

# **PHYS 158 Study Notes**

## **Electricity and**

## **Magnetism**

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# 1. Circuits

## 1.1. Basic Components

**Power Supplies (DC/AC)** Direct Current and Alternating Current.

**Resistors (R)** Resists current, consumes power. Light bulbs, lamps are also resistors.

**Capacitors (C)** Stores electric charge and energy. Not to be confused with batteries:

Batteries release energy in a slow manner; capacitors can discharge energy in a short burst.

**Inductors/Stabilizers (L)** Generates induced current, opposing passing current.

## 1.2. Current, Voltage, Capacitance, and Resistance

**Charge (Q)** The amount of electric charge, measured in Coulombs (C).

**Current (I)** The flow of electric charge,  $I = \frac{dQ}{dt}$ , measured in Amperes (A). It is generated by a voltage difference.

**Voltage (V)** The potential difference between two points, measured in Volts (V).

**Capacitance (C)** The ability to store electric charge, measured in Farads (F).

$$Q = CV \quad (1)$$

$$I = \frac{dQ}{dt} = C \frac{dV}{dt} \quad (2)$$

Capacitance of a capacitor depends on its material, area  $A$ , and distance  $d$  between plates.

$$C = \varepsilon \frac{A}{d} \quad (3)$$

where  $\varepsilon$  is the permittivity of the material.

For multiple capacitors,

$$C_{\text{series}} = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \dots} \quad (4)$$

$$C_{\text{parallel}} = C_1 + C_2 + \dots \quad (5)$$

**Resistance (R)** The opposition to the flow of electric current, measured in Ohms ( $\Omega$ ).

$$V = IR \quad (6)$$

$$P = IV = I^2 R = \frac{V^2}{R} \quad (7)$$

Resistance of a resistor depends on its material, length  $L$ , and cross-sectional area  $A$ .

$$R = \rho \frac{L}{A} \quad (8)$$

where  $\rho$  is the resistivity of the material.

For multiple resistors,

$$R_{\text{series}} = R_1 + R_2 + \dots \quad (9)$$

$$\frac{1}{R_{\text{parallel}}} = \frac{1}{R_1} + \frac{1}{R_2} + \dots \quad (10)$$

### 1.3. Voltage Drops

**Electromotive Force (EMF)** The voltage difference between the positive and negative terminals of a DC power supply (battery) is  $V$  or  $\epsilon$ , specified on the battery.

**Resistance** The voltage drop across a resistor is

$$\Delta V_R = IR \quad (11)$$

**Capacitance** The voltage drop across a capacitor is

$$\Delta V_C = \frac{Q}{C} \quad (12)$$

where  $C$  is the capacitance.

**Inductance** The voltage drop across an inductor is

$$\Delta V_L = -L \frac{dI}{dt} \quad (13)$$

where  $L$  is the inductance.