

Formulário de Eletromagnetismo e Circuitos

1. Força elétrica

$$\vec{F}_{ji} = \frac{k q_j q_i}{r_{j/i}^2} \hat{r}_{j/i} \quad \vec{F} = q \vec{E} \quad \vec{E}(\vec{r}) = \frac{kq}{r^2} \hat{r}$$

2. Cálculo do campo elétrico

$$\begin{aligned} \vec{E}(\vec{r}) &= k \sum_{i=1}^N \frac{q_i (\vec{r} - \vec{r}_i)}{|\vec{r} - \vec{r}_i|^3} & \vec{E}(\vec{r}) &\approx k \int_C \frac{\vec{r} - \vec{r}'}{|\vec{r} - \vec{r}'|^3} \lambda(\vec{r}') d\vec{s}' \\ \vec{E}(\vec{r}) &= k \iint_S \frac{\vec{r} - \vec{r}'}{|\vec{r} - \vec{r}'|^3} \sigma(\vec{r}') dA' & \Psi_S &= \iint_S \vec{E} \cdot d\vec{A} & \iint_S \vec{E} \cdot d\vec{A} &= 4\pi k q_{\text{int}} \\ \vec{E}_{\text{plano}} &= 2\pi k \sigma \hat{n} & \vec{E}_{\text{fio}}(\rho) &= \frac{2k\lambda}{\rho} \hat{\rho} \\ \frac{\partial E_x}{\partial y} &= \frac{\partial E_y}{\partial x} & \frac{\partial E_x}{\partial z} &= \frac{\partial E_z}{\partial x} & \frac{\partial E_y}{\partial z} &= \frac{\partial E_z}{\partial y} \end{aligned}$$

3. Potencial eletrostático

$$V = \frac{kq}{r} \quad V_Q - V_P = - \int_P^Q \vec{E} \cdot d\vec{r} \quad \vec{E} = -\vec{\nabla}V \quad V(\vec{r}) = \sum_{i=1}^N \frac{kq_i}{|\vec{r} - \vec{r}_i|}$$

4. Energia eletrostática e capacidade

$$\begin{aligned} U_e &= qV & \Delta E_c + \Delta E_p &= W_{nc} & E_c &= \frac{1}{2}mv^2 \\ \gamma &= \frac{1}{\sqrt{1 - v^2/c^2}} & \gamma &= 1 + \frac{E_c}{mc^2} & U_e(r) &= \frac{kq_1q_2}{r} \\ C_{\text{condutor}} &= \frac{Q}{V} & C &= \frac{K Q}{\Delta V} & U_e &= \frac{1}{2} \frac{Q^2}{C} = \frac{1}{2} C \Delta V^2 & C_{\text{plano}} &= \frac{KA}{4\pi k d} \\ C_{\text{esférico}} &= \frac{K a b}{k(b-a)} & \frac{1}{C_s} &= \frac{1}{C_1} + \frac{1}{C_2} + \dots + \frac{1}{C_n} & C_p &= C_1 + C_2 + \dots + C_n \end{aligned}$$

5. Força eletromotriz corrente e resistência

$$\begin{aligned} |I| &= \frac{|\Delta Q|}{\Delta t} & \Delta Q &= \int_{t_1}^{t_2} I(t) dt & J &= |\rho|v = \frac{I}{A} \\ \vec{J} &= \rho \vec{v} & P &= \Delta V I & P &= \epsilon I \\ R &= \rho_e \frac{\ell}{A} & \Delta V &= R I & P &= R I^2 = \frac{\Delta V^2}{R} \\ R &= R_{20} [1 + \alpha_{20}(T - 20)] & \Delta V_{\text{gerador}} &= \epsilon - rI & \Delta V_{\text{recetor}} &= \epsilon + rI \\ R_s &= R_1 + R_2 + \dots + R_N & \frac{1}{R_p} &= \frac{1}{R_1} + \frac{1}{R_2} + \dots + \frac{1}{R_N} & R_p &= \frac{R_1 R_2}{R_1 + R_2} \end{aligned}$$

6. Circuitos de corrente contínua

$$R_i = \frac{R_{ij}R_{ik}}{R_{12} + R_{23} + R_{13}} \quad \Delta V_i = \frac{R_i}{R_s} \Delta V \quad I_j = \frac{R_p}{R_j} I$$

7. Força magnética

$$\vec{F}_m = q(\vec{v} \times \vec{B}) \quad \vec{F} = q(\vec{E} + \vec{v} \times \vec{B}) \quad \omega = \frac{|q|B}{m}$$

$$r = \frac{v_{\perp}}{\omega} = \frac{mv_{\perp}}{|q|B} \quad \vec{M} = \vec{m} \times \vec{B} \quad \vec{m} = IA\hat{n}$$

8. Cálculo do campo magnético

$$\vec{B}(\vec{r}) = k_m \int_P^Q \frac{\vec{I} \times (\vec{r} - \vec{r}')}{|\vec{r} - \vec{r}'|^3} ds' \quad \vec{B}_{\text{fio inf.}}(\rho) = \frac{2k_m I}{\rho} \hat{\phi} \quad \oint_C \vec{B} \cdot d\vec{r} = 4\pi k_m I_C$$

$$B_{\text{sol. inf.}} = 4\pi k_m n I \quad \frac{F_{21}}{l} \approx \frac{2k_m I_1 I_2}{d}$$

9. Indução eletromagnética

$$\vec{E}_i = \vec{v} \times \vec{B} \quad \varepsilon_i = l |\vec{v} \times \vec{B}| \quad \Phi_S = \iint_S \vec{B} \cdot d\vec{A}$$

$$\varepsilon_i = -\frac{d\Phi}{dt} \quad \varepsilon_i = -L \frac{dI}{dt} \quad \Delta V = L \frac{dI}{dt} \quad I_d = \frac{1}{4\pi k} \iint_S \frac{\partial \vec{E}}{\partial t} \cdot d\vec{A}$$

10. Circuitos de corrente alternada

$$V(t) = V_{\max} \cos(\omega t + \varphi) \quad \mathbf{V} = Z\mathbf{I} \quad Z = R(\omega) + iX(\omega) \quad V_{\max} = |Z| I_{\max}$$

$$\varphi_V = \varphi_Z + \varphi_I \quad Z_R = R \quad Z_C = \frac{1}{i\omega C} = \frac{1}{\omega C} \angle -\frac{\pi}{2} \quad Z_L = i\omega L = \omega L \angle \frac{\pi}{2}$$

$$Z_s = Z_1 + Z_2 \quad Z_p = \frac{Z_1 Z_2}{Z_1 + Z_2} \quad V_{\text{ef}} = \frac{V_{\max}}{\sqrt{2}} \quad I_{\text{ef}} = \frac{I_{\max}}{\sqrt{2}}$$

$$\bar{P} = \frac{1}{2} V_{\max} I_{\max} \cos \varphi_Z \quad \mathbf{V}_{\text{out}} = \mathcal{R}(\omega) \mathbf{V}_{\text{in}}$$

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 eletrão	$m_e = 9.109 \times 10^{-31} \text{ kg}$
Massa do protão	$m_p = 1.673 \times 10^{-27} \text{ kg}$
Aceleração padrão da gravidade	$g = 9.807 \frac{\text{m}}{\text{s}^2}$