Soluzioni

(1) $r \leq r_1 \qquad E = 0$

$r_1 \leq r \leq r_2 \qquad E = \dfrac{\rho(r^2 - r_1^2)}{2\varepsilon_0 r}$

$r \geq r_2 \qquad E = \dfrac{\rho(r_2^2 - r_1^2)}{2\varepsilon_0 r}$

$$V_A - V_B = \int_0^{r_2} \vec{E} \cdot d\vec{r} = \int_{r_1}^{r_2} \frac{\rho(r^2 - r_1^2)}{2\varepsilon_0 r}\, dr$$

$$V_A - V_B = \frac{\rho(r_2^2 - r_1^2)}{4\varepsilon_0} - \frac{\rho r_1^2}{2\varepsilon_0} \ln\frac{r_2}{r_1}$$

(3) $I_0 = \dfrac{f}{R} \; ; \; R_{//} = R/2$

$t > 0$

$$f - L\frac{dI}{dt} = \frac{R}{2} I \qquad \tau = \frac{2L}{R}$$

$\Rightarrow$ Per parti :

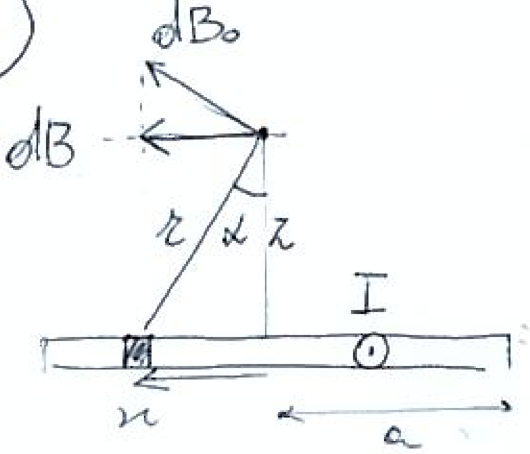
$$\int_{I_0}^{I} \frac{dI}{I - \frac{2f}{R}} = -\int_0^t \frac{dt}{\tau} \Rightarrow \underline{\underline{I = \frac{f}{R}\left(2 - e^{-t/\tau}\right)}}$$

$$U_0 = \frac{1}{2} L I_0 = \frac{1}{2} L \frac{\mathcal{E}^2}{R^2}$$

$$U_f = \frac{1}{2} L I_f^2 = 2 L \frac{\mathcal{E}^2}{R^2}$$

$$\Rightarrow \quad \Delta U = \frac{3}{2} L \frac{\mathcal{E}^2}{R^2}$$

(2)



$$dB_0 = \frac{\mu_0\, dI}{2\pi r}$$

$$dI = \frac{I}{2a} dx$$

$$\boxed{dB_0 = \frac{\mu_0 I\, dx}{4\pi a r}}$$

$$x = z\, tg\alpha$$

$$dx = \frac{z}{\cos^2\alpha} d\alpha \quad ; \quad r = \frac{z}{\cos\alpha}$$

$$dB = dB_0 \cos\alpha = \frac{\mu_0 I}{4\pi a \cancel{z}} \cdot \cancel{\cos\alpha}\, \frac{\cancel{z}}{\cancel{\cos^2\alpha}} d\alpha$$

$$dB = \frac{\mu_0 I}{4\pi a} d\alpha \qquad \cos\alpha_{max} = \frac{z}{\sqrt{z^2+a^2}}$$

$$\alpha_{max} = \arccos \frac{z}{\sqrt{z^2+a^2}}$$

$$B = \int_{-\alpha_{max}}^{\alpha_{max}} \frac{\mu_0 I \, d\alpha}{4\pi a} = \frac{\mu_0 I}{4\pi a} 2\alpha_{max}$$

$$B = \frac{\mu_0 I}{2\pi a} \arccos \frac{z}{\sqrt{z^2+a^2}} = 1{,}64 \cdot 10^{-6} \, T$$

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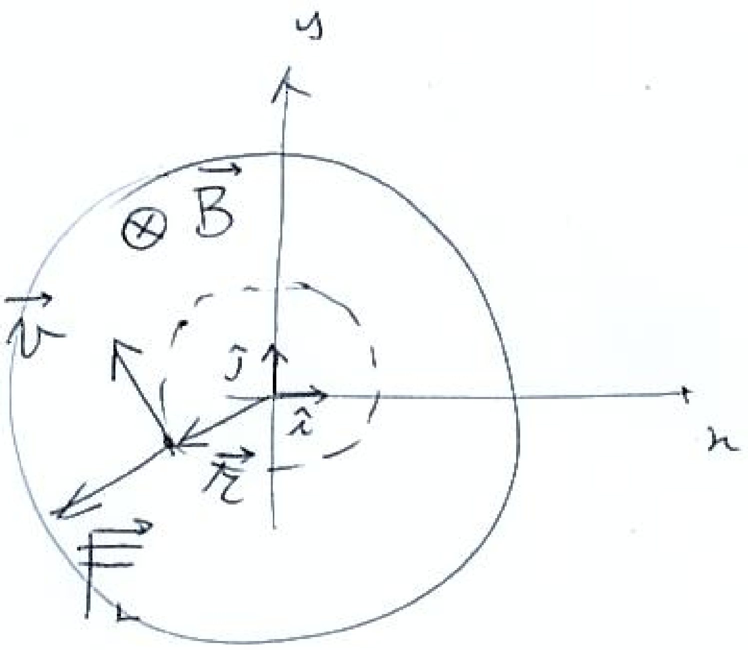

$$\frac{\vec{F}_L}{q} = \vec{E} = \vec{v} \times \vec{B} = \omega B \vec{r}$$

$$\vec{P} = \varepsilon_0(\varepsilon_r - 1)\omega B \vec{r} = \varepsilon_0(\varepsilon_r - 1)\omega B (x\hat{i} + y\hat{j})$$

$$\rho_P = -\vec{\nabla} \cdot \vec{P} = -\varepsilon_0(\varepsilon_r - 1)\omega B \left(\frac{\partial}{\partial x} x + \frac{\partial}{\partial y} y\right)$$

$$\rho_P = -2\varepsilon_0(\varepsilon_r - 1)\omega B$$

(5) $\overline{P} = 4\pi r^2 \overline{I}$ ← per onde sferiche

In generale vale:

$$\overline{I} = \frac{E_0^2}{2Z_0}$$

$$\Rightarrow \quad E_0^{MIN} \leq E_0 = \frac{1}{r}\sqrt{\frac{Z_0 \overline{P}}{2\pi}}$$

$$\Rightarrow \quad r \leq \frac{1}{E_0^{MIN}}\sqrt{\frac{Z_0 \overline{P}}{2\pi}} \qquad \square$$