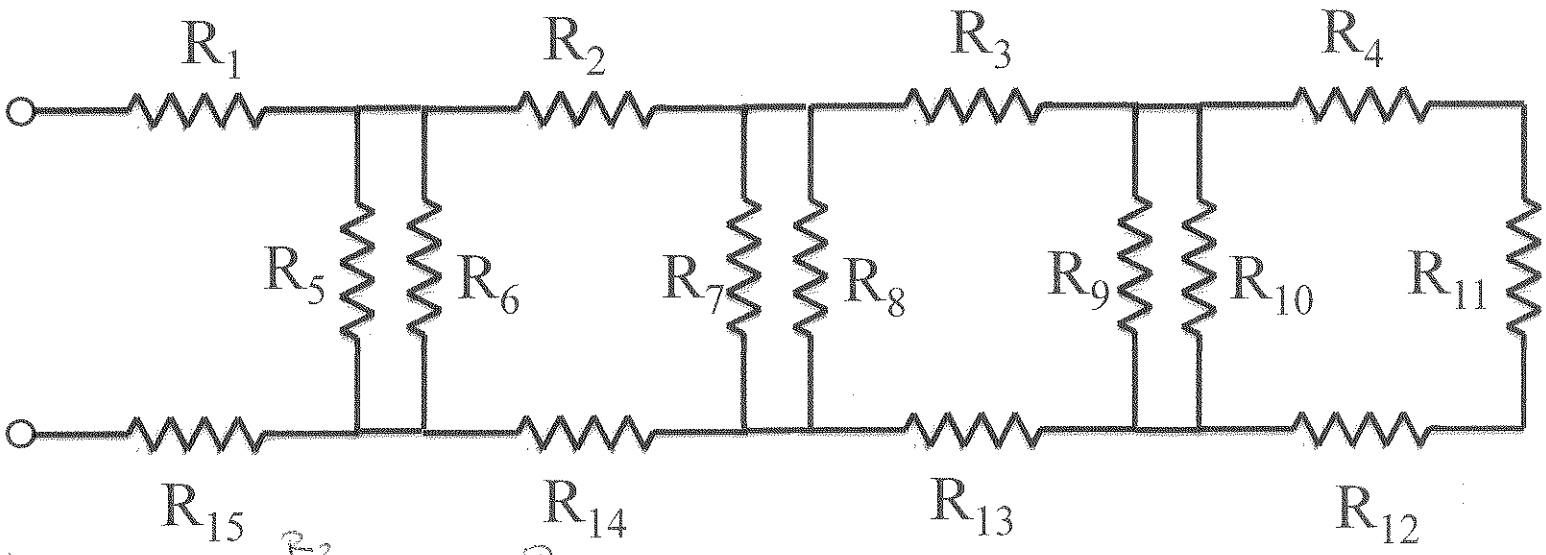
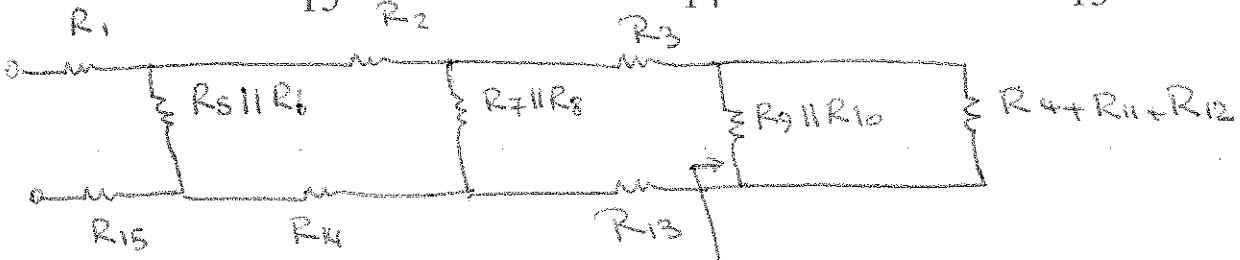
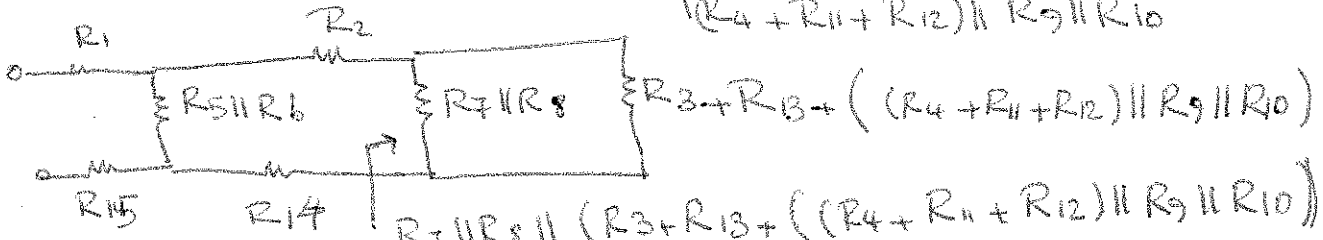
Problem 1: Solve for R_{eq}. You may use the parallel notation discussed in class.

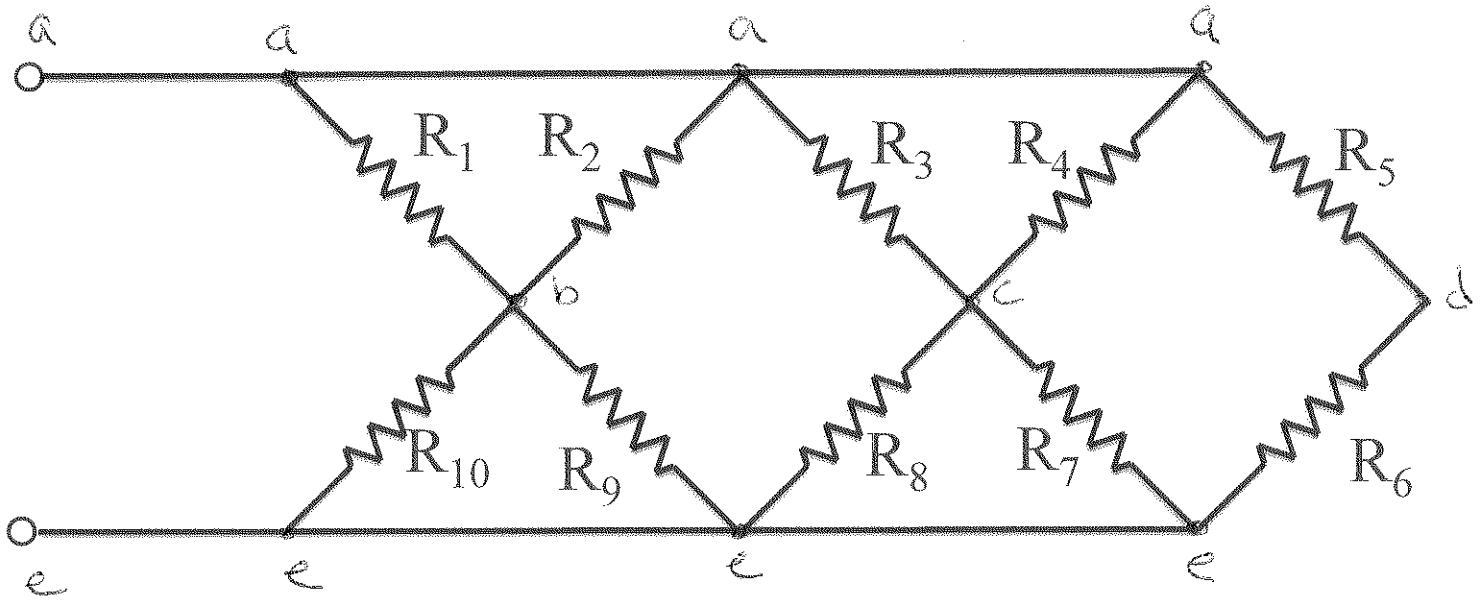


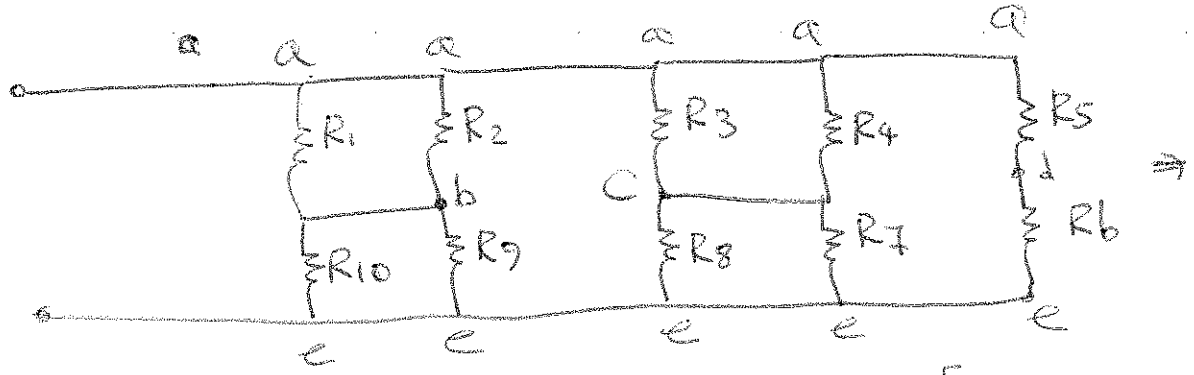


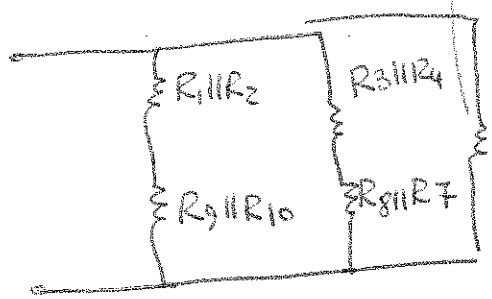


$$\Rightarrow R_{eq} = R_1 + R_{15} + \Big(R_5 \| R_6 \| \big(R_2 + R_{14} + \big(R_3 + R_{13} + \big((R_4 + R_{11} + R_{12}) \| R_9 \| R_{10}\big)\big) \| R_7 \| R_8\big)\Big)$$

Problem 2: Solve for R_{eq}. You may use the parallel notation discussed in class.

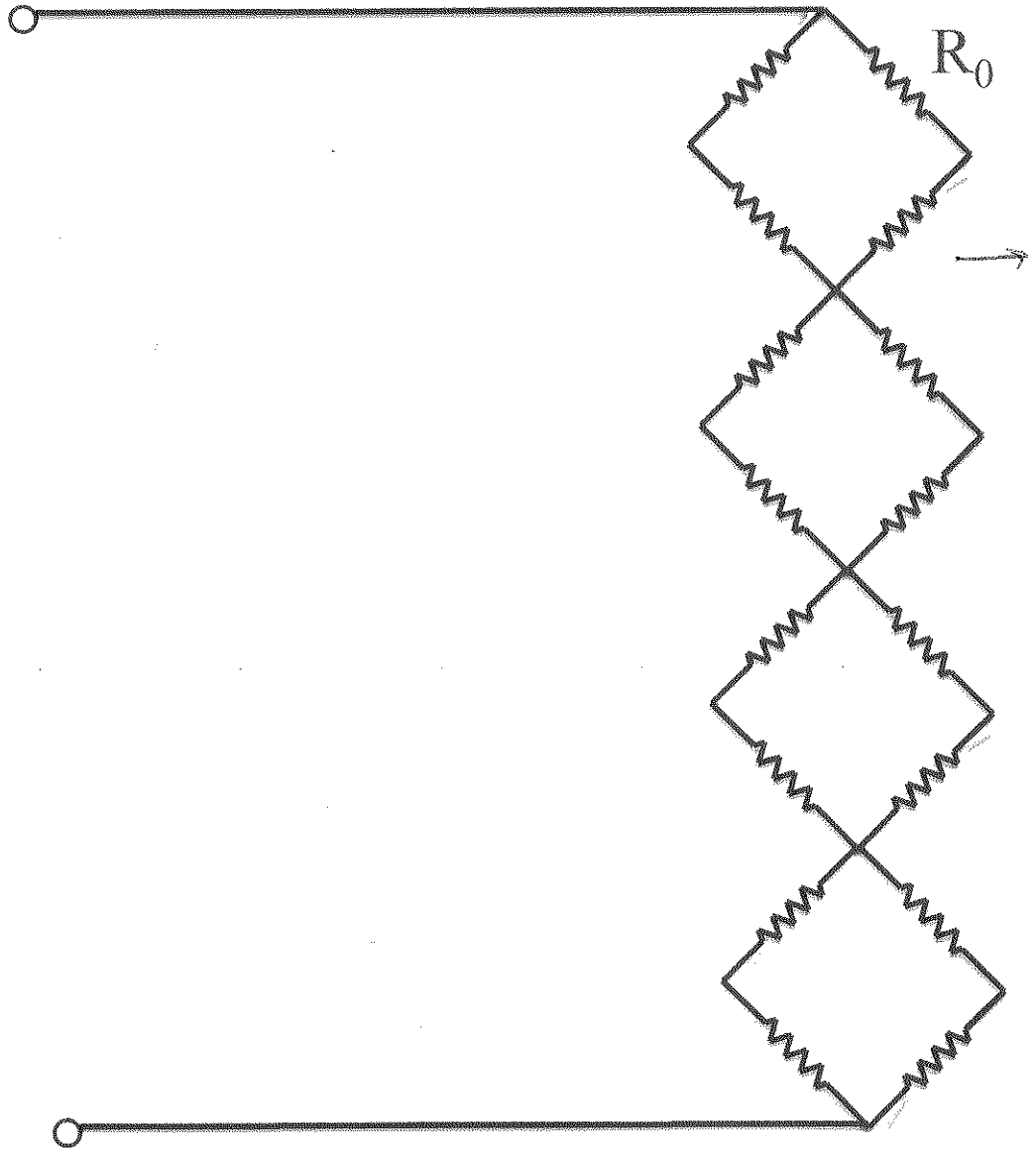


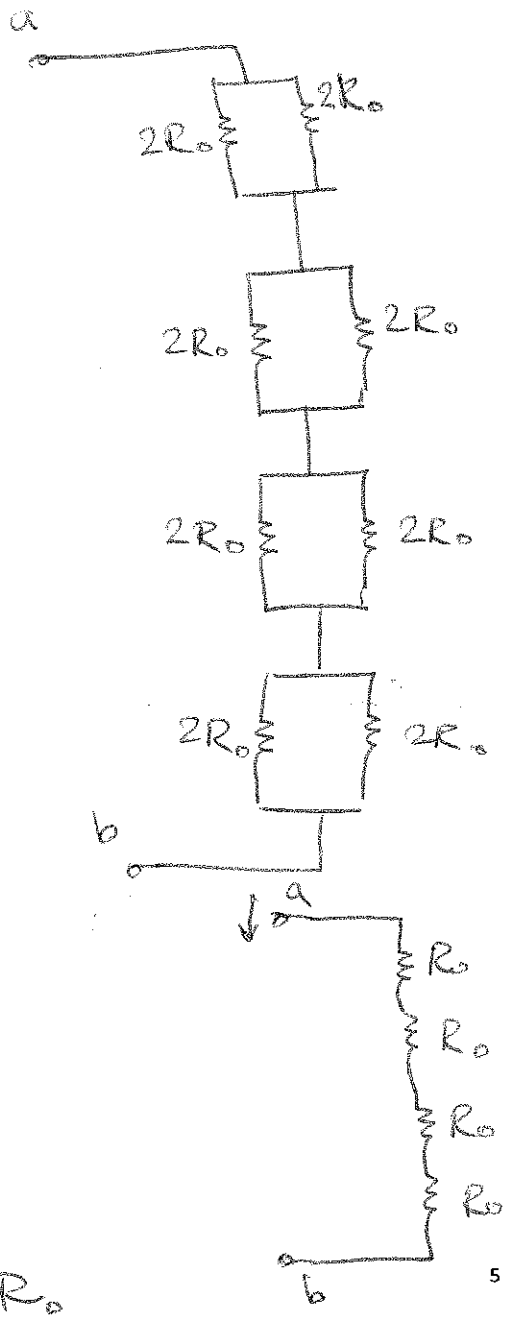




$$R_{eq} = (R_5+R_6) \,||\, \left[(R_3||R_4)+(R_8||R_7)\right] \,||\, \left[(R_1||R_2)+(R_9||R_{10})\right]$$

Problem 3: Solve for R_{eq}. All resistors have the same value R_0.

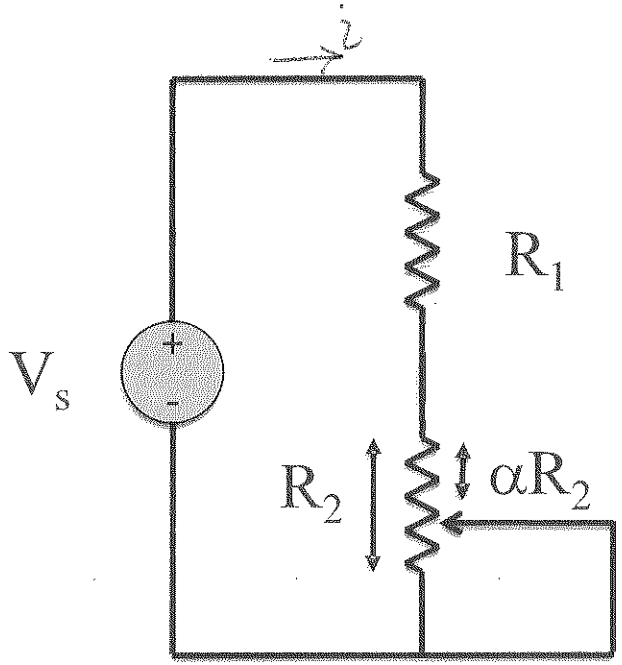




$\Rightarrow R_{eq} = 4R_0$

Problem 4: Potentiometer.

In the circuit below, the wiper divides the potentiometer resistance between αR_2 and $(1-\alpha)R_2$, where $0<\alpha<1$. Find the ratio of the power dissipated in R_1 to the power supplied by the voltage source (P1/Ps) as a function of α.



$$i_1 = \frac{V_S}{R_1 + \alpha R_2}$$

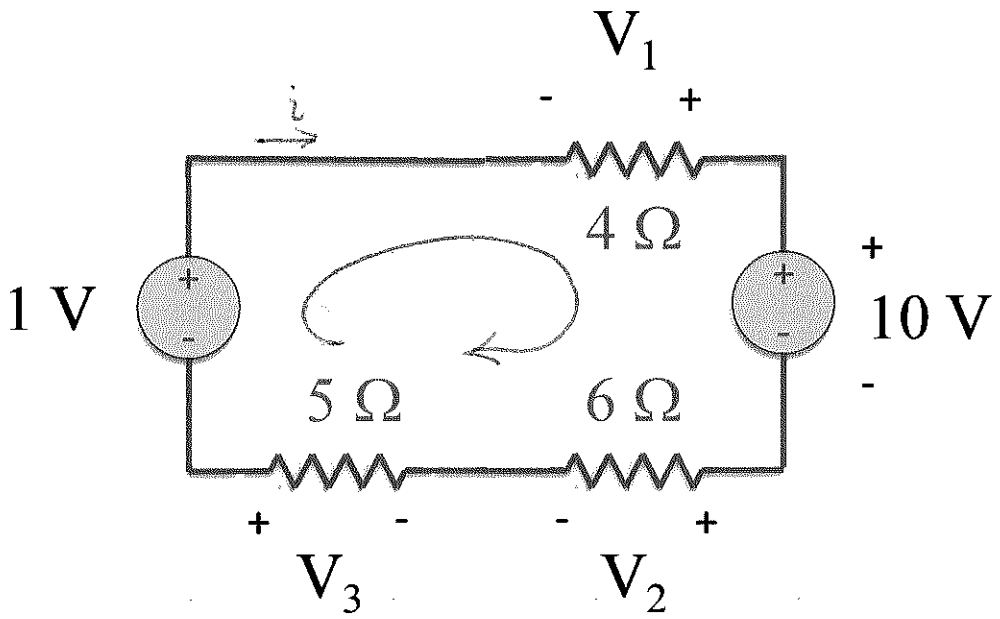
$$P_1 = i^2 \times R_1 = \frac{V_S^2 \cdot R_1}{(R_1 + \alpha R_2)^2}$$

$$P_S = V_S \cdot i = \frac{V_S^2}{R_1 + \alpha R_2}$$

$$\frac{P_1}{P_S} = \frac{\frac{V_S^2 \cdot R_1}{(R_1 + \alpha R_2)^2}}{\frac{V_S^2}{R_1 + \alpha R_1}} = \frac{R_1}{R_1 + \alpha R_2}$$

Problem 5: KVL & Ohm

Find V_1 through V_3 and the current flowing in the circuit below.



KVL: $-1 - V_1 + 10 + V_2 - V_3 = 0$

$\Rightarrow V_2 - V_1 - V_3 = -9$ *

Ohm's Law:

$$\begin{cases} V_2 = iR_2 = 6i \\ V_1 = -i_1 R_1 = -4i \\ V_3 = -i_1 R_3 = -5i \end{cases}$$

* $6i + 4i + 5i = -9 \Rightarrow i = -0.6\ A$

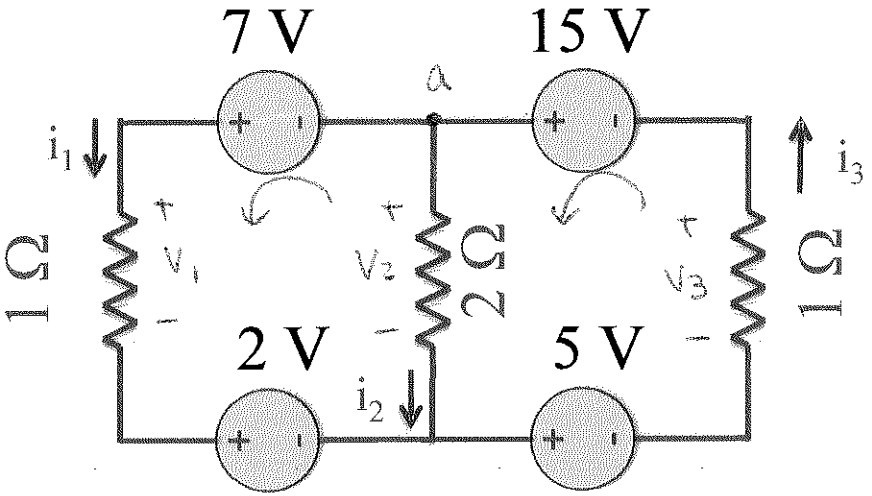
$V_2 = -3.6\ V$

$V_1 = 2.4\ V$

$V_3 = 3V$

Problem 6: KVL, KCL & Ohm

Find i_1 through i_3 in the circuit below.



KCL at node a: $i_3 = i_2 + i_1$

Ohm's Law:

$V_1 = i_1 \times 1\Omega = i_1$

$V_2 = i_2 \times 2\Omega = 2i_2$

$V_3 = -i_3 \times 1\Omega = -i_3$

KVL

$$\begin{cases} V_1 + 2 - V_2 - 7 = 0 \\ V_2 + 5 - V_3 - 15 = 0 \end{cases}$$

replace with i ⟹

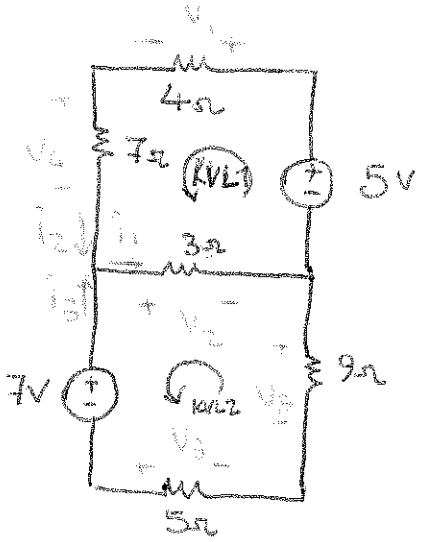
$$\begin{cases} i_1 - 2i_2 = 5 \\ 2i_2 + i_3 = 10 \end{cases}$$

replace i_3 from KCL ⟹

$$\begin{cases} i_1 - 2i_2 = 5 \\ 2i_2 + (i_1 + i_2) = 10 \end{cases}$$

$$\Rightarrow \begin{cases} i_1 - 2i_2 = 5 \\ 3i_2 + i_1 = 10 \end{cases} \Rightarrow \begin{cases} i_1 = 7\,A \\ i_2 = 1\,A \end{cases} \Rightarrow i_3 = 8\,A$$

Problem 7 : Find V_1 through V_4 and i_1 through i_3 in the circuit below.



KVL1: $V_1 + V_4 + V_2 - 5 = 0$

KVL2: $7 + V_3 - V_5 - V_2 = 0$

↓ replace with currents

$$\begin{cases} 4i_2 + 7i_2 + 3i_1 = 5 \\ 7 - 5i_3 - 9i_3 - 3i_1 = 0 \end{cases}$$

↓

$$\begin{cases} 11i_2 + 3i_1 = 5 \\ 3i_1 + 14i_3 = 7 \end{cases}$$

↓ replace i_1 with $i_2 + i_3$

$$\begin{cases} 11i_2 + 3(i_2 + i_3) = 5 \\ 3(i_2 + i_3) + 14i_3 = 7 \end{cases}$$

$$\begin{cases} 14i_2 + 3i_3 = 5 \\ 3i_2 + 17i_3 = 7 \end{cases}$$

$$\begin{cases} 238i_2 + 51i_3 = 85 \\ 9i_2 + 51i_3 = 21 \end{cases}$$

$$\Rightarrow \quad i_2 = 0.28\,A, \quad i_3 = 0.36\,A, \quad i_1 = 0.28 + 0.36 = 0.64\,A$$

Ohm's Law

$V_1 = 4 \cdot i_2$

$V_2 = 3 \cdot i_1$

$V_3 = -5i_3$

$V_4 = 7 \cdot i_2$

$V_5 = 9i_3$

KCL: $i_1 = i_2 + i_3$

$\Rightarrow$

$V_1 = 1.12\,V$

$V_2 = 1.92\,V$

$V_3 = -1.8\,V$

$V_4 = 1.96\,V$

$V_5 = 3.24\,V$