# Formulário de Electromagnetismo e Óptica

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**Electrostática**

- $\vec{E} = \frac{1}{4\pi\epsilon_0}\frac{q}{r^2}\vec{u}_r$
- $\frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \ N.m^2.C^{-2}$
- $\oint_\Gamma \vec{E} \cdot d\vec{l} = 0$
- $\vec{\nabla} \times \vec{E} = \vec{0}$
- $\oint_S \vec{D} \cdot \vec{n} \ dS = \int_V \rho \ dV$
- $\vec{\nabla} \cdot \vec{D} = \rho$
- $\oint_S \vec{P} \cdot \vec{n} \ dS = -\int_V \rho_{pol} \ dV$
- $\vec{\nabla} \cdot \vec{P} = -\rho_{pol}$
- $\sigma_{pol} = \vec{P} \cdot \vec{n}_{ext}$
- $\Phi_P = \int_{R_P}^{R_{ef}} \vec{E} \cdot d\vec{l}$
- $\vec{E} = -\vec{\nabla}\Phi$
- $\vec{D} = \vec{P} + \epsilon_0\vec{E}$
- $\vec{D} = \epsilon_0 (1 + \chi_E) \vec{E} = \epsilon\vec{E}$
- $Q = CV$
- $U_E = \frac{1}{2}\Sigma_i q_i \Phi_i$
- $u_E = \frac{1}{2}\vec{D}.\vec{E} = \frac{1}{2}\epsilon E^2 \ ; \ U_E = \int_V u_E dV$

**Corrente eléctrica estacionária**

- $\vec{J} = Nq\vec{v}$
- $\vec{J} = \sigma\vec{E}$
- $I = \int_S \vec{J} \cdot \vec{n} \ dS$
- $\oint_S \vec{J} \cdot \vec{n} \ dS = -\frac{d}{dt}\int_V \rho \ dV$
- $\vec{\nabla} \cdot \vec{J} = \frac{\partial\rho}{\partial t} = 0$

**Magnetostática**

- $\vec{B} = \frac{\mu_0}{4\pi}\int_\Gamma \frac{I \ d\vec{l} \times \vec{u}_r}{r^2}$
- $\frac{\mu_0}{4\pi} = 10^{-7} \ H/m$
- $d\vec{F} = Id\vec{l} \times \vec{B}$
- $\oint_S \vec{B} \cdot \vec{n} \ dS = 0$
- $\vec{\nabla} \cdot \vec{B} = 0$
- $\oint_\Gamma \vec{H} \cdot d\vec{l} = \int_S \vec{J} \cdot \vec{n} \ dS$
- $\vec{\nabla} \times \vec{H} = \vec{J}$
- $\vec{B} = \mu_0 \left(\vec{M} + \vec{H}\right)$
- $\vec{B} = \mu (1 + \chi_m) \vec{H} = \mu\vec{H}$
- $\oint_\Gamma \vec{M} \cdot d\vec{l} = \int_S \vec{J}_M \cdot \vec{n} \ dS$
- $\vec{\nabla} \times \vec{M} = \vec{J}_M$
- $u_M = \frac{1}{2}\vec{B}.\vec{H} = \frac{1}{2}\frac{B^2}{\mu} \ ; \ U_M = \int_V u_M dV$

## Movimento de partículas em campos

- $\vec{F} = q\left(\vec{E} + \vec{v} \times \vec{B}\right)$

## Campos variáveis e indução

- $\oint_\Gamma \vec{E} \cdot d\vec{l} = -\frac{d}{dt}\int_S \vec{B} \cdot \vec{n}\ dS$
- $\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$
- $\Phi_i = L_i I_i + M_{ij} I_j \quad ; \quad U_M = \frac{1}{2}\Phi I$
- $\oint \vec{H} \cdot d\vec{l} = \int_S \vec{J} \cdot \vec{n}\ dS + \frac{d}{dt}\int_S \vec{D} \cdot \vec{n}\ dS$
- $\vec{\nabla} \times \vec{H} = \vec{J} + \frac{\partial \vec{D}}{\partial t}$

## Ondas electromagnéticas

- $\vec{S} = \vec{E} \times \vec{H}$
- $\vec{n} = \frac{\vec{k}}{k}$
- $\frac{E}{B} = v$
- $v = \frac{1}{\sqrt{\epsilon\mu}}$
- $u_{EM} = u_E + u_M$
- $I = \left\langle \vec{S} \cdot \vec{n} \right\rangle$

## Óptica ondulatória

- $n_1\ \sin\theta_1 = n_2\ \sin\theta_2$
- $\tan\theta_B = \frac{n_2}{n_1}$

# Algumas fórmulas matemáticas

## Coordenadas cartesianas

- $d\vec{l} = dx\ \vec{u}_x + dy\ \vec{u}_y + dz\ \vec{u}_z$
- $dS = dx\ dy$
- $dV = dx\ dy\ dz$
- $\vec{\nabla} F = \left(\frac{\partial F}{\partial x}, \frac{\partial F}{\partial y}, \frac{\partial F}{\partial z}\right)$
- $\vec{\nabla} \cdot \vec{A} = \frac{\partial A_x}{\partial x} + \frac{\partial A_y}{\partial y} + \frac{\partial A_z}{\partial z}$
- $\vec{\nabla} \times \vec{A} = \left(\frac{\partial}{\partial x}, \frac{\partial}{\partial y}, \frac{\partial}{\partial z}\right) \times (A_x, A_y, A_z)$

## Coordenadas polares $(r, \theta)$

- $d\vec{l} = dr\ \vec{u}_r + r\ d\theta\ \vec{u}_\theta$
- $dS = r\ dr\ d\theta$

## Teorema da Divergência

- $\int_V \vec{\nabla} \cdot \vec{A}\ dV = \oint_S \vec{A} \cdot \vec{n}\ dS$

## Teorema de Stokes

- $\int_S (\vec{\nabla} \times \vec{A}) \cdot \vec{n}\ dS = \oint_S \vec{A} \cdot d\vec{l}$

## Identidades vectoriais

- $\vec{\nabla} \times (\nabla f) = 0$
- $\vec{\nabla} \cdot \left(\vec{A} \times \vec{B}\right) = \vec{B} \cdot \left(\vec{\nabla} \times \vec{A}\right) - \vec{A} \cdot \left(\vec{\nabla} \times \vec{B}\right)$
- $\vec{\nabla} \cdot \left(\vec{\nabla} \times \vec{A}\right) = 0$
- $\vec{\nabla} \times \left(\vec{\nabla} \times \vec{A}\right) = \vec{\nabla}\left(\vec{\nabla} \cdot \vec{A}\right) - \nabla^2 \vec{A}$