Formulari EM

Canvis de Coordenades

Coordenades cilíndriques (s, θ, z)

$s = \sqrt{x^2 + y^2} \quad \theta = \arctan \frac{y}{x} \quad z = z$

$x = s\cos\theta \quad y = s\sin\theta \quad z = z$

$$\begin{pmatrix} A_x \\ A_y \\ A_z \end{pmatrix} = \begin{pmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} A_s \\ A_\theta \\ A_z \end{pmatrix}$$

Coordenades esfèriques (r, θ, φ)

$r = \sqrt{x^2 + y^2 + z^2} \quad \theta = \arccos \frac{z}{r} \quad \varphi = \frac{y}{x}$

$x = r\sin\theta\cos\varphi \quad y = r\sin\theta\sin\varphi \quad z = r\cos\theta$

$$\begin{pmatrix} A_x \\ A_y \\ A_z \end{pmatrix} = \begin{pmatrix} \sin\theta\cos\varphi & \cos\theta\cos\varphi & -\sin\varphi \\ \sin\theta\sin\varphi & \cos\theta\sin\varphi & \cos\varphi \\ \cos\theta & -\sin\theta & 0 \end{pmatrix} \begin{pmatrix} A_s \\ A_\theta \\ A_z \end{pmatrix}$$

$d\vec{S}_{r=cte} = r^2\sin\theta d\theta d\varphi \quad d\vec{S}_{\theta=cte} = r\sin\theta dr d\varphi$

$d\vec{S}_{\varphi=cte} = r dr d\theta$

Electrostatica

$\vec{F}_{q_1q_2} = k\frac{q_1q_2}{d^2}\frac{\vec{r_2}-\vec{r_1}}{||\vec{r_2}-\vec{r_1}||} \qquad \vec{E}_q(\vec{r}) = \frac{kq}{|\vec{r}-\vec{r}_q|^2}\frac{(\vec{r}-\vec{r}_q)}{||\vec{r}-\vec{r}_q||}$

$\vec{F} = q\vec{E} \qquad \vec{p} = q\vec{l} \qquad \vec{M} = \vec{p}\times\vec{E}$

$\int_Q d\vec{E} = k\int_Q \frac{dq}{|\vec{r}-\vec{r'}|}\frac{(\vec{r}-\vec{r'})}{||\vec{r}-\vec{r'}||}$

$\Phi = \vec{E}\cdot\vec{S} \qquad \Phi = \int_S \vec{E}d\vec{S}$

Llei de Gauss $\oint_S \vec{E}d\vec{S} = \frac{q_{int}}{\varepsilon_o}$

Forma diferencial $\nabla\cdot\vec{E} = \frac{\rho}{\varepsilon_o}$

$W = \int_C \vec{F}d\vec{r} = -\Delta U$

$\Delta V = -\int \vec{E}d\vec{r} \qquad dV = -\vec{E}d\vec{r} = \Delta V$

$\vec{E} = -\vec{\nabla}V \qquad \Gamma = \oint_C \vec{E}d\vec{l} = \int_S(\vec{\nabla}\times\vec{E}) = 0$

$rot\ \vec{E} = \frac{\Gamma}{dS} = \vec{\nabla}\times\vec{E}$

$U = \frac{\varepsilon_0}{2}\int|\vec{E}|^2dV \qquad \eta_E = \frac{1}{2}\varepsilon_0|\vec{E}|^2$

Conductors

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

$C = \frac{Q}{V}$

Corrent

$I = \frac{dq}{dt} = nqvS = \int_S \vec{j}\cdot d\vec{S} = \sigma ES$

$\vec{j} = nq\vec{v} = \sigma E$

$\rho_i = q_i n_i$

Equacio de continuitat $j_2s_2 - j_1s_1 = -\frac{dQ}{dt}$

$\Delta V = El$

$\frac{\Delta V}{I} = R$

$\rho = \frac{1}{\sigma} \qquad R = \rho\frac{l}{S}$

Magnetisme

$\oint_C \vec{B}d\vec{l} = \mu_0 I$

$\vec{B} = \int_l d\vec{B} = \frac{\mu_o}{4\pi}\int_l \frac{Id\vec{l}\times\vec{r}}{r^3}$

$\vec{B}(\vec{r_p}) = \frac{\mu_o}{4\pi}q\frac{\vec{v}\times\vec{r}}{r^3}$

$\oint \vec{B}dS = 0$

$\varepsilon = -\frac{\partial\Phi_B}{\partial t}$

$\vec{F} = I\vec{d'}\times\vec{B}$

$I = \frac{\varepsilon}{R}$

$P = I^2R$

$\oint_C \vec{B}\cdot d\vec{l} = \mu_0 I_0$

$\eta_B = \frac{1}{2\mu_0}|\vec{B}|^2$

$\vec{M} = I\vec{S}\times\vec{B} = \vec{m}\times\vec{B}$

Electromagnetisme

$\oint_C \vec{B}d\vec{l} = \mu_0 I + \mu_0\varepsilon_0\frac{\partial\Phi_E}{\partial t}$

$\oint_C \vec{E}d\vec{l} = -\frac{\partial\Phi_B}{\partial t}$

Equacions de Maxwell

$\vec{\nabla}\cdot\vec{E} = \frac{\rho}{\varepsilon}$

$\vec{\nabla}\cdot\vec{B} = 0$

$\vec{\nabla}\times\vec{E} = -\frac{\partial\vec{B}}{\partial t}$

$\vec{\nabla}\times\vec{B} = \mu_0\vec{j} + \mu_0\varepsilon_0\frac{\partial\vec{E}}{\partial t}$

Dielectrics

$\sigma_b = \vec{P}\cdot\hat{n} \qquad \rho_b = -\vec{\nabla}\cdot\vec{P}$

$\vec{P} = \varepsilon_0\chi\vec{E}$

$\vec{D} = \varepsilon_0\varepsilon_r\vec{E} \qquad \varepsilon_r = 1 + \chi$

$\vec{S} = \vec{E}\times\vec{H} = \frac{1}{\mu}\vec{E}\times\vec{B}$

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Constants i Unitats

$k = 9\times10^9$	*Const de Coulomb* $[\frac{Nm^2}{C^2}]$
$e = -1.602\times10^{-19}$	*Càrrega Electró* $[C]$
$\vec{p}$	*Moment dipolar* $[Cm]$
$\vec{M}$	*Moment de forces* $[Nm]$
$\vec{E}$	*Camp Elèctric* $[\frac{N}{C}]$
Φ	*Flux Elèctric* $[\frac{Nm^2}{C}]$
$\varepsilon_0 = 8.8541\times10^{-12}$	*Permitivitat buit*$[\frac{C^2}{Nm^2}]$
W	*Treball* $[Nm]$
V	*Potencial* $[V]$
n	*portadors per* m^3
v	*velositat* $[\frac{m}{s^2}]$
$\vec{j}$	*vector densitat de corrent*[?]
ρ	*resistivitat*$[\Omega m]$
σ	*conductivitat* $[\frac{S}{m}]$
σ_b	*dens superficial de C* $[\frac{C}{m^2}]$
ρ_b	*dens volumica de C* $[\frac{C}{m^2}]$