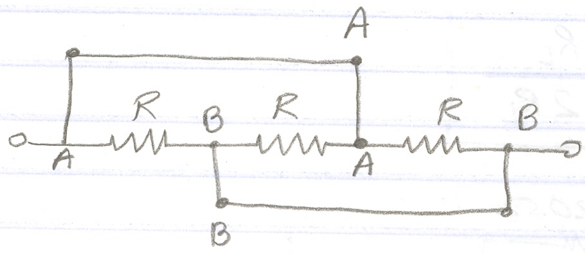
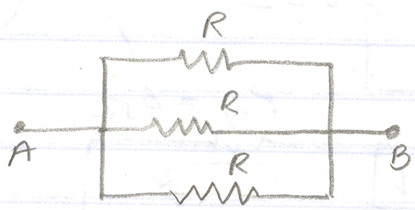
MAE-140 - Fall 2008
HW #2

2.40)



All resistors have one end at node A and the other at node B

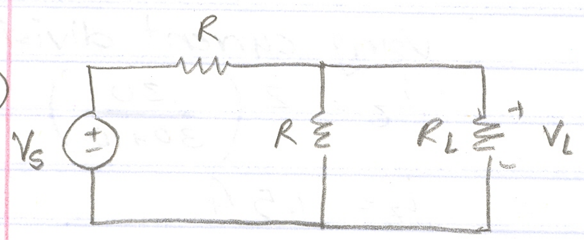


$$\frac{1}{R_{eq}} = \frac{1}{R} + \frac{1}{R} + \frac{1}{R}$$

$$= \frac{3}{R}$$

$$R_{eq} = \frac{R}{3}$$

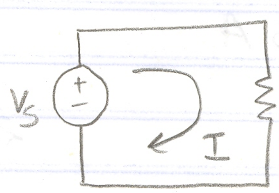
2.41)



$$R_{eq} = R + \underbrace{\left(\frac{1}{\frac{1}{R} + \frac{1}{R_L}}\right)}_{R_p}$$

Note R and R_L are parallel

$$R_{eq} = R + \frac{R R_L}{R + R_L}$$



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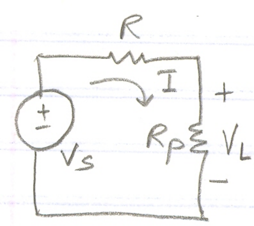


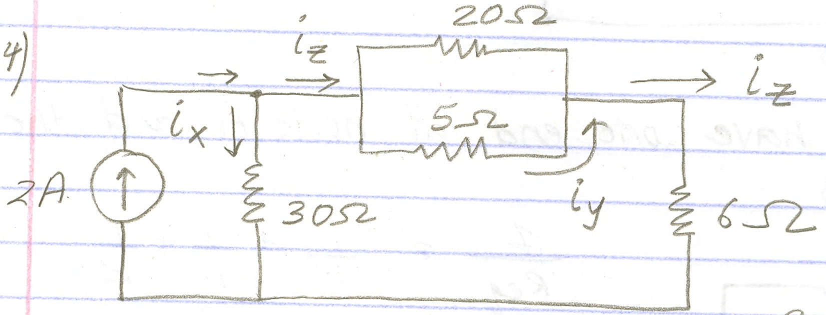
Using voltage division

$$V_L = I \cdot R_p = \frac{V_s}{R_{eq}}\left(\frac{R R_L}{R + R_L}\right) = \frac{V_s\left(\frac{R R_L}{R + R_L}\right)}{R + \frac{R R_L}{R + R_L}}$$

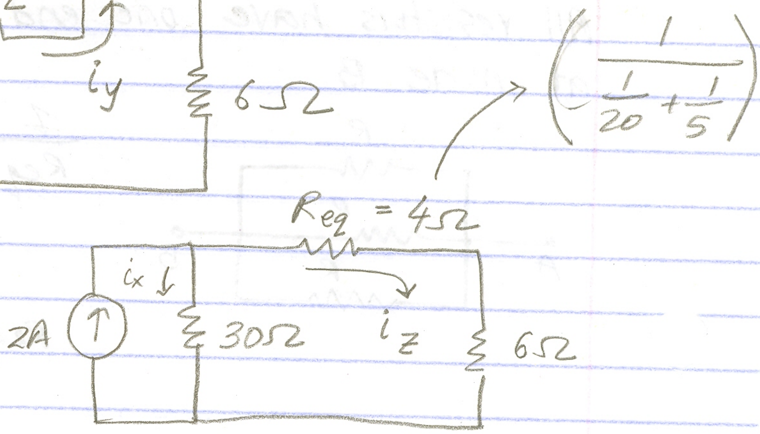
$$V_L = \frac{V_s \; R \cdot R_L}{R^2 + 2RR_L}$$

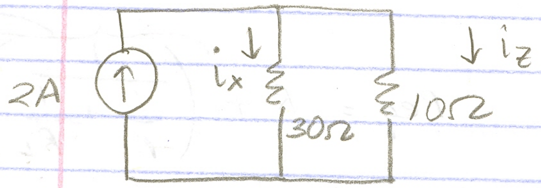
$$\boxed{V_L = \frac{V_s \; R_L}{R + 2R_L}}$$

2.44)



$$i_x + i_z = 2A$$



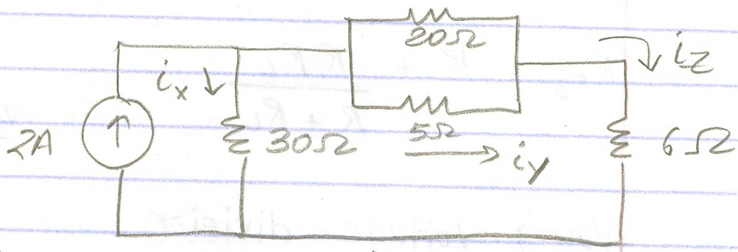


Using current division,

$$i_z = 2\left(\frac{30}{30+10}\right)$$

$$i_z = 1.5 A$$

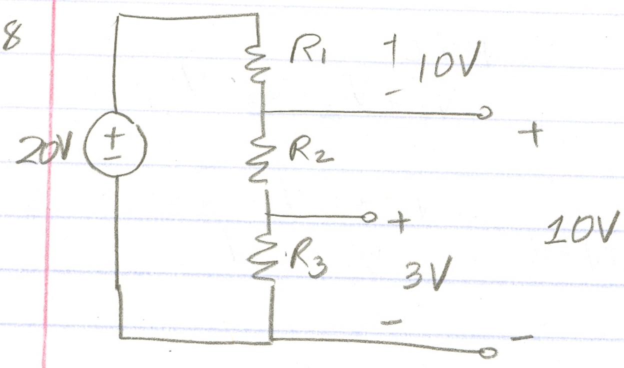
$$i_x = 0.5 A$$



$$i_y = i_z\left(\frac{20}{20+5}\right) \longrightarrow \text{current division}$$

$$= 1.5\left(\frac{20}{25}\right) = 1.2 A$$

2.48



Using KVL

$V_s - V_1 + V_2 - V_3 = 0$

$20 - V_1 - 10 = 0$

$V_1 = 10V$

Using voltage division

For R_1

$$V_1 = \frac{R1}{R_1+R_2+R_3} V_s$$

$$10 = \frac{R1}{R_1+R_2+R_3} 20 \Rightarrow R_1+R_2+R_3 = 2R_1$$

$$-R_1 + R_2 + R_3 = 0 \quad \text{---(1)}$$

For R_3 :

$$V_3 = \frac{R3}{R_1+R_2+R_3} (V_s)$$

$$3 = \frac{R3}{R_1+R_2+R_3} (20)$$

$$R_1+R_2+R_3 = \frac{20}{3} R_3 \Rightarrow R_1+R_2 - \frac{17}{3} R_3 = 0 \quad \text{---(2)}$$

For (R_2+R_3)

$$10 = \frac{R_2+R3}{R_1+R_2+R_3} (20) \Rightarrow R_1+R_2+R_3 = 2R_2+2R_3$$

$$R_1 - R_2 - R_3 = 0 \quad \text{---(3)}$$

Solving (2) and (3)

$$2R_1 - \frac{20}{3} R_3 = 0$$

$$\Rightarrow R_1 = \frac{10}{3} R_3$$

Solving (1) and (2)

$$2R_2 - \frac{14}{3} R_3 = 0$$

$$\Rightarrow R_2 = \frac{7}{3} R_3$$

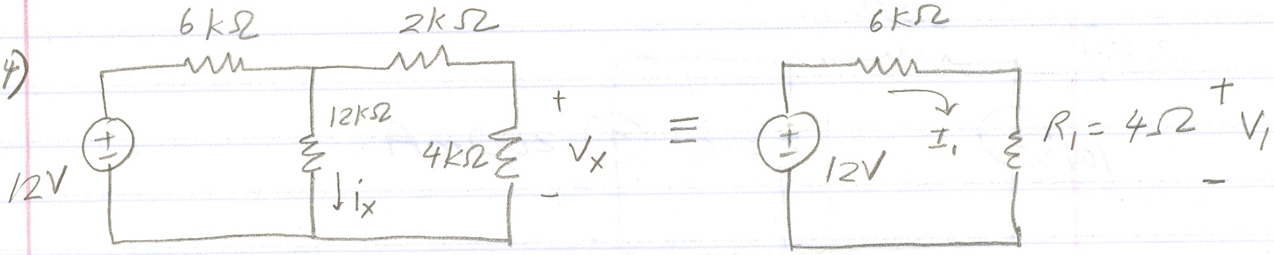
Choose any value for R_3 and get R_1 and R_2

One solution: $R_3 = 3\,k\Omega$

$\Rightarrow R_1 = 10\,k\Omega$

$R_2 = 7\,k\Omega$

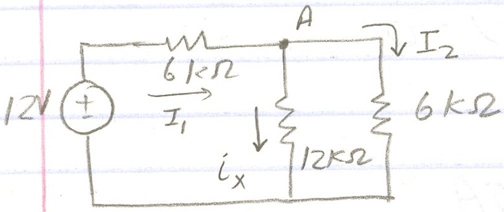
2.54)



$V_1 = 12\left(\frac{4}{6+4}\right) = \frac{48}{10} = 4.8V$

$I_1 R_1 + I_1(6) = 12\ V$ (using KVL)

$I_1 = \frac{12}{10k} = 1.2mA$



Using current division

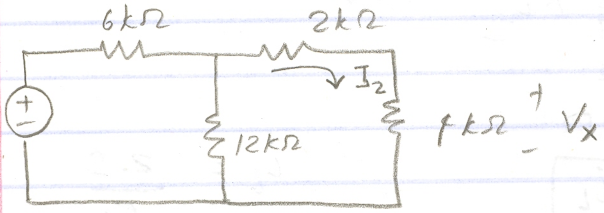
$i_x = (I_1)\left(\frac{6k\Omega}{12+6}\right)$

$i_x = 1.2\left(\frac{6}{18_3}\right) = 0.4\ mA$

At node A.

$I_1 = I_2 + i_x$

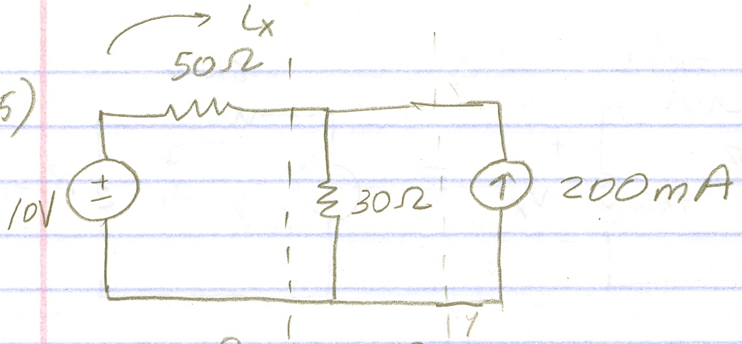
$1.2A = 0.4A + I_2 \Rightarrow I_2 = 0.8\ mA$

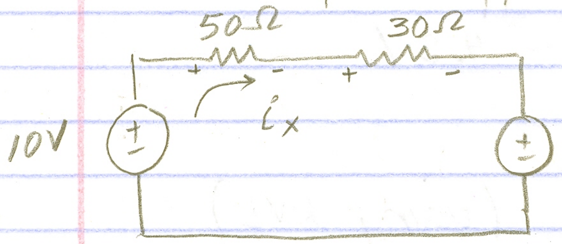


$V_x = I_2(4k\Omega) = (0.8\ mA)(4k\Omega) = 3.2\ V$

$V_x = 3.2V$

2.55)





$i_s R = (0.2)(30)$
$= 6V$

Using KVL

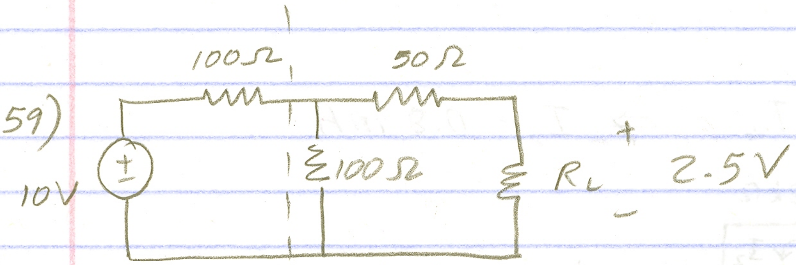
$10V - 50i_x - 30i_x - 6V = 0$

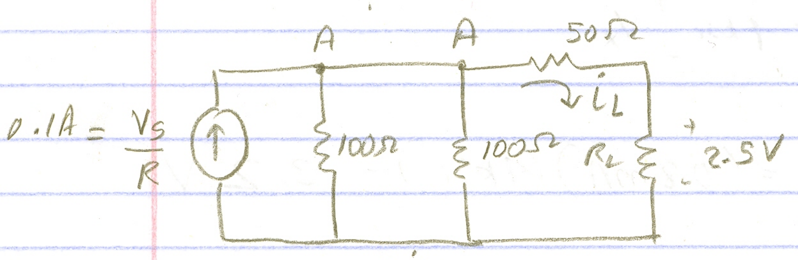
$4V - 80i_x = 0$

$i_x = \frac{4}{80} = 0.05A$

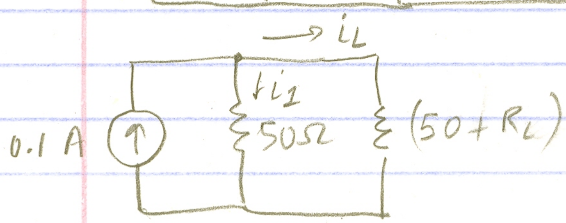
$\frac{100 \times 100}{200}$

2.59)





$i_L = \frac{2.5}{R_L}$



$i_L = (0.1)\left(\frac{50}{50+50+R_L}\right)$

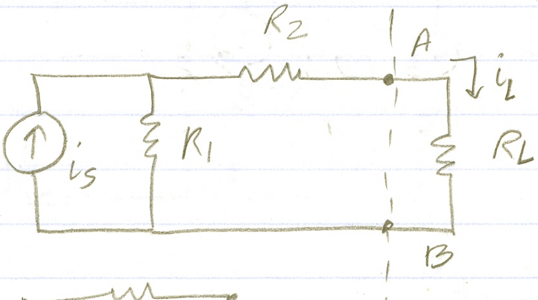
$\frac{2.5}{R_L} = \frac{5}{100+R_L}$

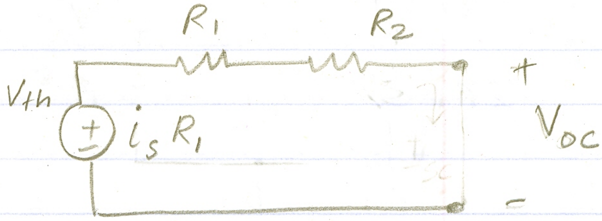
$$\frac{1}{R_L} = \frac{2}{100 + R_L}$$

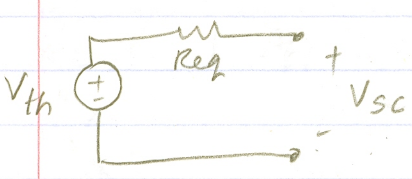
$$100 + R_L = 2R_L$$

$$\boxed{R_L = 100\,\Omega}$$

3.36a.)







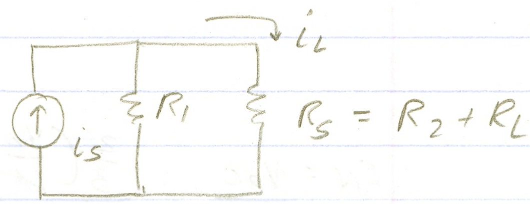
$$V_{th} = i_s R_1 = V_{oc}$$

$$R_{eq} = R_1 + R_2$$

$$I_{sc} = \frac{V_{th}}{R_1 + R_2} = \frac{i_s R_1}{R_1 + R_2}$$

b.) $$i_L = \frac{V_{th}}{R_{eq} + R_L} = \frac{i_s R_1}{R_1 + R_2 + R_L}$$

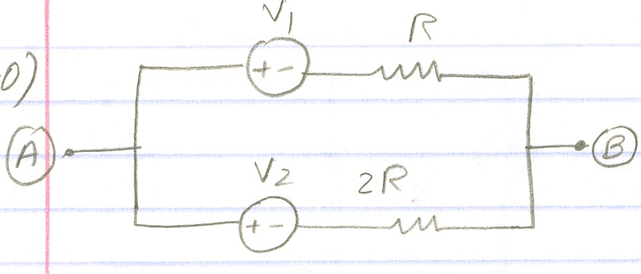
c.) Using current division

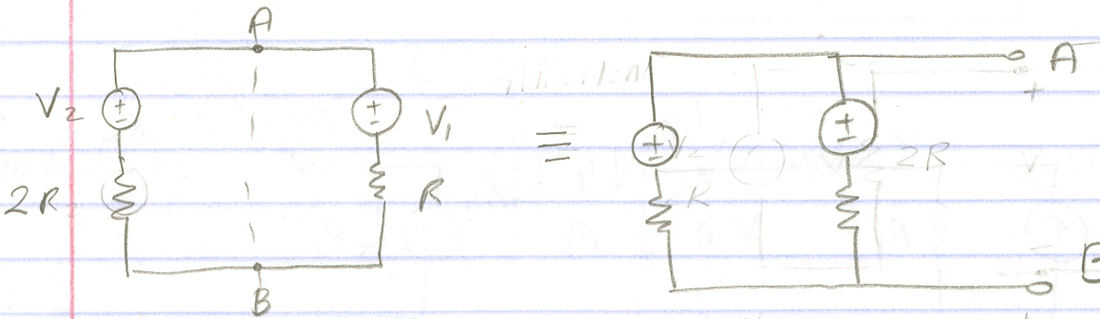


$$i_L = i_s\left(\frac{R_1}{R_1 + R_s}\right)$$

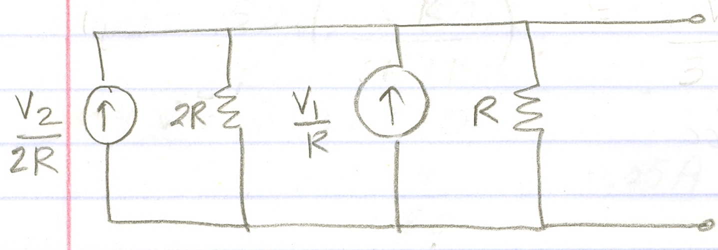
$$= i_s\left(\frac{R_1}{R_1 + R_2 + R_L}\right)$$

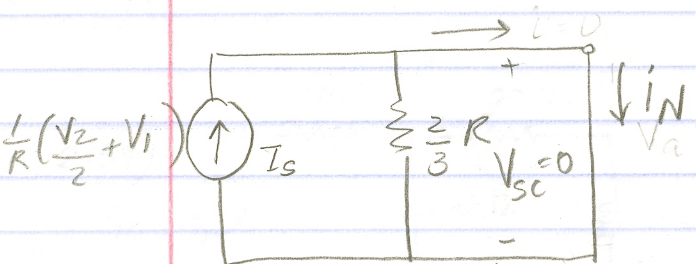
3.40)



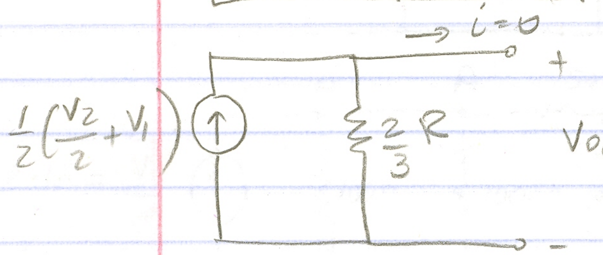


Norton Equivalent circuit





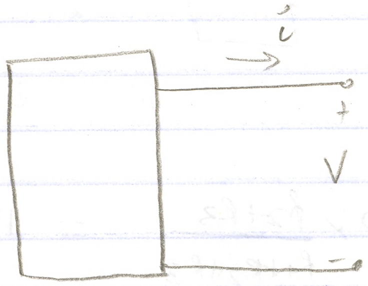
$i_N = I_S = \frac{1}{R}\left(\frac{V_2}{2} + V_1\right)$



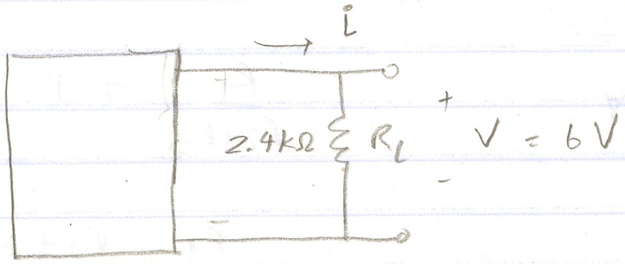
$$V_{OC} = I_N R = i_N\left(\frac{2}{3}R\right) = \frac{1}{R}\left(\frac{V_2}{2} + V_1\right)\left(\frac{2}{3}R\right) = \frac{2}{3}\left(\frac{V_2}{2} + V_1\right)$$

$$R_N = \frac{V_{OC}}{i_N} = \frac{\frac{2}{3}\left(\frac{V_2}{2} + V_1\right)}{\frac{1}{R}\left(\frac{V_2}{2} + V_1\right)} = \frac{2}{3}R$$

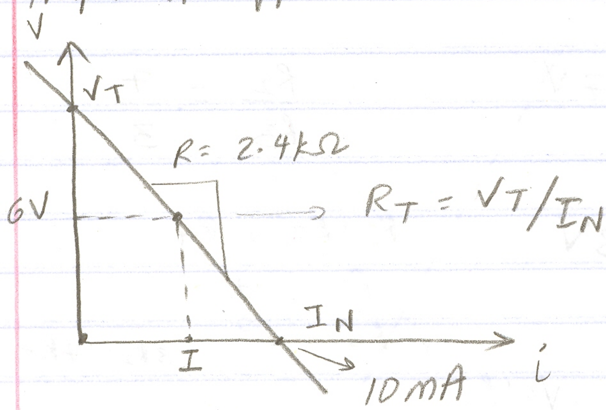
3.42)



$i = 10\,mA$ when $V = 0$



Graphical Approach



$$\Rightarrow I = \frac{V}{R} = \frac{6}{2.4k\Omega}$$

$$= 2.5\,mA$$