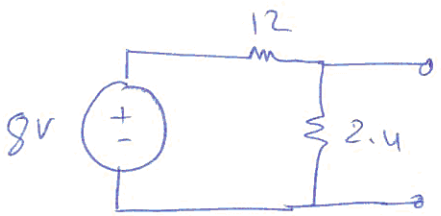
EECE210.
Q1.

21/11/07

Solution

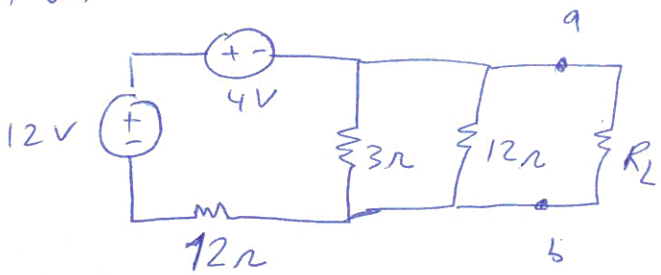
1/

R_{th} - seen from a-b:



$$R_{th} = \frac{12 \times 2.4}{14.4} = 2$$

$$V_{th} = \frac{8 \times 2.4}{14.4} = 1.33$$



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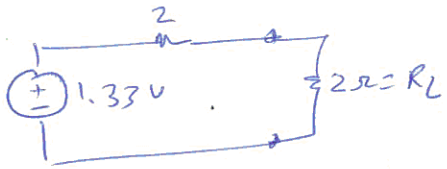
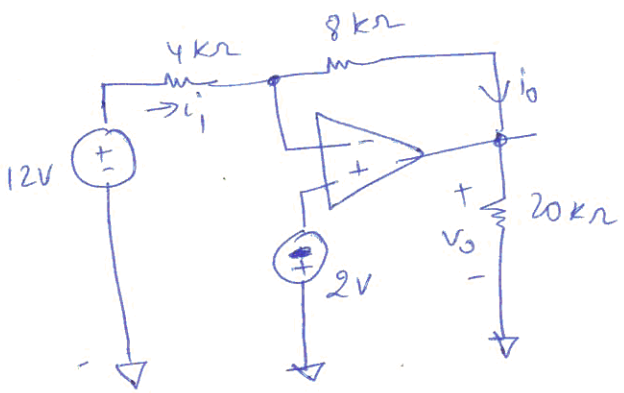


$$I = \frac{1.33}{4} \quad \& \quad P_{max} = \left(\frac{1.33}{4}\right)^2 \cdot 2 = 0.222\ W$$

2/



$V_+ = V_- \rightarrow V_- = -2V$

$$i_1 = \frac{12 - (-2)}{4\,K\Omega} = \frac{14}{4K\Omega}$$

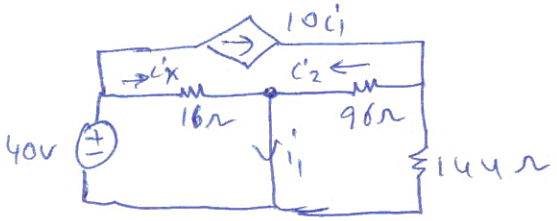
$$i_0 = i_1 = \frac{14}{4K\Omega} = 3.5\,mA$$

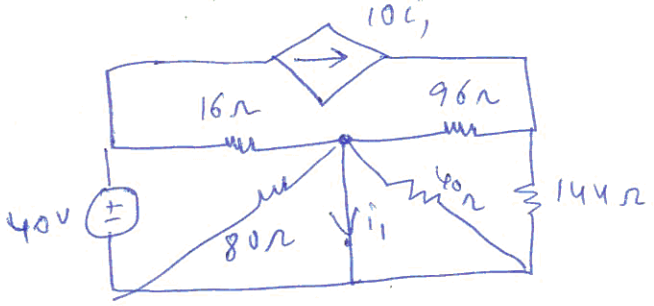
by KVL: $-V_- + 8K\Omega\, i_0 + V_0 = 0$

$$V_0 = V_- - 8K\Omega\, i_0 = -2 - 8000 \times 3.5 \times 10^{-3} = -30\,V$$

3/ $i_1 = ?$

the cirint can be redrawn as





$$i_x = \frac{40}{16} = 2.5 \quad \& \quad i_2 = \frac{10i_1 \times 144}{96 + 144} = 6i_1.$$

1/5

Hence $i_1 = i'_x + i'_2 = 2.5 + 6 i_1$

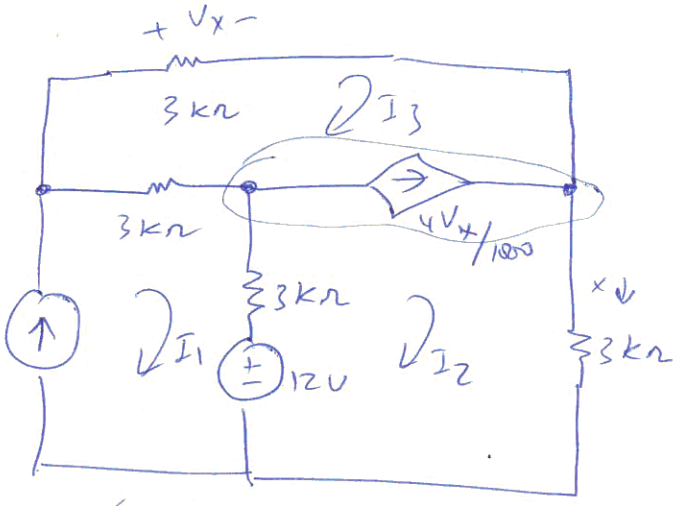
or $5 i_1 = -2.5$ & $i_1 = -0.5\ A$.

4)

$I_1 = 4\ mA$

Super mesh:

$3000 I_2 - 12 + 3000(I_2 - I_1) + 3000(I_3 - I_1) + 3000 I_3 = 0$



$\Rightarrow 3000 I_2 - 12 + 3000 I_2 - 3000 \times 4 \times 10^{-3} + 3000 I_3 - 3000 \times 4 \times 10^{-3} + 3000 I_3 = 0$

also $I_2 - I_3 = 4 \frac{V_x}{1000} = \frac{4 \times 3000 \times I_3}{1000}$

$\Rightarrow I_2 - I_3 = 12 I_3 \rightarrow 13 I_3 = I_2$

or $2 \times 3000 \times 13 I_3 - 12 + 12 + 2 \times 3000 I_3 - 12 = 0$

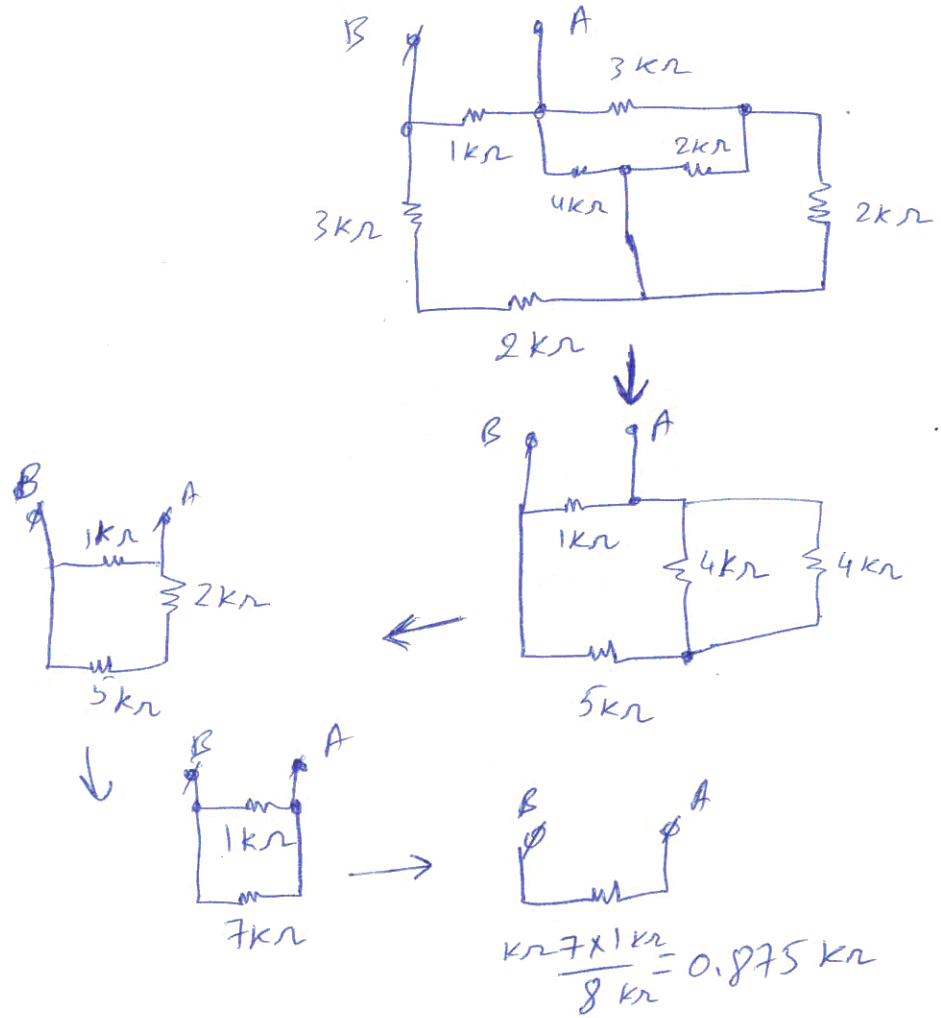
$\rightarrow 14 \times 2 \times 3000 I_3 = 36.$

$I_3 = \frac{36}{14 \times 2 \times 3000} = 0.428$

$\therefore I_2 = 13 I_3 = 13 \times 0.428 = 5.57\ mA.$

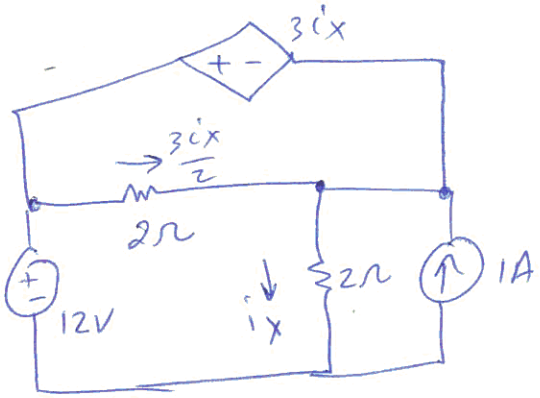
$\therefore I_x = I_2 = 5.57\ mA$

5)



$$\frac{7\text{k}\Omega \times 1\text{k}\Omega}{8\text{k}\Omega} = 0.875\ \text{k}\Omega$$

6/



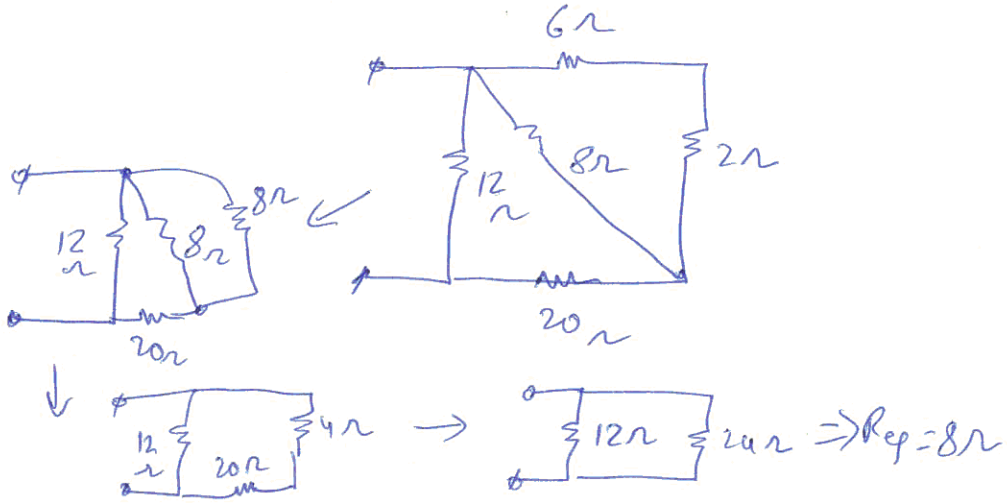
by KVL:

$$-12 + 2\times\frac{3i_x}{2} + 2i_x = 0$$

$$12 = 5i_x$$

$$i_x = \frac{12}{5} = 2.4\ \text{A}.$$

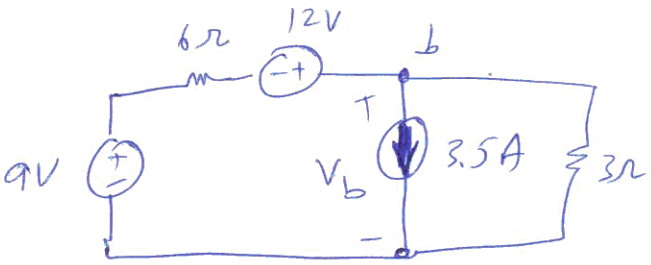
7/



$$\Rightarrow R_{eq} = 8\Omega$$

8/

By N.V.M:

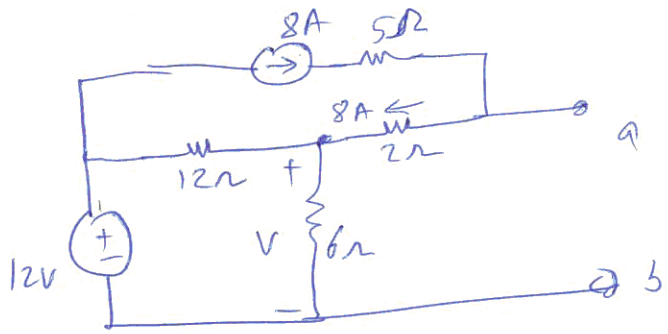


$$\frac{V_b}{3} + 3.5 + \frac{V_b - 21}{6} = 0$$

$$V_b\left(\frac{1}{3} + \frac{1}{6}\right) = \frac{21}{6} - 3.5 = 0$$

$$\Rightarrow V_b = 0$$

9/ $V_{ab} = ?$



$$-V_{ab} + 8\times 2 + V = 0$$

$$\boxed{V_{ab} = V + 16}$$

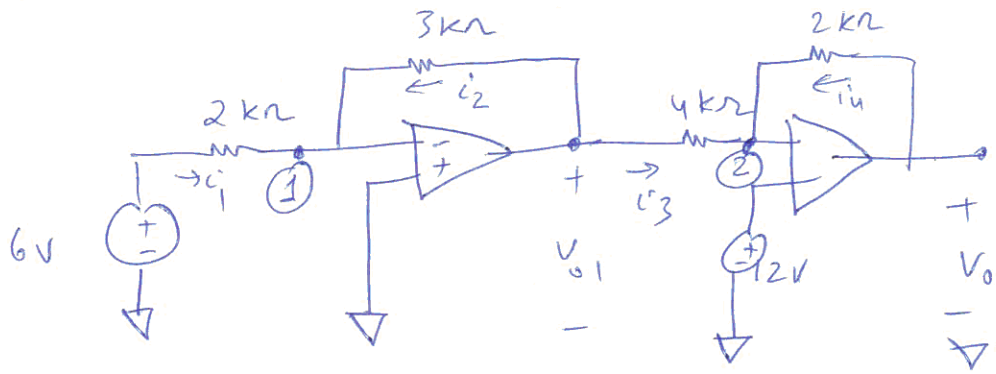
by N.V.M:

$$\frac{V}{6} - 8 + \frac{V-12}{12} = 0 \rightarrow V\left(\frac{1}{6} + \frac{1}{12}\right) = 9$$

$$V = 36$$

$$\Rightarrow V_{ab} = 36 + 16 = 52\,V.$$

10/ $V_o = ?$



$$V_1 = 0 \rightarrow i_1 = \frac{6}{2k\Omega} = 3\,mA$$

$$i_2 = -i_1 = -3\,mA \quad \& \quad KVL: -V_{o1} + 3k\Omega \times (-3\,mA) + 0 = 0$$

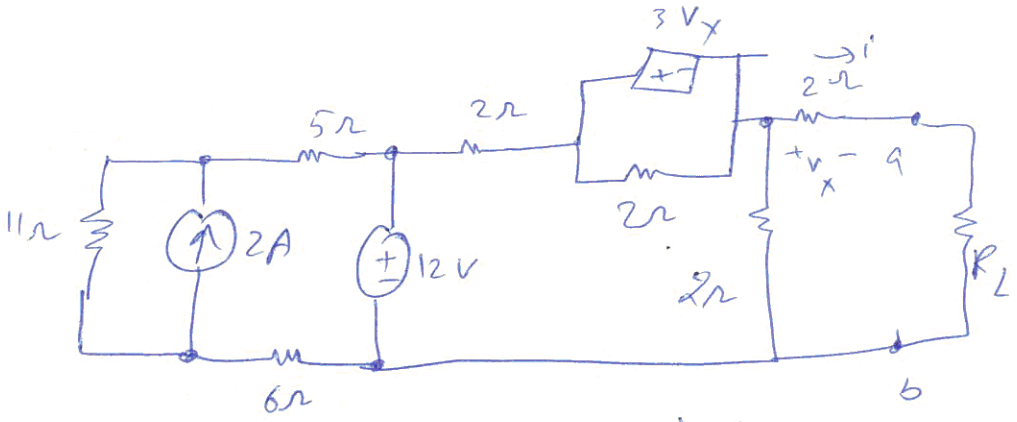
$$\Rightarrow V_{o1} = -9\,V.$$

$$V_2 = 12V \Rightarrow i_3 = \frac{V_{o1} - 12}{4k\Omega} = \frac{-9-12}{4k\Omega} = -\frac{21}{4}\,mA.$$

$$i_4 = -i_3 = +\frac{21}{4}\,mA \quad \& \quad KVL: -V_o + 2k\Omega \times \frac{21}{4}\,mA + 12 = 0$$

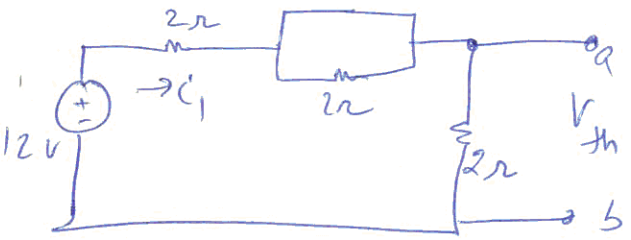
Hence: $V_o = \frac{21}{2} + 12 = 22.5\,V$

11).



$V_{th} = ?$ assume open circuit at a-b $\rightarrow i = 0 \rightarrow V_x = 0$

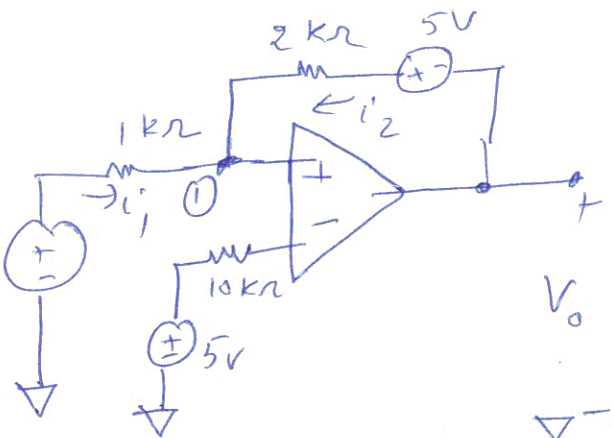
if $V_x = 0 \rightarrow$



$i_1 = \frac{12}{4} = 3$

& $V_{th} = 2 \times 3 = 6\,V$

12). $V_o = ?$



$V_+ = V_- = V_1 = 5\,V.$

$i_1 = \frac{10 - 5}{1\,k\Omega} = 5\,mA$

$i_2 = -i_1 = -5\,mA$

by KVL: $-V_o - 5V + 2k\Omega \times (-5\,mA) + 5V = 0$

$V_o = 2 \times -5 = -10\,V.$