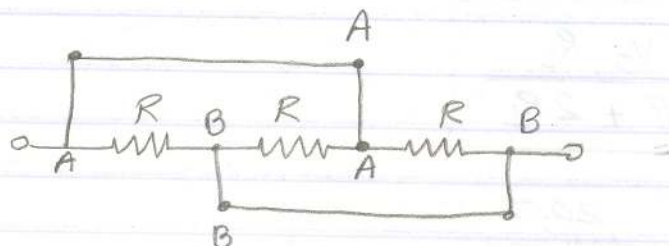


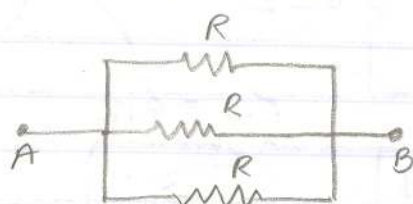
MAG-140 - Fall 2008

HW # 2

2.40)



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

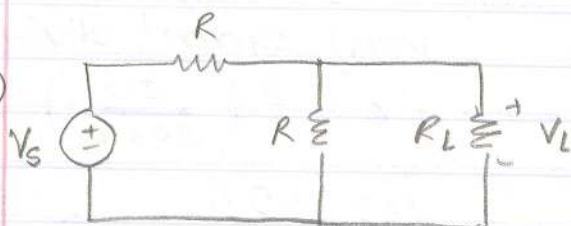


$$\frac{1}{R_{eq}} = \frac{1}{R} + \frac{1}{R} + \frac{1}{R}$$

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

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

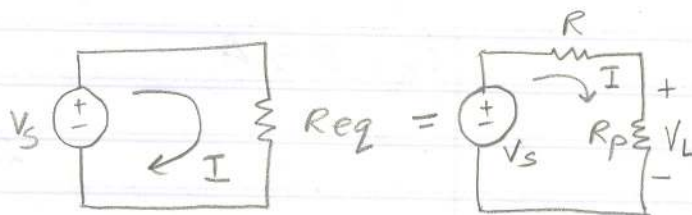
2.41)



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

Note R and R_L are parallel

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

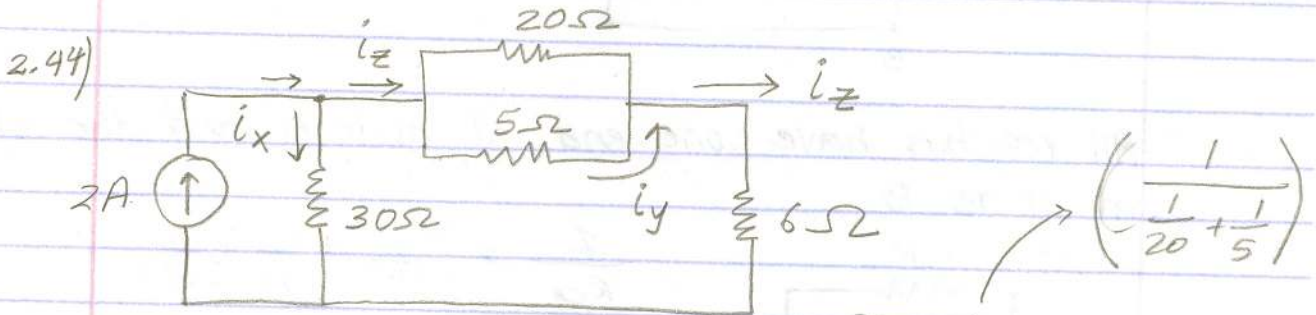


Using voltage division

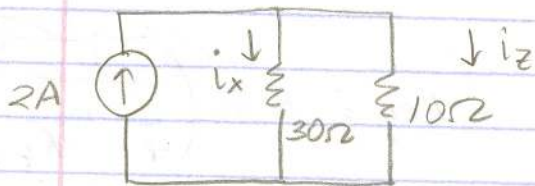
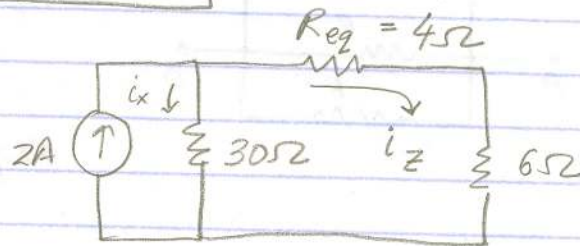
$$V_L = I \cdot R_p = \frac{V_s}{R_{eq}} \left(\frac{R R_L}{R + R_L} \right) = \frac{V_s \left(\frac{R R_L}{R + R_L} \right)}{R + \frac{R R_L}{R + R_L}}$$

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

$$V_L = \frac{V_S R_L}{R + 2R_L}$$



$$i_x + i_z = 2A$$

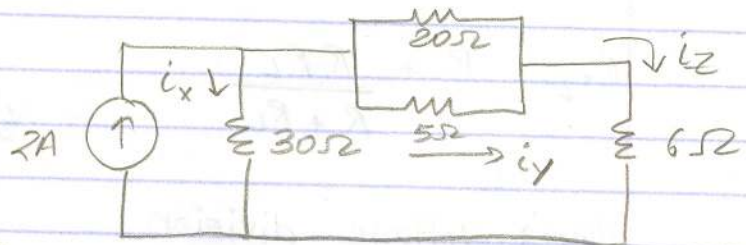


Using current division,

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

$$i_z = 1.5A$$

$$i_x = 0.5A$$

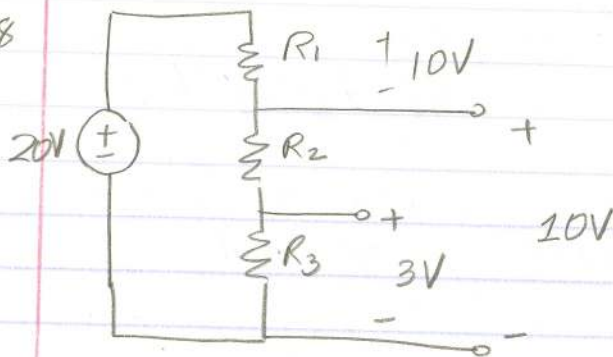


$$i_y = i_z \left(\frac{20}{20+5} \right)$$

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

→ current division

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

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

$$10 = \frac{R_1}{R_1 + R_2 + R_3} 20 \Rightarrow R_1 + R_2 + R_3 = 2R_1 \quad (1)$$

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

$$\text{For } R_3 : V_3 = \frac{R_3}{R_1 + R_2 + R_3} (V_s)$$

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

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

For $(R_2 + R_3)$

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

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

Solving (2) and (3)

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

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

Solving (1) and (2)

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

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

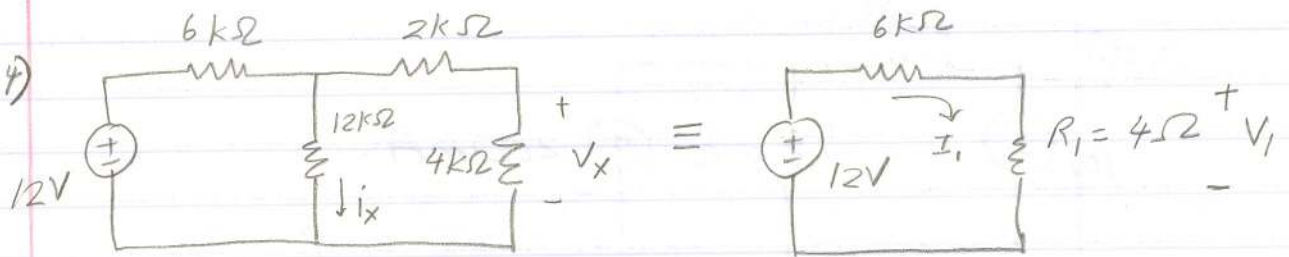
Choose any value for R_3 and get R_1 and R_2

One solution: $R_3 = 3 \text{ k}\Omega$

$$\Rightarrow R_1 = 10 \text{ k}\Omega$$

$$R_2 = 7 \text{ k}\Omega$$

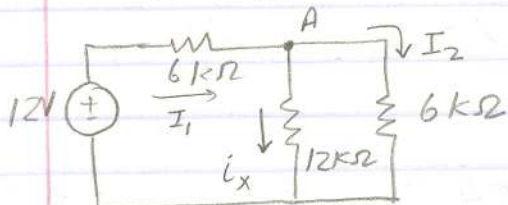
2.54)



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

$$I_1 R_1 + I_1 (6) = 12 \text{ V} \quad (\text{using KVL})$$

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



Using current division

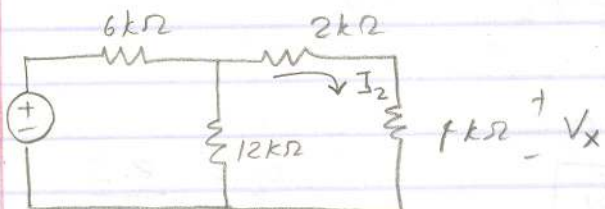
$$i_x = I_1 \left(\frac{6 \text{ k}\Omega}{12+6} \right)$$

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

At node A.

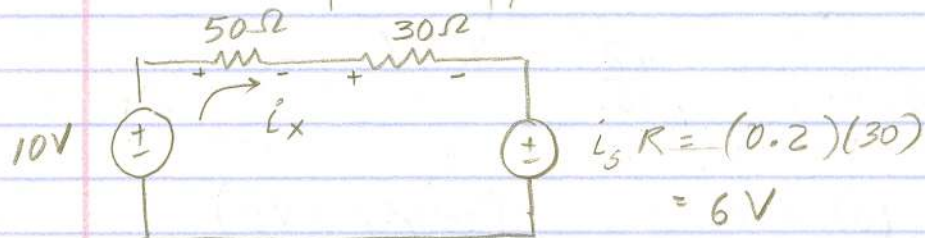
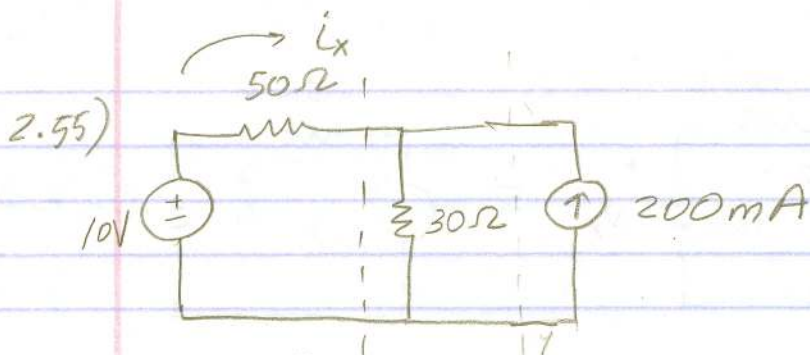
$$I_1 = I_2 + i_x$$

$$1.2 \text{ A} = 0.4 \text{ A} + I_2 \Rightarrow I_2 = 0.8 \text{ mA}$$



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

$$V_x = 3.2 \text{ V}$$

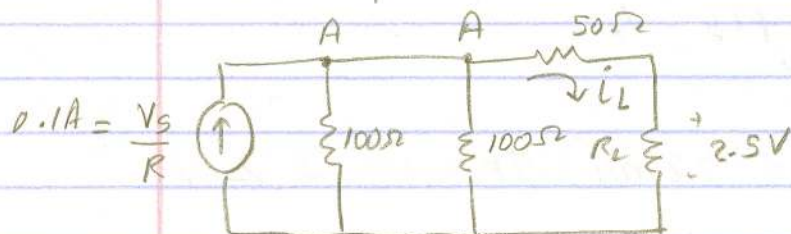
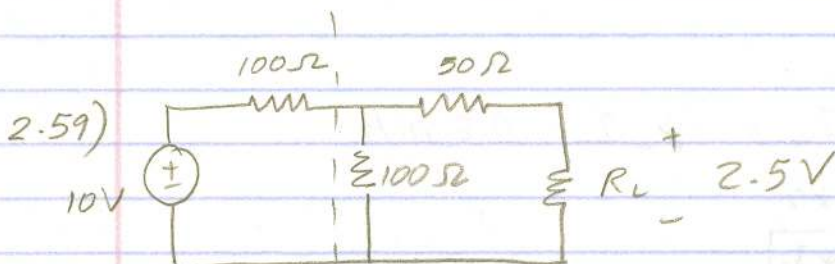


Using KVL

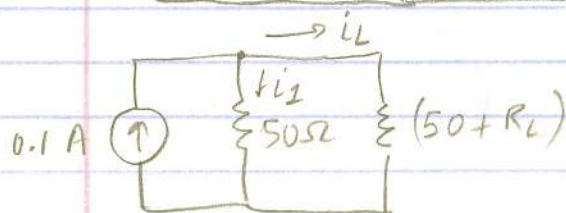
$$10V - 50i_x - 30i_x - 6V = 0$$

$$4V - 80i_x = 0$$

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



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



$$i_L = (0.1) \left(\frac{50}{50 + 50 + R_L} \right) \quad (3)$$

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

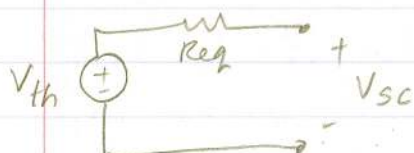
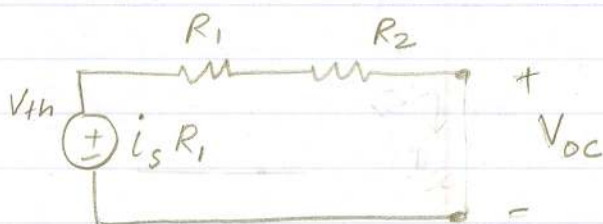
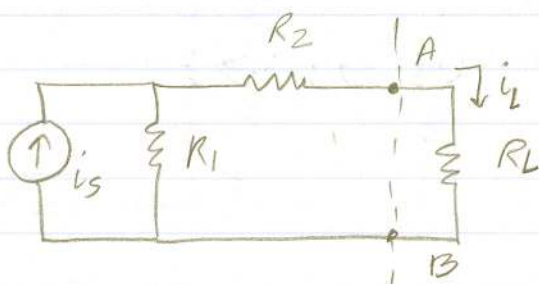
(6)

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

$$100 + R_L = 2R_L$$

$$R_L = 100 \Omega$$

3.36a)



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

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

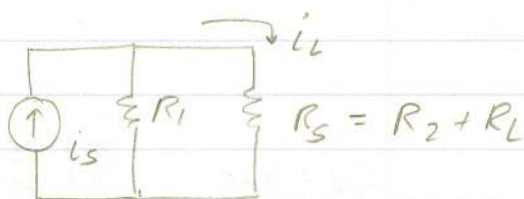
$$I_{sc} = \frac{V_{th}}{R_1 + R_2} = \frac{i_s R_1}{R_1 + R_2}$$

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

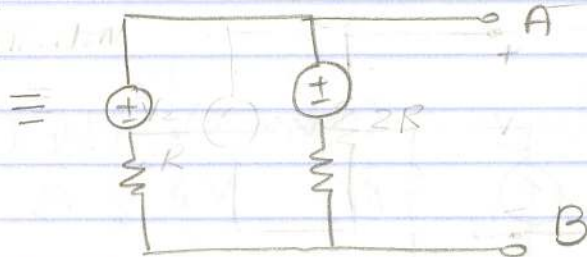
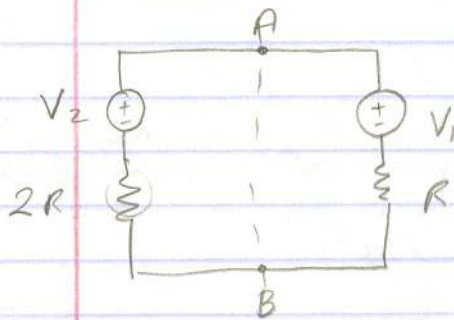
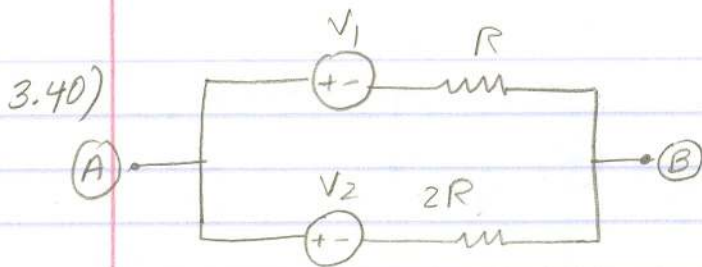
c) Using current division

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

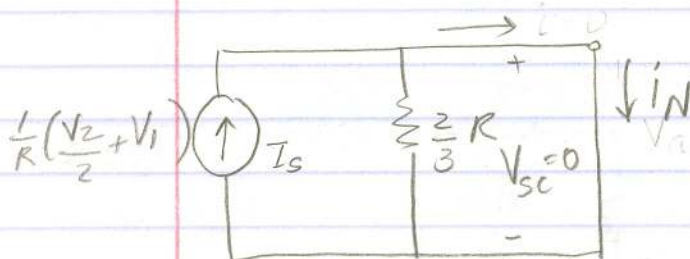
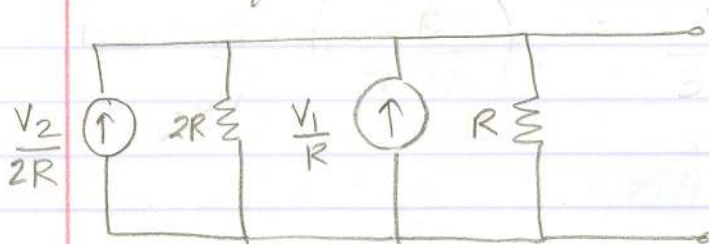
$$= i_s \left(\frac{R_1}{R_1 + R_2 + R_L} \right)$$



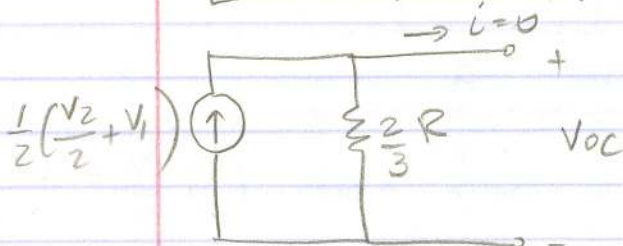
(7)



Norton Equivalent circuit



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



$$V_{OC} = I_N R$$

$$= I_N \left(\frac{2}{3} R \right)$$

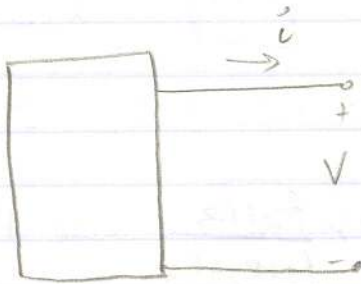
$$= \frac{1}{R} \left(\frac{V_2}{2} + V_1 \right) \left(\frac{2}{3} R \right)$$

$$= \frac{2}{3} \left(\frac{V_2}{2} + V_1 \right)$$

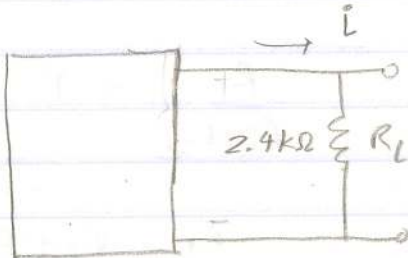
$$R_N = \frac{V_{OC}}{I_N} = \frac{\frac{2}{3} \left(\frac{V_2}{2} + V_1 \right)}{\frac{1}{R} \left(\frac{V_2}{2} + V_1 \right)} = \frac{2}{3} R$$

(8)

3.42)

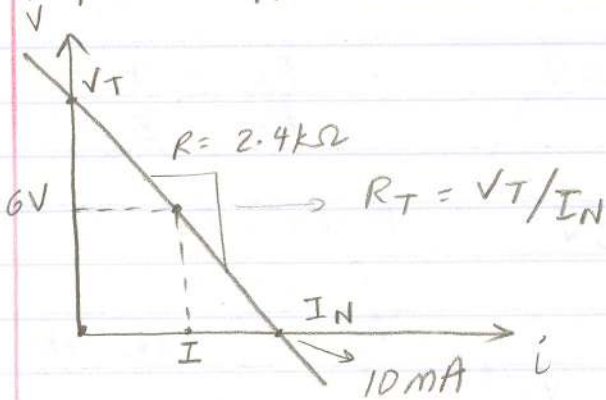


$i = 10 \text{ mA}$ when $V = 0$



$$i = \frac{V}{R} = \frac{6}{2.4 \text{ k}} = 2.5 \text{ mA}$$

Graphical Approach.



$$\Rightarrow I = \frac{V}{R} = \frac{6}{2.4 \text{ k}\Omega} = 2.5 \text{ mA}$$