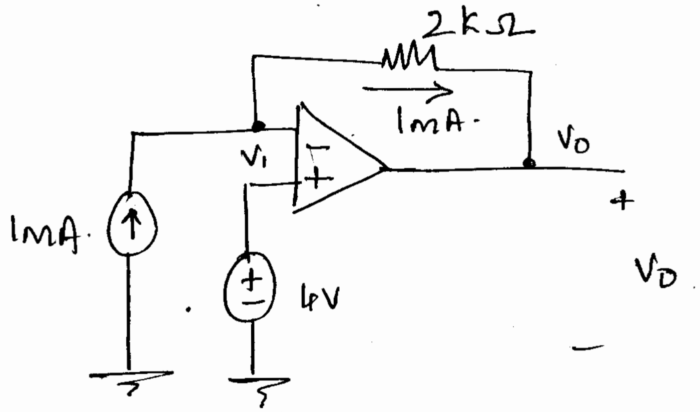
HW.4. ECE 300.

Solutions
Sidd.

(1)



Voltage at $V_1 = 4V$

We know that 1mA is flowing through the 2kΩ resistor in the diretion shown.

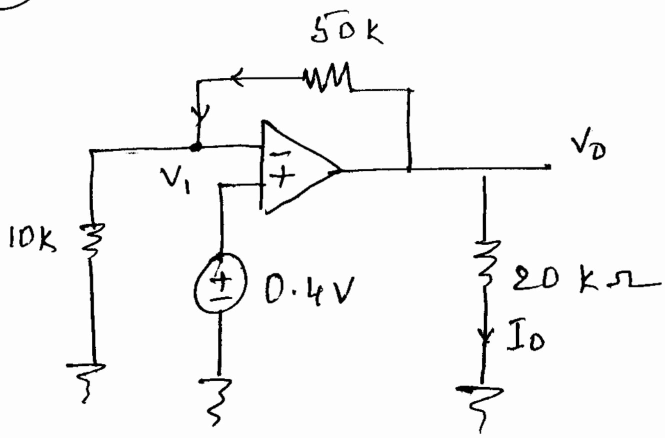
$$\frac{V_1 - V_0}{2k\Omega} = 1mA$$

$$\frac{4 - V_0}{2k\Omega} = 1mA$$

solving we get $V_0 = 2V$.

$$\boxed{V_0 = 2V}$$

(2)



$$\frac{V_0 - V_1}{50K} = \frac{V_1}{10K} \qquad V_1 = 0.4V$$

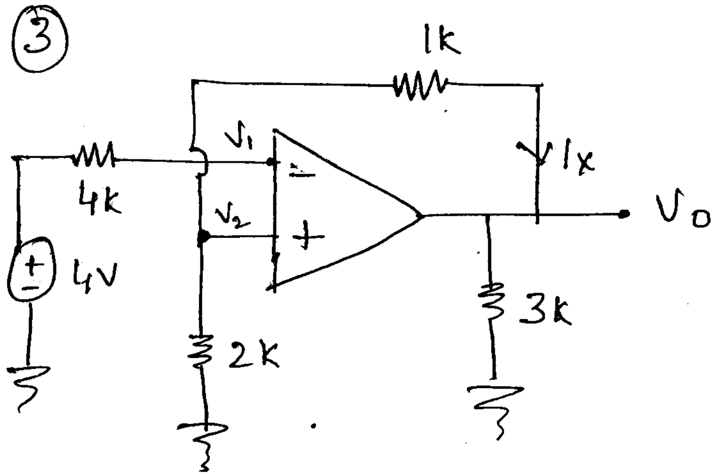
solving we get

$V_0 = 2.4V$

$$I_0 = \frac{2.4}{20K} = 1.2 \times 10^{-4} A.$$

$$\boxed{I_0 = 120\mu A}$$

(3)



$V_1 = 4V$ as no current goes into the inverting terminal

$V_1 = 4V = V_2$

Nodal analysis at V_2

$$\frac{V_2 - V_o}{1k} + \frac{V_2}{2k} = 0 \qquad V_2 = 4V.$$

solving. $\boxed{V_o = 6V}$

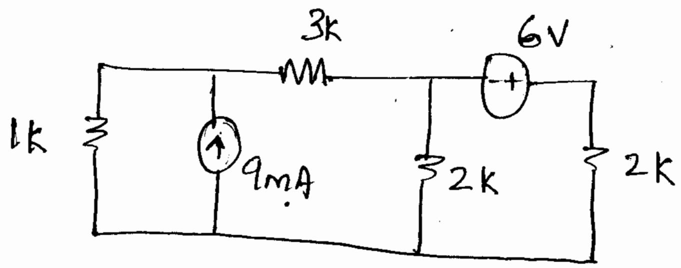
$$-I_x = \frac{V_o - V_2}{1k} = \frac{6-4}{1} = \frac{2}{1k} = 2mA$$

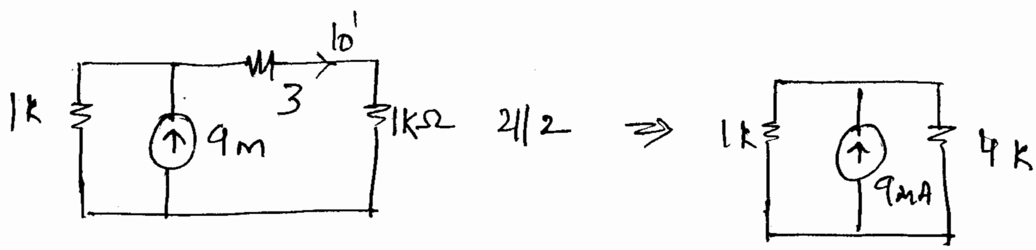
$-I_x = 2mA$

$\boxed{I_x = -2mA}$

4.10

I_0 with current source alone.

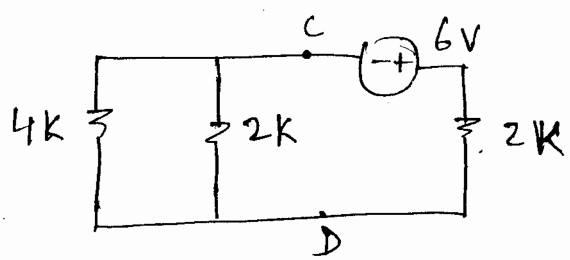




using current division

$$I_{01} = 1.8\,mA.$$

with voltage source alone



$$R_{CD} = (1K + 3K) \parallel 2K = 1.33\,k.$$

$$V_{CD} = -6\left[\frac{R_{CD}}{R_{CD} + 2k}\right] = -2.4\,V$$

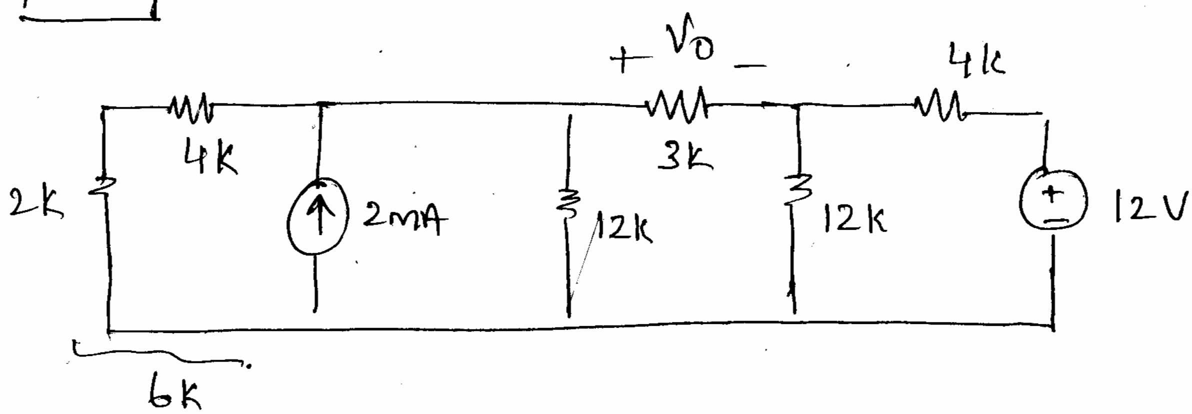
$$I_{0V} = \frac{-V_{CD}}{4K} = 0.6\,mA$$

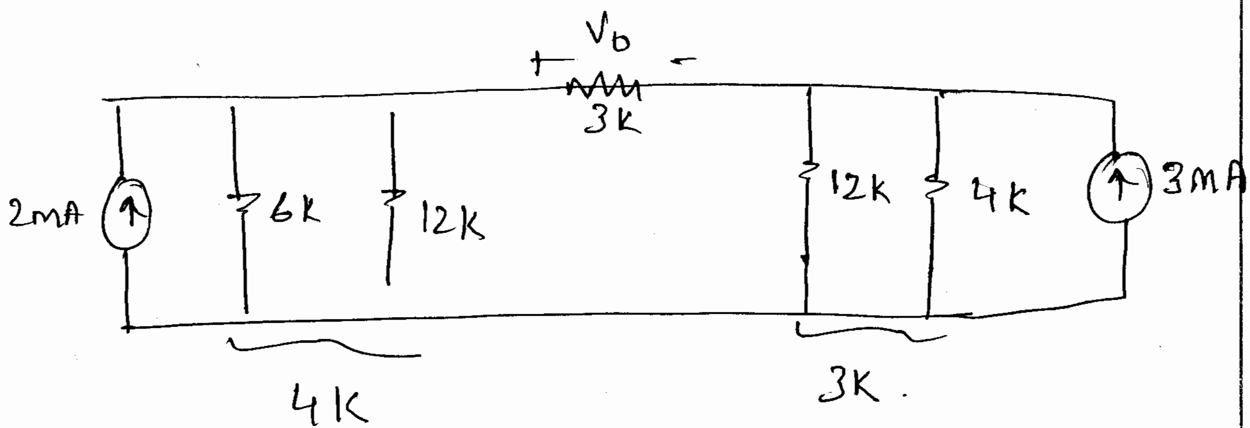
$$I_0 = I_{0i} + I_{0V}$$

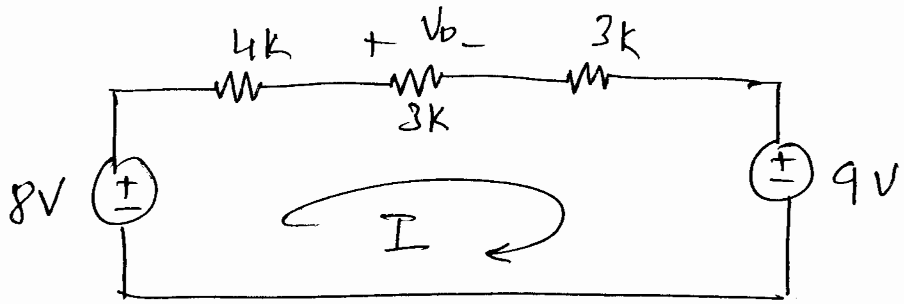
$$= 2.4\,mA$$

$$\boxed{I_0 = 2.4\,mA}$$

4.26







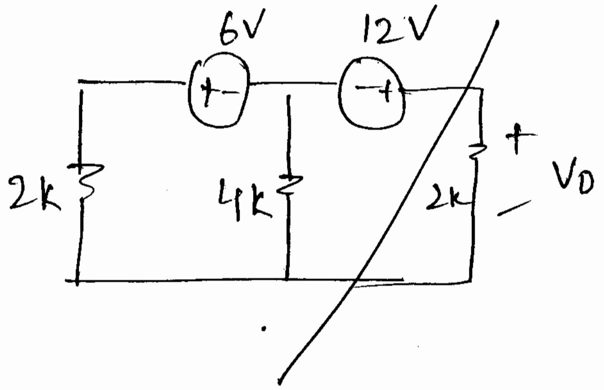
$$-8 + I(4k + 3k + 3k) + 9 = 0$$

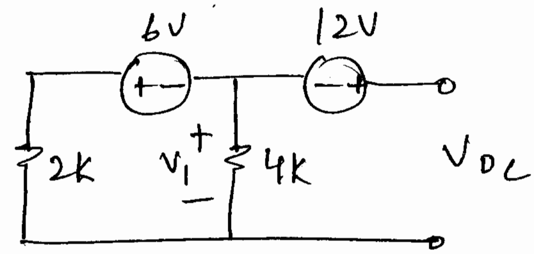
$$I = -0.1\text{mA}.$$

$$V_0 = I(3k) = -0.3\text{V}$$

$$\boxed{V_0 = -0.3\text{V}}$$

No 4.33

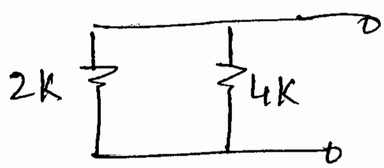




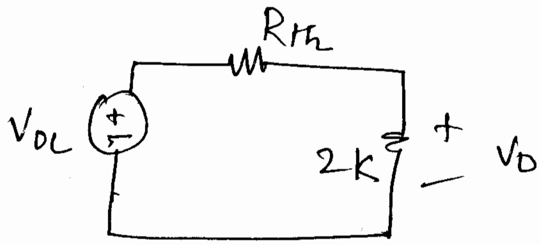
$$V_1 = -6\left[\frac{4k}{4k+2k}\right]$$

$$V_1 = -4V$$

$$V_{OC} = 12 + V_1 = 8V$$



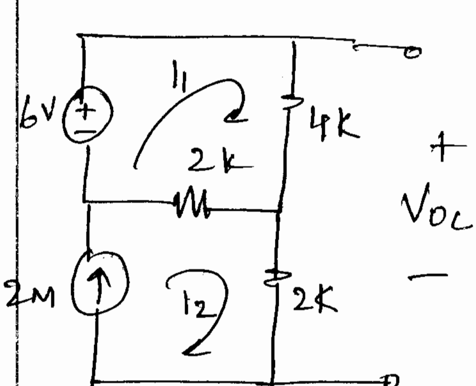
$$R_{th} = 2K // 4k = 1.33 K$$



$$V_O = V_{OC}\left[\frac{2k}{2k+R_{th}}\right]$$

$$\boxed{V_O = 4.8 V}$$

No 4.40



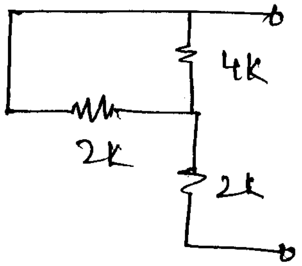
$$I_2 = 2mA.$$

$$-6 + 4kI_1 + 2k(I_1 - 2m) = 0$$

$$I_1 = \frac{10}{6K} = 1.66 mA.$$

$$V_{OC} = 4kI_1 + 2kI_2$$

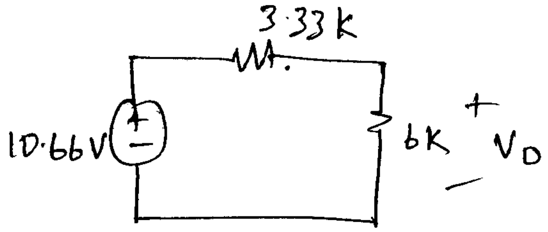
$$= 10.66 V$$



$\leftarrow R_{th} = 2k + (2k \parallel 4k)$

$= \frac{10}{3} k$

$= 3.33k$

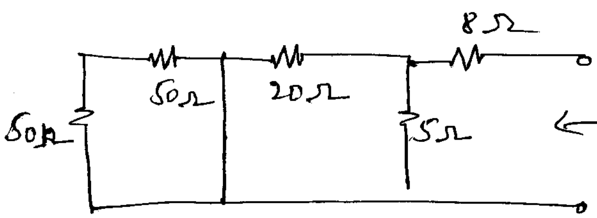


$V_0 = \frac{48}{7} = 6.85\,V$

$\boxed{V_0 = 6.85\,V}$

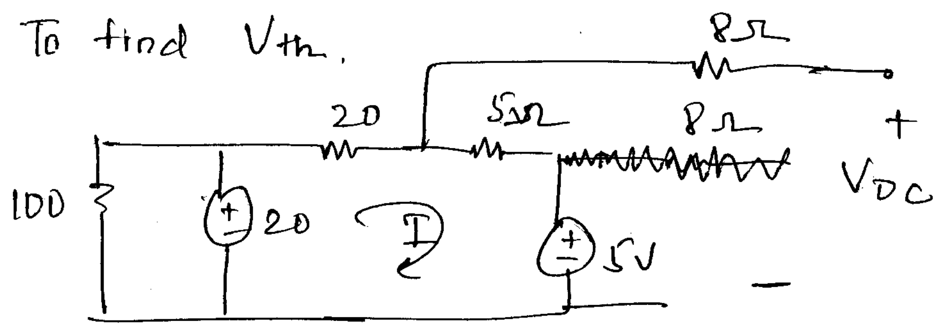
4.xx

To find R_{th}



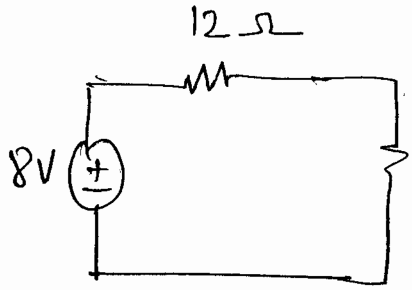
$R_{th} = 20 \parallel 5 + 8 = 12\,\Omega$

To find V_{th}.



$I = \frac{20 - 5}{25\,\Omega} = 0.6\,A.$

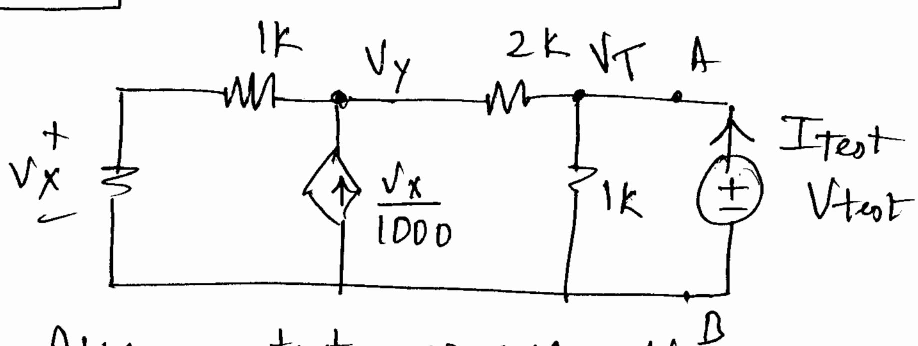
$V_{OC} = 20 - (0.6 \times 20) = 8\,V$



$$I_O = \frac{8V}{24\Omega} = 0.33 A.$$

$V_{th} = 8V$
$R_{th} = 12\Omega$
$I_O = 0.33A$

4.50



Apply a test source V_{test}.

We get $\frac{V_{test}}{I_{test}} = R_{th}$

$$V_x = V_y\left[\frac{1k}{1k+1k}\right] = V_x = V_y/2$$

At V_y: $\frac{V_x}{1K} = \frac{V_y}{2k} + \frac{V_{Test} - V_y}{2k}$

$\Rightarrow V_y = V_{test}$. $V_{test} = 0 = V_y$

At V_T:

$$I_{test} = \frac{V_{test}}{1K} + \frac{V_{test} - V_y}{2K}$$

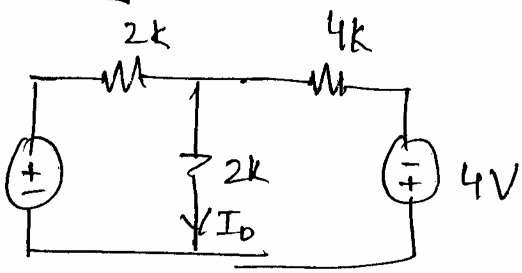
we know $V_y = V_{test}$

$$I_{test} = \frac{V_{test}}{1K}$$

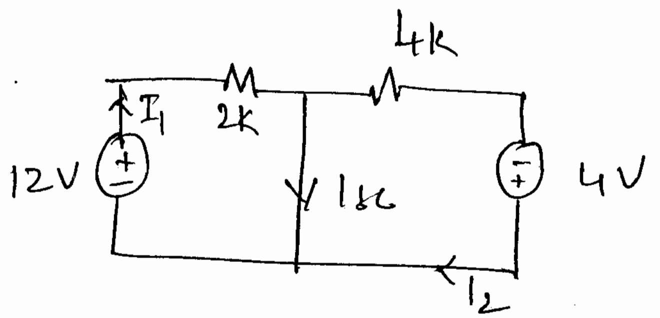
$$\frac{V_{test}}{I_{test}} = 1k = R_{AB}.$$

$$\boxed{V_{th} = 0 \quad R_{th} = 1k}$$

4.62



Finding I_{sc}.

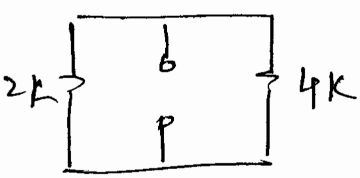


$$I_1 = \frac{12}{2k} = 6mA$$

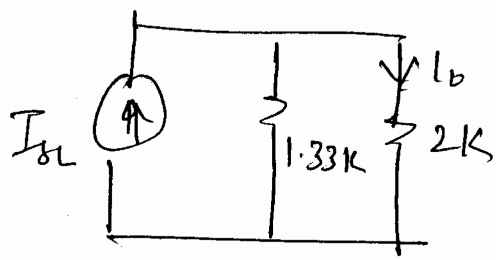
$$I_2 = \frac{4}{4k} = 1mA$$

$$I_{sc} = I_1 - I_2 = 5mA.$$

R_N



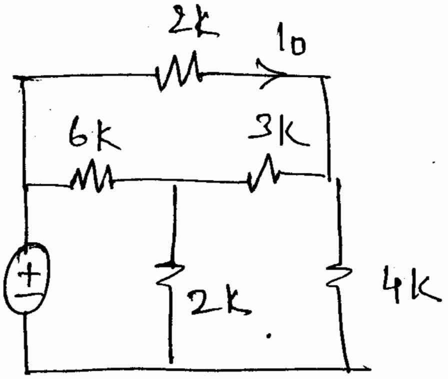
$$R_N = 2k \| 4k$$
$$= 1.33K.$$



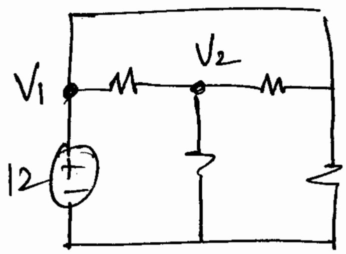
$$I_0 = I_{sc}\left[\frac{R_{eq}}{R_{eq} + 2k}\right]$$

$$\boxed{I_0 = 2mA}$$

4.65



Find Isc



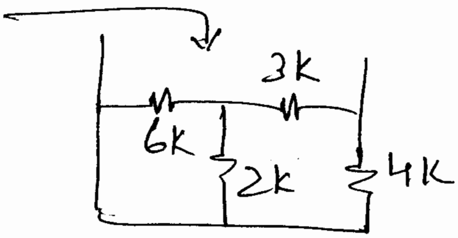
$V_1 = 12V$

$$\frac{V_1 - V_2}{6K} + \frac{V_1 - V_2}{3K} = \frac{V_2}{2K}$$

$$V_2 = 6V$$

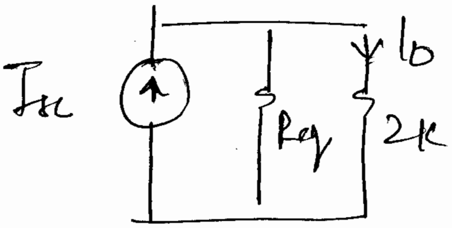
$$I_{sc} = \frac{V_1 - V_2}{3K} + \frac{V_1}{4K} = 5mA.$$

Req



$$R_{eq} = 4K \,||\, \{3K + (2K||6K)\}$$

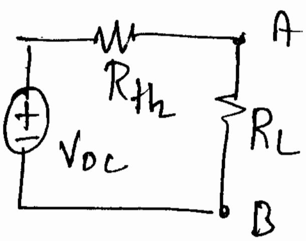
$$= 2.12K.$$



$$I_o = I_{sc}\left[\frac{R_{eq}}{R_{eq} + 2K}\right]$$

$$\boxed{I_o = 2.57mA}$$

4.69



$$V_{AB} = V_{oc}\left[\frac{R_L}{R_L + R_{th}}\right]$$

$$\Rightarrow V_{oc} = V_{AB}\left[1 + \frac{R_{th}}{R_L}\right]$$

If $R_L = 8k$ $V_{AB} = 16V$ $\Rightarrow$ $V_{oc} = 16\left[1 + \frac{R_{th}}{8K}\right]$

$R_L = 2k$ $V_{AB} = 8V$ $\Rightarrow$ $V_{oc} = 8\left[1 + \frac{R_{th}}{2k}\right]$

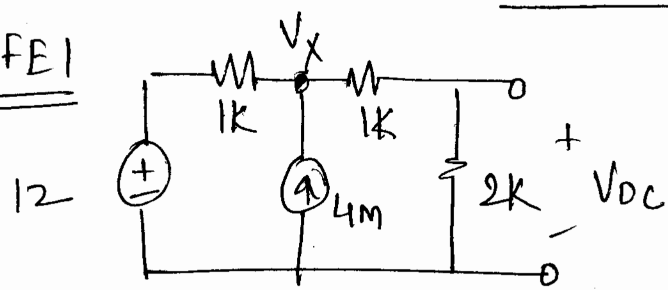
solving the simultaneous. Linear equations

$$R_{th} = 4k\Omega \qquad V_{oc} = 24V$$

If $R_L = 20k\Omega$ $V_{AB} = 24\left(\frac{20}{20+4}\right)$

$$\boxed{V_{AB} = 20V}$$

4FE1

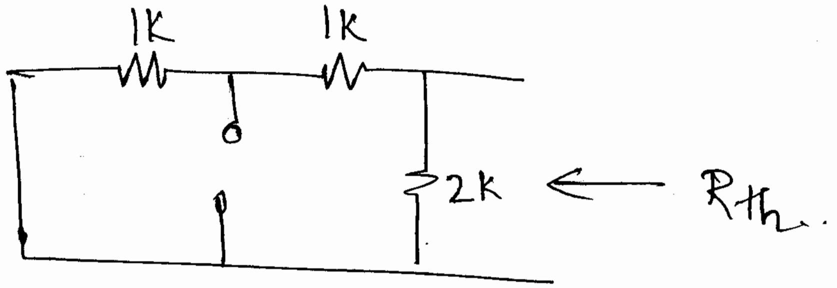


$$\frac{V_x - 12}{1k} + \frac{V_x}{3k} - 4mA = 0$$

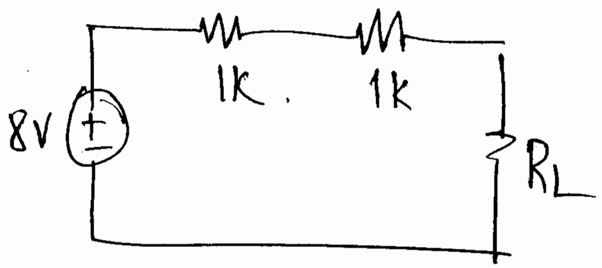
$$V_x = 12V$$

$$V_{oc} = V_x\left(\frac{2k}{2k + 1k}\right)$$

$$V_{oc} = 8V.$$



$R_{th} = 2k \| 2k = 1k\Omega$.



$R_L = 2k$ for max P.T.

$$\left(\frac{8}{4k}\right)^2 (2k) = 8mW$$

$$P_{max} = 8mW$$