Homework Prob 3-20 is duplicated.
Should have been 3-19
We will ~~drop~~ not replace problem 3-20 duplicate.

New Lab Kirchoff's Laws & Superposition

Lab 4
Kirchhoff's Laws and Superposition

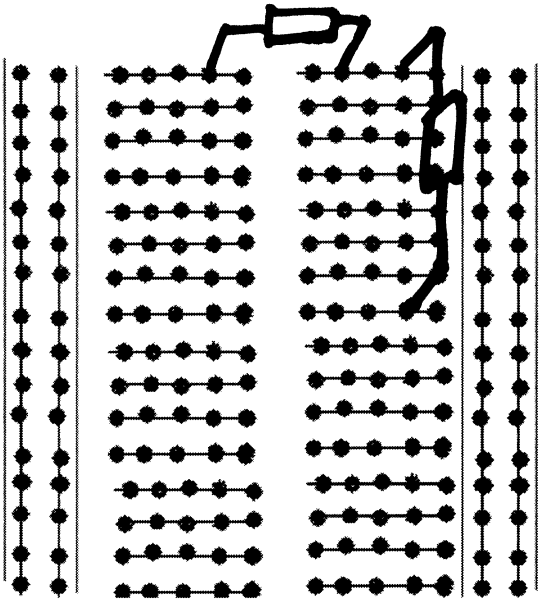


Diagram 1

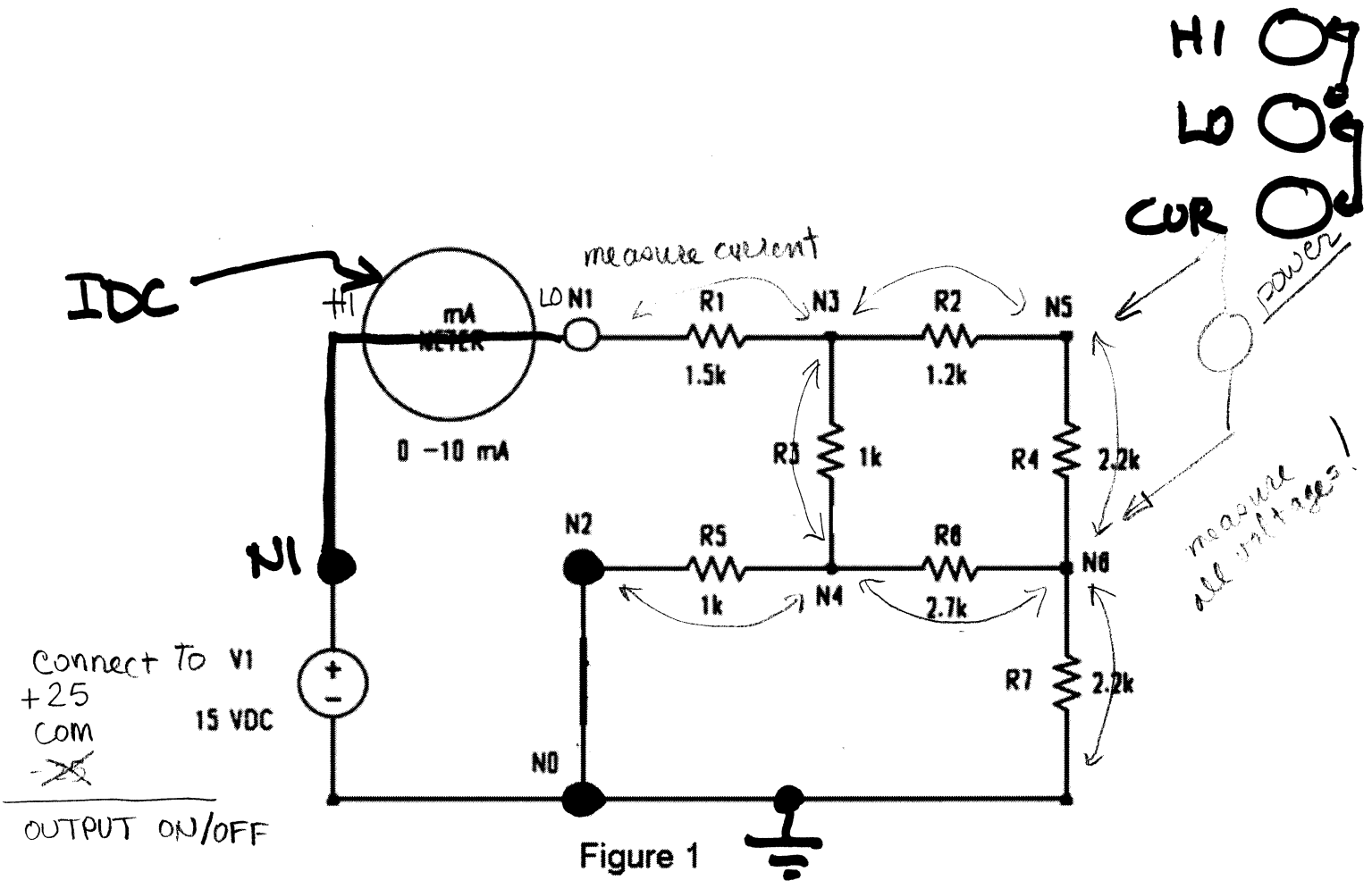
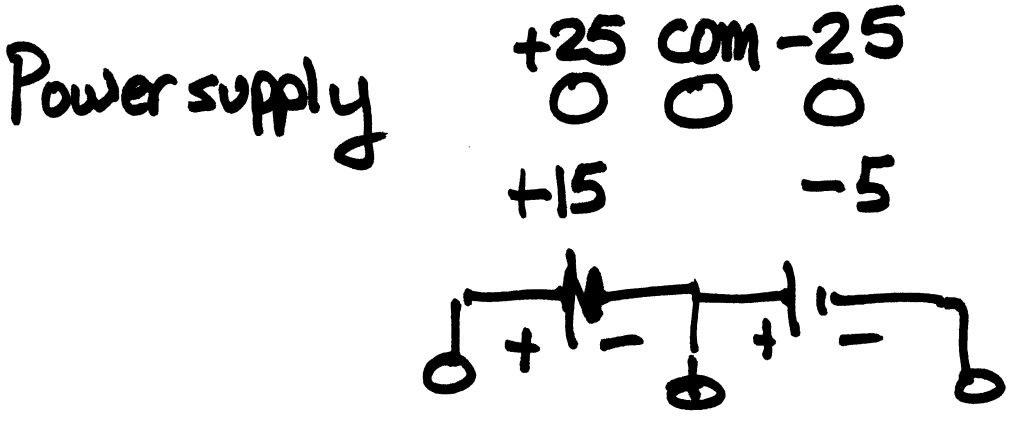


Figure 1

Power supply



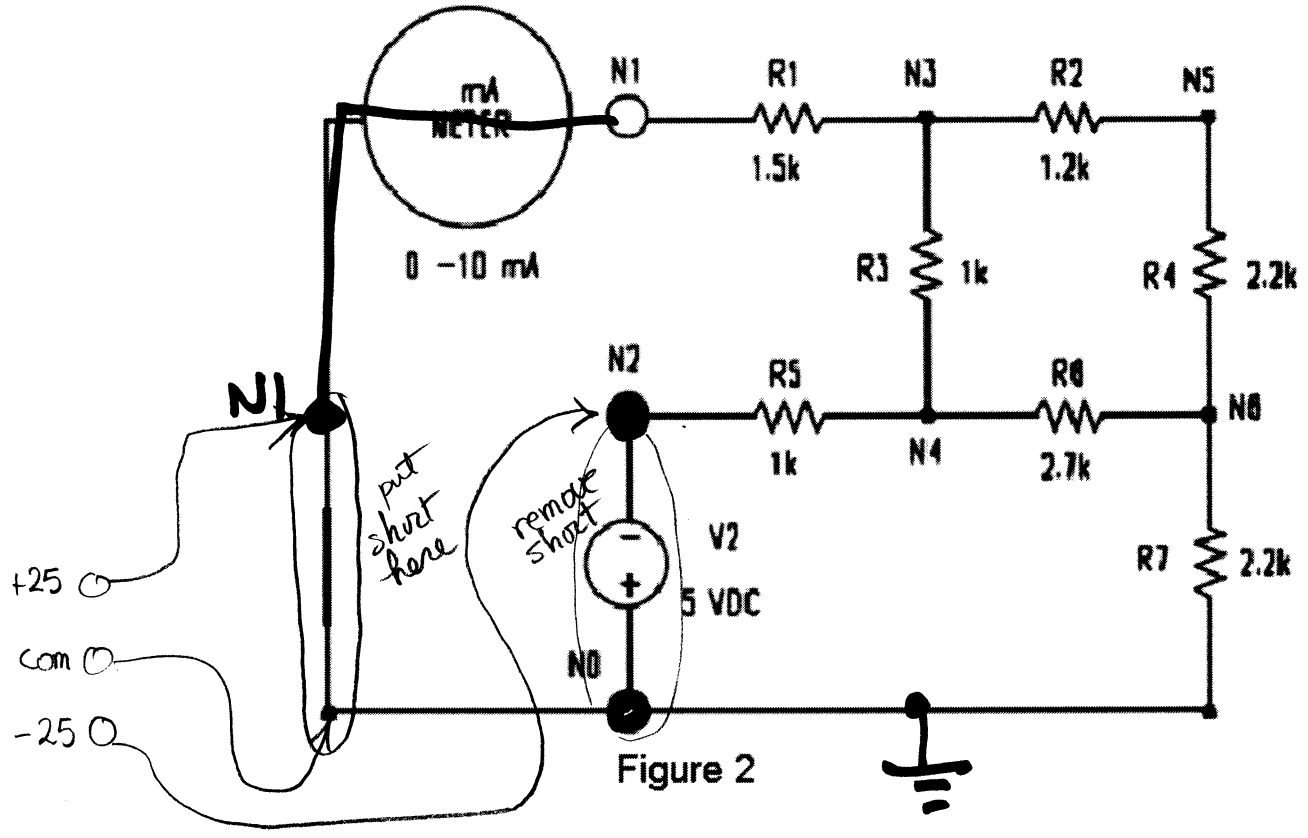
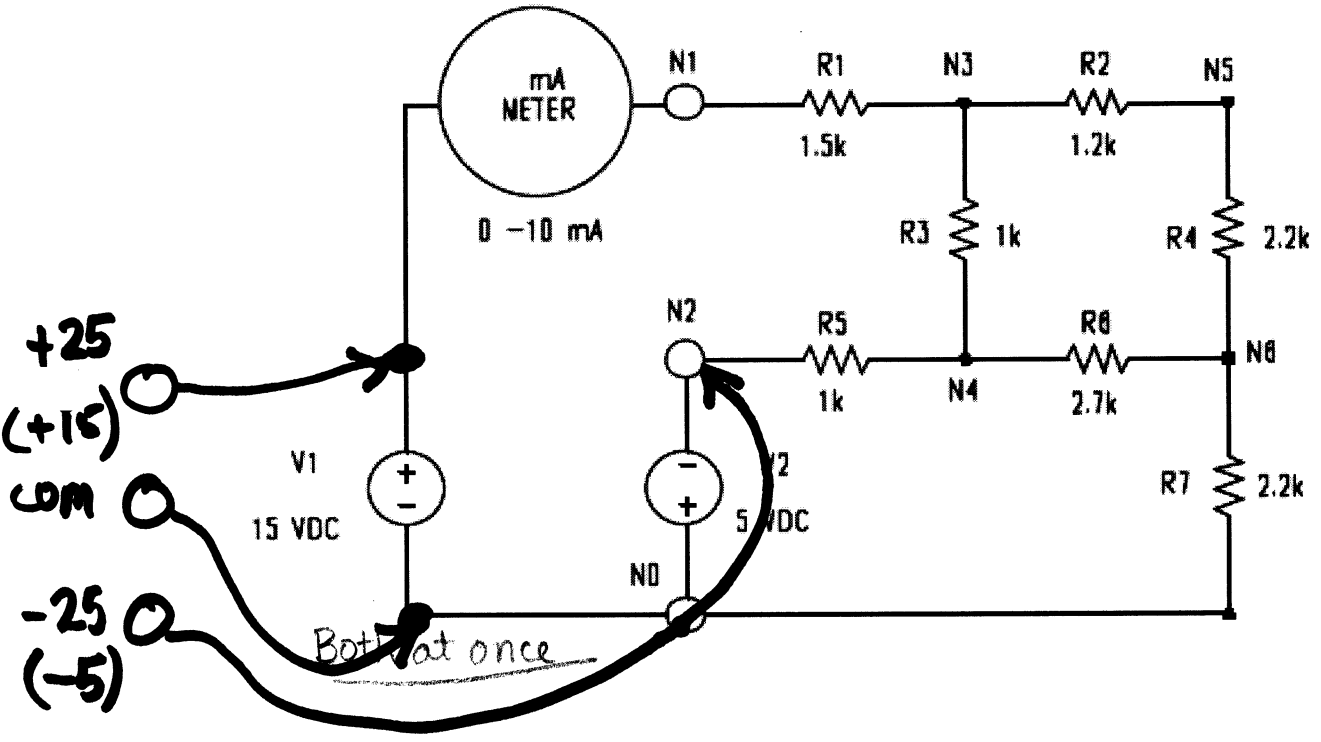

mA
METER
0 -10 mA
N1
R1
1.5k
N3
R2
1.2k
N5
R3
1k
R4
2.2k
N2
R5
1k
N4
R6
2.7k
N6
R7
2.2k
V2
5 VDC
N0
N1
put short here
remove short
+25
Com
-25

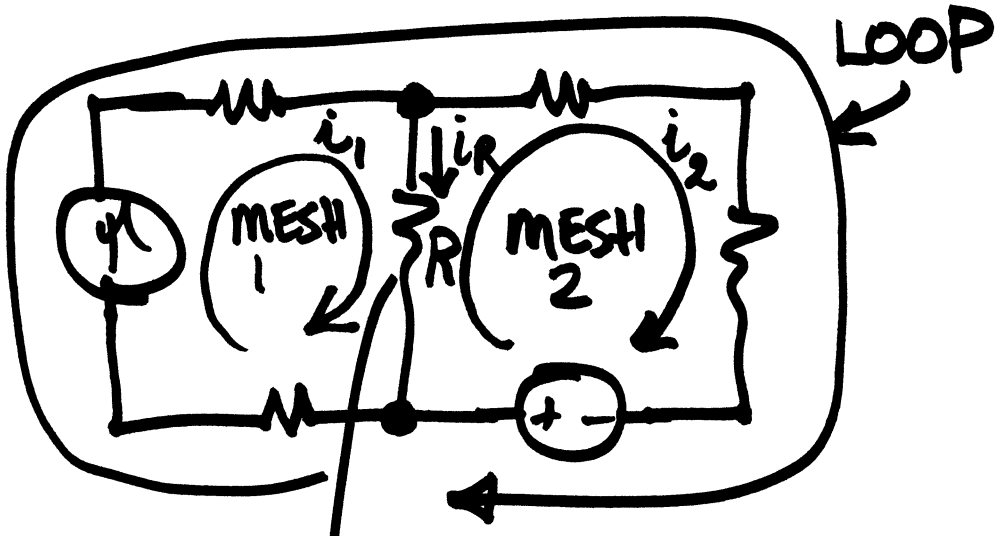
Figure 2



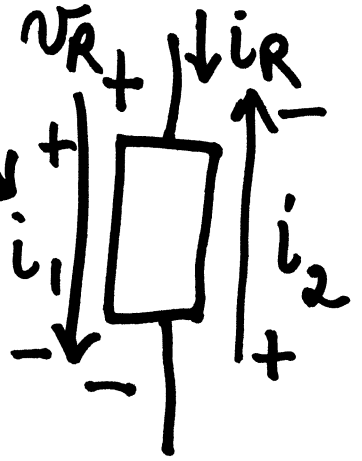
VERIFY SUPERPOSITION.

LOOP

MESH CURRENT



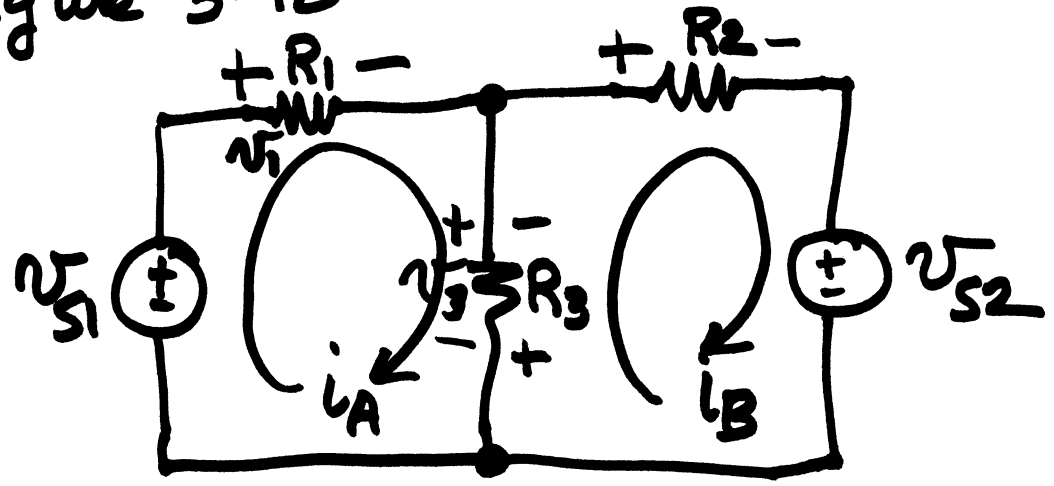
MESH CURRENT ANALYSIS



$$i_R = +i_1 - i_2$$

$$v_R = i_R R = +i_1 R - i_2 R$$

Figure 3-18 mesh current



really KVL equations for each mesh

mesh A ↻ $-v_{S1} + v_1 + v_3 = 0$

put in element values $-v_{S1} + i_A R_1 + i_A R_3 - i_B R_3 = 0$ (1)

mesh B ↻ $-v_3 + v_2 + v_{S2} = 0$

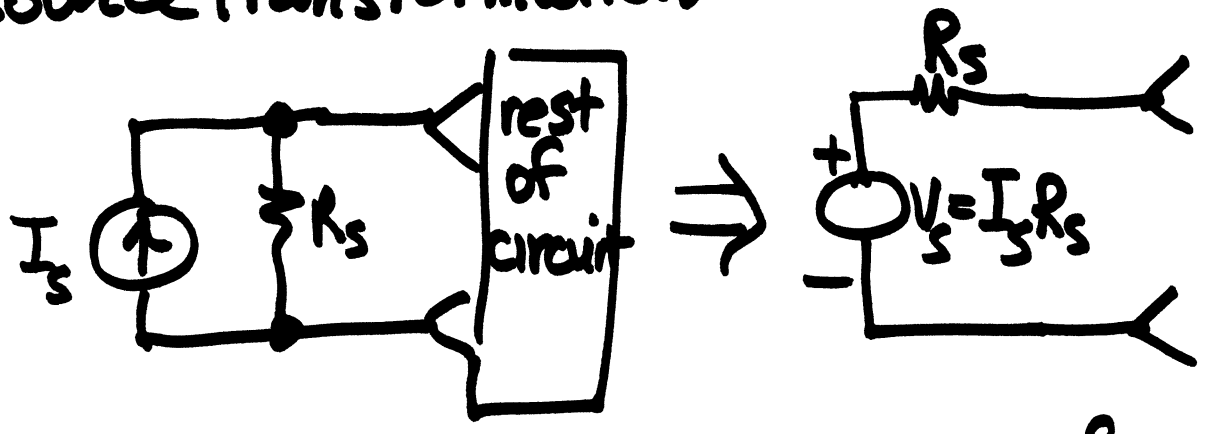
$+i_B R_3 - i_A R_3 + i_B R_2 + v_{S2} = 0$ (2)

$$(R_3 + R_1) i_A - R_3 i_B = +v_{S1}$$

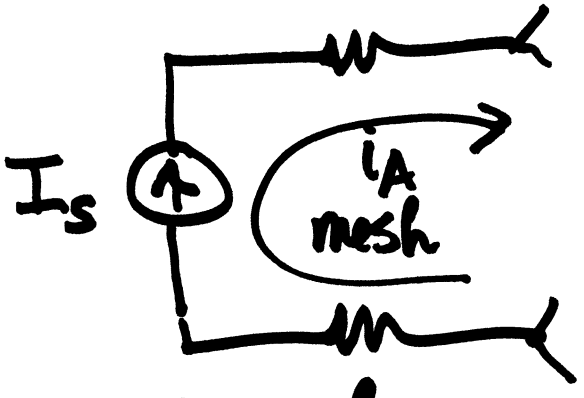
$$-R_3 i_A + (R_2 + R_3) i_B = -v_{S2}$$

Mesh current technique
–problems with current sources

1. source transformation



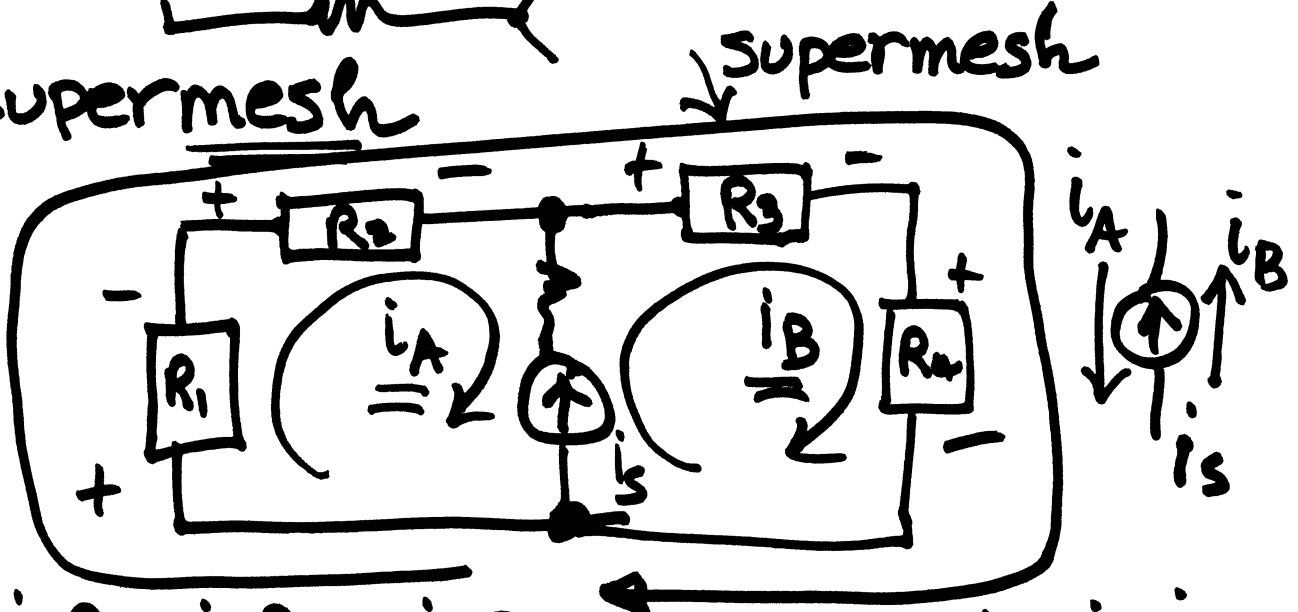
2. current source in an outer mesh (single current mesh)



$i_A = I_s$

3. supermesh

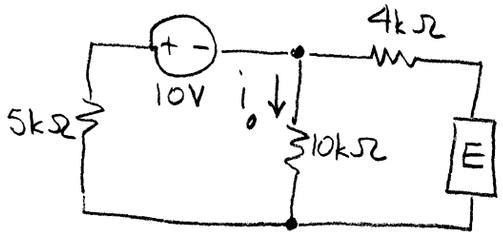
supermesh



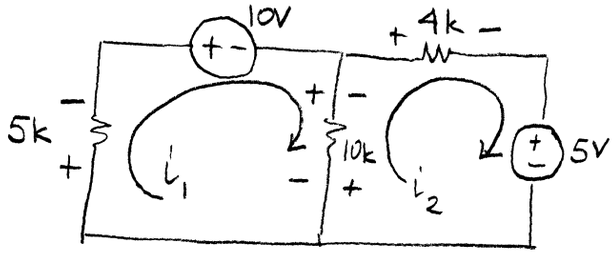
$+i_A R_1 + i_A R_2 + i_B R_3 + i_B R_4 = 0$ $\quad i_s = i_B - i_A$

Exercise 3-8

Use mesh analysis to find the current i_o in the circuit below when the element E is



(a) a 5 Volt voltage source with the positive reference at the top.



mesh 1 ↻ $+5k\,i_1 + 10 + 10k\,i_1 - 10k\,i_2 = 0$

mesh 2 ↻ $+10k\,i_2 - 10k\,i_1 + 4k\,i_2 + 5 = 0$

rearranging

$+15k\,i_1 - 10k\,i_2 = -10 \quad \times \frac{10^{-3}}{5}$

$-10k\,i_1 + 14k\,i_2 = -5 \quad \times \frac{10^{-3}}{5}$

$3i_1 - 2i_2 = -2\times10^{-3}$ (1)

$-2i_1 + 2.8i_2 = -1\times10^{-3}$ (2)

multiply top equation by 2/3

$2i_1 - \frac{4}{3}i_2 = -\frac{4}{3}\times10^{-3}$

$-2i_1 + \frac{14}{5}i_2 = -1\times10^{-3}$

Add and solve for i_2

$\left(-\frac{4}{3}+\frac{14}{5}\right)i_2 = \left(-\frac{4}{3}-1\right)\times10^{-3}$

$\frac{-20+42}{15}i_2 = \frac{-7}{3}\times10^{-3}$

$\frac{22}{15}i_2 = -\frac{7}{3}\times10^{-3}$

$i_2 = -\frac{7}{3}\cdot\frac{15}{22}\times10^{-3} = -1.591\text{ mA}$

Using Eqn (1)

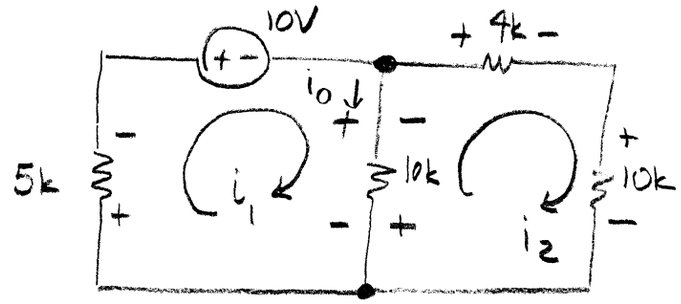
$3i_1 - 2(-1.591\text{ mA}) = -2\text{ mA}$

$3i_1 + 3.182\text{ mA} = -2\text{ mA}$

$i_1 = \frac{-2\text{mA} - 3.182\text{mA}}{3} = -1.727\text{ mA}$

$i_o = i_1 - i_2 = (-1.727 + 1.591)\text{ mA} = -0.136\text{ mA}$

(b) a 10 kΩ resistor.



mesh 1 ↻ $+5k\,i_1 + 10 + 10k\,i_1 - 10k\,i_2 = 0$

mesh 2 ↻ $+10k\,i_2 - 10k\,i_1 + 4k\,i_2 + 10k\,i_2 = 0$

rearranging $(15k\,i_1 - 10k\,i_2 = -10) \times \frac{10^{-3}}{5}$

$(-10k\,i_1 + 24k\,i_2 = 0) \times \frac{10^{-3}}{5}$

$$3i_1 - 2i_2 = -2\,mA \quad (1)$$

multiply × $\frac{3}{2}$ $$-2i_1 + \frac{24}{5}i_2 = 0 \quad (2)$$

$$3i_1 - 2i_2 = -2mA$$

$$-3i_1 + \frac{36}{5}i_2 = 0$$

$$\left(-2 + \frac{36}{5}\right)i_2 = -2\,mA$$

$$i_2 = \frac{-2}{-2+\frac{36}{5}}\,mA = -0.385\,mA$$

Substituting into (2)

$$-2i_1 + \frac{24}{5}(-0.385mA) = 0$$

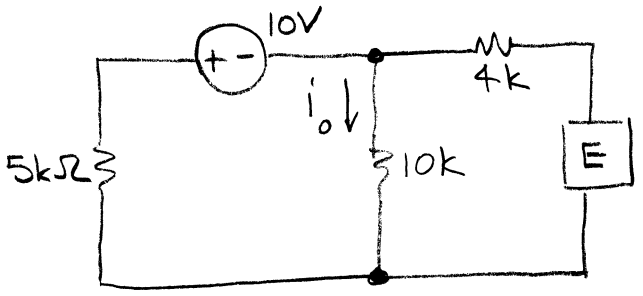
$$-2i_1 - 1.846mA = 0$$

$$i_1 = -0.923\,mA$$

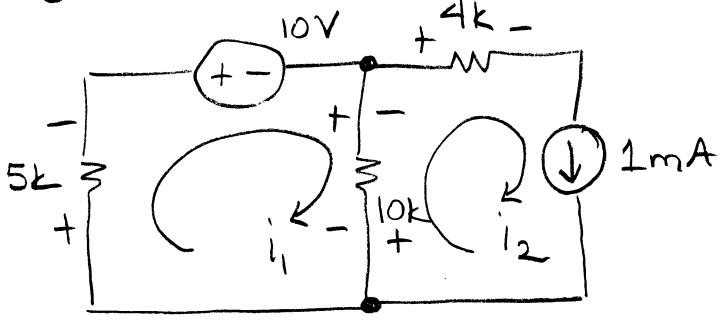
$$i_o = i_1 - i_2 = (-0.923\,mA) - (-0.385mA) = -0.538\,mA$$

Exercise 3-9

Use mesh analysis to find the current i_o in the circuit below when the element E is



(a) a 1mA current source with the reference arrow directed down



This is a current source with a mesh current i_2 going through it. By inspection $i_2 = 1\text{mA}$ and we don't need to write a mesh equation for it.

For mesh 1: ↻ $+5k i_1 + 10 + 10k i_1 - 10k i_2 = 0$

$$(15k i_1 - 10k i_2 = -10) \times \tfrac{1}{5} \times 10^{-3}$$

$$3 i_1 - 2 i_2 = -2\text{mA}$$

$$3 i_1 - 2(1\text{mA}) = -2\text{mA}$$

$$\Rightarrow i_1 = 0$$

$$i_o = i_1 - i_2 = (0) - (1\text{mA}) = -1\text{mA}$$

(b) two 20 kΩ resistors in parallel.

We can replace the two parallel resistors by an equivalent R_{EQ}.

$$R_{EQ} = \frac{(20k)(20k)}{20k + 20k} = 10k$$

This is exactly the same problem as Example 3-8 b.