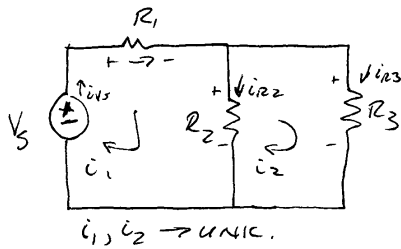


EE301/308 SPO9 HW #4 SOLUTION

PROBLEM 1



GIVEN: $V_S = 30V$, $R_1 = 500\Omega$
 $R_2 = 500\Omega$, $R_3 = 500\Omega$

FIND: MESH CURRENTS

- VOLTAGE ACROSS THE RESISTORS
- CURRENT THROUGH THE RESISTORS
- CURRENT THROUGH VOLTAGE SOURCE

KVL M1

$$-V_S + R_1 i_1 + R_2 (i_1 - i_2) = 0$$

$$\boxed{V_S = (R_1 + R_2) i_1 - R_2 i_2} \quad \text{EQU 1}$$

$$\left. \begin{aligned} i_1 &= 0.04A \\ i_2 &= 0.02A \end{aligned} \right\} \leftarrow$$

KVL M2

$$R_2 (i_2 - i_1) + R_3 i_2 = 0$$

$$\boxed{-R_2 i_1 + (R_2 + R_3) i_2 = 0} \quad \text{EQU 2}$$

$$i_{R1} = i_1 = 0.04A = 40mA$$

$$i_{R2} = 0.04A = 40mA \rightarrow$$

$$i_{V_S} = i_1 = 0.04A = 40mA$$

$$i_{V_S} = 0.04A = 40mA \uparrow$$

$$i_{R2} = i_1 - i_2 = 0.04 - 0.02$$

$$i_{R2} = 0.02A = 20mA \downarrow$$

$$i_{R3} = i_2$$

$$i_{R3} = 20mA = 0.02A \downarrow$$

$$V_{R1} = R_1 (i_1) = 500(0.04)$$

$$V_{R1} = 20V \pm \leftarrow$$

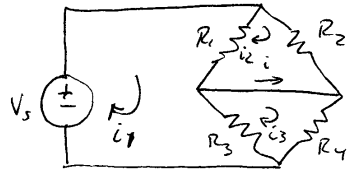
$$V_{R2} = R_2 (i_1 - i_2) = 500(0.04 - 0.02)$$

$$V_{R2} = 10V \pm \leftarrow$$

$$V_{R3} = R_3 i_2 = 500(0.02)$$

$$V_{R3} = 10V \pm \leftarrow$$

PROBLEM 2



GIVEN: $R_1 = 6\Omega$, $R_2 = 12\Omega$
 $R_3 = 12\Omega$, $R_4 = 6\Omega$
 $V_s = 10V$

FIND: ALL MESH CURRENTS
 i_{R2} , V_{R4} , i_{V_s} , i

$i_1, i_2, i_3 \rightarrow$ unknown

KVL M1

$$-V_s + R_1(i_1 - i_2) + R_3(i_1 - i_3) = 0$$

$$V_s = (R_1 + R_3)i_1 - R_1i_2 - R_3i_3 \quad \text{Eq. 1}$$

$$i_1 = \frac{5}{4} A = 1.25 A \leftarrow$$

$$i_2 = \frac{5}{6} A = 0.833 A \leftarrow$$

$$i_3 = \frac{15}{36} A = 0.4167 A \leftarrow$$

KVL M2

$$R_1(i_2 - i_1) + R_2i_2 = 0$$

$$-R_1i_1 + (R_1 + R_2)i_2 = 0 \quad \text{Eq. 2}$$

$$i_{R2} = i_2$$

$$i_{R2} = 0.833 A \leftarrow$$

KVL M3

$$R_3(i_3 - i_1) + R_4i_3 = 0$$

$$-R_3i_1 + (R_3 + R_4)i_3 = 0 \quad \text{Eq. 3}$$

$$V_{R4} = R_4(i_3)$$

$$V_{R4} = 5V \leftarrow$$

$$i_{V_s} = i_1$$

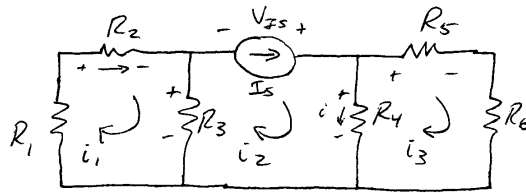
$$i_{V_s} = 1.25 A \leftarrow$$

$$i = i_3 - i_2$$

$$i = 0.4167 A \leftarrow$$

EE301/303 SPO9 HW #4 SOLUTION

PROBLEM 3



GIVEN: $R_1 = 15\Omega$, $R_2 = 15\Omega$
 $R_3 = 30\Omega$, $R_4 = 40\Omega$
 $R_5 = 20\Omega$, $R_6 = 20\Omega$
 $I_S = 100\text{mA}$

KNOWN: $i_2 = I_S$
 $i_2 = 100\text{mA} \leftarrow$

FIND: ALL MESH CURRENTS
 $i_{R2}, i_{R4}, V_{R5}, V_{R3}$
 V_{I_S}

UNK: i_1, i_3

KVL M1

$$R_1 i_1 + R_2 i_1 + R_3 (i_1 - i_2) = I_S R_3$$

$$(R_1 + R_2 + R_3) i_1 = R_3 I_S$$

$$i_1 = \frac{R_3 I_S}{R_1 + R_2 + R_3} = \frac{30(0.1)}{15 + 15 + 30}$$

$i_1 = 0.05\text{A} = 50\text{mA} \leftarrow$

$i_{R2} = i_1$
 $i_{R2} = 0.05\text{A} = 50\text{mA} \leftarrow$

$i_{R4} = i_2 - i_3$
 $i_{R4} = 0.1 - 0.05$
 $i_{R4} = 0.05\text{A} = 50\text{mA} \downarrow \leftarrow$

KVL M2

$$-V_{I_S} + R_4 (i_2 - i_3) - R_3 (i_1 - i_2) = 0$$

$$V_{I_S} = 40(0.1 - 0.05) - 30(0.05 - 0.1)$$

$$V_{I_S} = 2 - (-1.5)$$

$V_{I_S} = 3.5\text{V} \leftarrow$

KVL M3

$$R_4 (i_3 - i_2) + R_5 i_3 + R_6 i_3 = 0$$

$$R_4 I_S = (R_4 + R_5 + R_6) i_3$$

$$i_3 = \frac{R_4 I_S}{R_4 + R_5 + R_6} = \frac{40(0.1)}{40 + 20 + 20}$$

$i_3 = 0.05\text{A} = 50\text{mA} \leftarrow$

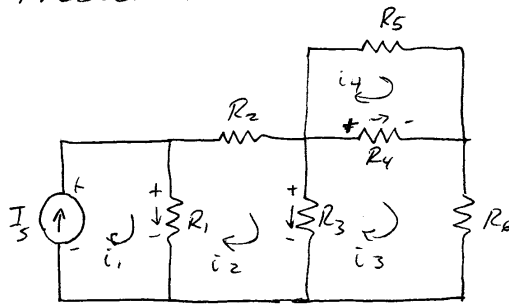
$V_{R5} = R_5 i_3 = 20(0.05)$

$V_{R5} = 1\text{V} \leftarrow$

$V_{R3} = R_3 (i_1 - i_2) = 30(0.05 - 0.1)$

$V_{R3} = -1.5\text{V} = 1.5\text{V} \leftarrow$

PROBLEM 4



GIVEN: $R_1 = 20\Omega$, $R_2 = 10\Omega$

$R_3 = R_4 = R_5 = 20\Omega$

$R_6 = 30\Omega$

$I_s = 5A$

FIND: • ALL MESH CURRENTS

• i_{R3} , i_{R4}

• V_{R1}

• V_{I_s}

KNOWN: $i_1 = I_s$ UNK: i_2, i_3, i_4

$i_1 = 5A$ ←

KVL M2

$$R_1(i_2 - I_s) + R_2 i_2 + R_3(i_2 - i_3) = 0$$

$$\boxed{R_1 I_s = (R_1 + R_2 + R_3) i_2 - R_3 i_3} \text{ Eqn 1}$$

KVL M3

$$R_3(i_3 - i_2) + R_4(i_3 - i_4) + R_6 i_3 = 0$$

$$\boxed{-R_3 i_2 + (R_3 + R_4 + R_6) i_3 - R_4 i_4 = 0} \text{ Eqn 2}$$

KVL M4

$$R_5 i_4 + R_4(i_4 - i_3) = 0$$

$$\boxed{-R_4 i_3 + (R_4 + R_5) i_4 = 0} \text{ Eqn 3}$$

Solving Eqns:

$i_2 = 2.31A$

$i_3 = 0.769A$

$i_4 = 0.385A$

$i_{R3} = i_2 - i_3$

$i_{R3} = 1.54A$ ↓ ←

$i_{R4} = i_3 - i_4$

$i_{R4} = 0.385A$ ←

$V_{R1} = R_1(i_1 - i_2)$

$V_{R1} = 53.84V$ ± ←

KVL M1

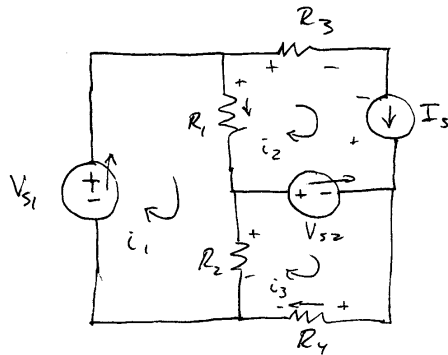
$-V_{I_s} + R_1(i_1 - i_2) = 0$

$V_{I_s} = R_1(i_1 - i_2)$

$V_{I_s} = 53.84V$ ± ←

PROBLEM 5

GIVEN: $R_1 = R_2 = 10\text{K}\Omega$, $R_3 = 2\text{K}\Omega$
 $R_4 = 1\text{K}\Omega$, $V_{S1} = 12\text{V}$
 $V_{S2} = 0.5\text{V}$, $I_S = 2.5\text{mA}$



FIND: • All MESH CURRENTS
 • i_{R1} , i_{R4} , V_{R3} , V_{R2}
 • $i_{V_{S1}}$, V_{I_S} , $i_{V_{S2}}$

KNOWN: $i_2 = I_S$
 $i_2 = 2.5\text{mA}$ ←

UNK: i_1 , i_3

KVL M1

$$-V_{S1} + R_1(i_1 - i_2) + R_2(i_1 - i_3) = 0$$

$$V_{S1} + R_1 I_S = (R_1 + R_2) i_1 - R_2 i_3 \quad \text{Eq 1}$$

KVL M3

$$R_4 i_3 + R_2(i_3 - i_1) + V_{S2} = 0$$

$$V_{S2} = R_2 i_1 - (R_2 + R_4) i_3$$

$$i_{V_{S1}} = i_1$$

$$i_{V_{S1}} = 3.3\text{mA} \uparrow$$

$$i_{V_{S2}} = i_3 - i_2$$

$$i_{V_{S2}} = -0.5\text{mA} = 0.5\text{mA}$$

KVL M2

$$R_3 i_2 - V_{I_S} - V_{S2} - R_1(i_1 - i_2) = 0$$

$$V_{I_S} = -V_{S2} + R_2 i_2 - R_1(i_1 - i_2)$$

$$V_{I_S} = -4\text{V} \leftarrow$$

$$i_1 = 3.3\text{mA} \leftarrow$$

$$i_3 = 3\text{mA} \leftarrow$$

$$i_{R1} = i_1 - i_2$$

$$i_{R1} = 0.85\text{mA} \downarrow \leftarrow$$

$$i_{R4} = i_3$$

$$i_{R4} = 3\text{mA} \leftarrow$$

$$V_{R3} = R_3 i_2$$

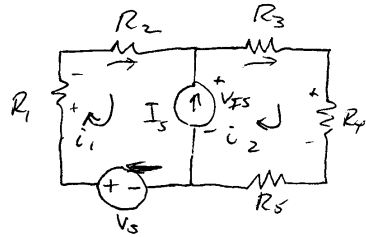
$$V_{R3} = 5\text{V} \leftarrow$$

$$V_{R2} = R_2(i_1 - i_3)$$

$$V_{R2} = 3.5\text{V} \leftarrow$$

EE301/303 SP09 HW#4 SOLUTION

PROBLEM 6



Given: $V_5 = 12V$, $I_5 = 5mA$

$R_1 = 300\Omega$, $R_2 = 500\Omega$

$R_3 = 60\Omega$, $R_4 = 240\Omega$

$R_5 = 180\Omega$

Find: Mesh currents, i_{R2} , i_{R3} , V_{R1} , V_{R4} , i_{V5} , V_{R5}

i_1, i_2 UNK & DEPENDENT?

$$i_2 - i_1 = I_5 \quad \text{EQU 1}$$

KVL M1

$$-V_5 + R_1 i_1 + R_2 i_1 + V_{I5} = 0$$

KVL M2

$$-V_{I5} + R_3 i_2 + R_4 i_2 + R_5 i_2 = 0$$

$$V_{I5} = (R_3 + R_4 + R_5) i_2$$

COMBINED KVL M1/M2 (SUPERMESH)

$$-V_5 + (R_1 + R_2) i_1 + (R_3 + R_4 + R_5) i_2 = 0$$

$$i_1 = 7.5mA \quad \leftarrow$$

$$i_2 = 12.5mA \quad \leftarrow$$

$$V_5 = (R_1 + R_2) i_1 + (R_3 + R_4 + R_5) i_2 \quad \leftarrow \text{EQU 2.}$$

$$i_{R2} = i_1$$

$$i_{R2} = 7.5mA \quad \leftarrow$$

$$i_{R3} = i_2$$

$$i_{R3} = 12.5mA \quad \leftarrow$$

$$V_{R1} = R_1 i_1$$

$$V_{R1} = 2.25V \quad \leftarrow$$

$$V_{R4} = R_4 i_2$$

$$V_{R4} = 3V \quad \leftarrow$$

FROM KVL M2

$$V_{I5} = (R_3 + R_4 + R_5) i_2$$

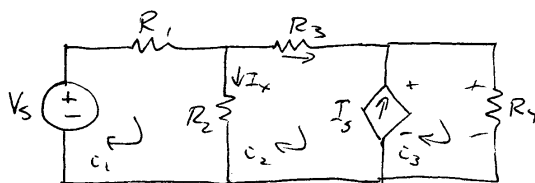
$$V_{I5} = 6V \quad \leftarrow$$

$$i_{V5} = i_1$$

$$i_{V5} = 7.5mA$$

1007

PROBLEM 7



Given: $R_1 = 10\Omega$, $R_2 = 2\Omega$

$R_3 = 1\Omega$, $R_4 = 5\Omega$

$I_s = 4I_x$, $V_s = 30V$

FIND: ALL MESH CURRENTS

i_{R3}, V_{R4}

i_{V5}, V_{I5}, I_s, I_x

KVL M1

$$-V_s + R_1 i_1 + R_2 (i_1 - i_2) = 0$$

$$V_s = (R_1 + R_2) i_1 - R_2 i_2 \quad \text{Eq. 2}$$

KVL M2

$$R_2 (i_2 - i_1) + R_3 i_2 + V_{I5} = 0$$

KVL M3

$$-V_{I5} + R_4 i_3 = 0$$

$$V_{I5} = R_4 i_3$$

COMBINED M2/M3 KVL

$$R_2 (i_2 - i_1) + R_3 i_2 + R_4 i_3 = 0$$

$$-R_2 i_1 + (R_2 + R_3) i_2 + R_4 i_3 = 0 \quad \text{Eq. 3}$$

$$i_{R3} = i_2$$

$$i_{R2} = 5A \leftarrow$$

$$V_{R4} = i_3 \cdot R_4$$

$$V_{R4} = -8.33V \leftarrow$$

$$I_x = i_1 - i_2 = -$$

$$I_x = -1.667A \leftarrow$$

$$i_{V5} = i_1$$

$$i_{V5} = 3.33A \leftarrow$$

$$V_{I5} = R_4 i_3$$

$$V_{I5} = -8.33V \leftarrow$$

$$I_s = 4I_x$$

$$I_s = -6.667A \leftarrow$$

i_1, i_2, i_3 unknown

i_2, i_3 dependent

$$i_3 - i_2 = I_s$$

$$I_s = 4I_x$$

$$I_x = i_1 - i_2$$

$$I_s = 4(i_1 - i_2)$$

$$i_3 - i_2 = 4i_1 - 4i_2$$

$$\text{Eq. 1} \quad 4i_1 - 3i_2 - i_3 = 0$$

$$i_1 = 3.33A$$

$$i_2 = 5A$$

$$i_3 = -1.667A$$