Electronic Components & Circuits Cheatsheet

A quick reference guide to electronic components, basic circuits, and essential concepts for electronics enthusiasts and engineers. This cheatsheet covers fundamental components, circuit laws, common circuit configurations, and important formulas.

Basic Electronic Components

Resistors

Definition:	A passive component that opposes the flow of electric current. Value measured in Ohms (Ω).
Types:	Fixed, Variable (Potentiometers, Trimmers), Thermistors, Photoresistors.
Color Code:	Each band represents a digit, multiplier, or tolerance. Example: Brown Black Red Gold = 1 0 x100 ±5% = 1kΩ ±5%
Ohm's Law:	V = IR Where V = Voltage (Volts), I = Current (Amperes), R = Resistance (Ohms).
Series Resistance:	R_total = R1 + R2 + R3 + ... The total resistance is the sum of individual resistances.
Parallel Resistance:	1/R_total = 1/R1 + 1/R2 + 1/R3 + ... The reciprocal of the total resistance is the sum of the reciprocals of individual resistances.

Capacitors

Definition:	A passive component that stores electrical energy in an electric field. Value measured in Farads (F).
Types:	Ceramic, Electrolytic, Film, Tantalum, Supercapacitors.
Capacitance Formula:	C = Q/V Where C = Capacitance (Farads), Q = Charge (Coulombs), V = Voltage (Volts).
Series Capacitance:	1/C_total = 1/C1 + 1/C2 + 1/C3 + ... The reciprocal of the total capacitance is the sum of the reciprocals of individual capacitances.
Parallel Capacitance:	C_total = C1 + C2 + C3 + ... The total capacitance is the sum of individual capacitances.
Energy Stored:	E = 0.5 * C * V^2 Where E = Energy (Joules), C = Capacitance (Farads), V = Voltage (Volts).

Inductors

Definition:	A passive component that stores energy in a magnetic field when electric current flows through it. Value measured in Henries (H).
Types:	Air-core, Iron-core, Ferrite-core.
Inductance Formula:	V = L * (dI/dt) Where V = Voltage (Volts), L = Inductance (Henries), dI/dt = Rate of change of current (Amperes/second).
Series Inductance:	L_total = L1 + L2 + L3 + ... The total inductance is the sum of individual inductances (assuming no mutual inductance).
Parallel Inductance:	1/L_total = 1/L1 + 1/L2 + 1/L3 + ... The reciprocal of the total inductance is the sum of the reciprocals of individual inductances (assuming no mutual inductance).
Energy Stored:	E = 0.5 * L * I^2 Where E = Energy (Joules), L = Inductance (Henries), I = Current (Amperes).

Circuit Laws and Theorems

Kirchhoff's Laws

Kirchhoff's Current Law (KCL):	The algebraic sum of currents entering a node (or junction) is zero. ∑ I_in = ∑ I_out
Kirchhoff's Voltage Law (KVL):	The algebraic sum of all voltages around any closed loop in a circuit is zero. ∑ V = 0

Thevenin's Theorem

Description:	Any linear circuit can be replaced by an equivalent circuit consisting of a voltage source (V_Th) in series with a resistor (R_Th).
V_Th:	The Thevenin voltage is the open-circuit voltage at the terminals of interest.
R_Th:	The Thevenin resistance is the equivalent resistance at the terminals of interest when all independent sources are turned off (voltage sources shorted, current sources opened).

Norton's Theorem

Description:	Any linear circuit can be replaced by an equivalent circuit consisting of a current source (I_N) in parallel with a resistor (R_N).
I_N:	The Norton current is the short-circuit current at the terminals of interest.
R_N:	The Norton resistance is the equivalent resistance at the terminals of interest when all independent sources are turned off (voltage sources shorted, current sources opened). R_N = R_Th

Superposition Theorem

Description:	In a linear circuit with multiple independent sources, the voltage or current for any element is the algebraic sum of the voltages or currents produced by each independent source acting alone (with other sources turned off).

Semiconductor Devices

Diodes

Definition:	A semiconductor device that allows current to flow primarily in one direction.
Types:	Rectifier, Zener, LED, Schottky.
Forward Bias:	Diode conducts when the anode is positive relative to the cathode.
Reverse Bias:	Diode blocks current when the anode is negative relative to the cathode.
Zener Diode:	Designed to operate in reverse breakdown to provide a stable voltage reference.

Transistors (BJT)

Definition:	A semiconductor device used to amplify or switch electronic signals and electrical power.
Types:	NPN, PNP.
Regions of Operation:	Cut-off, Active, Saturation.
Current Gain (β or hFE):	β = IC / IB Where IC = Collector Current, IB = Base Current.

Transistors (MOSFET)

Definition:	A type of transistor used for amplifying or switching electronic signals.
Types:	n-channel, p-channel, Enhancement-mode, Depletion-mode.
Regions of Operation:	Cut-off, Triode (Linear), Saturation.
Gate Voltage (VGS):	Controls the current flow between the drain and source.

Operational Amplifiers (Op-Amps)

Ideal Op-Amp Characteristics

Open-loop Gain (AOL):	Infinite
Input Impedance (Zin):	Infinite
Output Impedance (Zout):	Zero
Bandwidth:	Infinite

Common Op-Amp Configurations

Inverting Amplifier:	Vout = - (Rf / Rin) * Vin Where Rf = Feedback Resistance, Rin = Input Resistance.
Non-Inverting Amplifier:	Vout = (1 + (Rf / Rin)) * Vin Where Rf = Feedback Resistance, Rin = Input Resistance.
Voltage Follower (Buffer):	Vout = Vin (Unity Gain)
Summing Amplifier:	Vout = -Rf * (Vin1/R1 + Vin2/R2 + ...) Where Rf = Feedback Resistance, R1, R2, ... = Input Resistances.