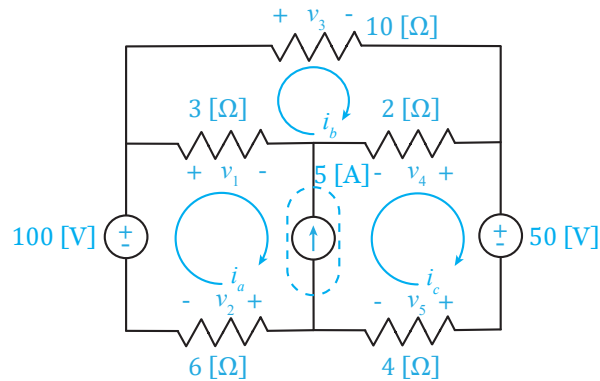


MEMS 0031 - Electrical Circuits
Quiz #5

Name: _____

Problem #1

Determine the mesh currents i_a , i_b and i_c using MCA.



Step 1: Construct N KVL loops. $N = 3$

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 equation:

$$i_c - i_a = 5 \text{ [A]} \quad (1)$$

Supermesh:

$$-100 \text{ [V]} + V_1 - V_4 + 50 \text{ [V]} + V_5 + V_2 = 0$$

Mesh Current b:

$$V_3 + V_4 - V_1 = 0$$

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

Supermesh :

$$\begin{aligned} -100 \text{ [V]} + (3 \text{ [}\Omega\text{)})(i_a - i_b) - (2 \text{ [}\Omega\text{)})(i_b - i_c) + 50 \text{ [V]} + (4 \text{ [}\Omega\text{)})i_c + (6 \text{ [}\Omega\text{)})i_a &= 0 \\ \implies 9i_a - 5i_b + 6i_c &= 50 \text{ [V]} \end{aligned} \quad (2)$$

Mesh Current b:

$$\begin{aligned} (10 \text{ [}\Omega\text{)})i_b + (2 \text{ [}\Omega\text{)})(i_b - i_c) - (3 \text{ [}\Omega\text{)})(i_a - i_b) &= 0 \\ \implies -3i_a + 15i_b - 2i_c &= 0 \end{aligned} \quad (3)$$

Putting eqns. 1 through 3 in matrix form:

$$\begin{bmatrix} -1 & 0 & 1 \\ 9 & -5 & 6 \\ -3 & 15 & -2 \end{bmatrix} \begin{bmatrix} i_a \\ i_b \\ i_c \end{bmatrix} = \begin{bmatrix} 5 \\ 50 \\ 0 \end{bmatrix} \Rightarrow \begin{bmatrix} i_a \\ i_b \\ i_c \end{bmatrix} = \begin{bmatrix} 1.75 \\ 1.25 \\ 6.75 \end{bmatrix}$$

Units are taken as [A].