Formelblad - Elektromagnetism D.

Maxwells ekvationer

1 $\oint_S \mathbf{D}\cdot d\mathbf{S} = Q$

2 $\oint_C \mathbf{E}\cdot d\mathbf{l} = -\int_S \frac{\partial \mathbf{B}}{\partial t}\cdot d\mathbf{S}$

3 $\oint_S \mathbf{B}\cdot d\mathbf{S} = 0$

4 $\oint_C \mathbf{H}\cdot d\mathbf{l} = \int_S \mathbf{J}\cdot d\mathbf{S} + \int_S \frac{\partial \mathbf{D}}{\partial t}\cdot d\mathbf{S}$

$\mathbf{D} = \varepsilon_0 \mathbf{E} + \mathbf{P}$ $\qquad$ $\mathbf{B} = \mu_0(\mathbf{H}+\mathbf{M})$

Potential och **E**-fält från elektriskt dipolmoment

$$V = \frac{p\cdot\cos\theta}{4\pi\varepsilon_0\cdot r^2}$$

$$\mathbf{E} = \frac{p}{4\pi\varepsilon_0\cdot r^3}\left(2\cos\theta\cdot\hat{\mathbf{r}} + \sin\theta\cdot\hat{\theta}\right)$$

B-fält från magnetiskt dipolmoment

$$\mathbf{B} = \frac{\mu_0 m}{4\pi\cdot r^3}\left(2\cos\theta\cdot\hat{\mathbf{r}} + \sin\theta\cdot\hat{\theta}\right)$$

Biot-Savarts lag

$$\mathbf{B} = \oint_C \frac{\mu_0 I d\mathbf{l}\times\hat{\mathbf{r}}}{4\pi r^2};\quad \mathbf{B} = \oint_\tau \frac{\mu_0 \mathbf{J}\times\hat{\mathbf{r}}d\tau}{4\pi r^2};\quad \mathbf{B} = \oint_S \frac{\mu_0 \mathbf{J}_s\times\hat{\mathbf{r}}dS}{4\pi r^2}$$

Gradient i olika koordinatsystem

$$grad(V) = \frac{\partial V}{\partial x}\cdot\hat{\mathbf{x}} + \frac{\partial V}{\partial y}\cdot\hat{\mathbf{y}} + \frac{\partial V}{\partial z}\cdot\hat{\mathbf{z}}$$ cartesiskt

$$grad(V) = \frac{\partial V}{\partial R}\cdot\hat{\mathbf{R}} + \frac{1}{R}\cdot\frac{\partial V}{\partial\phi}\cdot\hat{\phi} + \frac{\partial V}{\partial z}\cdot\hat{\mathbf{z}}$$ cylindriskt

$$grad(V) = \frac{\partial V}{\partial r}\cdot\hat{\mathbf{r}} + \frac{1}{r}\cdot\frac{\partial V}{\partial\theta}\cdot\hat{\theta} + \frac{1}{r\sin\theta}\cdot\frac{\partial V}{\partial\phi}\cdot\hat{\phi}$$ sfäriskt

Omvandling av rörliga koordinater till cartesiska.

$\hat{R} = \cos\varphi\hat{x} + \sin\varphi\hat{y}$ $\qquad$ $\hat{r} = \sin\theta\cos\varphi\hat{x} + \sin\theta\sin\varphi\hat{y} + \cos\theta\hat{z}$

$\hat{\varphi} = -\sin\varphi\hat{x} + \cos\varphi\hat{y}$ $\qquad$ $\hat{\theta} = \cos\theta\cos\varphi\hat{x} + \cos\theta\sin\varphi\hat{y} - \sin\theta\hat{z}$

$\hat{z} = \hat{z}$ $\qquad$ $\hat{\varphi} = -\sin\varphi\hat{x} + \cos\varphi\hat{y}$

Några vanliga integraler

$$\int\frac{dx}{\left(x^2+a^2\right)^{1/2}} = \ln\left[x + \left(x^2+a^2\right)^{1/2}\right]\ ;\ \int\frac{dx}{\left(x^2+a^2\right)} = \frac{1}{a}\arctan\left(\frac{x}{a}\right)$$

$$\int\frac{dx}{\left(x^2+a^2\right)^{3/2}} = \frac{x}{a^2\left(x^2+a^2\right)^{1/2}}\ ;\ \int\frac{dxx^2}{\left(x^2+a^2\right)} = x - a\arctan\left(\frac{x}{a}\right)$$

$$\int\frac{dxx^2}{\left(x^2+a^2\right)^{3/2}} = \frac{-x}{\left(x^2+a^2\right)^{1/2}} + \ln\left[x + \left(x^2+a^2\right)^{1/2}\right]$$

Energitäthet: $\frac{\partial W_{em}}{\partial\tau} = \frac{1}{2}\mathbf{E}\cdot\mathbf{D} + \frac{1}{2}\mathbf{B}\cdot\mathbf{H}.$

Ljushastighet i dielektriskt medium: $c_m = \left(\varepsilon_0\varepsilon_r\mu_0\right)^{-1/2} = c_0/\sqrt{\varepsilon_r}$.

Brytningsindex: $n = c_0/c_m = \sqrt{\varepsilon_r}$.

Intensitet hos plan elektromagnetisk våg: $\mathbf{I} = \varepsilon_0 c_0 n E_0^2 \sin^2(kx-\omega t)\cdot\hat{\mathbf{x}}$.

Telegrafekvationen för förlustfri ledning:

$$\frac{\partial^2 U}{\partial z^2} = L_l C_l \frac{\partial^2 U}{\partial t^2}$$ alternativt $$\frac{\partial^2 i}{\partial z^2} = L_l C_l \frac{\partial^2 i}{\partial t^2}$$