Section 6: Circuits I

1. Series Circuit Analysis

Three resistors, $R_1 = 15\,\Omega$, $R_2 = 30\,\Omega$, and $R_3 = 50\,\Omega$, are connected in series to a 12 V battery.

a) Draw the circuit diagram.
b) Calculate the total equivalent resistance.
c) Calculate the current flowing from the battery.

2. Parallel Circuit Analysis

The same three resistors ($R_1 = 15\,\Omega$, $R_2 = 30\,\Omega$, $R_3 = 50\,\Omega$) are now connected in parallel to the 12 V battery.

a) Draw the circuit diagram.
b) Calculate the total equivalent resistance.
c) Calculate the current flowing through each resistor.
d) Calculate the total current flowing from the battery.

3. Mixed Circuit

A resistor $R_1 = 10\,\Omega$ is connected in series with a parallel combination of two other resistors, $R_2 = 20\,\Omega$ and $R_3 = 20\,\Omega$. The entire circuit is connected to a 6 V source. What is the total current drawn from the source?

4. Kirchhoff's Laws

Using Kirchhoff's laws, find the currents I_1, I_2, I_3 in a circuit with two loops. Loop 1 (left): a 10V battery and a 2Ω resistor, shared branch in the middle. Loop 2 (right): a 5V battery and a 3Ω resistor. The shared branch has a 5Ω resistor. Assume currents are flowing out of the positive terminals.

5. Current Definition

A lightning bolt transfers a charge of 30 Coulombs to the ground in a time of 2 milliseconds. What is the average current of the lightning bolt?

6. Symmetry in Circuits

A cube is constructed from 12 identical resistors, each with resistance R. What is the equivalent resistance between two opposite corners of the cube?

7. Power & Energy

What is the power dissipated by a $100\,\Omega$ resistor when a voltage of 50 V is applied across it? How much energy is consumed in 5 minutes?

8. Multi-Source Circuit

For a circuit consisting of a 2V battery and a 1-ohm resistor in the left loop, and a 1V battery and a 3-ohm resistor in the right loop, with a 2-ohm resistor in the middle branch, calculate all currents.

9. Delta Connection

Find the equivalent resistance of a circuit where three $10\,\Omega$ resistors are connected to form a triangle (delta connection). What is the resistance between any two vertices?

10. Resistor Logic Puzzle

You have an supply of $1\,\Omega$ resistors. How can you combine them to create an equivalent resistance of $2.5\,\Omega$? Draw the diagram.