

Formulário de Eletromagnetismo e Circuitos

1. Força elétrica

$$\vec{F}_{ji} = \frac{k q_j q_i}{r_{j/i}^2} \hat{r}_{j/i}$$

$$\vec{F} = q \vec{E}$$

$$\vec{E}(\vec{r}) = \frac{kq}{r^2} \hat{r}$$

2. Cálculo do campo elétrico

$$\vec{E}(\vec{r}) = k \sum_{i=1}^N \frac{q_i (\vec{r} - \vec{r}_i)}{|\vec{r} - \vec{r}_i|^3}$$

$$\vec{E}(\vec{r}) \approx k \int_C \frac{\vec{r} - \vec{r}'}{|\vec{r} - \vec{r}'|^3} \lambda(\vec{r}') ds'$$

$$\vec{E}(\vec{r}) = k \iint_S \frac{\vec{r} - \vec{r}'}{|\vec{r} - \vec{r}'|^3} \sigma(\vec{r}') dA'$$

$$\Psi_S = \iint_S \vec{E} \cdot d\vec{A}$$

$$\oiint_S \vec{E} \cdot d\vec{A} = 4\pi k q_{\text{int}}$$

$$\vec{E}_{\text{plano}} = 2\pi k \sigma \hat{n}$$

$$\vec{E}_{\text{fio}}(\rho) = \frac{2k\lambda}{\rho} \hat{\rho}$$

$$\frac{\partial E_x}{\partial y} = \frac{\partial E_y}{\partial x}$$

$$\frac{\partial E_x}{\partial z} = \frac{\partial E_z}{\partial x}$$

$$\frac{\partial E_y}{\partial z} = \frac{\partial E_z}{\partial y}$$

3. Potencial eletrostático

$$V = \frac{kq}{r}$$

$$V_Q - V_P = - \int_P^Q \vec{E} \cdot d\vec{r}$$

$$\vec{E} = -\vec{\nabla}V$$

$$V(\vec{r}) = \sum_{i=1}^N \frac{kq_i}{|\vec{r} - \vec{r}_i|}$$

4. Energia eletrostática e capacidade

$$U_e = qV$$

$$\Delta E_c + \Delta E_p = W_{\text{nc}}$$

$$E_c = \frac{1}{2}mv^2$$

$$\gamma = \frac{1}{\sqrt{1 - v^2/c^2}}$$

$$\gamma = 1 + \frac{E_c}{mc^2}$$

$$U_e(r) = \frac{kq_1q_2}{r}$$

$$C_{\text{condutor}} = \frac{Q}{V} \quad C = \frac{KQ}{\Delta V}$$

$$U_e = \frac{1}{2} \frac{Q^2}{C} = \frac{1}{2} C \Delta V^2$$

$$C_{\text{plano}} = \frac{KA}{4\pi k d}$$

$$C_{\text{esférico}} = \frac{Kab}{k(b-a)}$$

$$\frac{1}{C_s} = \frac{1}{C_1} + \frac{1}{C_2} + \dots + \frac{1}{C_n}$$

$$C_p = C_1 + C_2 + \dots + C_n$$

5. Força eletromotriz corrente e resistência

$$|I| = \frac{|\Delta Q|}{\Delta t}$$

$$\Delta Q = \int_{t_1}^{t_2} I(t) dt$$

$$J = |\rho|v = \frac{I}{A}$$

$$\vec{J} = \rho \vec{v}$$

$$P = \Delta V I$$

$$P = \varepsilon I$$

$$R = \rho_e \frac{\ell}{A}$$

$$\Delta V = RI$$

$$P = RI^2 = \frac{\Delta V^2}{R}$$

$$R = R_{20} [1 + \alpha_{20}(T - 20)]$$

$$\Delta V_{\text{gerador}} = \varepsilon - rI$$

$$\Delta V_{\text{recetor}} = \varepsilon + rI$$

$$R_s = R_1 + R_2 + \dots + R_N$$

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \dots + \frac{1}{R_N}$$

$$R_p = \frac{R_1 R_2}{R_1 + R_2}$$

6. Circuitos de corrente contínua

$$R_i = \frac{R_{ij}R_{ik}}{R_{12} + R_{23} + R_{13}}$$

$$\Delta V_i = \frac{R_i}{R_s} \Delta V$$

$$I_j = \frac{R_p}{R_j} I$$

7. Força magnética

$$\begin{aligned}\vec{F}_m &= q \left(\vec{v} \times \vec{B} \right) & \vec{F} &= q \left(\vec{E} + \vec{v} \times \vec{B} \right) & \omega &= \frac{|q|B}{m} \\ r &= \frac{v_{\perp}}{\omega} = \frac{mv_{\perp}}{|q|B} & \vec{M} &= \vec{m} \times \vec{B} & \vec{m} &= IA \hat{n}\end{aligned}$$

8. Cálculo do campo magnético

$$\begin{aligned}\vec{B}(\vec{r}) &= k_m \int_P^Q \frac{\vec{I} \times (\vec{r} - \vec{r}')}{|\vec{r} - \vec{r}'|^3} ds' & \vec{B}_{\text{fil. inf.}}(\rho) &= \frac{2k_m I}{\rho} \hat{\phi} & \oint_C \vec{B} \cdot d\vec{r} &= 4\pi k_m I_C \\ B_{\text{sol. inf.}} &= 4\pi k_m nI & \frac{F_{21}}{l} &\approx \frac{2k_m I_1 I_2}{d}\end{aligned}$$

9. Indução eletromagnética

$$\begin{aligned}\vec{E}_i &= \vec{v} \times \vec{B} & \varepsilon_i &= l |\vec{v} \times \vec{B}| & \Phi_S &= \iint_S \vec{B} \cdot d\vec{A} \\ \varepsilon_i &= -\frac{d\Phi}{dt} & \varepsilon_i &= -L \frac{dI}{dt} & \Delta V &= L \frac{dI}{dt} & I_d &= \frac{1}{4\pi k} \iint_S \frac{\partial \vec{E}}{\partial t} \cdot d\vec{A}\end{aligned}$$

10. Circuitos de corrente alternada

$$\begin{aligned}V(t) &= V_{\text{máx}} \cos(\omega t + \varphi) & \mathbf{V} &= Z\mathbf{I} & Z &= R(\omega) + iX(\omega) & V_{\text{máx}} &= |Z| I_{\text{máx}} \\ \varphi_V &= \varphi_Z + \varphi_I & Z_R &= R & Z_C &= \frac{1}{i\omega C} = \frac{1}{\omega C} \angle -\frac{\pi}{2} & Z_L &= i\omega L = \omega L \angle \frac{\pi}{2} \\ Z_s &= Z_1 + Z_2 & Z_p &= \frac{Z_1 Z_2}{Z_1 + Z_2} & V_{\text{ef}} &= \frac{V_{\text{máx}}}{\sqrt{2}} & I_{\text{ef}} &= \frac{I_{\text{máx}}}{\sqrt{2}} \\ \bar{P} &= \frac{1}{2} V_{\text{máx}} I_{\text{máx}} \cos \varphi_Z & \mathbf{V}_{\text{out}} &= \mathcal{R}(\omega) \mathbf{V}_{\text{in}}\end{aligned}$$

11. Ondas eletromagnéticas

$$\vec{\nabla} \cdot \vec{E} = 4\pi k \rho \quad \vec{\nabla} \cdot \vec{B} = 0 \quad \vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t} \quad \vec{\nabla} \times \vec{B} = 4\pi k_m \vec{J} + \frac{k_m}{k} \frac{\partial \vec{E}}{\partial t} \quad c^2 = \frac{k}{k_m}$$

Constantes

Unidade de carga elementar	$e = 1.602 \times 10^{-19} \text{ C}$
Constante de Coulomb	$k = 8.988 \times 10^9 \frac{\text{N} \cdot \text{m}^2}{\text{C}^2}$
Constante magnética	$k_m = 10^{-7} \frac{\text{N}}{\text{A}^2}$
Velocidade da luz no vácuo	$c = 2.998 \times 10^8 \text{ m/s}$
Massa do elétron	$m_e = 9.109 \times 10^{-31} \text{ kg}$
Massa do próton	$m_p = 1.673 \times 10^{-27} \text{ kg}$
Aceleração padrão da gravidade	$g = 9.807 \frac{\text{m}}{\text{s}^2}$