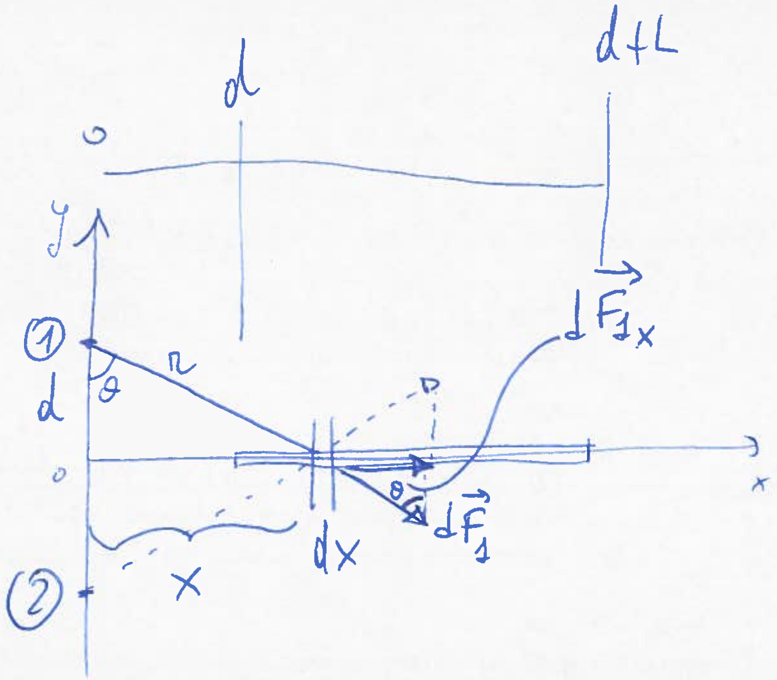
1)



$dq = \lambda dx$

$\lambda = \frac{q}{L}$

$$dF_1 = \frac{Q\,dq}{4\pi\varepsilon_0 r^2} \qquad dF_{1x} = \frac{Q\,dq}{4\pi\varepsilon_0 r^2}\,\mathrm{sen}\,\theta$$

$$\vec{F}_T = \hat{x}\ \underset{\substack{\uparrow \\ ①\ e\ ②}}{2} \int_d^{d+L} dF_{1x}\,dx$$

$$\frac{x}{d} = \tan\theta \rightarrow x = d\tan\theta \rightarrow dx = \frac{d}{\cos^2\theta}\,d\theta$$

$$r\cos\theta = d \rightarrow r = \frac{d}{\cos\theta}$$

$$x_1 = d \rightarrow \theta_1 = \arccos\left(\frac{d}{r_1}\right) = \arccos\left(\frac{d}{\sqrt{d^2+d^2}}\right)$$

$$x_2 = d+L \quad \rightarrow \theta_2 = \arccos\left(\frac{d}{r_2}\right) = \arccos\left(\frac{d}{\sqrt{d^2+(d+L)^2}}\right)$$

Sostituisco nell' integrale

$$\vec{F}_T = \hat{x}\,\cancel{2}\cdot \int_{\theta_1}^{\theta_2} Q\,\frac{q}{L}\,\frac{\cancel{d}}{\cancel{\cos\theta}}\,\frac{1}{2\cancel{4}\pi\varepsilon}\,\sin\theta\,\frac{\cancel{\cos\theta}}{\cancel{d^2}}\,d\theta =$$

$$= \hat{x}\,\frac{Q\,q\,\cancel{d}}{2\pi L\varepsilon d}\int_{\theta_1}^{\theta_2}\sin\theta\,d\theta =$$

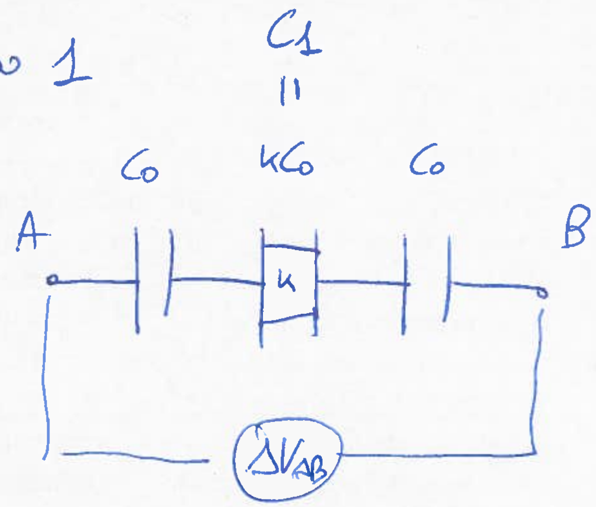
$$= \hat{x}\,\frac{Qq}{2\pi L d\varepsilon}\left[\cos\theta_1 - \cos\theta_2\right] =$$

$$= \hat{x}\,\frac{Qq}{2\pi L d\varepsilon}\left[\cos\left(\arccos\frac{d}{\sqrt{2d^2}}\right) - \cos\left(\arccos\frac{d}{\sqrt{d^2+(d+L)^2}}\right)\right] =$$

$$= \hat{x}\,\frac{Qq\,\cancel{d}}{2\pi L\cancel{d}\varepsilon}\left[\frac{1}{d\sqrt{2}} - \frac{1}{\sqrt{d^2+(d+L)^2}}\right]$$

2)

Caso 1



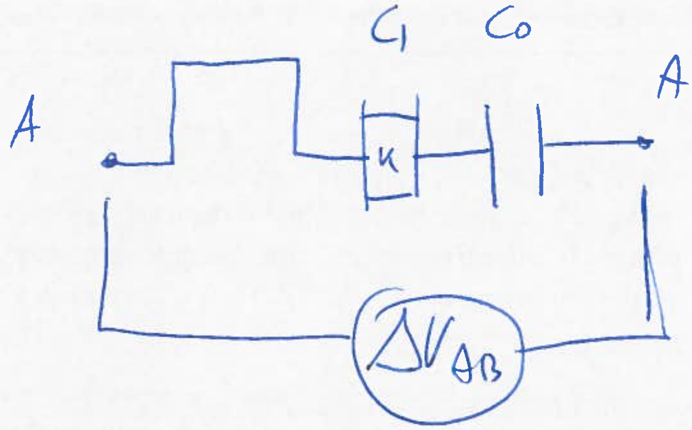
$$C_0 = \varepsilon \frac{S}{d}$$

$$C_{S_1} = \frac{1}{\frac{1}{C_0}+\frac{1}{C_0}+\frac{1}{kC_0}}$$

$$U_{e_1} = \frac{1}{2} C_{S_1} \Delta V_{AB}^2$$

$$\left(\left(Q_{S_1} = C_{S_1} \Delta V_{AB}\right)\right)$$

Caso 2

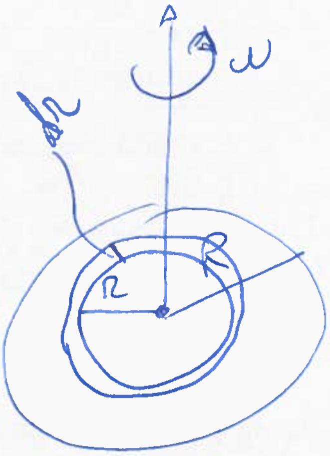


$$C_{S_2} = \frac{1}{\frac{1}{C_0}+\frac{1}{kC_0}}$$

$$U_{e2} = \frac{1}{2} C_{S_2} \Delta V_{AB}^2 \qquad \Delta U_e = U_{e2} - U_{e1}$$

$$Q_1 = Q_{S_2} = C_{S_2} \Delta V_{AB}$$

3)



$$T = \frac{2\pi}{\omega}$$

$$di = \frac{dq}{T} \quad \text{ca } dq = \sigma 2\pi r\, dr$$

$$\sigma = \frac{q}{\pi R^2}$$

$$di = \frac{q}{\cancel{\pi} R^2}\,\frac{2\cancel{\pi} r\, dr}{T} = \frac{2 q \omega r\, dr}{R^2\, 2\pi}$$

$$d\vec{m} = di \cdot \pi r^2$$

$$\vec{m} = \int_0^R d\vec{m} = \int_0^R \frac{\cancel{\pi} r^2 \cancel{2} q \omega}{R^2 \cancel{2}\cancel{\pi}}\, r\, dr = \int_0^R \frac{q\omega r^3\, dr}{R^2} =$$

$$= \frac{q\omega}{R^2}\int_0^R r^3\, dr = \frac{q\omega R^{\cancel{4}\,2}}{4\cancel{R^2}} = \frac{q\omega R^2}{4}$$

$$\vec{M} = \vec{m} \times \vec{B} \Rightarrow M = mB \operatorname{sen}\theta = \frac{q\omega R^2}{4} B \operatorname{sen}\theta$$

4)

Caso A

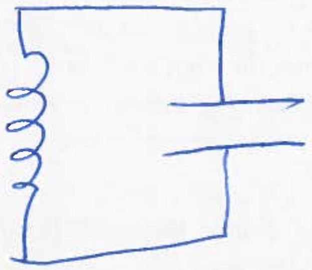
 è un corto circuito

= 

$$i_A = \frac{f}{R} = i_L$$

$$U_L = \frac{1}{2} L i_L^2 = \frac{1}{2} L \left(\frac{f}{R}\right)^2$$

Caso B



è un oscillatore che oscilla con frequenza $\nu = \frac{\omega}{2\pi}$ con $\omega = \frac{1}{\sqrt{LC}}$

l'energia max su L è $U_L = \frac{1}{2} L \left(\frac{f}{R}\right)^2$ che si distribuisce su C con energia $U_C = \frac{1}{2} C V_{MAX}^2 = U_L = \frac{1}{2} L \left(\frac{f}{R}\right)^2$

da cui $V_{MAX}^2 = \frac{L}{C}\left(\frac{f}{R}\right)^2 \rightarrow V_{MAX} = \left(\frac{f}{R}\right)\sqrt{\frac{L}{C}}$

Se voglio $V_{MAX} = f \rightarrow \sqrt{\frac{L}{CR^2}} = 1 \rightarrow C = \frac{L}{R^2}$