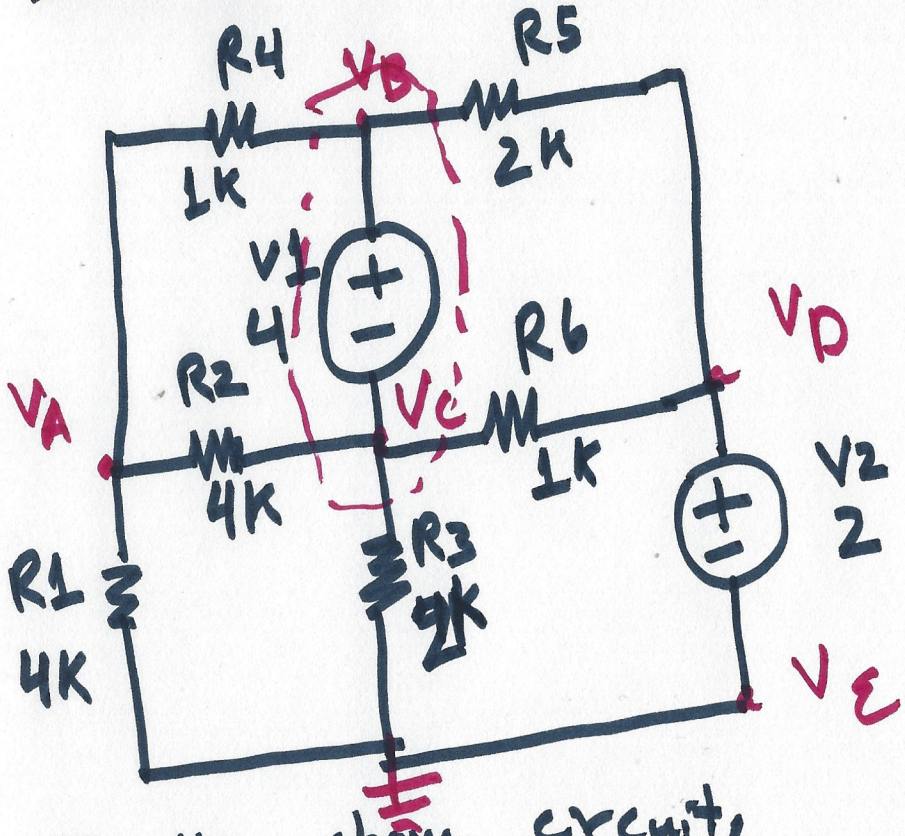
#2) Circuit Analysis – Node/Mesh (20 points)



$V_D = 2V$

$V_B - V_C = 4V$

$V_E = 0V$

In the above circuit,

a) clearly Label each node as V_A, V_B, etc (2 pts)

b) Identify a ground node (1 pt)

c) Based on your choice in part b), indicate any nodes with known voltages and any pairs of nodes with known relationships (2 pts)

d) Determine the set of Linear equations needed to determine the nodal voltages. Clearly indicate each expression. (put a box around them). (4 pts)

~~Node A~~ Node A: $-\frac{V_A}{R_1} - \frac{V_A - V_C}{R_2} - \frac{V_A - V_B}{R_4} = 0$

Super Node: $-\frac{V_B - V_A}{R_4} - \frac{V_B - V_D}{R_5} - \frac{V_C - V_A}{R_2} - \frac{V_C}{R_3} - \frac{V_C - V_D}{R_6} = 0$

e) Determine the voltage across R2. (1pt)

$$-\left(\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}\right)V_A+\frac{1}{R_4}V_B+\frac{1}{R_2}V_C=0$$

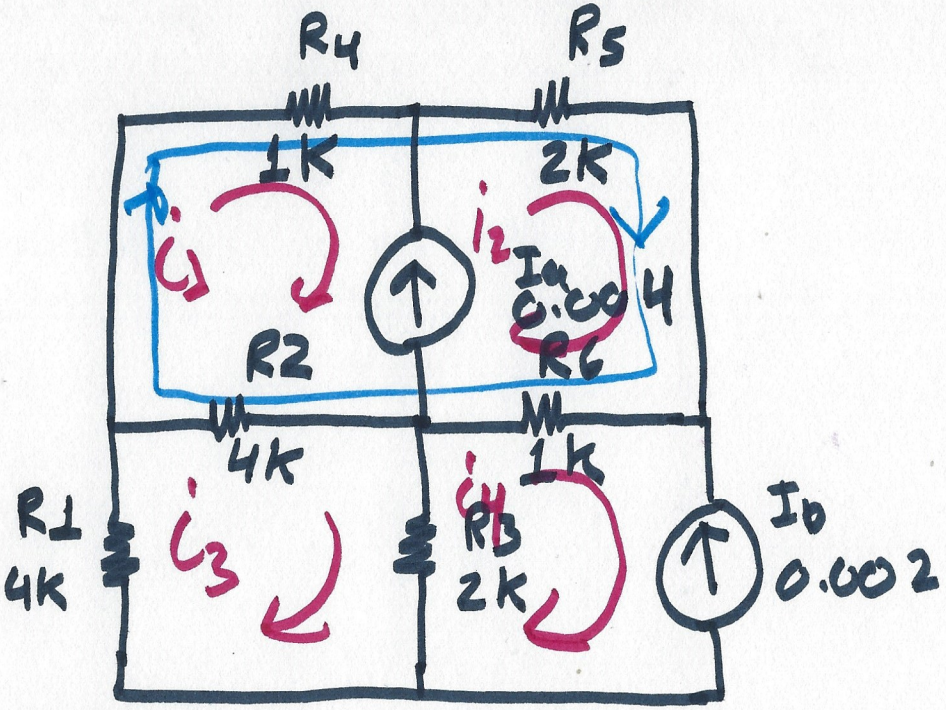
$$\left(\frac{1}{R_4}+\frac{1}{R_2}\right)V_A-\left(\frac{1}{R_4}+\frac{1}{R_5}\right)V_B-\left(\frac{1}{R_2}+\frac{1}{R_3}+\frac{1}{R_6}\right)V_C=-\frac{V_D}{R_6}$$

$$V_B-V_C=4$$

$V_A = 2.79V$ $V_B = 0.151V$

V_C

$$V_{R2}=V_A-V_C=2.64V$$



$i_4 = -0.002$

$i_2 - i_1 = 0.004$ (3)

$i_K = i_x - i_y$

In the above circuit

a) Clearly Label current Loops, I_1, I_2, etc (2pts)

b) Based on your choice in part b), Indicate any Loop currents with known values and any pairs of Loop currents with known relationships (2pts)

C) Determine the set of Linear equations needed to determine the Loop currents. Clearly indicate each expression (put a box around them). (4pts)

$$R_1 i_3 + R_2(i_3 - i_1) + R_3(i_3 - i_4) = 0$$

$$\boxed{(R_1 + R_2 + R_3) i_3 - R_2 i_1 - R_3 i_4 = 0} \quad (2)$$

$$\boxed{(R_4 + R_2) i_1 - R_2 i_3 + (R_5 + R_6) i_2 - R_6 i_4 = 0} \quad (1)$$

d) Determine the voltage across R2. (2pts)

$$\begin{bmatrix} 5K & 3K & -4K \\ -4K & 0 & 10K \\ -1 & 1 & 0 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} 2 \\ 4 \\ 0.002 \end{bmatrix}$$

$i_1 = -0.375\ mA$

$i_2 = 1.625\ mA$

$i_3 = 0.25\ mA$

$V_{R2} = 4k(i_1 - i_3)$

$= -2.5\ V$