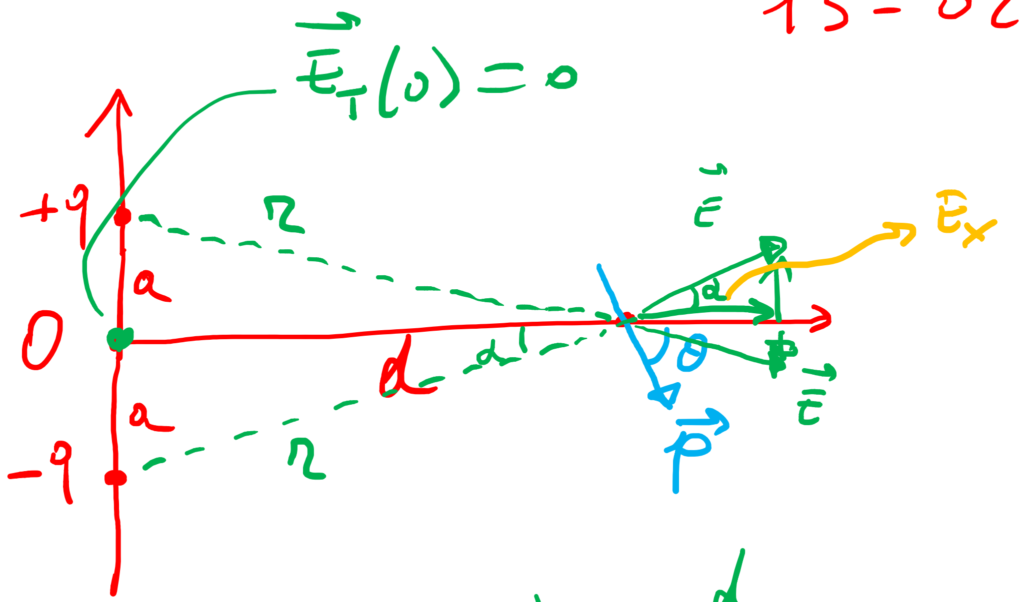
15-02-2022

1)



$$r=\sqrt{a^2+d^2}$$

$$E=\frac{q}{4\pi\varepsilon}\frac{1}{r^2}$$

$$E_x=E\cos\alpha$$

$$E_y=E\,\mathrm{sen}\,\alpha$$

$$\cos\alpha=\frac{d}{\sqrt{a^2+d^2}}\qquad \mathrm{sen}\,\alpha=\frac{a}{\sqrt{a^2+d^2}}$$

$$\vec{E}_T(d)=\hat{x}E_{Tx}+\hat{y}E_{Ty}$$

$E_{Ty}=0$ (si annullano le componenti lungo y)

$$\vec{E}_T(d)=\hat{x}\,2E_x=\hat{x}\,2E\cos\alpha=\hat{x}\,\frac{2q\,d}{4\pi\varepsilon\,(a^2+d^2)^{3/2}}$$

$\vec{E}_T(0)=0$ perché simmetrico tra $+q$ e $+q$

$$U_{dipolo} = -\vec{p}\cdot\vec{E} \qquad \mathcal{L}_{est} = -\mathcal{L}_E$$

$$\mathcal{L}_E = -\Delta U_{dipolo} = -\mathcal{L}_{est} \rightarrow \mathcal{L}_{est} = +\Delta U_{dipolo}$$

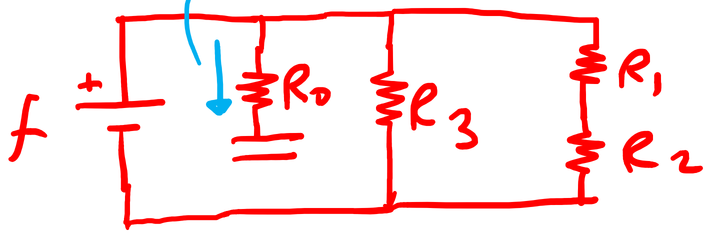
$$\mathcal{L}_{est} = U_{dipolo}(\text{FINALE}) - U_{dipolo}(\text{INIZIALE}) = U_{dipolo}(0) - U_{dipolo}(d) =$$

$$= \underbrace{-\vec{p}\cdot\vec{E}(0)}_{=0} + \vec{p}\cdot\vec{E}(d) = p\,E(d)\cos 60^\circ =$$

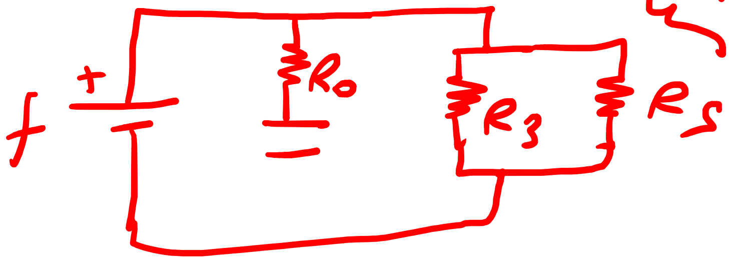
$$= \frac{p\,2q\,d}{4\pi\varepsilon\,(e^2+d^2)^{3/2}}\underbrace{\cos 60^\circ}_{=\frac{1}{2}} = \frac{p\,q\,d}{4\pi\varepsilon\,(e^2+d^2)^{3/2}}$$

2) INIZIO

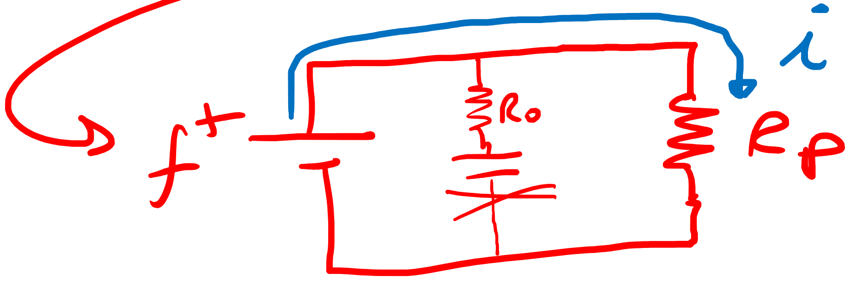
$i_{R_0} = 0$



$R_S = R_1 + R_2$



$$R_P = \frac{1}{\frac{1}{R_3} + \frac{1}{R_S}}$$



$$i = \frac{f}{R_P}$$

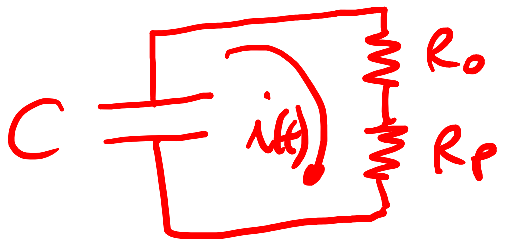
Siccome su R_0
non scorre corrente

$$\Delta V_{R_0} = R_0 \cdot 0 = 0$$

Per cui: $\boxed{V_{C_{INIZ}} = f}$

$$E_{R_3} = \int_0^{+\infty} R_3\, i_3^2\, dt = \int_0^{+\infty} \frac{V_{R_3}^2}{R_3}\, dt$$

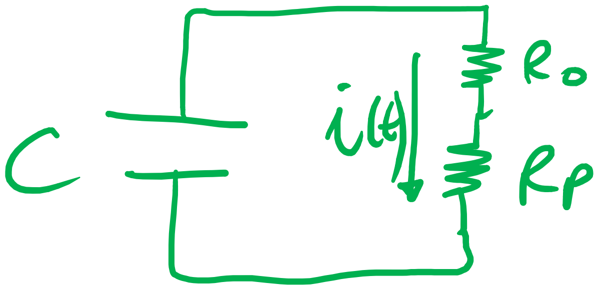
DOPO



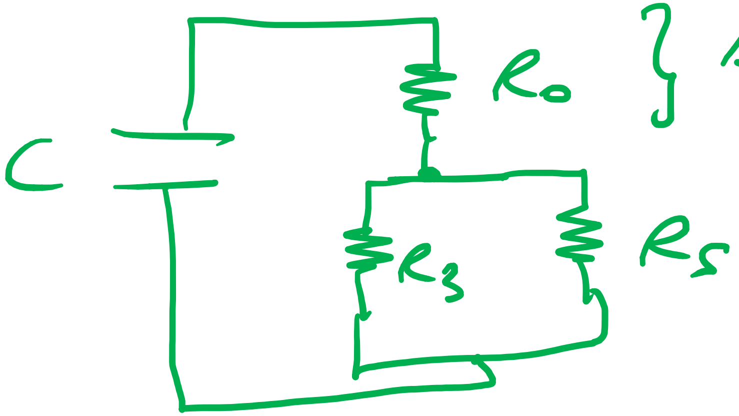
$$\tau = (R_0 + R_P)\, C$$

$$V_C(t) = f e^{-\frac{t}{\tau}}$$

$$i(t) = \frac{V_C(t)}{R_0 + R_P}$$



$\rightarrow$



$\} \ \Delta V_{R_0} = R_0 \, i(t)$

$$i(t) = \frac{f}{R_0+R_p} e^{-\frac{t}{\tau}} \qquad \boxed{\tau = (R_0+R_p)C}$$

$$\rightarrow V_{R_p} = R_p \, i(t) = V_{R_3}$$

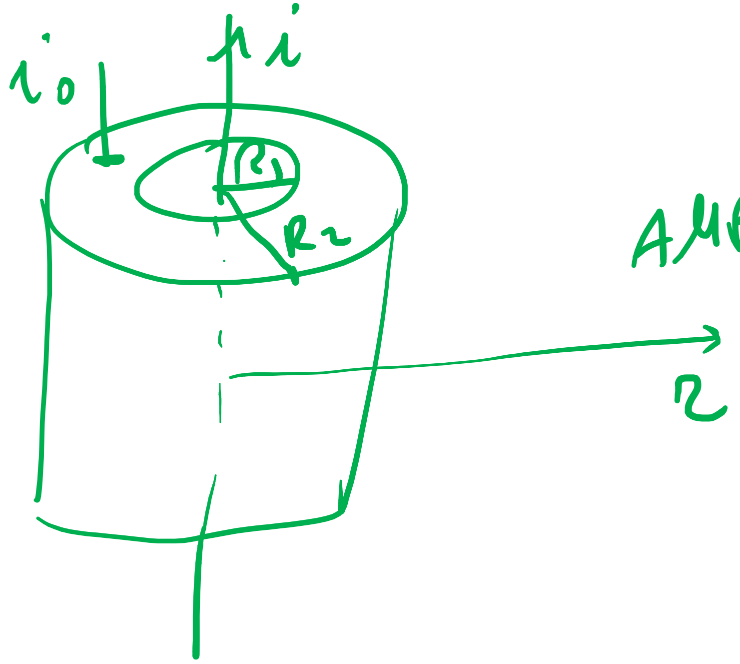
$$E_{m\,R_3} = \int_0^{+\infty} \frac{V_{R_3}^2}{R_3} \, dt = \int_0^{+\infty} \frac{R_p^2}{R_3} \, i^2(t) \, dt =$$

$$= \frac{R_p^2}{R_3} \int_0^{+\infty} \frac{f^2}{(R_0+R_p)^2} e^{-\frac{2t}{\tau}} \, dt = \frac{R_p^2 f^2}{R_3 (R_0+R_p)^2} \left(-\frac{\tau}{2}\right) [0-1] =$$

P.5

$$E_{m R_3} = \frac{R_p^2 \, f^2 \, \cancel{(R_o+R_p)} \, C}{R_3 \, (R_o+R_p)^{2} \; 2}$$

3)



per $0 < r < R_1$

AMPERE: $\oint \vec{B} \cdot d\vec{l} = \mu_0 i \rightarrow$

$\rightarrow 2\pi r B(r) = \mu_0 i$

$\rightarrow B(r) = \dfrac{\mu_0 i}{2\pi r}$ NON È MAI NULLO

per $R_1 \le r \le R_2$

$j_0 = \dfrac{i_0}{\pi(R_2^2 - R_1^2)}$ (VERSO IL BASSO)

AMPERE: $\oint \vec{B} \cdot d\vec{l} = \mu_0 \left[i - j_0 \pi (r^2 - R_1^2) \right]$

$B(r) = \dfrac{\mu_0}{2\pi r} \left[i - i_0 \dfrac{\cancel{\pi}(r^2 - R_1^2)}{\cancel{\pi}(R_2^2 - R_1^2)} \right]$

$B(r)$ può essere $= 0$ solo se $i_0 \geq i$ in quel caso

si deve avere $i - i_0 \dfrac{(r^2 - R_1^2)}{(R_2^2 - R_1^2)} = 0$

$$i_0 \frac{r^2 - R_1^2}{R_2^2 - R_1^2} = i \rightarrow i_0 (r^2 - R_1^2) = i (R_2^2 - R_1^2) \Rightarrow$$

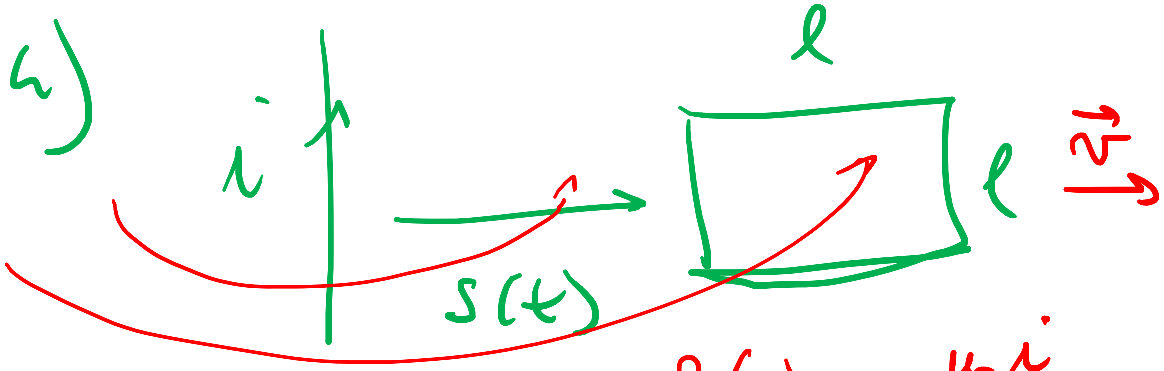
$$\rightarrow (r^2 - R_1^2) = \frac{i}{i_0} (R_2^2 - R_1^2) \rightarrow r^2 = R_1^2 + \frac{i}{i_0} (R_2^2 - R_1^2)$$

quindi $r = + \sqrt{R_1^2 + \frac{i}{i_0} (R_2^2 - R_1^2)}$

per $r > R_2$ $\oint \vec{B}(r) \cdot d\vec{l} = \mu_0 (i - i_0)$ da cui $B(r) = 0$ mai se $i \neq i_0$

sempre se $i = i_0$

4)



$$s(t) = s_0 + vt$$

$$\phi(B) = \ell \int_{s(t)}^{s(t)+\ell} B(r)\,dr =$$

$$B(r) = \frac{\mu_0 i}{2\pi r}$$

$$\phi(\vec{B}) = \frac{\ell \mu_0 i}{2\pi} \int_{s(t)}^{s(t)+\ell} \frac{dr}{r} = \frac{\mu_0 i \ell}{2\pi} \ln \frac{s(t)+\ell}{s(t)} = \frac{\mu_0 i \ell}{2\pi} \ln \left[\frac{s_0+vt+\ell}{s_0+vt} \right]$$

$$= \frac{\mu_0 i \ell}{2\pi} \left[\ln(s_0+vt+\ell) - \ln(s_0+vt) \right]$$

$$f_{em} = -\frac{d\phi(B)}{dt} = -\frac{\mu_0 i \ell}{2\pi} \left[\frac{1 \cdot v}{s_0+vt+\ell} - \frac{1 \cdot v}{s_0+vt} \right]$$

$$f_{em} = \frac{\mu_0 i \ell v}{2\pi} \left[\frac{1}{s_0+vt} - \frac{1}{s_0+vt+\ell} \right] = \frac{\mu_0 i \ell v \left[\cancel{s_0} + \cancel{vt} + \ell - \cancel{s_0} - \cancel{vt} \right]}{2\pi (s_0+vt)(s_0+vt+\ell)} = \frac{\mu_0 i v \ell^2}{2\pi (s_0+vt)(s_0+vt+\ell)}$$

$$f_{em}(t = t^*) \rightarrow \frac{\mu_0 i v \ell^2}{2\pi (s_0+vt^*)(s_0+vt^*+\ell)}$$