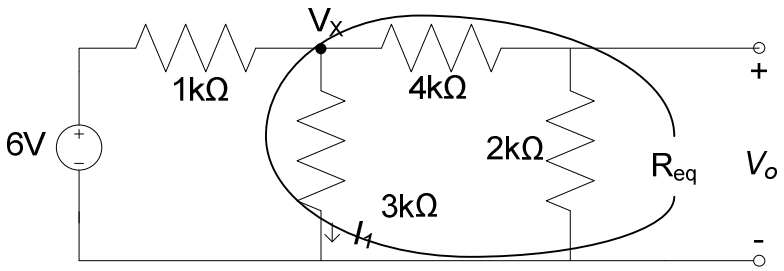
Solution Set 4 (Fall 2008)

4.1



R_{eq} = 3k // (4k+2K)
= 3k // 6k
$= \frac{3*6}{3+6} = 2k\Omega$

Voltage divider:

$V_x = 6v \cdot \frac{Req}{Req+1K} = 6v \cdot \frac{2}{2+1}$

$\underline{\underline{V_x = 4v}}$

Voltage divider:

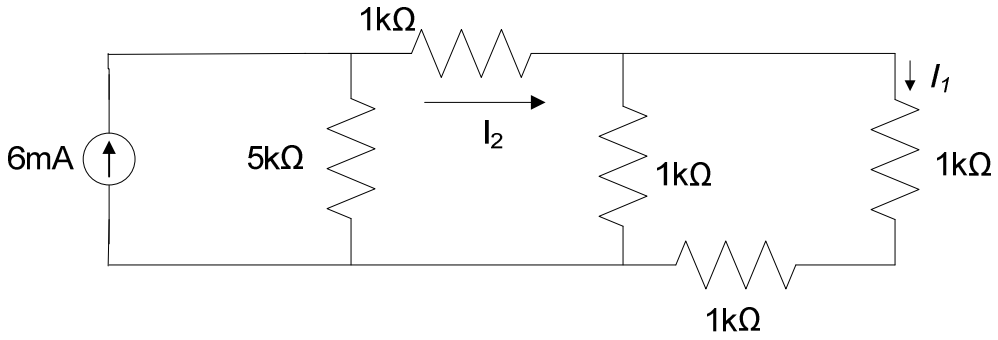
$Vo = V_x \cdot \frac{4}{4+8} = 4 \cdot \frac{2}{3}$

$Vo = \frac{8}{3} v$

$I_1 = \frac{Vx}{3k\Omega} = \frac{4}{3} mA = 1.33mA$

*Note: V_o is not a voltage division directly of 6v as the current through the 1kΩ resistor is different than through 4kΩ & 2kΩ resistor.

4.2



Current divider:

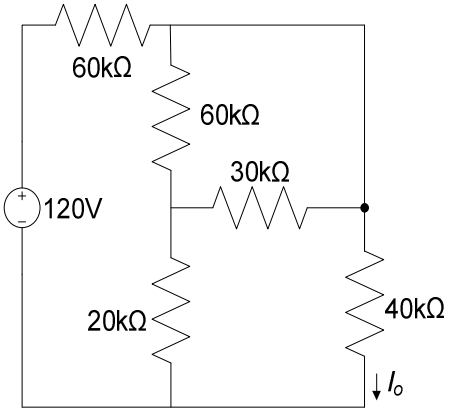
$$I_2 = 6\text{mA} \cdot \frac{5\text{k}\Omega}{5\text{k}\Omega + (1\text{k}\Omega + 2\text{k} \,//\, 1\text{k})} = 3\text{mA} \cdot \frac{3}{2}$$

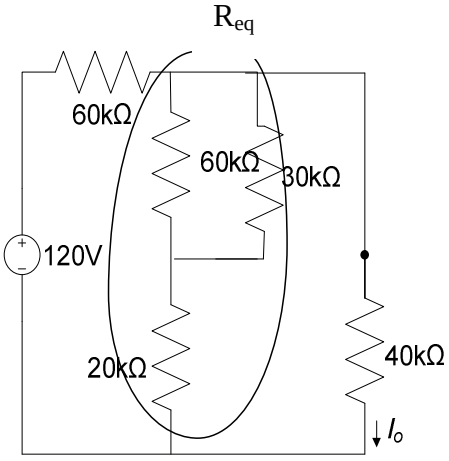
$$= \frac{9}{2}\text{mA}$$

$$I_1 = I_2 \cdot \frac{1\text{k}}{1\text{k} + 2\text{k}} = \frac{9}{2} \cdot \frac{1}{3}\ \text{mA}$$

$$\Rightarrow I_1 = \frac{3}{2}\text{mA}$$

4.3





Voltage Divider:

R_{eq}= (60k//30k+20k)//40k

$V_x = 120V * \frac{R_{eq}}{R_{eq} + 60k\Omega}$ = 40k//40k

$= 120V * \frac{20k\Omega}{20k\Omega + 60k\Omega}$ $\Rightarrow R_{eq} = 20k\Omega$

$\Rightarrow V_x = \underline{\underline{30V}}$

$I_0 = \frac{V_x}{40k\Omega} = \frac{30V}{40k\Omega}$

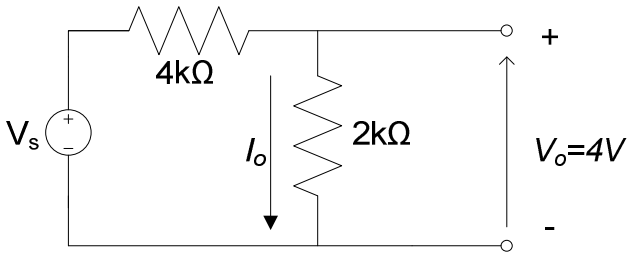
$\Rightarrow I_0 = \underline{\underline{0.75mA}}$

OR

$I_T = \frac{120V}{R_{eq} + 60k\Omega} = \frac{120V}{20k\Omega + 60k\Omega} = 1.5mA$

$I_0 = I_T * \frac{60k // 30k + 20k}{60k // 30k + 20k + 40k} = I_T * \frac{1}{2} = \underline{\underline{0.75mA}}$

4.4



Voltage Divider: OR $I_0 = \frac{V_0}{2k\Omega} = 2mA$ [Ohm's Law]

$$V_0 = V_s * \frac{2k\Omega}{2k\Omega + 4k\Omega}$$

$$\Rightarrow V_s = V_0 * \frac{6k\Omega}{2k\Omega}$$

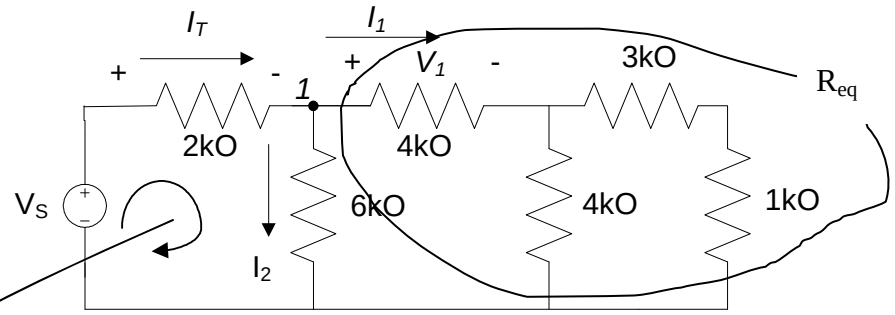
$$= 4V*3$$

$\Rightarrow V_s = \underline{\underline{12V}}$

$V_s = I_0\ (4k+2k) = 2mA*6k\Omega$

$\Rightarrow V_s = \underline{\underline{12V}}$

4.5



(N.B. The "O"s in the above diagram are actually Ωs, for some reason Word will no longer show them correctly in two of this solution set's visio diagrams.)

V_1=12V

$$I_1 = \frac{12V}{4k} = 3mA$$

R_{eq}=4k+ (4k//4k)=6k

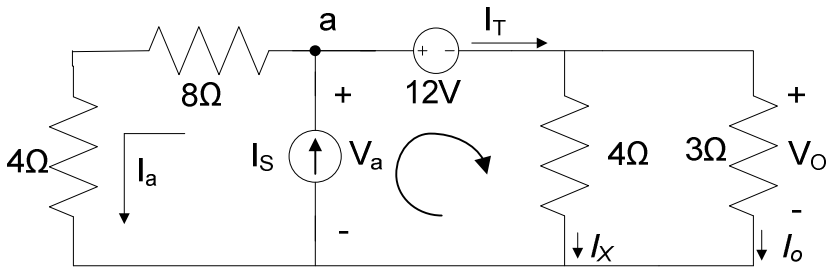
$$I_1 = \frac{6k}{6k + R_{eq}} \bullet I_T = \frac{1}{2} I_T$$

I_T=6mA

KCL @ node 1: I_T-I_1-I_2=0
I_2=I_T-I_1=3mA

KVL: -V_S+2k•I_T+6k•I_2 = 0
V_S = 2k(6mA) + 6k(3mA) = <u>30 V</u>

4.6



I_o =2A
So V_O=2A·3Ω=6V

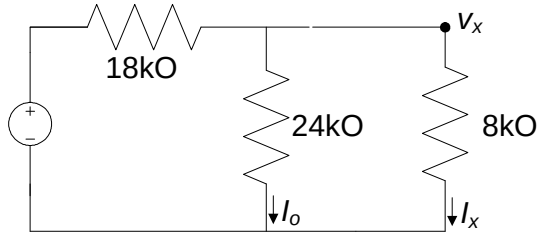
$$I_X = \frac{6V}{4\Omega} = 1.5A$$

$I_T=I_O+I_X$=3.5A
KVL: $-V_a+12V+I_O\cdot 3\,\Omega=0$
V_a=12V+6V=18V

$$I_a = \frac{V_a}{12} = 1.5A$$

KCL @ a : $-I_a+I_S-I_T=0$
$I_S=I_a+I_T$=1.5A+3.5A=5A

4.7



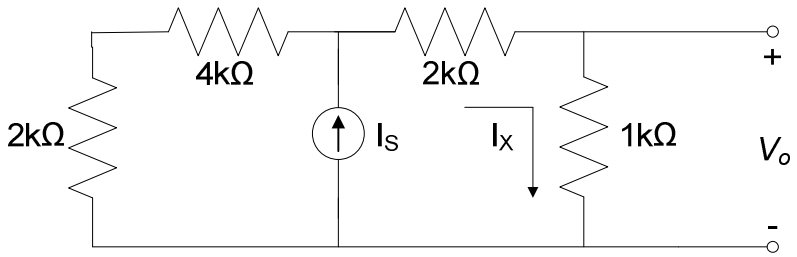
(Change 4kΩ in problem statement to 8kΩ)
$P_{8k}=I_X\cdot V_X$=36mW
But: $I_X = \frac{V_X}{8k}$

$$P_{8k} = \frac{V_X^2}{8k} \text{ or } P_{8k} = I_X^2 \cdot 8k$$

$$I_X = \sqrt{\frac{36mW}{8k}} = \frac{6}{\sqrt{8}}mA,\ V_X = \frac{6}{\sqrt{8}}mA\cdot 8\text{k}\,\Omega \cong 17V$$

So $I_O = \frac{V_X}{24k} \cong \frac{17V}{24k\Omega} = 0.707mA$

4.8

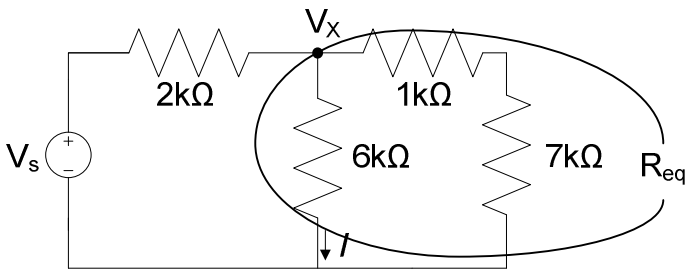


$$I_X = \frac{V_O}{1k} = \frac{6V}{1k} = 6mA$$

$$I_X = \frac{(4k+2k)}{(4k+2k)+(2k+1k)}\cdot I_S = 6mA$$

$$I_S = \frac{9}{6} \cdot 6mA = 9mA$$

4.9 If I =4mA in the circuit below, find V_S.



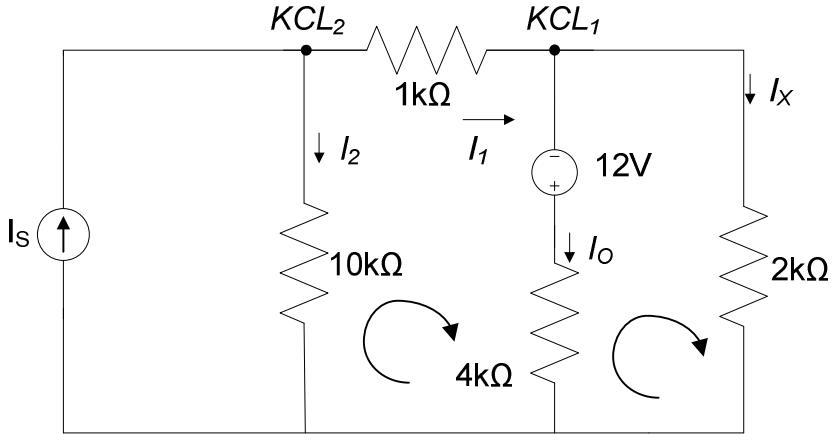
V_X=I·6k=4mA·6kΩ=24V

$$V_X = V_S \cdot \frac{R_{eq}}{R_{eq} + 2k}$$

R_{eq}=(1k+7k)//6k=3.43k Ω

$$V_S = 24V \cdot \frac{(3.43+2)}{3.43} = 38V$$

4.10



I_o =4mA

KVL: 12V- I_O·4k + I_X·2k = 0

V_X = I_X·2k = I_O·4k-12V

=4mA·4k-12V=4V

$$I_X = \frac{4V}{2k} = 2mA$$

KCL: I_1- I_O - I_X = 0 ➔ I_1= 2mA+4mA=6mA

KVL: -I_2·10k + I_1·1k + I_O·4k-12V=0

I_2·10k=6V+16V-12V=10V

I_2=1mA

KCL: I_S-I_2-I_1 ➔ I_S=1mA+6mA=7mA