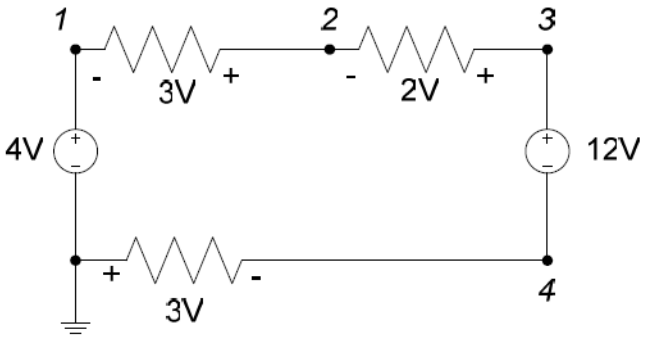
Solution Set 3 (Fall 2010)

3.1 Find V_{14} in the network below:



Solution:

$V_{14} = V_{12} + V_{23} + V_{34}$;

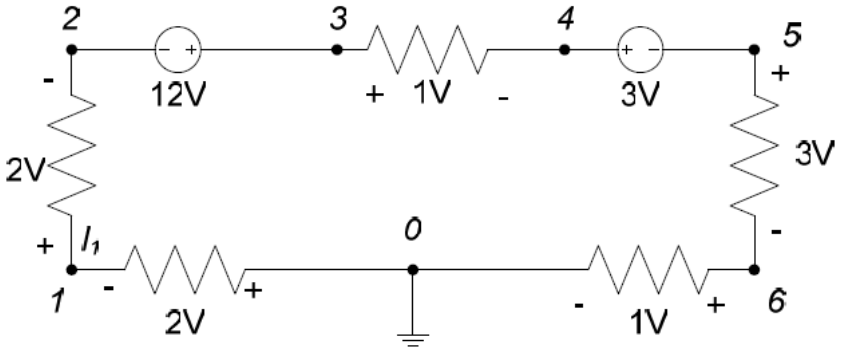
$V_{14} = (-3)V + (-2)V + (+12)V = 7V$;

or

$V_{14} = V_{10} + V_{04}$;

$V_{14} = (+4)V + (+3)V = 7V$;

3.2 Find V_{20} and V_{64} in the network below:



Solution:

$V_{20} = V_{21} + V_{10} = (-2)V + (-2)V = -4V$

$V_{64} = V_{65} + V_{54} = (-3)V + (-3)V = -6V$;

3.3 Repeat 2.12 and find the power in each:

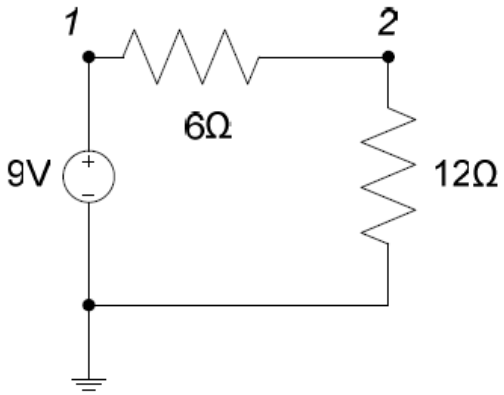
i) $6\,\Omega$ resistor;

ii) $12\,\Omega$ resistor;

iii) 9 volt source

a) when the source is +9V DC

b) when the source is $+9\sqrt{2}$ sin 100t



Solution:

(a) $Vs = 9V$, DC source

$$I = \frac{Vs}{6\Omega + 12\Omega} = \frac{9V}{18\Omega} = 0.5A;$$

Power absorbed by $12\,\Omega$ resistor: $P = I^2 R_{12\Omega} = 0.5^2\,A \cdot 12\Omega = 3W$;

Power absorbed by $6\,\Omega$ resistor: $P = I^2 R_{6\Omega} = 0.5^2\,A \cdot 6\Omega = 1.5W$;

Voltage source: $P = Vs \cdot (-I) = 9V \cdot (-0.5A) = -4.5W$

(Negative sign indicates supplied pover)

(b) $Vs = 9\sqrt{2}\sin(100t)$, AC source

$V_{peak} = 9\sqrt{2}V$;

$$V_{rms} = \frac{V_{peak}}{\sqrt{2}} = 9V;$$

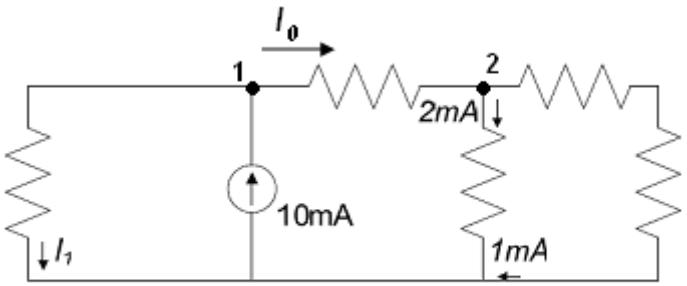
$$I_{rms} = \frac{V_{rms}}{6\Omega + 12\Omega} = \frac{9V}{18\Omega} = 0.5A$$

Power absorbed by $12\,\Omega$ resistor: $P = {I_{rms}}^2 R_{12\Omega} = 0.5A^2 \cdot 12\Omega = 3W$;

Power absorbed by $6\,\Omega$ resistor: $P = {I_{rms}}^2 R_{6\Omega} = 0.5A^2 \cdot 6\Omega = 1.5W$;

Voltage source: $P = Vs_{rms} \cdot (-I_{rms}) = 9V \cdot (-0.5A) = -4.5W$;

3.4 Find I_1 in the network below:



Solution:

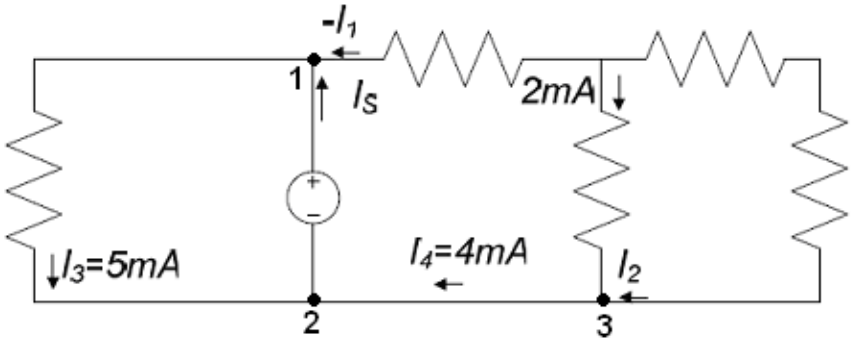
Let's apply KCL at the node 2:

$I_0 - 2mA - 1mA = 0 \longrightarrow I_0 = 3mA;$

Let's apply KCL at the node 1:

$10\text{mA} - I_1 - I_0 = 0 \longrightarrow I_1 = 7mA;$

3.5 Find I_1 and I_2 in the network below:



Solution:

Let's apply KCL at the node 2:

$5mA + 4mA - I_s = 0 \longrightarrow I_s = 9mA;$

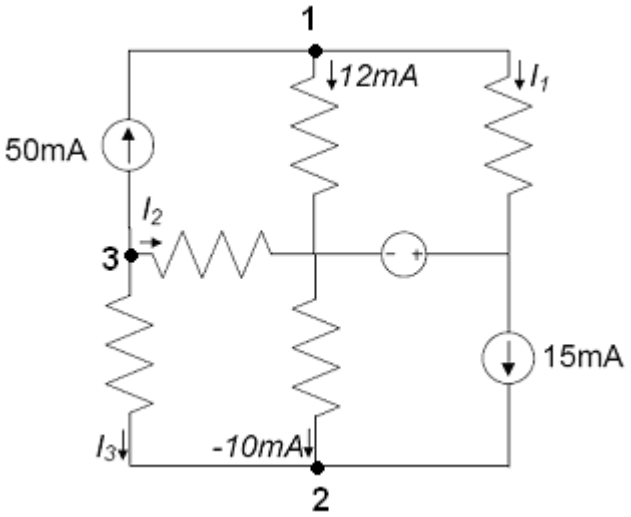
Let's apply KCL at the node 1:

$I_s - I_1 - 5mA = 0 \longrightarrow I_1 = 4mA;$

Let's apply KCL at the node 3:

$I_2 + 2mA - 4mA = 0 \longrightarrow I_2 = 2mA;$

3.6 Find I_1, I_2 and I_3 in the network below:



Solution:

Let's apply KCL at the node 1:

$50mA - 12mA - I_1 = 0 \longrightarrow I_1 = 38mA;$

Let's apply KCL at the node 2:

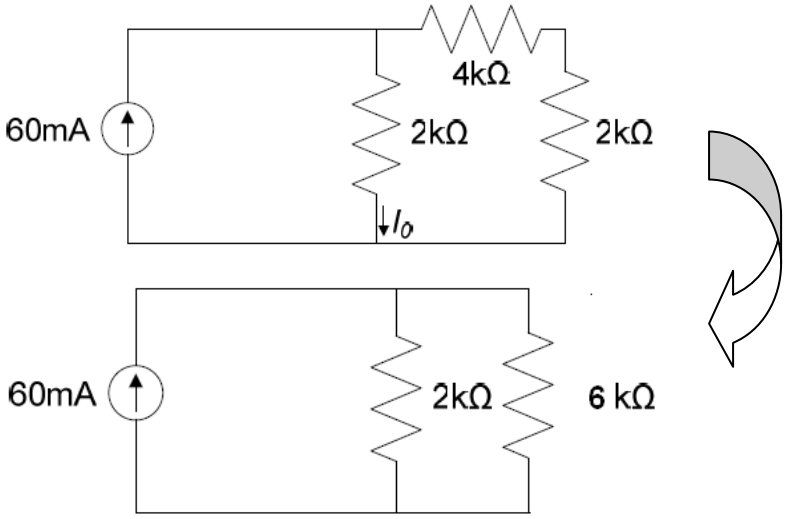
$15mA - 10mA + I_3 = 0 \longrightarrow I_3 = -5mA;$

KCL@3:

$-50mA - I_3 - I_2 = 0 \longrightarrow I_2 = -45mA;$

3.7 Find I_0 in the network below:

Solution:

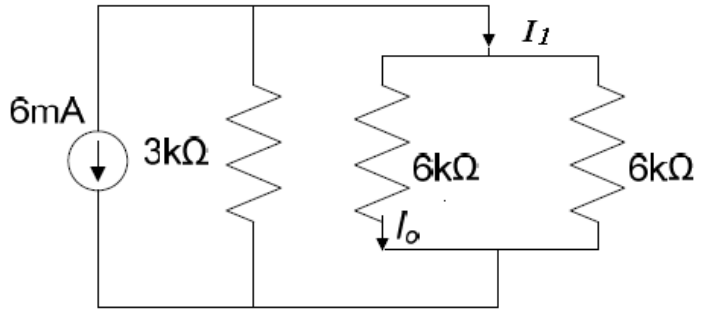


Using current division: $I_0 = 60mA\frac{6\Omega}{6\Omega + 2\Omega} = 45mA;$

3.8 Find I_0 in the network below:

Solution:

The network can be redrawn as:



Where I_1 can be found with help of current division rule:

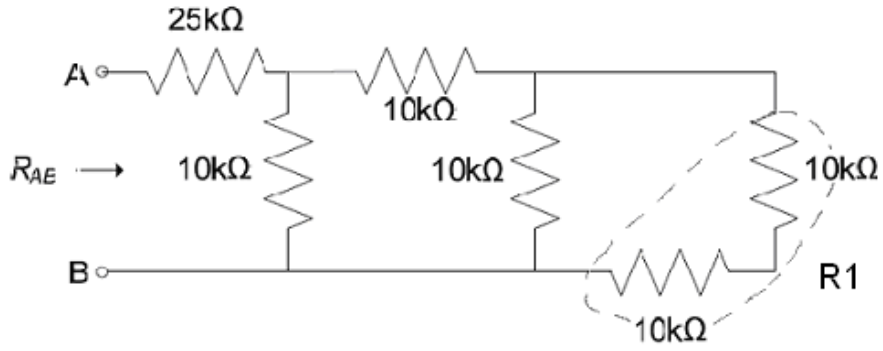
$$I_1 = -6mA * \frac{3k\Omega}{3k\Omega + (6k\Omega \parallel k\Omega)} = -3mA;$$

Applying the same rule I_0 can be found:

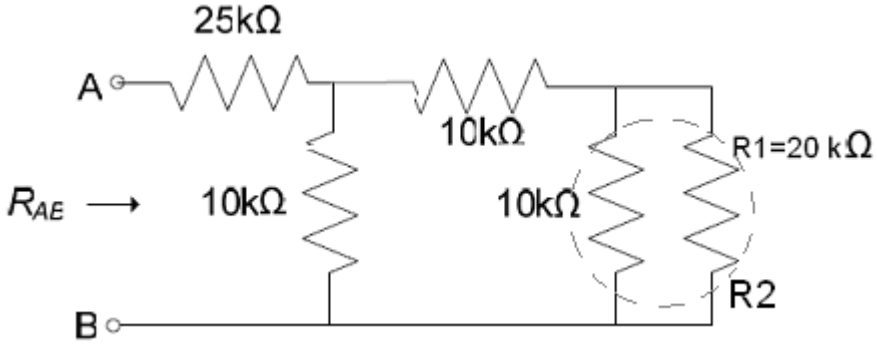
$$I_0 = -3mA * \frac{6k\Omega}{6k\Omega + 6k\Omega} = -1.5mA;$$

3.9 Find R_{AB} in the network below:

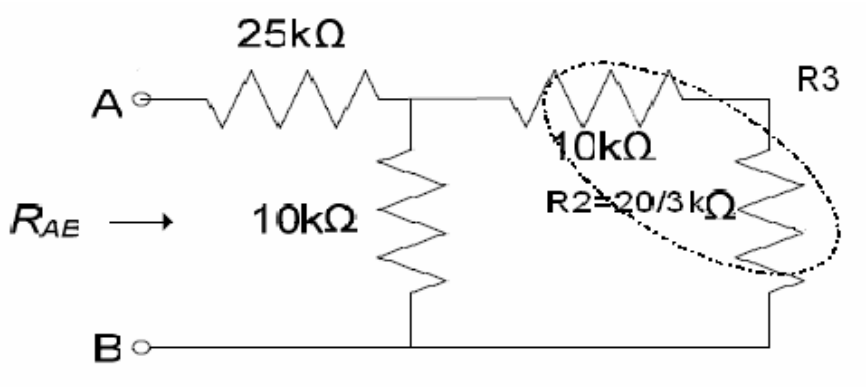
Solution:



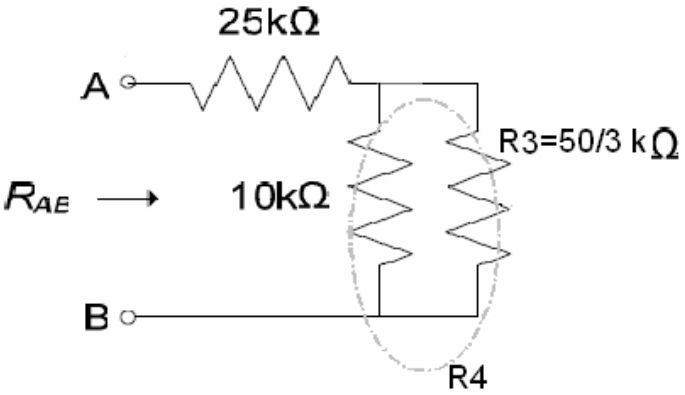
$R1 = 10k\Omega + 10k\Omega = 20k\Omega;$



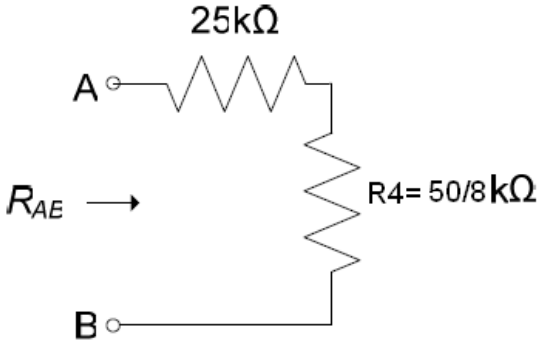
$R2 = R1 \parallel 10k\Omega = 20k\Omega \cdot 10k\Omega / (20k\Omega + 10k\Omega) = 20/3k\Omega;$



$$R3 = R2 + 10k\Omega = 20/3k\Omega + 10k\Omega = 50/3k\Omega;$$

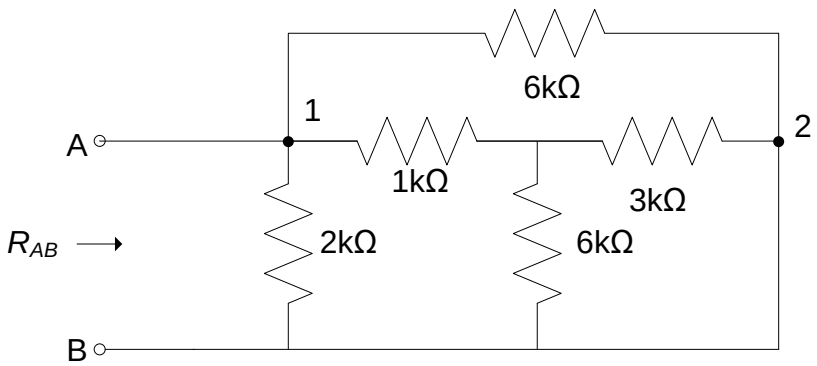


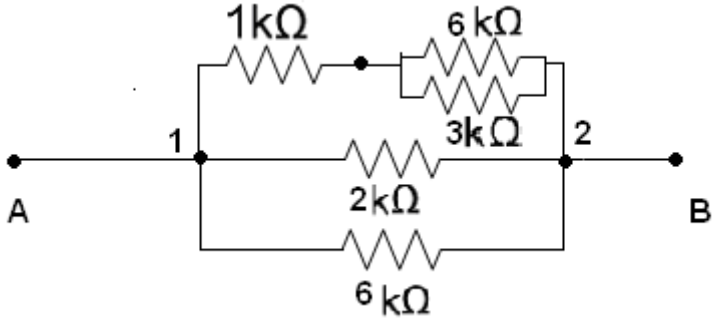
$$R4 = 10k\Omega \| 50/3k\Omega = \frac{10k\Omega * 50k\Omega}{3(10k\Omega + 50/3k\Omega)} = 50/8k\Omega;$$



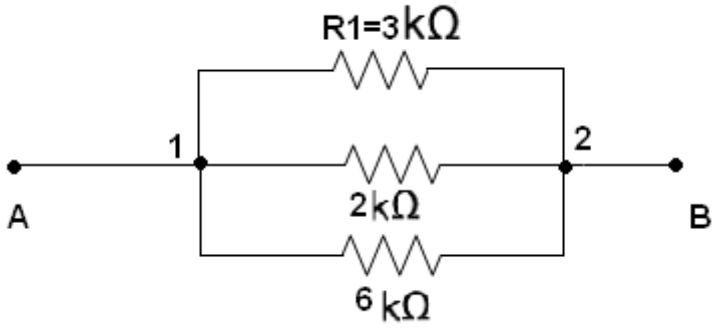
$$R_{AB} = 25k\Omega + 50/8k\Omega = 125/4k\Omega$$

3.10 Find R_{AB} in the network below:
Solution:

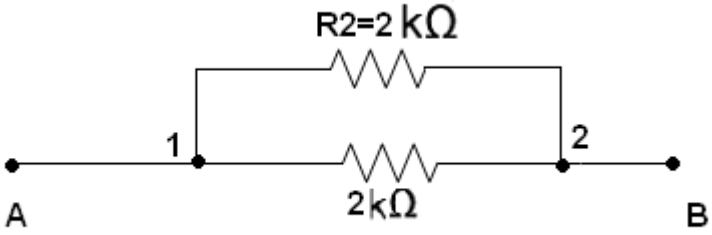




$$R1 = 1k\Omega + 6k\Omega \| 3k\Omega = 1k\Omega + \frac{6k\Omega * 3k\Omega}{6k\Omega + 3k\Omega} = 3k\Omega;$$

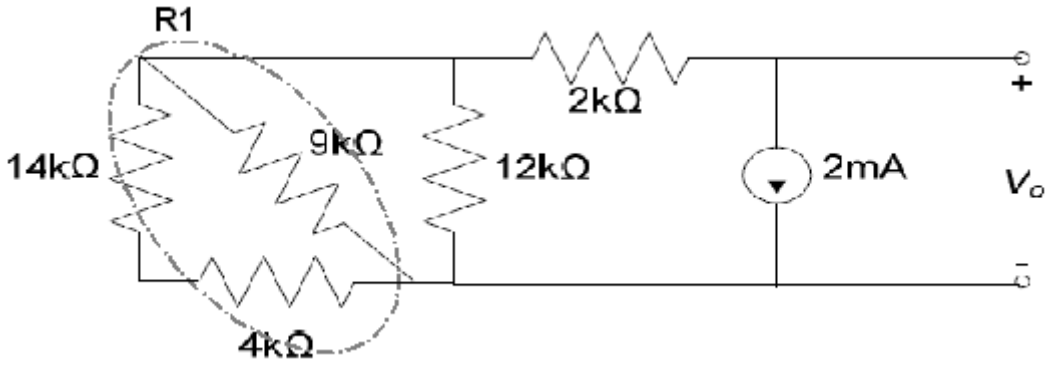


$$\text{R2} = R1 \| 6k\Omega = \frac{3k\Omega * 6k\Omega}{3k\Omega + 6k\Omega} = 2k\Omega;$$



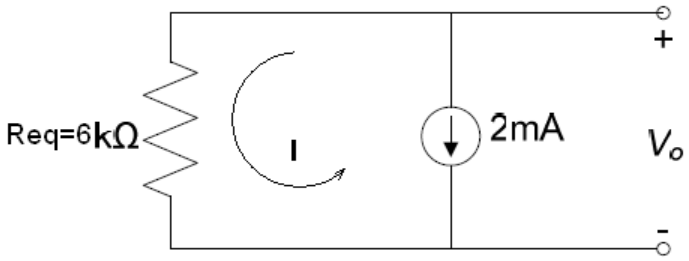
$$R_{AB} = 2k\Omega \| 2k\Omega = \frac{2k\Omega + 2k\Omega}{2k\Omega * k\Omega} = 1k\Omega$$

3.11 Find V_0 in the network below:
Solution:
$V_0 = I * \text{Re}\, q;$



$$R1 = 9k\Omega \,\|\, (14k\Omega + 4k\Omega) = 9k\Omega \,\|\, 18k\Omega = \frac{9k\Omega * 18k\Omega}{9k\Omega + 18k\Omega} = 6k\Omega;$$

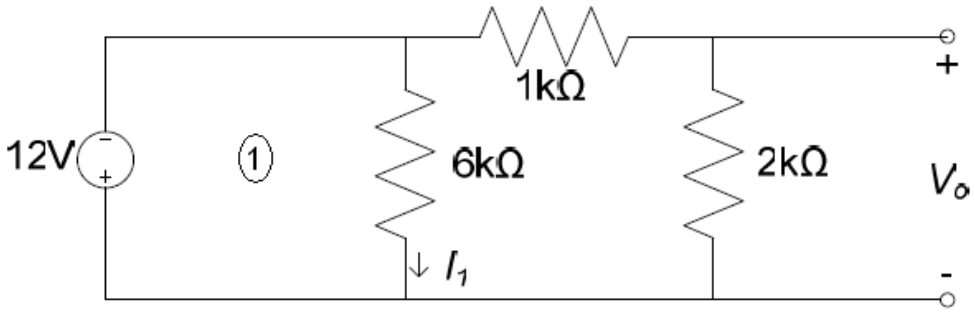
$$\mathrm{Re}\, q = 2k\Omega + R1 \,\|\, 12k\Omega = 2k\Omega + \frac{6k\Omega * 12k\Omega}{6k\Omega + 12k\Omega} = 6k\Omega;$$



I=-2mA;

$V_0 = I * \mathrm{Re}\, q = -2mA * 6k\Omega = -12V;$

3.12 Find I_1 and V_0 in the following network:
Solution:



Ohm's law in the loop 1:

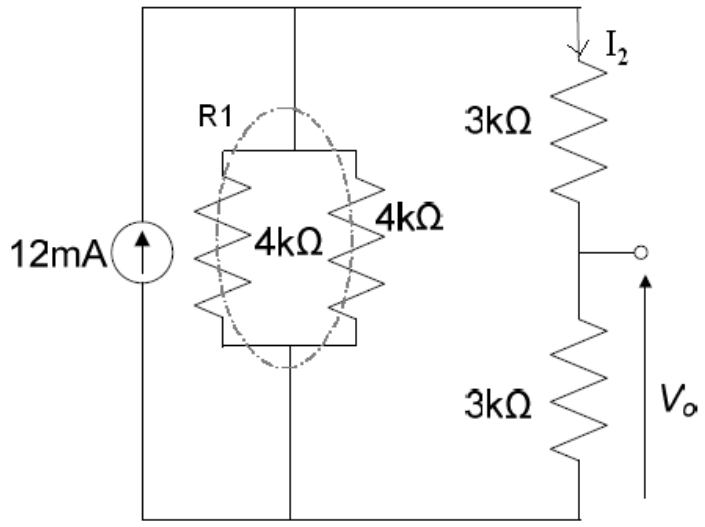
$I_1 * 6k\Omega + 12V = 0 \longrightarrow I_1 = -2mA;$

Using voltage division:

$$V_0 = -12\frac{2k\Omega}{2k\Omega + 1k\Omega} = -8V\ ;$$

Negative sign is due to the fact that source and *Vo* have opposite sign.

3.13 Find V_0 in the following network:
Solution:



$R1 = 4k\Omega \parallel 4k\Omega = 2k\Omega;$

Using current division: $I_2 = 12mA\dfrac{2k\Omega}{2k\Omega + (3k\Omega + 3k\Omega)} = 3mA;$

$V_0 = I_2 * 3k\Omega = 9V$