MA2009 Tutorial 1

Circuits Fundamentals

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Kirchhoff’s Law

\[ \sum_{\text{node}} i_n = 0 \]

\[ \sum_{\text{loop}} v_n = 0 \]
T1.1: Kirchhoff’s Law

- Apply KVL to find the voltages $V_1$ and $V_2$

Kirchhoff’s Voltage Law:

$$\sum v_n = 0$$

1. **Loop 1**

$$\sum v_n = -5 + 3 + v_2 = 0 \quad \Rightarrow \quad v_2 = 2V$$

2. **Loop 2**

$$\sum v_n = -5 + 3 - 10 + v_1 = 0 \quad \Rightarrow \quad v_1 = 12V$$
T1.2: Kirchhoff’s Law

- Identify all nodes in the circuit below
- Using KCL, determine the current through $R_3$ know that

\[ V_S = 12V \]

\[ R_S = 1k\Omega, R_1 = 2k\Omega \]

\[ R_2 = 4k\Omega, R_3 = 6k\Omega \]

Kirchhoff ‘s Current Law: \[ I_1 = I_2 + I_3 \]

Since $R_2$ and $R_3$ are in parallel:

\[ R_2I_2 = R_3I_3 \]

Kirchhoff ‘s Voltage Law:

\[ V_S = (R_S + R_1)I_1 + R_3I_3 \]

\[ \therefore I_3 = \frac{V_S}{(R_S + R_1)(R_3 / R_2 + 1) + R_3} = 0.8mA \]
T1.3: Ohm’s Law

- Use Ohm’s law and KCL to determine the current in the circuit.

Applying KCL, we have

\[ I_1 + I_2 = 10 \text{A} \]

Denoting \( V \) the voltage across the resistors and applying Ohm’s law, we have

\[ I_1 = \frac{V}{15 \Omega}, \quad I_2 = \frac{V}{30 \Omega} \]

which, substituted in the first equation, leads to

\[ \frac{V}{15 \Omega} + \frac{V}{30 \Omega} = 10 \text{A} \quad \therefore V = 100 \text{V} \]

Then, use Ohm’s law to determine the currents

\[ I_1 = 6.66 \text{A}, \quad I_2 = 3.33 \text{A} \]
T1.4: Kirchhoff’s and Ohm’s Law

a) Use KCL and Ohm’s law to determine the voltage $V$ across the source

\[ I_s = I_1 + I_2 = \frac{V}{R_1} + \frac{V}{R_2} \]

\[ \therefore V = \frac{R_1 R_2}{R_1 + R_2} I_s \]

b) Use KVL and Ohm’s law to determine the current $I$ through the source

\[ V_s = V_1 + V_2 \]

\[ I = \frac{V_s}{R_1 + R_2} \]

\[ V_1 = R_1 I = \frac{R_1}{R_1 + R_2} V_s \]

\[ V_2 = R_2 I = \frac{R_2}{R_1 + R_2} V_s \]