Formulário de Eletromagnetismo e Circuitos

1. Força elétrica

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

2. Cálculo do campo elétrico

$$\vec{E}(\vec{r}) = k\sum_{i=1}^{N}\frac{q_i\,(\vec{r}-\vec{r}_i)}{|\vec{r}-\vec{r}_i|^3} \qquad \vec{E}(\vec{r}) \approx k\int_{\mathrm{C}}\frac{\vec{r}-\vec{r}'}{|\vec{r}-\vec{r}'|^3}\,\lambda(\vec{r}')\,\mathrm{d}s'$$

$$\vec{E}(\vec{r}) = k\iint_{\mathrm{S}}\frac{\vec{r}-\vec{r}'}{|\vec{r}-\vec{r}'|^3}\sigma(\vec{r}')\,\mathrm{d}A' \qquad \Psi_{\mathrm{S}} = \iint_{\mathrm{S}}\vec{E}\cdot\mathrm{d}\vec{A} \qquad \oiint_{\mathrm{S}}\vec{E}\cdot\mathrm{d}\vec{A} = 4\pi k q_{\mathrm{int}}$$

$$\vec{E}_{\mathrm{plano}} = 2\pi k\sigma\,\hat{n} \qquad \vec{E}_{\mathrm{fio}}(\varrho) = \frac{2k\lambda}{\varrho}\hat{\varrho}$$

$$\frac{\partial E_x}{\partial y} = \frac{\partial E_y}{\partial x} \qquad \frac{\partial E_x}{\partial z} = \frac{\partial E_z}{\partial x} \qquad \frac{\partial E_y}{\partial z} = \frac{\partial E_z}{\partial y}$$

3. Potencial eletrostático

$$V = \frac{kq}{r} \qquad V_{\mathrm{Q}} - V_{\mathrm{P}} = -\int_{\mathrm{P}}^{\mathrm{Q}}\vec{E}\cdot\mathrm{d}\vec{r} \qquad \vec{E} = -\vec{\nabla}V \qquad V(\vec{r}) = \sum_{i=1}^{N}\frac{kq_i}{|\vec{r}-\vec{r}_i|}$$

4. Energia eletrostática e capacidade

$$U_{\mathrm{e}} = qV \qquad \Delta E_{\mathrm{c}} + \Delta E_{\mathrm{p}} = W_{\mathrm{nc}} \qquad E_{\mathrm{c}} = \frac{1}{2}mv^2$$

$$\gamma = \frac{1}{\sqrt{1-v^2/c^2}} \qquad \gamma = 1 + \frac{E_{\mathrm{c}}}{mc^2} \qquad U_{\mathrm{e}}(r) = \frac{kq_1q_2}{r}$$

$$C_{\mathrm{condutor}} = \frac{Q}{V} \qquad C = \frac{K\,Q}{\Delta V} \qquad U_{\mathrm{e}} = \frac{1}{2}\frac{Q^2}{C} = \frac{1}{2}C\Delta V^2 \qquad C_{\mathrm{plano}} = \frac{K\,A}{4\pi\,k\,d}$$

$$C_{\mathrm{esférico}} = \frac{K\,a\,b}{k(b-a)} \qquad \frac{1}{C_{\mathrm{s}}} = \frac{1}{C_1} + \frac{1}{C_2} + \ldots + \frac{1}{C_n} \qquad C_{\mathrm{p}} = C_1 + C_2 + \ldots + C_n$$

5. Força eletromotriz corrente e resistência

$$|I| = \frac{|\Delta Q|}{\Delta t} \qquad \Delta Q = \int_{t_1}^{t_2} I(t)\,\mathrm{d}t \qquad J = |\rho|v = \frac{I}{A}$$

$$\vec{J} = \rho\vec{v} \qquad P = \Delta V\,I \qquad P = \varepsilon\,I$$

$$R = \rho_{\mathrm{e}}\frac{\ell}{A} \qquad \Delta V = R\,I \qquad P = R\,I^2 = \frac{\Delta V^2}{R}$$

$$R = R_{20}\,[1 + \alpha_{20}(T-20)] \qquad \Delta V_{\mathrm{gerador}} = \varepsilon - rI \qquad \Delta V_{\mathrm{recetor}} = \varepsilon + rI$$

$$R_{\mathrm{s}} = R_1 + R_2 + \ldots + R_N \qquad \frac{1}{R_{\mathrm{p}}} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots + \frac{1}{R_N} \qquad R_{\mathrm{p}} = \frac{R_1\,R_2}{R_1+R_2}$$

6. Circuitos de corrente contínua

$$R_i = \frac{R_{ij}R_{ik}}{R_{12}+R_{23}+R_{13}} \qquad \Delta V_i = \frac{R_i}{R_{\mathrm{s}}}\,\Delta V \qquad I_j = \frac{R_{\mathrm{p}}}{R_j}\,I$$

7. Força magnética

$$\vec{F}_\mathrm{m} = q\left(\vec{v}\times\vec{B}\right) \qquad \vec{F} = q\left(\vec{E}+\vec{v}\times\vec{B}\right) \qquad \vec{F}_\mathrm{m} = \ell\,\vec{I}\times\vec{B}$$

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

8. Cálculo do campo magnético

$$\vec{B}(\vec{r}) = k_\mathrm{m}\int_\mathrm{P}^\mathrm{Q}\frac{\vec{I}\times\left(\vec{r}-\vec{r}'\right)}{\left|\vec{r}-\vec{r}'\right|^3}\,\mathrm{d}s' \qquad \vec{B}_{\text{fio inf.}}(\varrho) = \frac{2k_\mathrm{m}I}{\varrho}\,\hat{\phi} \qquad \oint_\mathrm{C}\vec{B}\cdot\mathrm{d}\vec{r} = 4\pi k_\mathrm{m}I_\mathrm{C}$$

$$B_{\text{sol. inf.}} = 4\pi k_\mathrm{m}nI \qquad \frac{F_{21}}{l} \approx \frac{2k_\mathrm{m}I_1I_2}{d}$$

9. Indução eletromagnética

$$\vec{E}_\mathrm{i} = \vec{v}\times\vec{B} \qquad \varepsilon_\mathrm{i} = l\,|\vec{v}\times\vec{B}| \qquad \Phi_\mathrm{S} = \iint_\mathrm{S}\vec{B}\cdot\mathrm{d}\vec{A}$$

$$\varepsilon_\mathrm{i} = -\frac{\mathrm{d}\,\Phi}{\mathrm{d}\,t} \qquad \varepsilon_\mathrm{i} = -L\frac{\mathrm{d}\,I}{\mathrm{d}\,t} \qquad \Delta V = L\,\frac{\mathrm{d}\,I}{\mathrm{d}\,t} \qquad I_\mathrm{d} = \frac{1}{4\pi k}\iint_\mathrm{S}\frac{\partial\vec{E}}{\partial t}\cdot\mathrm{d}\vec{A}$$

10. Circuitos de corrente alternada

$$V(t) = V_\text{máx}\cos(\omega t+\varphi) \qquad \mathbf{V} = Z\mathbf{I} \qquad Z = R(\omega)+\mathrm{i}\,X(\omega) \qquad V_\text{máx} = |Z|\,I_\text{máx}$$

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

$$Z_\mathrm{s} = Z_1+Z_2 \qquad Z_\mathrm{p} = \frac{Z_1Z_2}{Z_1+Z_2} \qquad V_\text{ef} = \frac{V_\text{máx}}{\sqrt{2}} \qquad I_\text{ef} = \frac{I_\text{máx}}{\sqrt{2}}$$

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

11. Ondas eletromagnéticas

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

Constantes

Unidade de carga elementar	$e = 1.602\times10^{-19}\ \mathrm{C}$
Constante de Coulomb	$k = 8.988\times10^{9}\ \dfrac{\mathrm{N}\cdot\mathrm{m}^2}{\mathrm{C}^2}$
Constante magnética	$k_\mathrm{m} = 10^{-7}\ \dfrac{\mathrm{N}}{\mathrm{A}^2}$
Velocidade da luz no vácuo	$c = 2.998\times10^{8}\ \mathrm{m/s}$
Massa do eletrão	$m_\mathrm{e} = 9.109\times10^{-31}\ \mathrm{kg}$
Massa do protão	$m_\mathrm{p} = 1.673\times10^{-27}\ \mathrm{kg}$
Aceleração padrão da gravidade	$g = 9.807\ \dfrac{\mathrm{m}}{\mathrm{s}^2}$