

Understanding Electrical Circuits

Understanding Electrical Circuits – Study Notes

1. Basic Concepts

Term	Definition	Symbol / Unit
Voltage (Electric Potential Difference)	Work needed to move a unit charge between two points.	(V) – volts (V)
Current	Flow of electric charge through a conductor.	(I) – amperes (A)
Resistance	Opposition to the flow of current.	(R) – ohms (Ω)
Power	Rate at which electrical energy is transferred.	(P = VI) – watts (W)
Conductance	Ease with which current flows (reciprocal of resistance).	(G = 1/R) – siemens (S)

Ohm’s Law

[$V = I \times R$ or $I = \frac{V}{R}$]

Power Relationships

[$P = VI = I^2R = \frac{V^2}{R}$]

2. Circuit Elements

Element	Function	Typical Symbol
Battery / Source	Provides voltage (EMF).	$\displaystyle \boxed{\text{large circle arrow right}}$
Resistor	Limits current, creates voltage drop.	$\displaystyle \boxed{\text{large } \Omega}$
Capacitor	Stores energy in an electric field; blocks DC after charging.	$\displaystyle \boxed{\text{large parallel}}$
Inductor	Stores energy in a magnetic field; opposes changes in current.	$\displaystyle \boxed{\text{large } \text{sqcap}}$

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Element	Function	Typical Symbol
Switch	Opens or closes a path for current.	–
Diode	Allows current in one direction only.	?
Transistor	Amplifies or switches signals.	NPN/PNP symbols

3. Types of Circuits

Type	Description	Key Characteristics
Series Circuit	Components connected end-to-end; same current flows through each.	Total resistance ($R_T = R_1 + R_2 + \dots$); voltage divides.
Parallel Circuit	All component terminals share the same two nodes; voltage is common.	Total resistance ($\displaystyle \frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$); currents add.
Series-Parallel	Combination of series and parallel groups.	Analyze by reducing step-by-step.
Complex (Network)	Arbitrary interconnections; may require Kirchhoff's rules or matrix methods.	Use node-voltage or mesh-current analysis.

4. Kirchhoff's Laws

1. Kirchhoff's Current Law (KCL) – Node rule

$\left[\sum I_{\text{entering}} = \sum I_{\text{leaving}} \right]$ The algebraic sum of currents at any node equals zero.

2. Kirchhoff's Voltage Law (KVL) – Loop rule

$\left[\sum V_{\text{rise}} - \sum V_{\text{drop}} = 0 \right]$ The directed sum of potential differences around any closed loop is