$$\vec{F}_{ab} = K \cdot \frac{q_a \cdot q_b}{r^2} \hat{r}_{ab} \qquad \vec{E} = \frac{\vec{F}}{q} \qquad \vec{E} = K \cdot \sum_i \frac{q_i}{r_i^3} \hat{r}_i$$

$$d\vec{E} = K \cdot \frac{dq}{r^2} \hat{r}$$

$$\Phi = \oint_S \vec{E} \cdot \vec{ds} = \frac{\sum q}{\varepsilon_0} \qquad E \cdot \Delta S = \frac{\Delta S \cdot \sigma}{\varepsilon_0} \text{ (Conductor)} \qquad \text{L Gauss.}$$

$$W_{A\to B} = \int_A^B dW = \int_A^B \vec{F} \cdot \vec{dl} = \int_A^B -q \cdot \vec{E} \cdot \vec{dl} = U_B - U_A = -q \int_A^B \vec{E} \cdot \vec{dl}$$

$$U(r) = -q \cdot \int_\infty^r \vec{E} \cdot \vec{dl} = \frac{-q \cdot Q}{4\pi \varepsilon_0 r} \quad \Big\| \quad U = \sum U_i = K \cdot q \sum \frac{Q_i}{r_i}$$

$$V = \frac{U}{q} = K \cdot \sum \frac{Q_i}{r_i} = K \cdot \int_{DIST} \frac{dq}{r} \qquad dq = \lambda \cdot dl = \sigma \cdot ds = \rho \cdot dvol$$

$$V_{AB} = -\int_B^A \vec{E} \cdot \vec{dl} = \frac{W_{A\to B}}{q} \qquad V(r) = -\int_\infty^r \vec{E} \cdot \vec{dl} \qquad V_{AB} = E_r \cdot d \ \Big|_{E = \text{cte dirección } r}$$

$$E_x = -\frac{\partial V}{\partial x} \qquad \vec{E} = -\nabla \cdot V$$

Q en paralelo: Distintos — Q en serie: Iguales

V en paralelo: Iguales — V en serie: Distintos

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

Placas paralelas: $V = E \cdot d = \frac{Q}{A \varepsilon_0} d \ \Big|_{\sigma = \frac{Q}{A}} \Rightarrow C = \varepsilon_0 \cdot \frac{A}{d}$

Cilíndrico: $V_{AB} = -\int_B^A \vec{E} \cdot \vec{dl} = -\int_B^A \frac{\lambda}{2\pi \varepsilon_0 r} \cdot dr = \frac{Q}{2\pi \varepsilon_0 \ell} \ln\left(\frac{R_B}{R_A}\right) \ \Big|_{\lambda = \frac{Q}{\ell}} \Rightarrow C = \frac{2\pi \varepsilon_0 \ell}{\ln(R_B/R_A)}$

$$C_1 \| C_2 = C_1 + C_2 \qquad C_1 \text{ serie } C_2 = \frac{C_1 \cdot C_2}{C_1 + C_2}$$

$$dU = V \cdot dq \Rightarrow \int dU = \int \frac{Q}{C} \cdot dq = \frac{1}{2} \frac{Q^2}{C} \qquad u = \frac{U}{Vol} \qquad u = \frac{\varepsilon_0 E^2}{2}$$

$$F_x = -\frac{\partial U}{\partial x} \Big|_{\text{Carga CTE}} = -\frac{Q^2}{2C^2} \frac{\partial C}{\partial x} \Big|_{V \text{ CTE}} = \frac{1}{2} V^2 \cdot \frac{\partial C}{\partial x}, \quad C = \varepsilon \cdot \frac{S}{x}$$

$$I = \frac{dQ}{dt} \qquad dQ = q \cdot n \cdot S \cdot v\, dt \quad , \quad I = q \cdot n \cdot S \cdot v$$

$$J = \frac{dI}{dS} \qquad \vec{J} = \sigma \cdot \vec{E} = \frac{\vec{E}}{\rho} \qquad R = \frac{V_1 - V_2}{I} = \frac{1}{G}$$

$R = \rho \cdot \frac{l}{S}$ (Conduct. cilíndrico)

$$dW = dU_1 - dU_2 = (V_1 - V_2) \cdot q = (V_1 - V_2) \cdot I \cdot dt = I^2 \cdot R \cdot dt \Rightarrow P = I^2 \cdot R = \frac{V^2}{R} = V \cdot I$$

$$R_1 \| R_2 = \frac{R_1 \cdot R_2}{R_1 + R_2} \qquad R_1 \text{ serie } R_2 = R_1 + R_2$$

$$\vec{F_m} = \frac{\mu_0 \cdot Q \cdot q}{4\pi \cdot r^2} \vec{v} \times (\vec{v}' \times \vec{r}) = q \cdot \vec{v} \times \vec{B} \quad , \quad \vec{B} = \frac{\mu_0}{4\pi} \cdot \frac{Q}{r^2} \vec{v} \times \vec{r}$$

$$\vec{F} = \vec{F_e} + \vec{F_m} = q(\vec{E} + \vec{v} \times \vec{B})$$

F. sobre un conductor: $F = \int I \cdot \vec{dl} \times \vec{B}$

$$\vec{\tau} = I \cdot \vec{S} \times \vec{B}$$

$$m = I \cdot m \cdot \vec{S} \Rightarrow \vec{\tau} = \vec{m} \times \vec{B}$$

L. Biot-Savart:

$$dB = \frac{\mu_0}{4\pi} \frac{I \cdot \vec{dl} \times \vec{r}}{r^2}$$

L. Ampere $\oint \vec{B} \cdot \vec{dl} = \mu_0 \cdot \sum I$

Flujo campo magn. $\Phi = \oint \vec{B} \cdot \vec{dS}$ Wb

L. Faraday: $\varepsilon = -\frac{d\Phi}{dt}$ L. Lenz: Signo negativo, ley de Newton

$$|\varepsilon| = B \cdot l \cdot v \qquad \frac{\Phi}{I} = L = CTE \qquad \varepsilon = -\frac{\Phi}{dt} = -L \frac{di(t)}{dt} = -v(t)$$

$$P = \frac{dU}{dt} = i(t) \cdot v(t) = i(t) \cdot L \cdot \frac{di(t)}{dt} \Rightarrow dU = L\, i(t) \cdot di(t) \Rightarrow U = \frac{1}{2} I^2 \cdot L$$

$$u = \frac{B^2}{2\mu_0} = \frac{U}{vol}$$

$$F = \nabla \cdot u$$

R: $V(t) = R \cdot i(t)$

$i(t) = \frac{V(t)}{R}$

C: $V(t) = \frac{q(t)}{C} = \frac{1}{C} \int i(t) \cdot dt$

$i(t) = C \cdot \frac{d\,V(t)}{dt}$

$V_c(t=0^-) = V_c(t=0^+)$

L: $i(t) = \frac{\Phi(t)}{L} = \frac{1}{L} \int V(t)\,dt$

$V(t) = L \cdot \frac{d\,I(t)}{dt}$

$i_L(t=0^-) = i_L(t=0^+)$

$e^{jx} = \cos x + j \cdot \operatorname{sen} x$

$z = a + bj = |z|(\cos x + j \operatorname{sen} x) = |z| \cdot e^{jx}$

$\cos\varphi = \frac{e^{j\varphi} - e^{-j\varphi}}{2}$

$\operatorname{sen}\varphi = \frac{e^{j\varphi} - e^{-j\varphi}}{2 \cdot j}$

$Y = H(s) \cdot X$

Impedancias: $Z_R = R$ $\quad Z_C = \frac{1}{Cs}$ $\quad Z_L = Ls$

$$V_c = V_f - (V_i - V_f) \cdot e^{-t/RC}, \quad RC = \tau$$

Imp complejas: $Z_R = R$ $\quad Z_L = j \cdot \underbrace{wL}_{X_L} = jX_L$ $\quad Z_C = \frac{1}{j\underbrace{wC}_{X_C}} = -j \cdot X_C$

Potencia media/activa: $P = V_{ef} \cdot I_{ef} \cdot \cos\varphi = \frac{V}{\sqrt{2}} \frac{I}{\sqrt{2}} \cdot \cos\varphi = \frac{VI}{2} \cos\varphi$, $\underbrace{\cos\varphi = \cos(\varphi_v - \varphi_i)}_{\text{Factor de potencia}}$

" aparente: $S = V_{ef} \cdot I_{ef}$ (VA)

" reactiva: $Q = V_{ef} \cdot I_{ef} \cdot \operatorname{sen}\varphi$ (VAR)

$$P_{MAX} = \frac{|G|^2}{4 \cdot R_g}$$

Si existe adaptación, $Z_{AB} = Z_g^*$