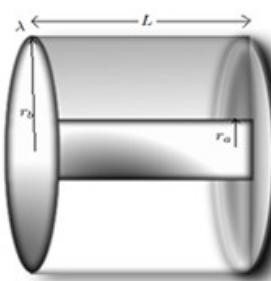
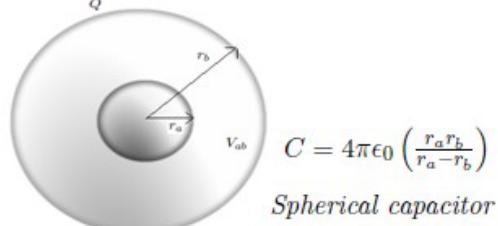
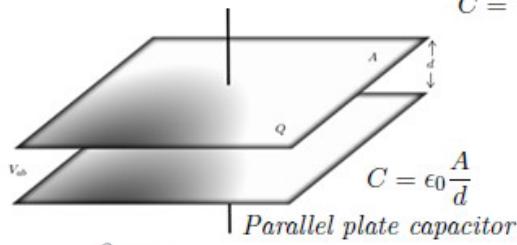


Capacitors and capacitanceDefinition of capacitance

$$C = \frac{Q}{V_{ab}}$$

Capacitors in series

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \cdots + \frac{1}{C_n}$$

$$Q_{eq} = Q_1 = Q_2 = \cdots = Q_n$$

$$V_{eq} = V_1 + V_2 + \cdots + V_n$$

Capacitors in parallel

$$C_{eq} = C_1 + C_2 + \cdots + C_n$$

$$Q_{eq} = Q_1 + Q_2 + \cdots + Q_n$$

$$V_{eq} = V_1 = V_2 = \cdots = V_n$$

Energy in a capacitorEnergy stored in a capacitor

$$U = \frac{Q^2}{2C} = \frac{1}{2}CV^2 = \frac{1}{2}QV \quad (J)$$

Energy density

$$u = \frac{1}{2}\epsilon_0 E^2 \quad (J/m^3)$$

DielectricsParallel plate capacitor filled with dielectric

$$C = KC_0 = K\epsilon_0 \frac{A}{d}$$

Energy density of a capacitor with dielectric

$$u = \frac{1}{2}K\epsilon_0 E^2 = \frac{1}{2}\epsilon E^2 \quad (J/m^3)$$

$$E = \frac{\sigma}{K\epsilon_0} \quad \text{Electric field in a parallel plate capacitor filled with a dielectric}$$

$$E = \frac{Q}{4\pi K\epsilon_0 r^2} \quad \text{Electric field in a Spherical capacitor filled with a dielectric}$$

$$E = \frac{\lambda}{2\pi r K\epsilon_0} \quad \text{Electric field in a cylindrical capacitor filled with a dielectric}$$

$$\oint \vec{K} \cdot d\vec{A} = \frac{Q_{enc,free}}{\epsilon_0} \quad \text{Gauss's law in a dielectric}$$

Current and current density

$$\text{Current} \quad I = \frac{dQ}{dt} = n|q|v_d A \quad (A)$$

Current density

$$J = \frac{I}{A} = n|q|v_d \quad (A/m^2)$$

Resistors in series - parallel

$$R_{eq} = R_1 + R_2 + \cdots + R_n \quad \text{Resistors in series}$$

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_n} \quad \text{Resistors in parallel}$$

Resistivity

$$\rho = \frac{E}{J} \quad (\Omega \cdot m)$$

$$\rho(T) = \rho_0 [1 + \alpha(T - T_0)]$$

Resistors

$$V = IR$$

$$R = \frac{\rho L}{A}$$

Energy and power in circuitsGeneral circuit element

$$P = V_{ab}I \quad (W)$$

Power dissipated in a resistor

$$P = V_{ab}I = I^2 R = \frac{V_{ab}^2}{R}$$

Conduction in metals

$$\text{Mean free time between collisions} \quad \tau_c = \frac{m}{nq^2\rho} \quad (s)$$

R-C CircuitsCharging capacitor

$$q = Q \left(1 - e^{-t/RC} \right)$$

$$i = I e^{-t/RC}$$

Kirchoff's rules

$$\sum I = 0 \quad \text{Current/junction rule}$$

$$\sum V = 0 \quad \text{Voltage/loop rule}$$

Discharging capacitor

$$q = Q e^{-t/RC}$$

$$i = -I e^{-t/RC}$$