Electrical Circuits

An electrical circuit consists of various element connected by wires. When the circuit is closed, electrical charges flow through the wire. Basic variables for measurement in circuits:

$Q(t)$: amount of charge in circuit

$I(t)$: current in circuit = flow of charge

These variables are related by the equation:

$$I = \frac{dQ}{dt}$$

To study circuits, we look at the change in electrical potential (the voltage) as you go around the circuit.

Elements of Circuits

1. **Resistor**: opposes current

   E.g. light bulb

   Potential difference (voltage drop) across a resistor is proportional to the current in the resistor:

   $$V_R = RI \qquad \text{Ohm's Law}$$

   R is a constant of proportionality called the *resistance*.

2. **Inductor**: opposes change in current

   Potential difference across an inductor is proportional to the rate of change of current:

   $$V_L = L\frac{dI}{dt} \qquad \text{Law of Induction}$$

   L is a constant of proportionality called the *inductance*.

3. **Capacitor**: stores charge

   Potential difference across a capacitor is proportional to the charge in the capacitor

$$V_C = \frac{Q}{C} \qquad \text{Coulomb's Law}$$

   C is a constant of proportionality called the *capacitance*.

4. The **source or applied voltage** is described by some known function of time, $V(t)$, which depends on the particular source.

   E.g. battery or generator

Units

Q - coulomb	R - ohm
I - ampere	L - henry
E - volt	C - farad

The physical law governing electrical circuits is a statement of conservation of electrical potential energy.
Kirchhoff's Law The algebraic sum of the instantaneous potential differences around any closed circuit is zero.