - 0.045v_2 = 10$ ——— (1)

$$\frac{v_2 - v_1}{22} - 0.006v_1 + \frac{v_2}{30} = 0$$

$$\text{or}, \quad -0.051 v_1 + 0.0788 v_2 = 0 \qquad \text{(II)}$$

$$v_1 = 70.99\text{V}, \quad v_2 = 45.94\text{V}$$

$$\therefore V_{oc} = V_{th} = v_2 = 45.94\text{V}$$

$$\therefore P_{max} = \frac{V_{th}^2}{4R_{th}} = 34.37\text{mW}$$

2) (a)

$$V_{ab} = \frac{R_L}{R_L + R_{th}} V_{th}$$

If $R_L = 10k\Omega$, $V_{ab} = \frac{10}{10+R_{th}} V_{th} = 20V$ — (1)

If $R_L = 30k\Omega$, $V_{ab} = \frac{30}{30+R_{th}} V_{th} = 40V$ — (11)

(11) ÷ (1) $\Rightarrow \frac{30}{10} \cdot \frac{10+R_{th}}{30+R_{th}} = \frac{40}{20}$

$$\text{or}, \quad \frac{10+R_{th}}{30+R_{th}} = \frac{2}{3}$$

$$\text{or}, \quad 30 + 3R_{th} = 60 + 2R_{th}$$

$$\text{or}, \quad R_{th} = 30k\Omega$$

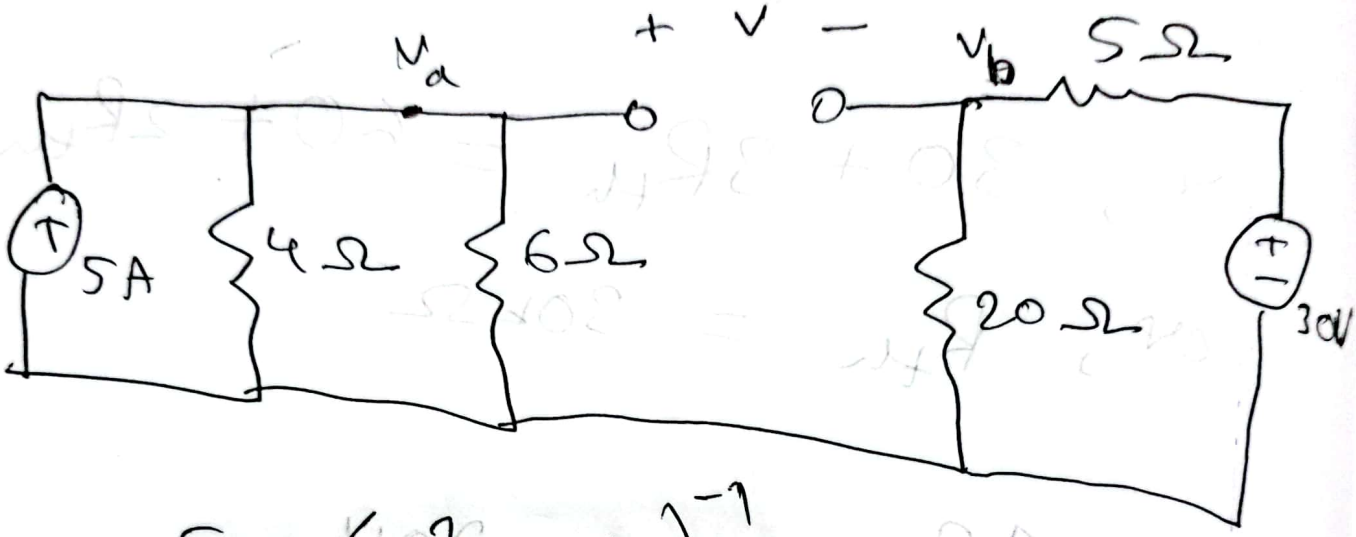
$$\therefore \quad \frac{10}{10+30} V_{th} = 20V$$

$$\text{or}, \quad V_{th} = \frac{20 \times 40}{10} = 80V$$

(b) If $R_L = 20k\Omega$,

$$V_{ab} = \frac{20}{20+30} \times 80 = 32V$$

3) For $t<0$,



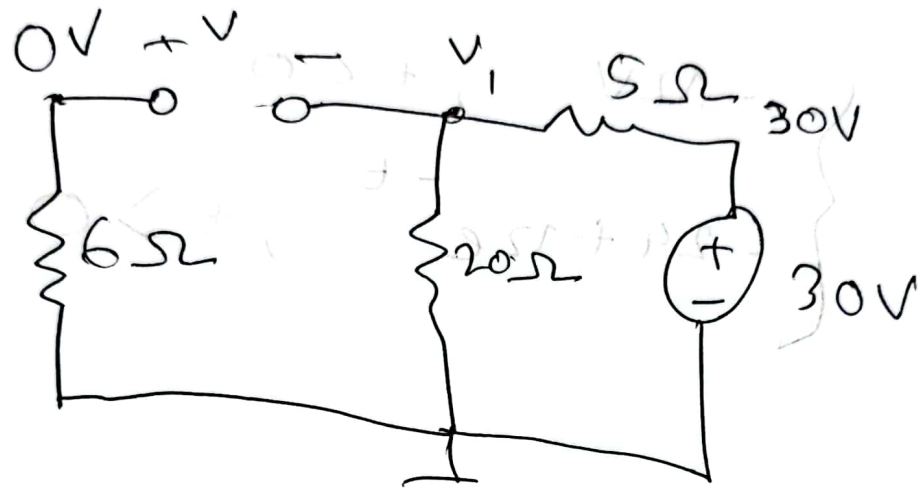
$$V_a = 5 \times \left(\frac{1}{4} + \frac{1}{6}\right)^{-1} = 12V$$

$$V_b = \frac{20}{20+5} \times 30 = 24V$$

$$\therefore V = V_a - V_b = -12V$$

$$\therefore V_0 = -12V$$

For $t > 0$,



$$\frac{v_1}{20} + \frac{v_1 - 30}{5} = 0$$

or, $v_1 = 24V$

$\therefore v = V_s = -24V$

For $t < 0$, $v = -12V$

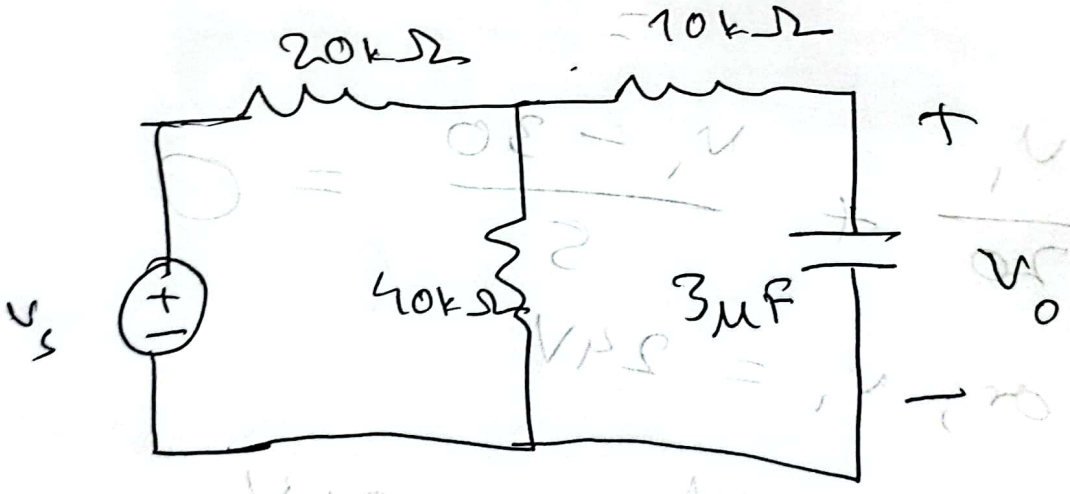
For $t > 0$, $v(t) = V_s + (V_0 - V_s)e^{-\frac{t}{RC}}$

Here, $R = 6 + \left(\frac{1}{5} + \frac{1}{20}\right)^{-1} = 10\Omega$

$$\therefore \tau = RC = 10 \times \frac{100}{1000} = 1s$$

$$\therefore v(t) = \begin{cases} -12V & , t < 0 \\ -24 + 12e^{-t} & , t > 0 \end{cases}$$

4)



$$v_o = \frac{40}{20+40} v_s$$

$$= \frac{2}{3} v_s$$

For $t < 0$, $v_s = 10V$

$\therefore v_o = V_o = 6.67V$

For $t > 0$, $v_s = 30V$,

$\therefore v_o = V_s = 20V$

Here, $R = 10 + \left(\frac{1}{20} + \frac{1}{40}\right)^{-1}$

$= 23.33k\Omega$

$\therefore \tau = RC = 23.33 \times 1000 \times 3 \times 10^{-6}$

$= 0.0699s$

$$\therefore v(t) = \begin{cases} 6.67V, & t < 0 \\ 20 - 13.33e^{-\frac{t}{0.0699}}, & t > 0 \end{cases}$$