

Circuits Lab Notes

Electric Charge (q) – A fundamental physical property of matter which results in a force of attraction or a force of repulsion between objects each having a net electric charge.

Coulomb (C) – SI unit of electric charge. 1 electron = - 1.602 x 10⁻¹⁹ C

Types of Electric Charge – Only two different types of electric charge have been discovered:

Positive designates the type of net charge found in a nucleus of an atom and

Negative designates the type of charge associated with an electron.

Law of Charges – **Like** Charges repel; **Unlike** Charges attract.

Coulomb Force Law – The **magnitude** of the force of interaction between two point charges is proportional to the product of the charges and inversely proportional to the distance squared between the two charges, i.e.

$$F = k \frac{q_1 q_2}{r^2} \quad \text{where} \quad k = 9 \times 10^9 \frac{\text{Nm}^2}{\text{C}^2} \quad \text{and}$$

the **direction** of the force is along the line connecting the two charges.

Electric Field – A region of space in which a electric charge experience a force.

The **magnitude** of the field is equal to the force experienced per unit charge and

the **direction** of the field is the direction of the force on a positive charge.

Electric Field SI Unit = N/C or Volt/ m

Delta Symbol, (Δ) – the difference between values, $\Delta (_) = (_)_{\text{final value}} - (_)_{\text{initial value}}$

Electric Potential Difference (ΔV) – the electric potential energy per unit charge.

Volt (V) – SI unit of Electric potential difference (1V = 1J/coul).

Electromotive Force (EMF) – any device which can establish an electric potential difference across a circuit, e.g. battery, generator, alternator, power supply, etc.

Electric Current (i)– the net movement of electric charge past a given location.

Electric Circuit – a continuous path along which an electric current can flow.

Requirements for an electric current:

An electric potential difference between **any two points** along the current path and electric charges **free to move at every point** along the current path.

Electron Current -- the net movement of negative electric charge past a given location.

Conventional Current – A positively charged current equal in magnitude to the electron current but moving in a direction opposite to the electron current.

Ampere (A) – SI unit of electric current, (1A = 1Coul/sec).

Electric Power delivered to a Circuit ($P = i \Delta V$) SI Unit of Power = Watt (W)

Electrical Resistance (R) – The amount of potential difference across a circuit required to cause one Ampere of current to flow, i.e.

$$R = \Delta V / I$$

Note: Electrical Resistance converts Electrical Energy into Heat.

Electrical Power converted into heat ($P_{\text{heat}} = i^2 R$)

Ohm (Ω) – SI unit of electrical resistance. ($1\Omega = 1 \text{ V/A}$)

Ohm's Law – If the electrical resistance remains constant, then the electric potential drop across a circuit is proportional to the current in the circuit, i.e.

$$\Delta V = R i$$

Internal Resistance (R_i) – the resistance associated with an *EMF*. Part of the potential drop produced by the *EMF* must be used to cause current in the circuit to also flow through the *EMF*. The actual potential drop available to the circuit outside the *EMF* is called the **Terminal Voltage** (V_T) is calculated by the following equation:

$$V_T = EMF - i R_i$$

Note: As the current in a circuit is increased the terminal voltage available to the circuit decreases. The internal resistance is in series with the total resistance of the circuit.

Electrical Capacitance (C) – the amount of charge which must be added or removed to change the electric potential difference by one volt, i.e.

$$C = \Delta q / \Delta V$$

Farad (F) – SI unit of electrical capacitance. ($1 \text{ F} = 1 \text{ C/V}$)

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RC Time Constant - the product of the resistance through which a capacitor is being charged or discharged and the capacitance. This product equals the time for 63% of the charging or discharging to occur. Note: (Ohm)(Farad) = second

Galvanometer – A sensitive device used to measure very small currents.

Voltmeter – A galvanometer protected by a current limiting series resistor used to measure electrical potential differences.

Ammeter - A galvanometer protected by a current limiting shunt (parallel) resistor used to measure electrical current.

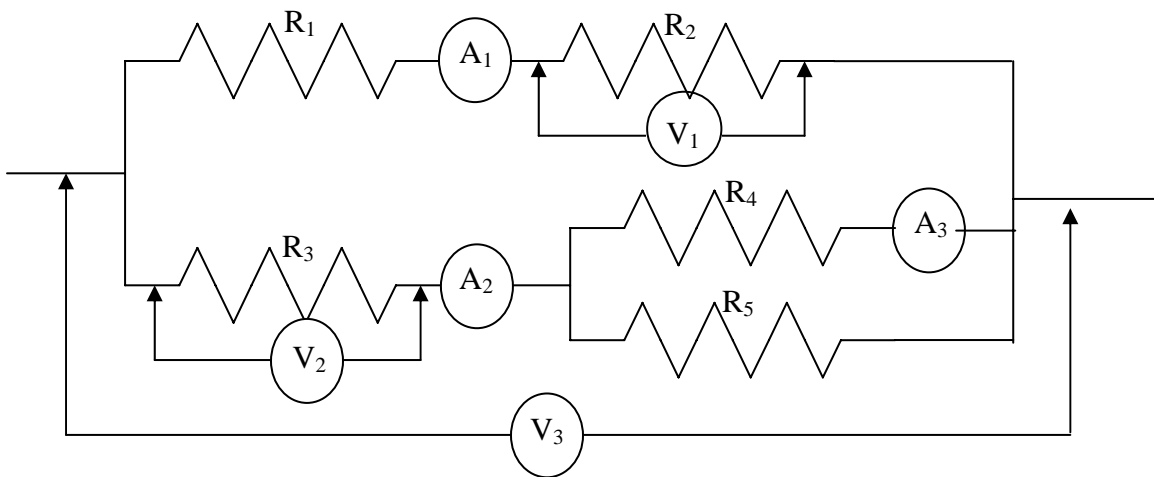
Multimeter – A galvanometer protected by a range of switch selectable series or shunt resistors for the purpose of measuring a range of electrical potential differences, electrical currents, and resistance.

Battery – an *EMF* that converts chemical energy into electrical energy.

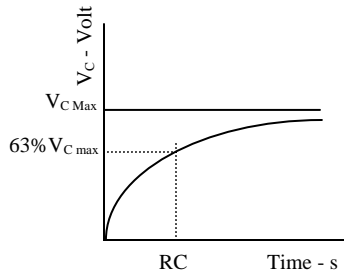
Generator / Alternator – an *EMF* that converts mechanical energy to electrical energy.

Power Supply - an *EMF* that converts electrical energy into a more useful form of electrical energy, usually a different electrical potential difference or from alternating current to direct current or vice versa.

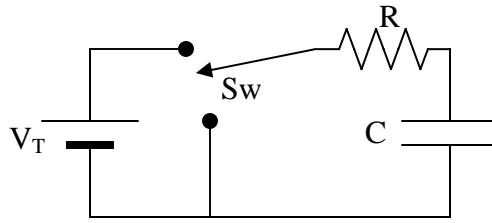
Schematic Diagram – A symbolic representation of a circuit using standardized symbols for circuit components.



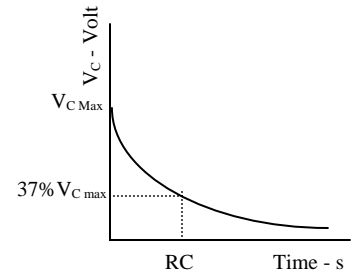
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Graph: RC Circuit Charging



Series RC Circuit with Battery (V_T) and switch



Graph: RC Circuit Discharging

