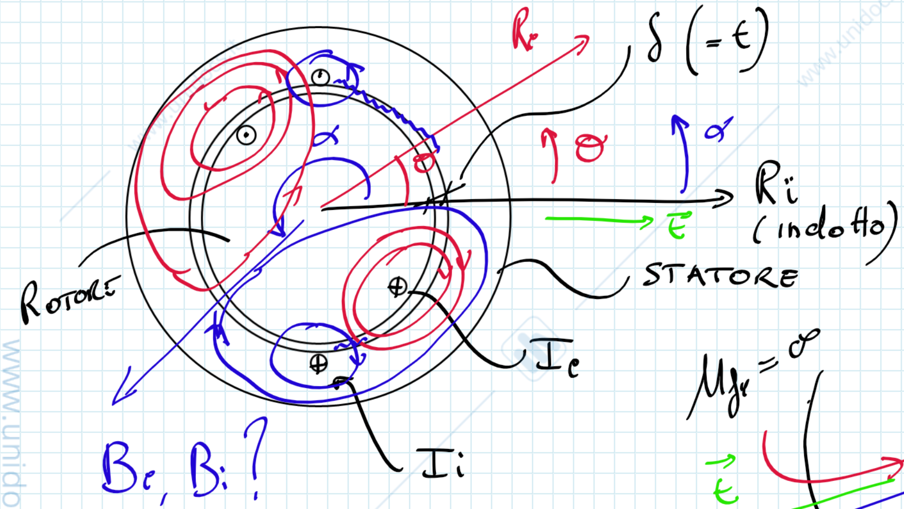
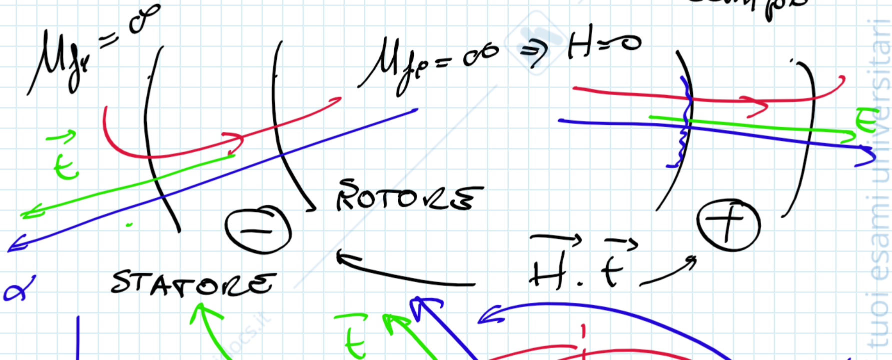
Giunto Elettromagnetico

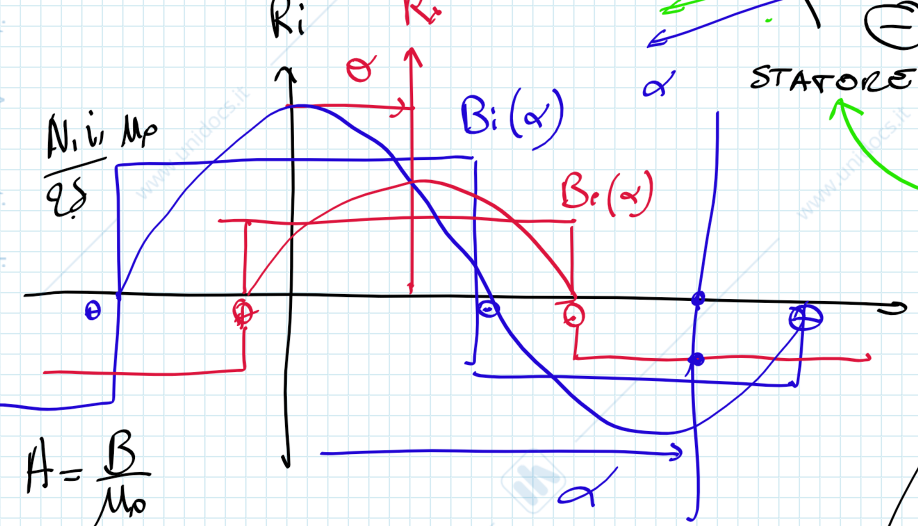


$B_i(\alpha)$, $B_e(\alpha)$ $\longrightarrow$ L_{ii}, L_{ee}, $L_{ie} = L_{ei}$

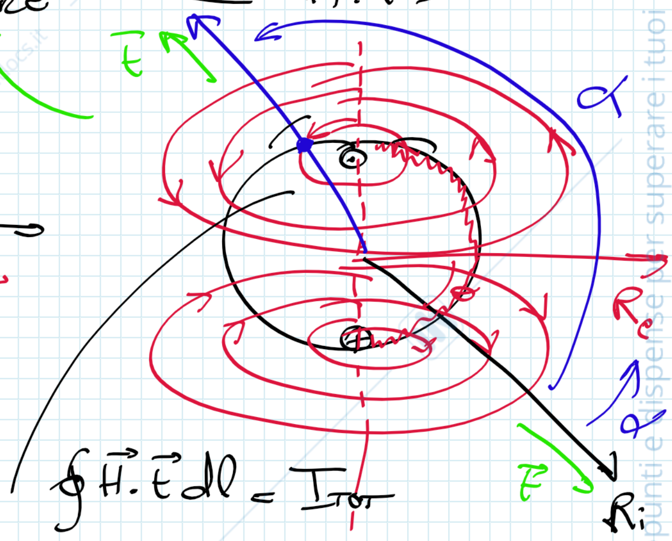
$$\oint \vec{H}\cdot\vec{t}\,dl = I_{TOT}$$

↑ una linea di campo

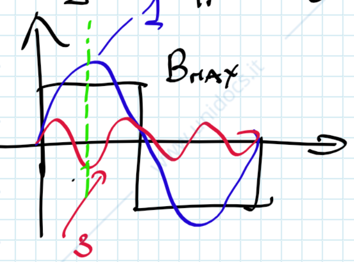




$$H = \frac{B}{\mu_0}$$

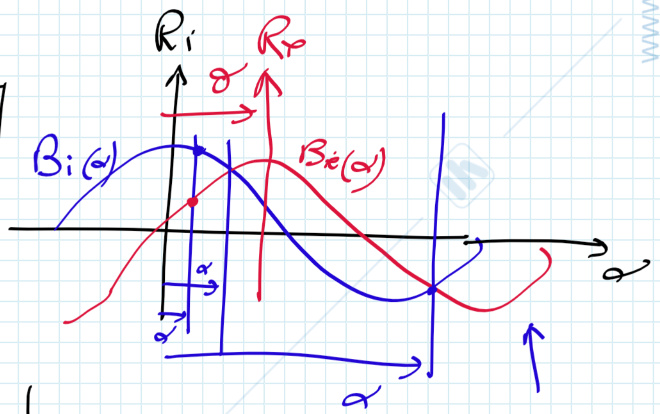


$$B_{i_1}(\alpha) = \frac{4}{\pi}\frac{N_i I_i}{2\delta}\mu_0 \cdot \cos(\alpha)$$



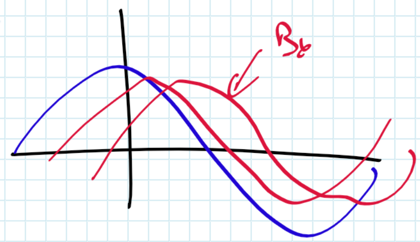
$$\rightarrow \quad B_K = \frac{B_{MAX}}{K}\cdot\frac{4}{\pi} \qquad K = 1, 3, 5, 7, \dots$$

$$\left[\begin{aligned} B_{e_1}(\alpha) &= \frac{4}{\pi}\frac{N_e I_e}{2\delta}\mu_0 \cos(\alpha - \theta) \\ B_{i_1}(\alpha) &= \frac{4}{\pi}\frac{N_i I_i}{2\delta}\mu_0 \cos(\alpha) \end{aligned}\right]$$

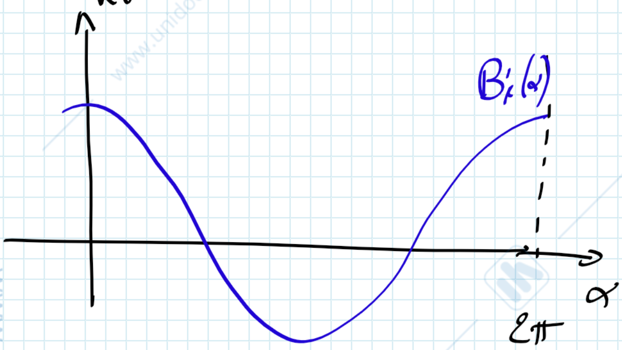


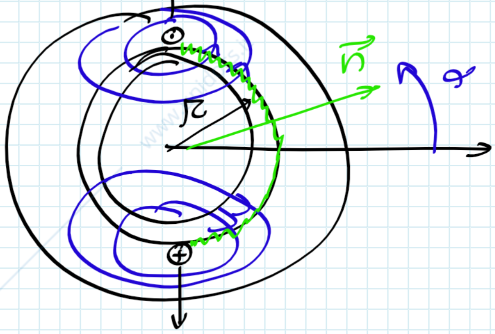
$$L_{ii} = \left.\frac{\Psi_{ii}}{I_i}\right|_{I_e=0} \qquad L_{ee} = \left.\frac{\Psi_{ee}}{I_e}\right|_{I_i=0}$$

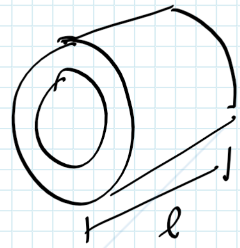
$$L_{ie} = L_{ei} = \left.\frac{\Psi_{ie}}{I_e}\right|_{I_i=0} = \left.\frac{\Psi_{ei}}{I_i}\right|_{I_e=0}$$



$$L_{ii} = \frac{\Psi_{ii}}{I_i}\Big|_{I_r=0}$$



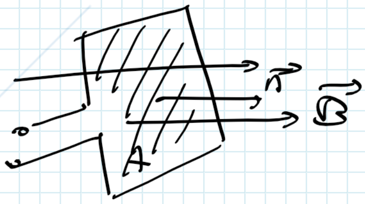




$$B_i(\alpha) = \frac{4}{\pi}\cdot\frac{N_i I_i}{2\delta}\mu_0\cos(\alpha)$$

$$\Psi_{ii} = N_i\varphi_i$$

$$\varphi = \int_S \vec{B}\cdot\vec{n}\,dS$$



$r_r \simeq r_i = r$

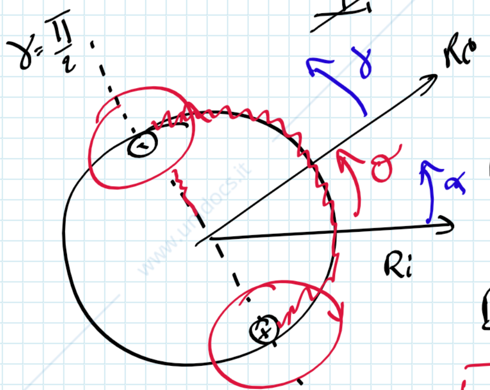
↑

$\delta \ll 1$ traferro piccolo

$$\varphi_i = \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} B_i(\alpha)\overbrace{r\cdot l\cdot d\alpha}^{dS}$$

$$L_{ii} = \frac{N_i\int_{-\frac{\pi}{2}}^{+\frac{\pi}{2}}\frac{4}{\pi}\frac{N_i I_i}{2\delta}\mu_0\cdot\cos(\alpha)\, r\, l\, d\alpha}{I_i}$$

$$L_{ii} = \frac{\frac{4}{\pi}\frac{N_i^2 \cancel{I_i}}{2\delta}\mu_0 r l\int_{-\frac{\pi}{2}}^{+\frac{\pi}{2}}\cos\alpha\, d\alpha}{\cancel{I_i}} = \frac{4}{\pi}\frac{N_i^2}{2\delta}\mu_0 r l\left[\sin\alpha\right]_{-\frac{\pi}{2}}^{\frac{\pi}{2}} = \boxed{\frac{4}{\pi}\frac{N_i^2}{\cancel{2}\delta}\mu_0 r l\cdot \cancel{2}}$$

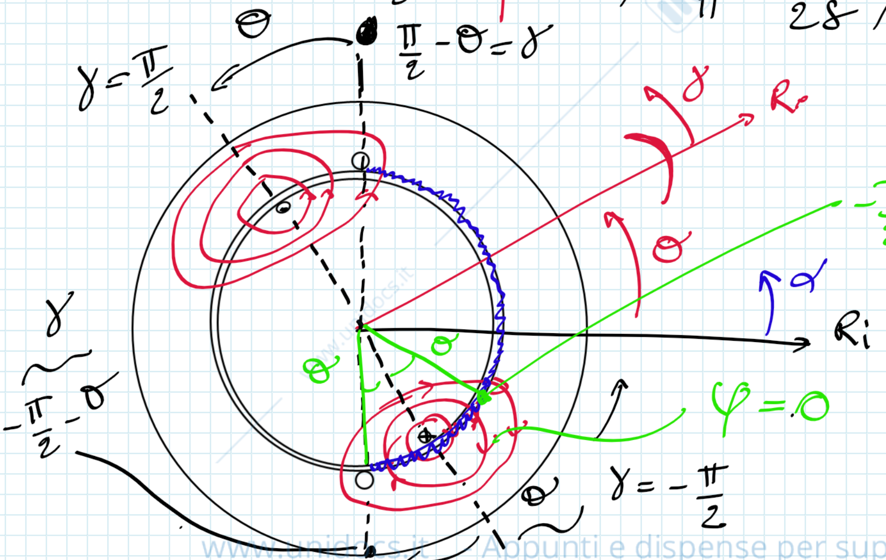


$$L_{rr} = \frac{\Psi_{rr}}{I_r}\Big|_{I_i=0} \Rightarrow \boxed{L_{rr} = \frac{4}{\pi}\frac{N_r^2}{\cancel{2}\delta}\mu_0 r l\, \cancel{2}}$$

$$B_r(\alpha) = \frac{4}{\pi}\frac{N_r i_r}{2\delta}\mu_0\cos(\alpha-\theta)$$

$$\boxed{B_r(\gamma) = \frac{4}{\pi}\frac{N_r i_r}{2\delta}\mu_0\cos(\gamma)}$$

$$\gamma = (\alpha-\theta)$$



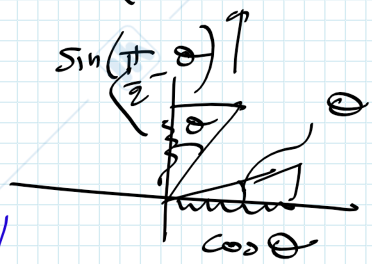
$$L_{ir} = \frac{\Psi_{ir}}{I_r}\Big|_{I_i=0}$$

$$\Psi_{ir} = \int_{-\frac{\pi}{2}-\theta}^{\frac{\pi}{2}-\theta} \dots\dots = \int_{-\frac{\pi}{2}+\theta}^{\frac{\pi}{2}-\theta}$$

$$\boxed{\varphi_{ei} = \int_{-\frac{\pi}{2}+\theta}^{\frac{\pi}{2}-\theta} B(\gamma)\, r l\, d\gamma = \int_{-\frac{\pi}{2}+\theta}^{\frac{\pi}{2}-\theta} \frac{4}{\pi}\cdot\frac{N_e I_e}{2\delta}\mu_0 \cos\gamma\, r l\, d\gamma =}$$

$$\varphi_{ie} = \frac{4}{\pi}\frac{N_e I_e}{2\delta}\mu_0 r l \left[\sin\gamma\right]_{-\frac{\pi}{2}+\theta}^{\frac{\pi}{2}-\theta} = \frac{4}{\pi}\frac{N_e I_e}{2\delta}\mu_0 r l \left(\sin\left(\frac{\pi}{2}-\theta\right) - \sin\left(-\frac{\pi}{2}+\theta\right)\right)$$

$$= \frac{4}{\pi}\frac{N_e I_e}{2\delta}\mu_0 r l \left(\cos\theta - (-\cos\theta)\right) =$$



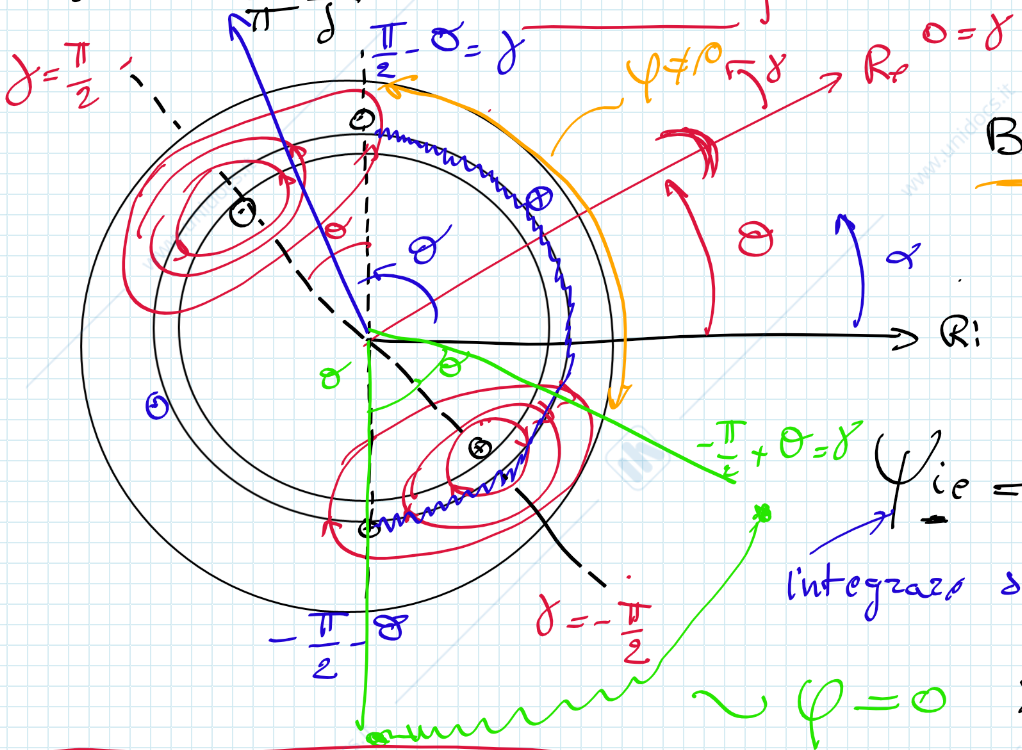
$$= \frac{4}{\pi}\frac{N_e I_e}{2\delta}\mu_0 r l\, 2\cos\theta$$

$$L_{ie} = \frac{N_i \cdot \frac{4}{\pi}\frac{N_e \cancel{I_e}}{\delta}\mu_0 r l \cos\theta}{\cancel{I_e}} = N_i N_e \frac{4}{\pi}\frac{\mu_0 r l}{\delta}\cos\theta$$

$$N_i = N_e = N$$

$$L_{ii} = \frac{4}{\pi}\frac{N^2}{\delta}\mu_0 r l \qquad L_{ee} = \frac{4}{\pi}\frac{N^2}{\delta}\mu_0 r l \qquad \boxed{L_{ee} = L_{ii} = L}$$

$$\boxed{L_{ie} = L_{ei} = \frac{4}{\pi}\frac{N^2}{\delta}\mu_0 r l = L\cos\theta}$$



$$B_e(\gamma) = \frac{4}{\pi}\cdot\frac{N_e i_e}{2\delta}\mu_0 \cos(\gamma)$$

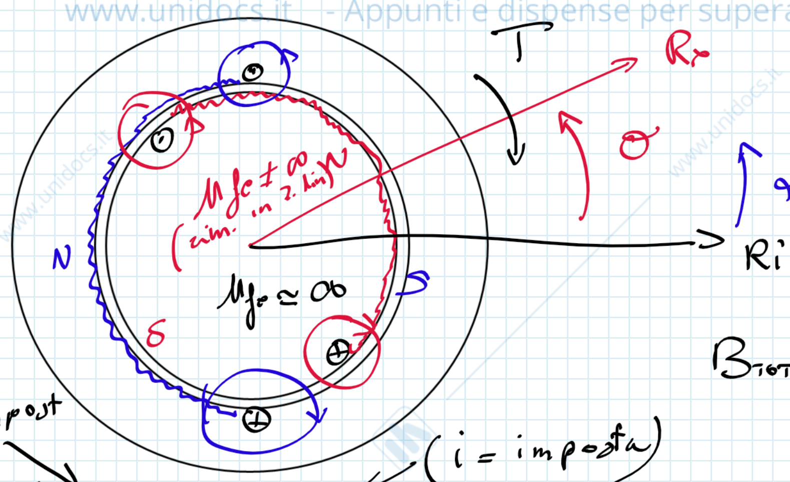
$$\gamma = (\alpha - \theta)$$

$$\Psi_{ie} = N_i\, \varphi_{ie} = \int_{-\frac{\pi}{2}+\theta}^{\frac{\pi}{2}-\theta}$$

l'integraz. sul blu

$\sim \varphi = 0$ x che le linee di flusso la att. due volte

$$\boxed{\begin{array}{l} L_{ee} = L_{ii} = L \qquad (N_e = N_i) \\ L_{ie} = L_{ei} = L\cos\theta \end{array}}$$



$$B_i(\alpha) = \frac{4}{\pi}\frac{N_i I_i}{2\delta}\mu_0 \cos(\alpha)$$

$$B_e(\alpha) = \frac{4}{\pi}\frac{N_r I_e}{2\delta}\mu_0 \cos(\alpha - \theta)$$

$$B_{TOT}(\alpha) = B_i(\alpha) + B_e(\alpha)$$

φ = impost

(i = imposta)

$$F = -\frac{\partial W}{\partial x} = \frac{\partial W^*}{\partial x} \leftarrow \text{se il sist lineare} \quad W = W^*$$

$$T = -\frac{\partial W}{\partial \theta} = \frac{\partial W^*}{\partial \theta} \leftarrow \quad // \quad // \quad W = W^*$$

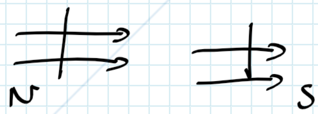
energia è acc. solo nel traferro !! Fe $\Rightarrow \mu_{fe} = \infty \quad H = 0$

$$W = \frac{1}{2}Li^2 = \frac{1}{2}\overset{\varphi}{\widetilde{Li}}\,i = \frac{1}{2}\varphi i = \frac{1}{2}N\varphi i = W^*$$

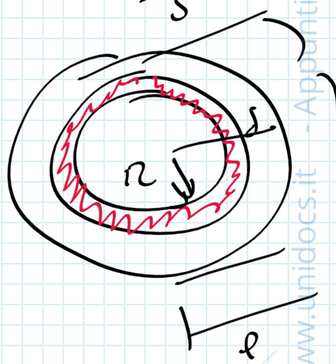
$$N_e = N_i = N$$

$$dW = dW^* = \frac{1}{2}N d\varphi . i$$

$$W^* = \int_{V_{traf}} dW^* \Rightarrow \int_{V_{traf.}} \frac{B^2}{2\mu_0} dV = W^*$$



pressione magnetica



$$T = \frac{\partial}{\partial \theta}\int_V \frac{B^2}{2\mu_0} dV = \frac{\partial}{\partial \theta}\int_0^{2\pi} \frac{B^2}{2\mu_0} . r . l . \delta \, d\alpha$$

$$T = \frac{\partial}{\partial \theta}\int_0^{2\pi} \frac{\left(B_e(\alpha) + B_i(\alpha)\right)^2}{2\mu_0} r l \delta \, d\alpha =$$

$$B_e(\alpha) = \overbrace{\frac{4}{\pi}\frac{N . I_e}{2\delta}\mu_0}^{B_e} \cos(\alpha - \theta)$$

$$B_i(\alpha) = \underbrace{\frac{4 N . I_i}{\pi \; 2\delta}\mu_0}_{B_i} \cos(\alpha)$$

$$= \frac{\partial}{\partial \theta}\int_0^{2\pi} \frac{\left(B_e \cos(\alpha - \theta) + B_i \cos\alpha\right)^2}{2\mu_0} r l \delta \, d\alpha$$

$$\int_0^{2\pi} \cos^2 x \, dx = \pi \quad (x - s)$$

$$\frac{\partial}{\partial \theta} = 0$$

$$= \frac{\partial}{\partial \theta}\int_0^{2\pi} \frac{\cancel{B_e^2 \cos^2(\alpha - \theta)} + \cancel{B_i^2 \cos^2\alpha} + 2 B_e B_i \cos(\alpha - \theta)\cos\alpha}{2\mu_0} r l \delta \, d\alpha$$

$$T=\frac{\partial}{\partial\vartheta}\int_0^{2\pi}\frac{2B_r\cos(\alpha-\vartheta)B_i\cos(\alpha)}{2\mu_0}\cdot r l\delta\, d\alpha =$$

Werner2.

$\cos a\cos b=\frac{1}{2}(\cos(a+b)+\cos(a-b))$

$$=\frac{\partial}{\partial\vartheta}\int_0^{2\pi}\frac{\cancel{2}\frac{1}{\cancel{2}}B_rB_i\left(\cos(2\alpha-\vartheta)+\cos(\vartheta)\right)}{2\mu_0}\cdot rl\delta\, d\alpha$$

$\cos x=\cos -x$

$\int_0^{2\pi}\cos(2\alpha-\vartheta)=0$

2π

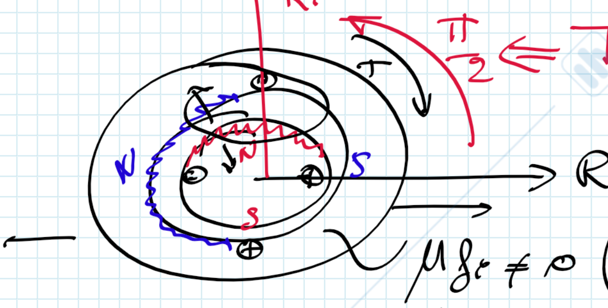
$$=\frac{\partial}{\partial\vartheta}\int_0^{2\pi}\frac{\underbrace{\cancel{B_rB_i\cos(2\alpha-\vartheta)}}_{=0}+B_rB_i\cos\vartheta}{2\mu_0}\, rl\delta\, d\alpha=$$

$[\alpha]_0^{2\pi}=2\pi$

$V_0=$ Volume traferro

$$=\frac{\partial}{\partial\vartheta}\left[\frac{B_rB_i\cos\vartheta}{2\mu_0}rl\delta\int_0^{2\pi}d\alpha\right]=\frac{\partial}{\partial\vartheta}\left[\frac{B_rB_i\cos\vartheta}{2\mu_0}\, rl\delta\, 2\pi\right]$$

$$\boxed{T=-\frac{B_rB_i}{2\mu_0}\cdot V_0\sin\vartheta}$$

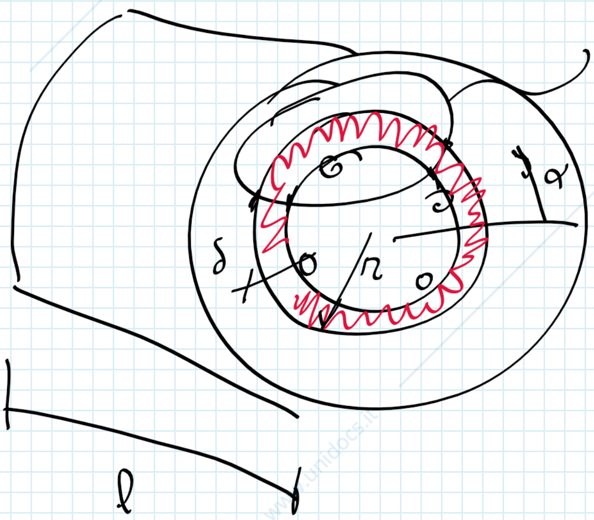


$\frac{\pi}{2}\Leftarrow T_{MAX}$!!

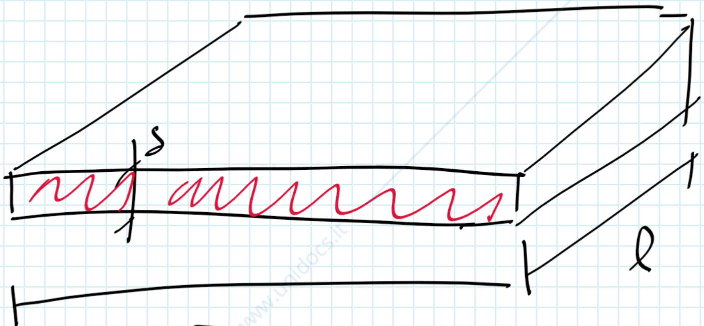
$\mu_{fe}\neq\infty$ (lineare)

$W_{fe}=$ cost quindi non inf. la coppia

$$T=-\frac{\frac{N^2I_rI_i}{(2\delta)^2}\cdot\mu_0^2\cdot V_0}{2\mu_0}\sin\vartheta=-KI_rI_i\sin\vartheta$$



$l_{fe}=$ cost $\Rightarrow\mu_{fe}\neq\infty\Rightarrow W_{fe}=$ "cost" non dip ϑ



$r\cdot2\pi$

$\left(\int_0^{2\pi}r\cdot d\alpha\right)$