PROBLEM 1

Using the passive sign convention, mark the polarity of the current source and the direction of current flow through the voltage source & resistor.

PROBLEM 2

Using Ohm's law, given that \( V_{ES} = 2.5 \text{ Volts} \), \( R_3 = R_4 = 250 \Omega \), \( I_{R_1} = 10 \text{ mA} \) & \( R_1 = 2 \text{ K}\Omega \), find the current through \( R_3 \) & voltage drop across \( R_1 \).

\[ V_{R_1} = R_1 \cdot I_{R_1} = 2000 \times 0.01 \]

\[ V_{R_2} = 20 \text{V} \]

\[ I_{R_3} = \frac{V_{R_3}}{R_3} = \frac{2.5}{250} = 0.01 \text{mA} \]

Note: There is an inconsistency in this problem; only use Ohm's law. Fix solution.
Problems 3

Using KCL, find values of $I_S$ & $I_4$ given that $I_{R_2} = 20 \text{mA}$, $I_{R_3} = 10 \text{mA}$ & $I_{R_5} = 3 \text{mA}$.

**KCL NA:**

\[
I_S - I_{R_2} = 0
\]
\[
I_S = I_{R_2}
\]
\[
I_S = 20 \text{mA}
\]

**KCL NB:**

\[
I_{R_2} - I_{R_3} - I_{R_4} - I_{R_5} = 0
\]
\[
I_{R_2} = 20 \text{mA}
\]
\[
I_{R_3} = 10 \text{mA}
\]
\[
I_{R_4} = 3 \text{mA}
\]
\[
I_{R_5} = 7 \text{mA}
\]

Check KCL NC:

\[-I_S + I_{R_3} + I_{R_4} + I_{R_5} = 0\]
\[-20 + 10 + 7 + 3 = 0\]
\[0 = 0 \text{V}\]
Problem 4

Using KVL, find \( V_{R1}, V_{R2} \)

KVL L1: \(-25 + 5 + V_{R1} = 0\)
\( V_{R1} = 20 V \)

KVL OUTER LOOP:
\(-25 + 5 + V_{R2} + 15 V = 0\)
\( V_{R2} = 25 - 5 - 15\)
\( V_{R2} = 5 V \)

CHECK KVL L2: \(-V_{R1} + V_{R2} + 15 V = 0\)
\(-20 + 5 + 15 V = 0\)
\( 0 = 0 \)

Problem 5

The Cost of Energy is $0.25/kWh. If the Power Delivered is 200 watts, the Electric Bill for 20 days is $153.

Find the Power in Watts Delivered if the Current on the Supply Voltage is 120V.

\[
\text{Power} = \frac{\text{Cost}}{\text{Efficiency}} \cdot \frac{1}{\text{Days}} \cdot \frac{1000 \text{W}}{1 \text{kW}} = \frac{910.71 \text{ W}}{120 \text{ V}} = 7.59 \text{ A}
\]
**Problem 6**

Using KCL, KVL & Ohm's Law:

- Given: \( V_s = 15 \text{ V}, V_R2 = 5 \text{ V} \)
- \( R_1 = 500 \Omega, R_2 = 500 \Omega, R_3 = 500 \Omega \)

**KVL Outer Loop:**
- \(-V_s + V_{R1} + V_{R2} = 0\)
- \(V_{R1} = V_s - V_{R2} = 15 - 5 = 10 \text{ V} \)
- \(V_{R2} = 5 \text{ V} \)

**KVL LI:**
- \(-V_s + V_{R2} + V_{R3} = 0\)
- \(15 - 10 + V_{R3} = 0\)
- \(V_{R3} = 5 \text{ V} \)

Currents can be found using Ohm's Law:

- \(I_{R1} = \frac{V_{R1}}{R_1} = \frac{10}{500} = 0.02 \text{ A} = 20 \text{ mA} \)
- \(I_{R2} = \frac{V_{R2}}{R_2} = \frac{5}{500} = 0.01 \text{ A} = 10 \text{ mA} \)
- \(I_{R3} = \frac{V_{R3}}{R_3} = \frac{5}{500} = 0.01 \text{ A} = 10 \text{ mA} \)

\(i_{S1} = I_{R1} = 0.02 \text{ A} \)

\(P_{R1} = i_{R1} \cdot V_{R1} = (0.02)(10) = 0.2 \text{ W} \)

\(P_{R2} = i_{R2} \cdot V_{R2} = (0.01)(5) = 0.05 \text{ W} \)

\(P_{R3} = i_{R3} \cdot V_{R3} = (0.01)(5) = 0.05 \text{ W} \)

\(? P_{S3} = P_{R1} + P_{R2} + P_{R3} => 0.3 = 0.2 + 0.05 + 0.05 \)

\(0.3 = 0.3 \checkmark \)
**Problem 7**

Using KVL, find values for $V_{21}, V_{22},$ and $V_{23}$.

- **KVL L1:** $-5 + V_{21} + 10 = 0$
  - $V_{21} = -10 + 5$
  - $V_{21} = -5$

- **KVL L2:** $-10 + 15 - V_{23} = 0$
  - $V_{23} = -10 + 15$
  - $V_{23} = 5$

- **KVL L3:** $+V_{22} - 15 - V_{21} = 0$
  - $V_{22} = +15 - V_{21} = 15 - (-5)$
  - $V_{22} = 10$

**Check outer loop:** $-5 + V_{22} + V_{23} = 0$

- $-5 + 10 - 5 = 0$
- $-10 + 10 = 0$

*Note: Different solution paths are possible.*
Problem 9

Using KCL, find values for $I_1$, $I_2$, and $I_3$. What does a negative current mean?

\[ KCL \text{NC} \]
\[ I_3 + 12 - 4 = 0 \]
\[ I_3 = 8 - 12 \]
\[ I_3 = -4 mA \]

\[ \underline{\text{CHECK}} \]
\[ -2 - 12 + I_2 = 0 \]
\[ 14 mA = I_2 \]

\[ KCL \text{NA} \]
\[ 2mA - I_3 - I_1 = 0 \]
\[ 2 - (-4) = I_1 \]
\[ 2 + 8 = I_1 \]
\[ I_1 = 10 mA \]

\[ KCL \text{NB} \]
\[ I_1 - I_2 + 4 = 0 \]
\[ 10 + 4 = I_2 \]

\[ 14 mA = I_2 \]

Note:
Different solution path is possible

A negative current indicates that the current is really flowing in the opposite direction.
Problem 10

Write the KCL equation for the supernode shown.

Using the values for the currents found in Problem 9, show that KCL is valid for the supernode.

\[ I_3 - 2 \text{mA} - 4 \text{mA} + I_2 = 0 \]
\[ -8 - 2 - 4 + 14 = 0 \]
\[ -14 + 14 = 0 \]