DC Notes

ECE 2210 / 00

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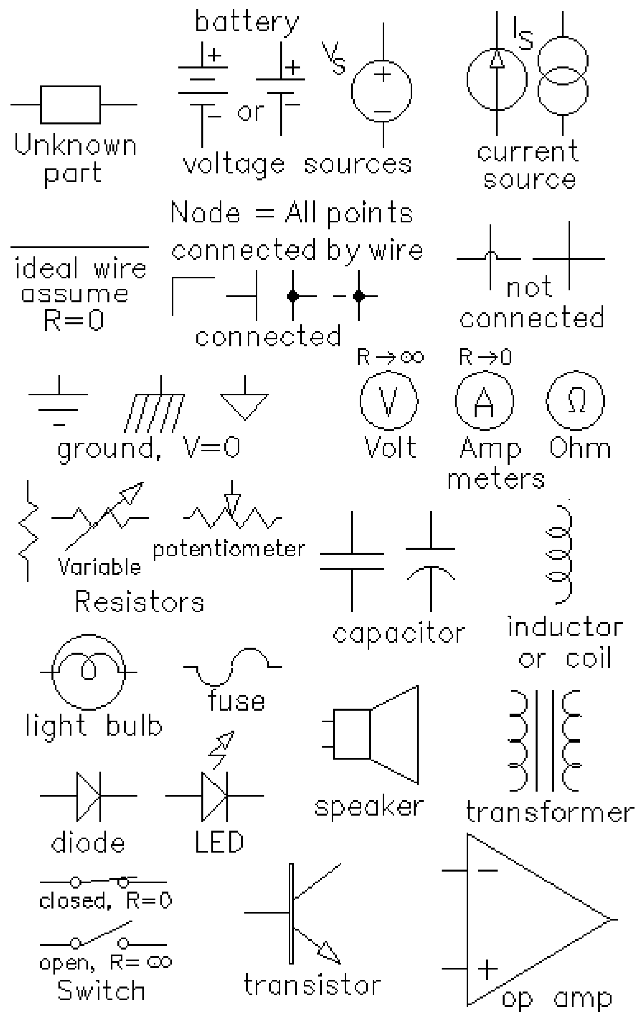
2/8/00, rev 1/28/06

Basic electrical quantities | **Unit**

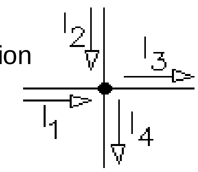
		Unit
Charge, actually moves	Q	Coulomb (C)
Current, like fluid flow	$I = \frac{Q}{s}$	Amp (A, mA, µA,...)
Voltage, like pressure	V	volt (V, mV, kV,...)
Resistance	$R = \frac{V}{I}$	Ohm (Ω, kΩ, MΩ,...)
Conductance	$G = \frac{1}{R}$	Siemens (S, old unit mho)
Power energy/time	$P = V \cdot I$	Watt (W, mW, kW, MW,...)

Schematic symbols



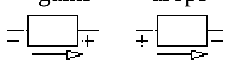
KCL, **K**irchhoff's **C**urrent **L**aw

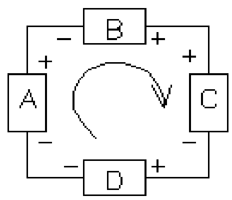
$I_{in} = I_{out}$ of any point, part, or section



KVL, **K**irchhoff's **V**oltage **L**aw

$V_{gains} = V_{drops}$ around any loop

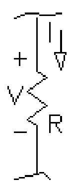




Node = all points connected by wire, all at same voltage (potential)

Ohm's law (resistors)

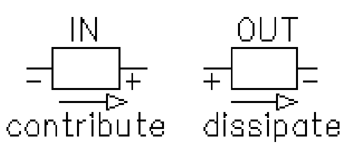
$$V = I \cdot R$$



$$I = \frac{V}{R}$$

$$R = \frac{V}{I}$$

Power $P_{IN} = P_{OUT}$ for resistor circuits



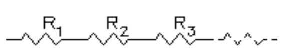
$P = V \cdot I$ for everything

$= I^2 \cdot R = \frac{V^2}{R}$ for resistors

Maximum power transfer: $R_L = R_{Th}$

Load = Thevenin's

Resistors



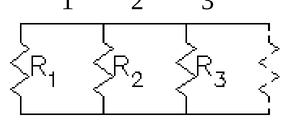
series: $R_{eq} = R_1 + R_2 + R_3 + \ldots$

Exactly the **same current** through each resistor

Voltage divider:

$$V_{Rn} = V_{total} \cdot \frac{R_n}{R_1 + R_2 + R_3 + \ldots}$$

parallel: $R_{eq} = \dfrac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots}$



Exactly the **same voltage** across each resistor

current divider:

$$I_{Rn} = I_{total} \cdot \frac{\frac{1}{R_n}}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots}$$

Multiple unknowns:

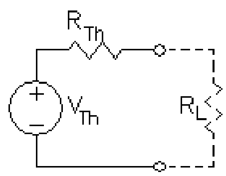
1. Combine resistors into equivalents where possible.
2. Use superposition if there are multiple sources and you know all the resistors.
3. Use KCL, KVL, & Ohm's laws to write multiple equations and solve.

DC Notes

Thévenin equivalent

To calculate a circuit's Thévenin equivalent:

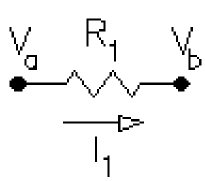
1) Remove the load and calculate the open-circuit voltage where the load used to be. This is the Thévenin voltage (V_{Th}).
2) Zero all the sources. (To zero a voltage source, replace it with a short. To zero a current source, replace it with an open.)
3) Compute the total resistance between the load terminals. (DO NOT include the load in this resistance.) This is the Thévenin source resistance (R_{Th}).



4) Draw the Thévenin equivalent circuit and add your values.

Nodal Analysis

1) If the circuit doesn't already have a ground, label one node as ground (zero voltage). If the ground can be defined as one side of a voltage source, that will make the following steps easier.
2) Label unknown node voltages as V_a, V_b, ... and label the current in each resistor as I_1, I_2, ...
3) Write Kirchoff's current equations for each unknown node.
4) Replace the currents in your KCL equations with expressions like the one below.



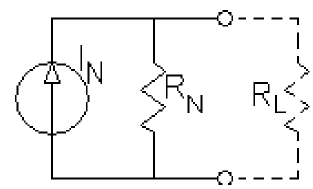
$$I_1 = \frac{V_a - V_b}{R_1}$$

5) Solve the multiple equations for the multiple unknown voltages

Norton equivalent

To calculate a circuit's Norton equivalent:

1) Replace the load with a short (a wire) and calculate the short-circuit current in this wire. This is the Norton current (I_N). Remove the short.
2) Zero all the sources. (To zero a voltage source, replace it with a short. To zero a current source, replace it with an open.)
3) Compute the total resistance between the load terminals. (DO NOT include the load in this resistance.) This is the Norton source resistance (R_N). (Exactly the same as theThévenin source resistance (R_{Th})).



4) Draw the Norton equivalent circuit and add your values.

OR (the more common way)...

1) Find the Thévenin equivalent circuit.
2) Convert to Norton circuit, $R_N = R_{Th}$ and $I_N = V_{Th}/R_{Th}$.

Superposition

For circuits with **more than 1 source**.

1) Zero all but one source. (To zero a voltage source, replace it with a short. To zero a current source, replace it with an open.)
2) Compute your wanted voltage or current due to the remaining source. Careful, some may be negative.
3) Repeat the first two steps for all the sources.
4) Sum all the contributions from all the sources to find the actual voltage or current. **Watch your signs!**