Formulário de Eletromagnetismo e Circuitos

1. Força elétrica

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

2. Cálculo do campo elétrico

$$\begin{split} \vec{E}(\vec{r}) &= k \, \sum_{i=1}^{N} \frac{q_{i} \, (\vec{r} - \vec{r}_{i})}{|\vec{r} - \vec{r}_{i}|^{3}} \qquad \vec{E}(\vec{r}) \approx k \int_{\mathcal{C}} \frac{\vec{r} - \vec{r}'}{|\vec{r} - \vec{r}'|^{3}} \, \lambda(\vec{r}') \, \mathrm{d}s' \\ \vec{E}(\vec{r}) &= k \, \iint_{\mathcal{S}} \frac{\vec{r} - \vec{r}'}{|\vec{r} - \vec{r}'|^{3}} \sigma(\vec{r}') \, \mathrm{d}A' \quad \Psi_{\mathcal{S}} = \iint_{\mathcal{S}} \vec{E} \cdot \mathrm{d}\vec{A} \qquad \oiint_{\mathcal{S}} \vec{E} \cdot \mathrm{d}\vec{A} = 4\pi k q_{\mathrm{int}} \\ \vec{E}_{\mathrm{plano}} &= 2\pi k \sigma \, \hat{n} \qquad \vec{E}_{\mathrm{fio}}(\varrho) = \frac{2k \lambda}{\varrho} \hat{\varrho} \\ \frac{\partial E_{x}}{\partial y} &= \frac{\partial E_{y}}{\partial x} \qquad \frac{\partial E_{x}}{\partial z} = \frac{\partial E_{z}}{\partial x} \qquad \frac{\partial E_{z}}{\partial z} = \frac{\partial E_{z}}{\partial y} \end{split}$$

3. Potencial eletrostático

$$V = rac{kq}{r}$$
 $V_{
m Q} - V_{
m P} = -\int_{
m P}^{
m Q} ec{E} \cdot {
m d} ec{r}$ $ec{E} = -ec{
abla} V$ $V(ec{r}) = \sum_{i=1}^N rac{kq_i}{|ec{r} - ec{r}_i|}$

4. Energia eletrostática e capacidade

$$E_{
m p}=qV$$
 $\Delta E_{
m c}+\Delta E_{
m p}=W_{
m nc}$ $E_{
m c}=rac{1}{2}mv^2$ $\gamma=rac{1}{\sqrt{1-v^2/c^2}}$ $\gamma=1+rac{E_{
m c}}{mc^2}$ $E_{
m p}(r)=rac{kq_1q_2}{r}$ $C=rac{Q}{V}$ $C=rac{KQ}{\Delta V}$ $C_{
m plano}=K\epsilon_0rac{A}{d}$ $C_{
m esf\'erico}=K\epsilon_0rac{4\pi ab}{b-a}$ $rac{1}{C_{
m s}}=rac{1}{C_1}+rac{1}{C_2}+\ldots+rac{1}{C_n}$ $C_{
m p}=C_1+C_2+\ldots+C_n$

5. Força eletromotriz corrente e resistência

$$\begin{split} |I| &= \frac{|\Delta Q|}{\Delta t} & \Delta Q = \int_{t_1}^{t_2} I(t) \, \mathrm{d}t & J = |\rho| v = \frac{I}{A} \\ \vec{J} &= \rho \vec{v} & P = \Delta V \, I & P = \varepsilon \, I \\ R &= \rho_\mathrm{e} \frac{\ell}{A} & \Delta V = R \, I & P = R \, I^2 = \frac{\Delta V^2}{R} \\ R &= R_{20} \left[1 + \alpha_{20} (T - 20) \right] & \Delta V_{\mathrm{gerador}} = \varepsilon - r I & \Delta V_{\mathrm{recetor}} = \varepsilon + r I \\ R_{\mathrm{s}} &= R_1 + R_2 + \ldots + R_N & \frac{1}{R_\mathrm{p}} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots + \frac{1}{R_N} & R_\mathrm{p} = \frac{R_1 \, R_2}{R_1 + R_2} \end{split}$$

6. Circuitos de corrente contínua

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

7. Força magnética

$$ec{F}_{
m m} = q \left(ec{v} imes ec{B}
ight) \hspace{1cm} ec{F} = q \left(ec{E} + ec{v} imes ec{B}
ight) \hspace{1cm} \omega = rac{|q|B}{m}
onumber \ r = rac{v_{\perp}}{\omega} = rac{mv_{\perp}}{|q|B} \hspace{1cm} ec{M} = ec{m} imes ec{B} \hspace{1cm} ec{m} = IA \, \hat{n}$$

8. Cálculo do campo magnético

$$ec{B}(ec{r}) = k_{
m m} \int_{
m P}^{
m Q} rac{ec{I} imes (ec{r} - ec{r}')}{|ec{r} - ec{r}'|^3} \, {
m d}s' \qquad ec{B}_{
m fio~inf.}(arrho) = rac{2k_{
m m}I}{arrho} \, \hat{\phi} \qquad \oint_{
m C} ec{B} \cdot {
m d}ec{r} = 4\pi k_{
m m}I_{
m C} \ B_{
m sol.~inf.} = 4\pi k_{
m m}I \qquad \qquad rac{F_{21}}{l} pprox rac{2k_{
m m}I_1I_2}{d} \$$

9. Indução eletromagnética

$$ec{E}_{
m i} = ec{v} imes ec{B}$$
 $\qquad arepsilon_{
m i} = l \, |ec{v} imes ec{B}|$ $\qquad arPhi_{
m S} = \iint_{
m S} ec{B} \cdot {
m d} ec{A}$ $\qquad arepsilon_{
m i} = -rac{{
m d} \, ec{ heta}}{{
m d} \, t}$ $\qquad arepsilon_{
m i} = -Lrac{{
m d} \, I}{{
m d} \, t}$ $\qquad \Delta V = Lrac{{
m d} \, I}{{
m d} \, t}$ $\qquad I_{
m d} = rac{1}{4\pi k} \iint_{
m S} rac{\partial ec{E}}{\partial t} \cdot {
m d} ec{A}$

10. Circuitos de corrente alternada

$$\begin{split} V(t) &= V_{\text{máx}} \cos \left(\omega t + \varphi\right) \quad \mathbf{V} = Z\mathbf{I} & Z = R(\omega) + \mathrm{i}\,X(\omega) & V_{\text{máx}} = |Z|\,I_{\text{máx}} \\ \varphi_V &= \varphi_Z + \varphi_I & Z_R = R & Z_C = \frac{1}{\mathrm{i}\omega C} = \frac{1}{\omega C}\,\angle - \frac{\pi}{2} & Z_L = \mathrm{i}\omega L = \omega L\,\angle\,\frac{\pi}{2} \\ Z_{\text{s}} &= Z_1 + Z_2 & Z_{\text{p}} = \frac{Z_1 Z_2}{Z_1 + Z_2} & V_{\text{ef}} = \frac{V_{\text{máx}}}{\sqrt{2}} & I_{\text{ef}} = \frac{I_{\text{máx}}}{\sqrt{2}} \\ \bar{P} &= \frac{1}{2}\,V_{\text{máx}}I_{\text{máx}}\cos\varphi_Z & \mathbf{V}_{\text{out}} = \mathcal{R}(\omega)\,\mathbf{V}_{\text{in}} \end{split}$$

11. Ondas eletromagnéticas

$$ec{
abla} \cdot ec{E} = 4\pi k
ho \qquad ec{
abla} \cdot ec{B} = 0 \qquad ec{
abla} imes ec{E} = -rac{\partial ec{B}}{\partial t} \qquad ec{
abla} imes ec{B} = 4\pi k_{
m m} ec{J} + rac{k_{
m m}}{k} rac{\partial ec{E}}{\partial t} \qquad c^2 = rac{k_{
m m}}{k_{
m m}} ec{B} = 4\pi k_{
m m} ec{J} + rac{k_{
m m}}{k} rac{\partial ec{E}}{\partial t} \qquad c^2 = rac{k_{
m m}}{k_{
m m}} ec{B} = 4\pi k_{
m m} ec{J} + rac{k_{
m m}}{k} rac{\partial ec{E}}{\partial t} \qquad c^2 = rac{k_{
m m}}{k_{
m m}} ec{B} = 4\pi k_{
m m} ec{J} + rac{k_{
m m}}{k} rac{\partial ec{E}}{\partial t} \qquad c^2 = rac{k_{
m m}}{k_{
m m}} ec{B} = 4\pi k_{
m m} ec{J} + rac{k_{
m m}}{k} rac{\partial ec{E}}{\partial t} \qquad c^2 = rac{k_{
m m}}{k_{
m m}} ec{B} = 4\pi k_{
m m} ec{J} + rac{k_{
m m}}{k} rac{\partial ec{E}}{\partial t} \qquad c^2 = rac{k_{
m m}}{k_{
m m}} ec{B} = 4\pi k_{
m m} ec{J} + rac{k_{
m m}}{k} rac{\partial ec{E}}{\partial t} \qquad c^2 = rac{k_{
m m}}{k_{
m m}} ec{B} = 4\pi k_{
m m} ec{J} + rac{k_{
m m}}{k_{
m m}} rac{\partial ec{E}}{\partial t} \qquad c^2 = rac{k_{
m m}}{k_{
m m}} ec{B} = 4\pi k_{
m m} ec{J} + rac{k_{
m m}}{k_{
m m}} rac{\partial ec{E}}{\partial t} \qquad c^2 = rac{k_{
m m}}{k_{
m m}} ec{B} = 4\pi k_{
m m} ec{J} + rac{k_{
m m}}{k_{
m m}} rac{\partial ec{E}}{\partial t} \qquad c^2 = rac{k_{
m m}}{k_{
m m}} ec{B} = 4\pi k_{
m m} ec{J} + rac{k_{
m m}}{k_{
m m}} rac{\partial ec{E}}{\partial t} \qquad c^2 = rac{k_{
m m}}{k_{
m m}} rac{\partial ec{E}}{\partial t} \qquad c^2 = rac{k_{
m m}}{k_{
m m}} rac{\partial ec{E}}{\partial t} \qquad c^2 = rac{k_{
m m}}{k_{
m m}} rac{\partial ec{E}}{\partial t} \qquad c^2 = rac{k_{
m m}}{k_{
m m}} rac{\partial ec{E}}{\partial t} \qquad c^2 = rac{k_{
m m}}{k_{
m m}} rac{\partial ec{E}}{\partial t} \qquad c^2 = 2\pi k_{
m m} \end{c}$$

Constantes

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