A. Mesh Analysis - Represents a voltage sum

1. Solve for mesh currents instead of node voltages
2. loop - KVL closed path
3. Mesh - loop with no interior elements
4. Use KVL

M_1: $-V_{S1} + V_1 + V_3 = 0$

$V_1 = R_1 i_1$

$V_3 = R_3(i_1 - i_2)$

$-V_{S1} + R_1 i_1 + R_3 i_1 - i_2 = 0$ ← Eq 1

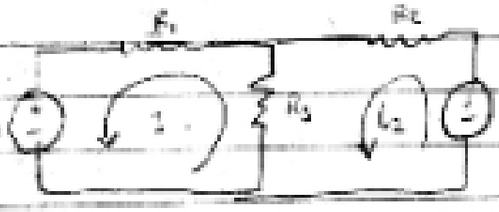
M_2: $-V_3 + V_2 + V_{S2} = 0$

$V_2 = R_2 i_2$

$-R_3(i_1 - i_2) + R_2 i_2 + V_{S2} = 0$

$R_3(i_2 - i_1) + R_2 i_2 + V_{S2} = 0$ ← Eq 2

$$\begin{bmatrix} (R_1+R_3) & -R_3 \\ -R_3 & (R_2+R_3) \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \end{bmatrix} = \begin{bmatrix} V_{S1} \\ -V_{S2} \end{bmatrix}$$

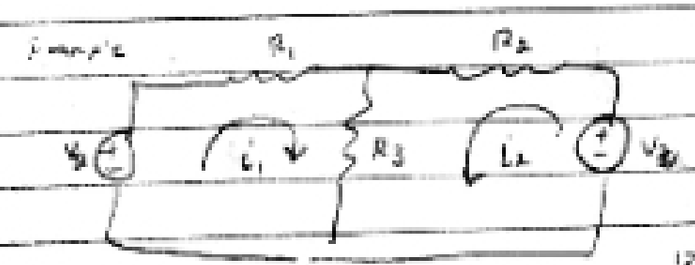


M_1: $V_{S1} + R_3(i_1 - i_2) + R_1 i_1$

M_2: $-V_{S2} + R_2 i_2 + R_3(i_2 - i_1)$

$$\begin{bmatrix} R_3+R_1 & -R_3 \\ -R_3 & R_2+R_3 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \end{bmatrix} = \begin{bmatrix} V_{S1} \\ -V_{S2} \end{bmatrix}$$

Example

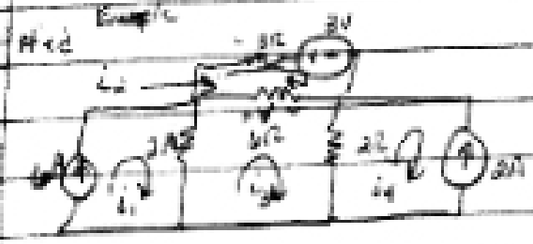


M_1: $-V_{S1} + R_1 i_1 + R_3(i_1 - i_2)$

M_2: $-V_{S2} + R_2 i_2 + R_3(i_2 - i_1)$

$$\begin{bmatrix} R_1+R_3 & -R_3 \\ -R_3 & R_2+R_3 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \end{bmatrix} = \begin{bmatrix} V_{S1} \\ V_{S2} \end{bmatrix}$$

Example



$V = 6(i_2 - i_3) = 6(-2)$

$6 - 2 = \boxed{4V}$

Find V

$i_1 = 6A \quad i_4 = -2A$

M_2: $+3i_2 + 3V + 6(i_2 - i_3) = 0$

M_3: $2(i_3 - i_1) + 6(i_3 - i_2) + 2(i_3 - i_4) = 0$

$9i_3 - 6i_2 = -3$ ✓

$-6i_2 + 18i_3 = 8 \rightarrow -9i_2 + 15i_3 = 12$ ✓

$9i_3 = 9 \quad i_3 = 1A$

$9i_2 - 6(1A) = -3 \quad 9i_2 = 3 \quad i_2 = \frac{1}{3}A$