PHYS 158 Study Notes

Electricity and Magnetism

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Contents

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, and Resistance

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

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

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

Resistance (R) The opposition to the flow of electric current, measured in Ohms (Ω).

$$V = IR \tag{1}$$

$$P = IV = I^2R = \frac{V^2}{R} \tag{2}$$

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

$$R = \rho\frac{L}{A} \tag{3}$$

where ρ is the resistivity of the material.

For multiple resistors,

$$R_{\text{series}} = R_1 + R_2 + ... \tag{4}$$

$$\frac{1}{R_{\text{parallel}}} = \frac{1}{R_1} + \frac{1}{R_2} + ... \tag{5}$$

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 ε, specified on the battery.

Resistance The voltage drop across a resistor is

$$\Delta V_R = IR \tag{6}$$

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Capacitance The voltage drop across a capacitor is

$$\Delta V_C = \frac{Q}{C} \tag{7}$$

where C is the capacitance.

Inductance The voltage drop across an inductor is

$$\Delta V_L = -L\frac{\mathrm{d}I}{\mathrm{d}t} \tag{8}$$

where L is the inductance.