COE 152 : BASIC ELECTRONICS

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Outline ...

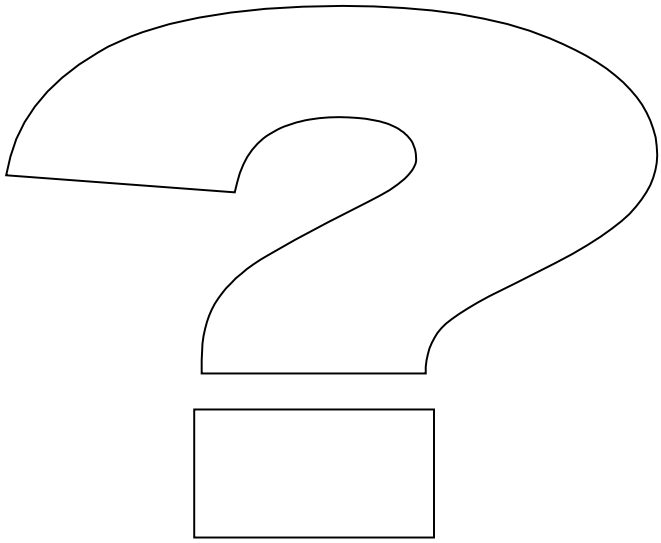
- Electronic Devices
  - Electronic Components: Resistors, Capacitors, Inductors, Voltage, Current
  - Nature of the atom. Basic Concepts of semiconductor charge carriers, Energy bands, Intrinsic and Extrinsic semiconductors. Carrier Transport: Diffusion current, drift current, mobility, conductivity and resistivity. Generation and recombination of carriers.
  - P-N junction Diode, Zener Diode, tunnel diode, p-I-n diode, avalanche photo diode, LED, BJT, JFET, MOSFET, Basics of LASERS
  - Introduction to IC fabrication

...Outline...

- Basic Analog Circuits:
  - Small Signal Equivalent circuits of diodes, BJTs, and MOSFETs.
  - Basic diode circuits: clipping, clamping, rectifier circuits
  - Basic BJT circuits: BJT characteristics, BJT configurations (CB, CC, CE), switching , Amplifiers: single and multi-stage. Frequency response of amplifiers

...Outline

- Basic Digital Cicuits:
  - Boolean Algebra
  - Basic Logic Gates: AND, OR, NOT, NAND, NOR
  - Digital IC Families: DTL, TTL, ECL, MOS, CMOS



Voltage

(Adapted partly from University of Pennsylvania)

- A battery positive terminal (+) and a negative terminal (-). The difference in charge between each terminal is the potential energy the battery can provide. Unit of measurement is volts (V)

Water Analogy

V E Potential

Voltage = **E**lectro-**M**otive **F**orce, the driving force in electron flow

Water Analogy	Electrical Equivalent
High Pressure $\text{Pressure} = \frac{\text{Force}}{\text{Area}}$ Pump Low Pressure	High Voltage $\text{Voltage} = \frac{\text{Energy}}{\text{Charge}}$ Low Voltage **Unit = Volts**
Pressure without flow	Voltage without flow

Voltage Sources

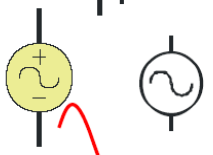
Symbols

Cell

Battery

UniPolar

BiPolar (AC)



Power supplies

Properties

Constant Voltage, independent of the amount of current

Usually ideal

Examples

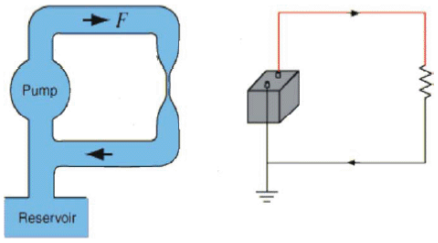
Batteries

Power Supplies

Signal Generators

Ground

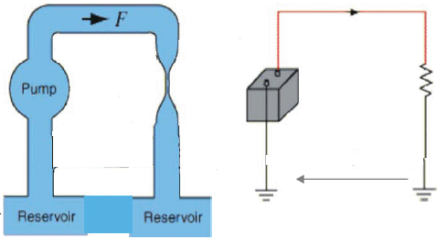
Provides a reference point



Purely a reference point

Does not participate in current flow

An integral path in the current flow



Symbols

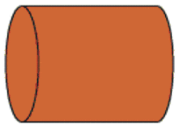
Earth

Analog Gnd

Current

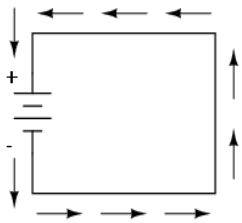
- Current is the flow of electrons through a circuit. The unit of measurement is Ampere (A)

Flow of Water



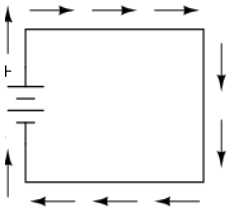
Flow of Charge

Electron flow notation



Electric charge moves from the negative (surplus) side of the battery to the positive (deficiency) side.

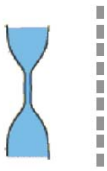
Conventional flow notation



Electric charge moves from the positive (surplus) side of the battery to the negative (deficiency) side.

Resistance

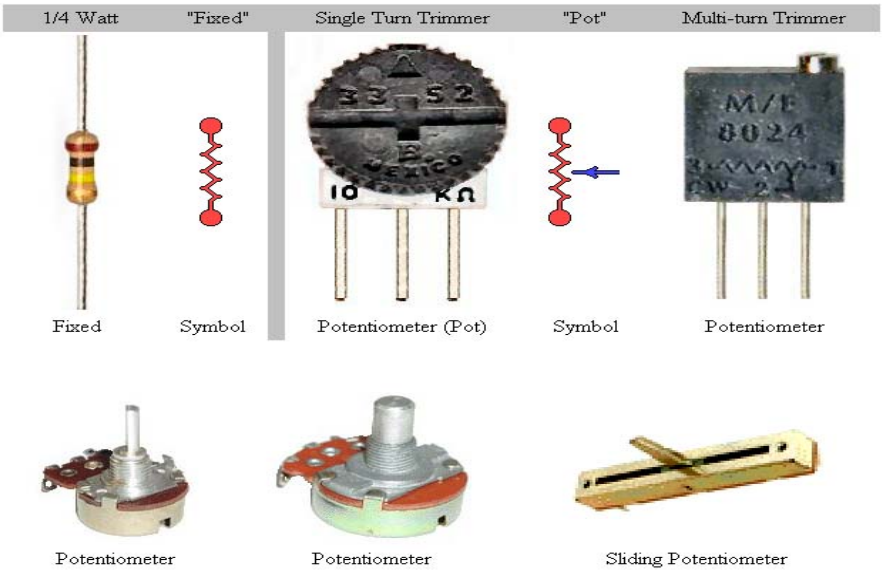
Constriction creates Resistance to water flow



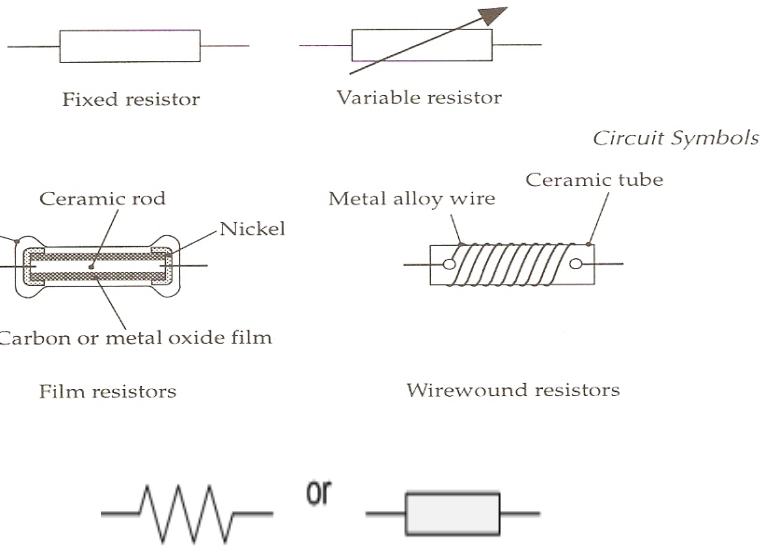
Resistor creates Resistance to current flow

- All materials have a resistance that is dependent on cross-sectional area, material type and temperature
- A resistor dissipates power in the form of heat

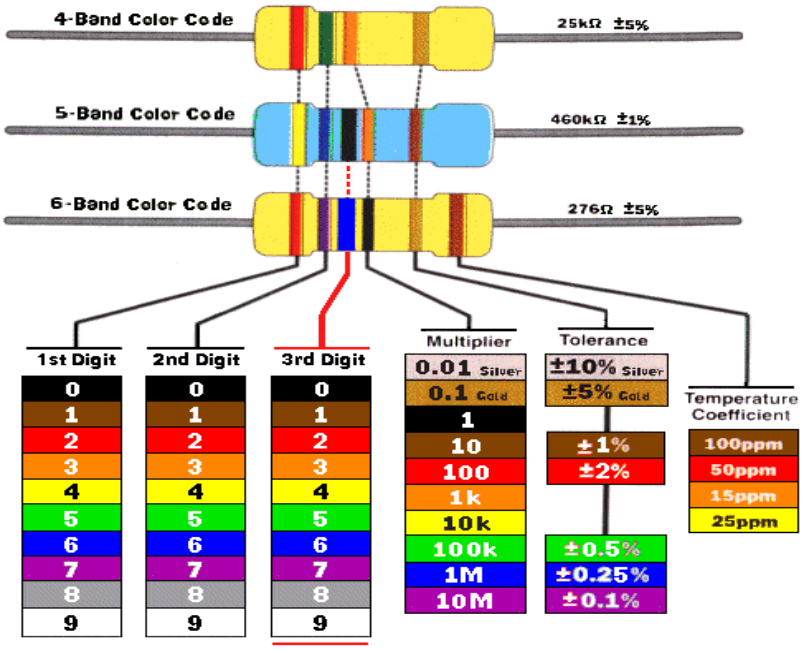
Types of Resistors



Resistor Types and Symbols

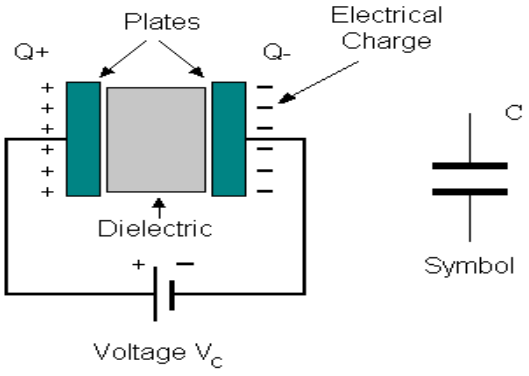


Resistor Color Code



Capacitance

- A capacitor (Condenser) is used to store charge for a short time
- It is made up of two parallel conductive plate separated by an insulating material called a Dielectric



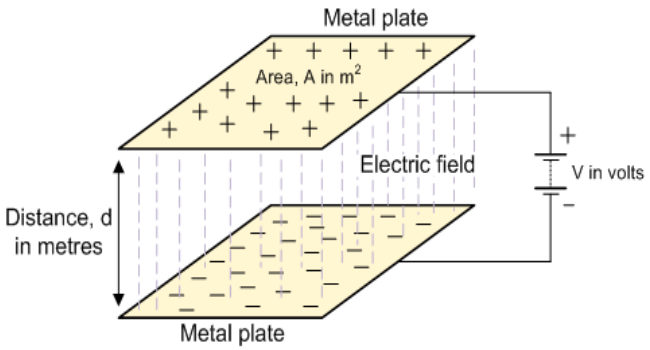
...Capacitance

- Unit of capacitance is Farad (F)
- Farad is very large and usually measured in microfarad (μF), nanofarad (nF) or picofarad (pF)

$$C = \frac{Q}{V}$$

- Where *Q* is the charge measured in coulombs, C
- *V* is the potential difference across the plates and it is measured in volts, V

...Capacitance

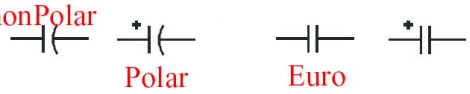


$$C = \varepsilon \frac{A}{d}$$

- Where *A* is the overlapping area of the plates
- *d* is the distance between the two plate
- ε is the relative permitivity or the dielectric constant

...Capacitance

Symbols nonPolar



Polar Euro

Properties

Characteristic Equations: $I = C\frac{dV}{dT}$

$V = \frac{1}{C}\int IdT$ Integrating Charge (storage)

Markings

Polar vs Non-Polar Electrolytics mark (-) Tantalums mark (+)

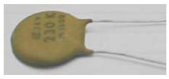
Values Longer lead

Examples

Mylar

Monolythic Cermamic

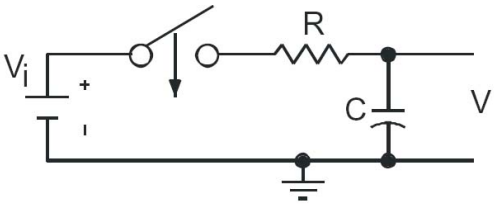
Tantalum



Ceramic

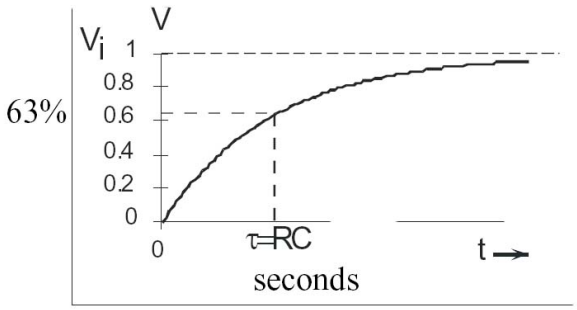
Electrolytic

Capacitor Charging

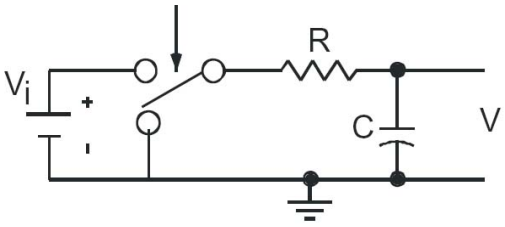


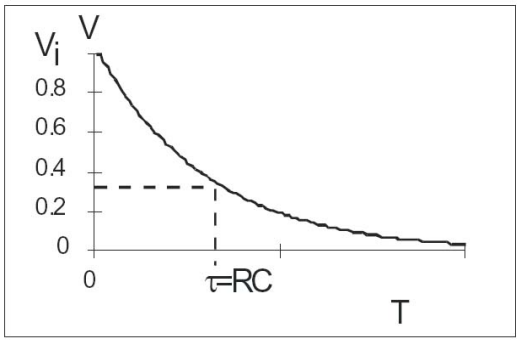
$V = V_i + Ae^{-t/RC}$

$A = -V_i$



Capacitor Discharging



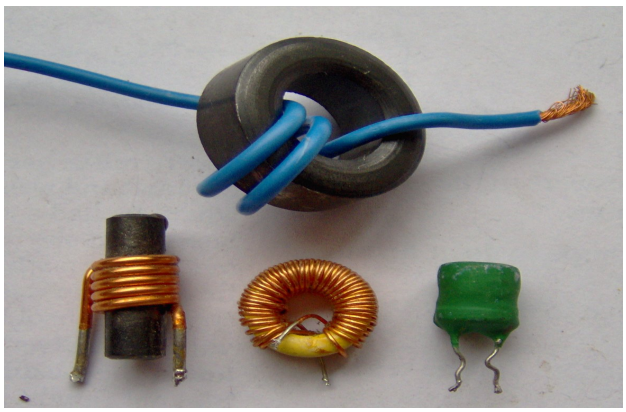


$$V = Ae^{-t/RC}$$

$$A = V_i$$

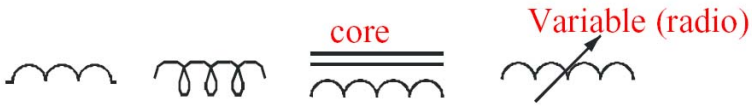
Inductance

- A passive element that stores energy in its magnetic field
- It is also know as choke, coil or reactor



Inductance

Symbols



Properties

Characteristic Equation: $V = L\frac{dI}{dT}$

Examples

Any where you have wire.
Motor windings have significant inductance
Long leads also have small inductance

Design of Electronic Circuits

- Circuits should be designed to work, not made to work
- Design factors contributing to good circuit design
  - Minimum number of components
  - Minimum number of power supplies
  - Low power dissipation and current drain
  - Minimum size and weight of components

Breadboards

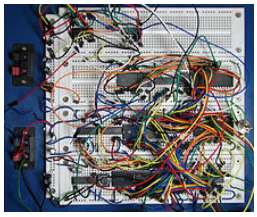
- Used for prototyping of electronic circuits
- They are solderless and can therefore be reused
- Stripboards are used to build soldered prototypes

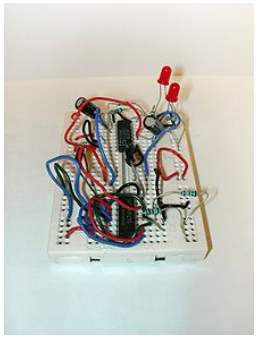
Breadboard

Stripboard

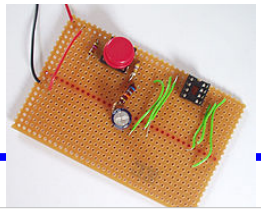
Breadboards

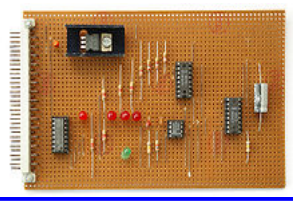
- Populated Breadboard





- Populated Breadboard





Breadboard Layout

- Made up of two areas called strips
  - Terminal Strips
    - These areas hold most of the electronic components
  - Bus strips
    - The bus strip contains two columns for the power supply

Breadboard Layout