

# MEMS 0031 - Electrical Circuits

## Quiz #4

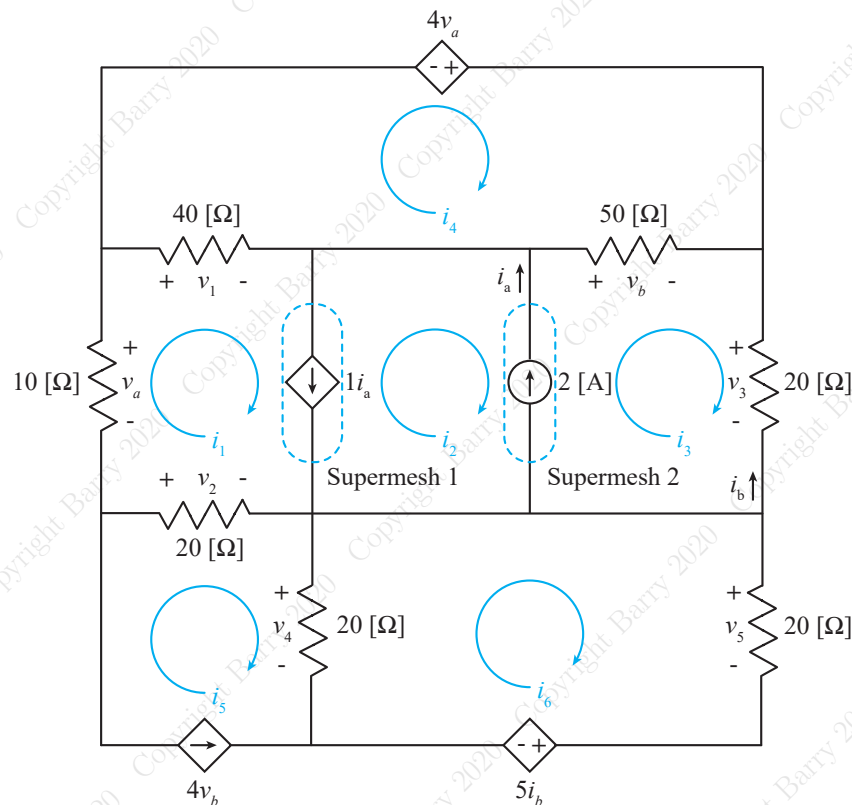
Assigned: June 15<sup>th</sup>, 2020

Due: June 17<sup>th</sup>, 2020, 9:00 pm

Name: \_\_\_\_\_

### Problem #1

Using Mesh Current Analysis, determine the branch currents  $i_1$  through  $i_6$ . Work is to be done on the homework submission sheet. The academic integrity statement must either be submitted as presented on this sheet, along with your work, or copied over to the homework submission sheet - both methods required a signature and date. If the academic integrity statement is not included, the assignment will be marked as incorrect.



Step 1: Construct  $N$  KVL loops.  $N = 6$

Step 2: Assign voltage potentials across resistors/current sources consistent PSC. Note - do not dually label shared elements!

Step 3: Construct  $N - \#CS$  KVL equations, describing each mesh current:

Supermesh 1 equation:

$$i_1 - i_2 = i_a$$

Supermesh 2 equation:

$$i_3 - i_2 = 2\text{ [A]}$$

Supermesh:

$$-V_a + V_1 + V_b + V_3 - V_2 = 0$$

Mesh Current 4:

$$-V_1 - 4V_a - V_b = 0$$

Mesh Current 5:

$$i_5 = -4V_b$$

Mesh Current 6:

$$-V_4 + V_5 + 5i_b = 0$$

Step 4: Apply Ohm's law to express voltage potentials in terms of mesh currents.

Supermesh 1 equation:

$$i_1 - i_2 = 2 \quad (1)$$

Supermesh 2 equation:

$$i_3 - i_2 = 2 \quad (2)$$

Supermesh:

$$\begin{aligned} (10 [\Omega])i_1 + (40 [\Omega])(i_1 - i_4) + (50 [\Omega])(i_3 - i_4) + (20 [\Omega])i_3 - (20 [\Omega])(i_5 - i_1) &= 0 \\ \implies 70i_1 + 70i_3 - 90i_4 - 20i_5 &= 0 \end{aligned} \quad (3)$$

Mesh Current 4:

$$\begin{aligned} -(40 [\Omega])(i_1 - i_4) - 4(-10 [\Omega])i_1 - (50 [\Omega])(i_3 - i_4) &= 0 \\ \implies -50i_3 + 90i_4 &= 0 \end{aligned} \quad (4)$$

Mesh Current 5:

$$i_5 = -4(50 [\Omega])(i_3 - i_4) \implies 200i_3 - 200i_4 + i_5 = 0 \quad (5)$$

Mesh Current 6:

$$-(20 [\Omega])(i_5 - i_6) + (20 [\Omega])i_6 + 5(-i_3) = 0 \implies -5i_3 - 20i_5 + 40i_6 = 0 \quad (6)$$

Putting eqns. 1 through 6 in matrix form:

$$\begin{bmatrix} 1 & -1 & 0 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 & 0 & 0 \\ 70 & 0 & 70 & -90 & -20 & 0 \\ 0 & 0 & -50 & 90 & 0 & 0 \\ 0 & 0 & 200 & -200 & 1 & 0 \\ 0 & 0 & -5 & 0 & -20 & 40 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \\ i_4 \\ i_5 \\ i_6 \end{bmatrix} = \begin{bmatrix} 2 \\ 2 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} \implies \begin{bmatrix} i_1 \\ i_2 \\ i_3 \\ i_4 \\ i_5 \\ i_6 \end{bmatrix} = \begin{bmatrix} 0 \\ -2 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

### Academic Integrity Statement:

I hereby attest that I have received no assistance (from a friend, from another student, from an on-line resource, such as Chegg, etc.), and that I have provided no assistance to another student, during this exam. All the work presented within is solely my own work.

Signature: \_\_\_\_\_

Date: \_\_\_\_\_