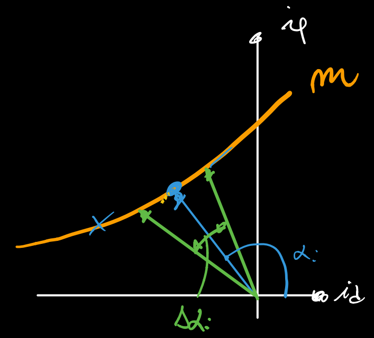
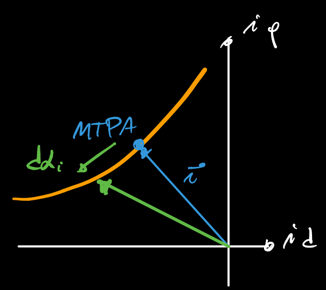
MTPA ON-LINE

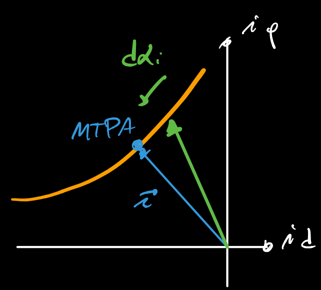


GRANDEZZA DI PERTURBAZIONE α_i

$$\Delta\alpha_i = P_h \operatorname{sen}(\omega_h t)$$

un perturbazione in "alta frequenza"



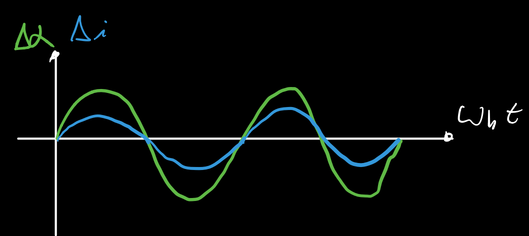


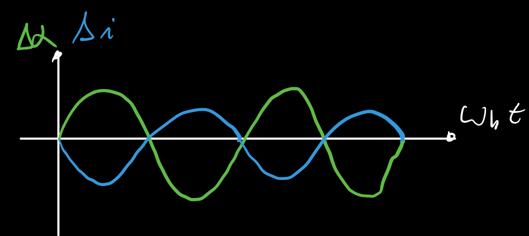
$d\alpha_i > 0 \Rightarrow |\vec{i}| \nearrow$

$d\alpha_i > 0 \Rightarrow |\vec{i}| \searrow$

$$\vec{i} = \bar{I} + \vec{\Delta i}$$

$i_d + j i_q$





$$\Delta i = I_h \operatorname{sen}(\omega_h t)$$

$$\Delta i = I_h \operatorname{sen}(\omega_h t + \pi)$$

$$\varepsilon = \Delta i \Delta\alpha = P_h \operatorname{sen}(\omega_h t) \cdot I_h \operatorname{sen}(\omega_h t + k'\pi)$$

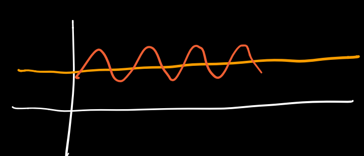
$$= P_h \operatorname{sen}(\omega_h t)\, I_h \operatorname{sen}\left(\omega_h t + \frac{1-k}{2}\pi\right)$$

$$= P_h I_h \operatorname{sen}(\omega_h t) \operatorname{sen}\left(\omega_h t + \frac{1-k}{2}\pi\right)$$

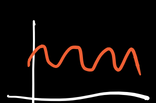
$$= \frac{k}{2} P_h I_h \left[1 - \cos(2\omega_h t)\right]$$

$k' < \begin{matrix} 0 \\ 1 \end{matrix}$ $\qquad k' = \frac{1-k}{2}$

$k < \begin{matrix} 1 \\ -1 \end{matrix}$



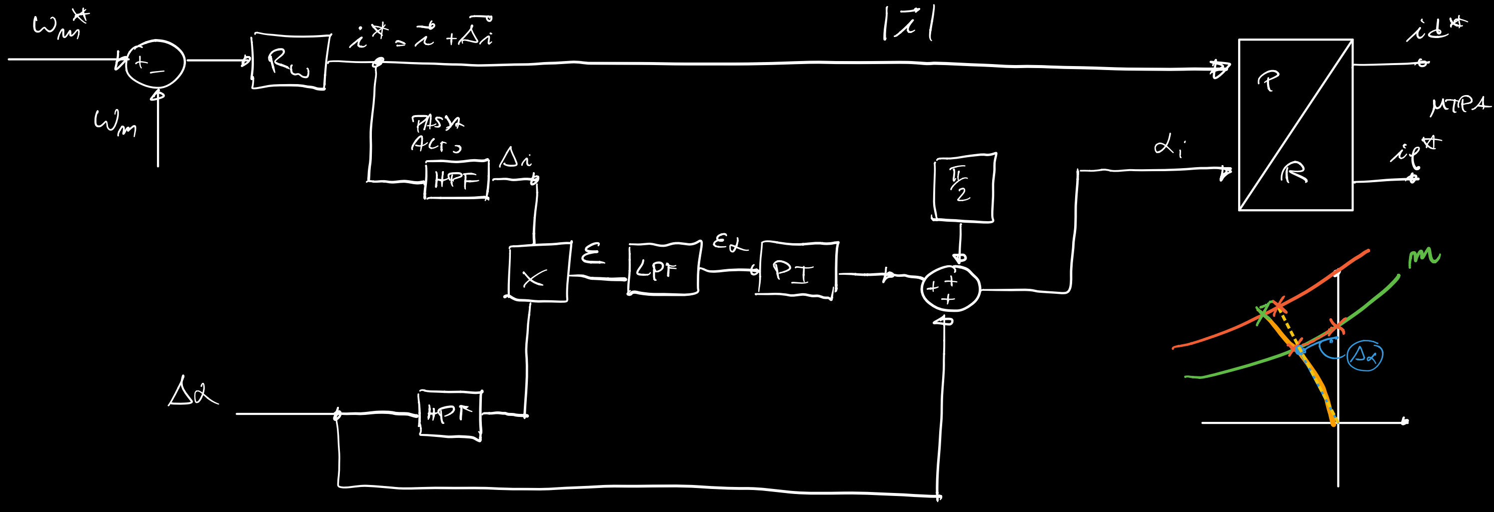
QUESTO È UN ERRORE



$$\varepsilon \rightarrow \boxed{LPF} \rightarrow \varepsilon_\alpha \quad \frac{k P_h I_h}{2}$$

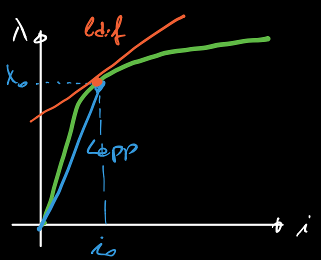
FILTRO PASSA BASSO

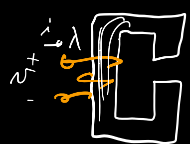
$$\varepsilon_\alpha = 0 \iff \text{MTPA!}$$



SATURAZIONE

$$\begin{cases} v_d = R i_d + \dfrac{d\lambda_d}{dt} - \omega_m^e \lambda_q \\ v_q = R i_q + \dfrac{d\lambda_q}{dt} + \omega_m^e \lambda_d \end{cases}$$





$$\lambda_d = \lambda_d(i_d)$$
$$\lambda_q = \lambda_q(i_q)$$

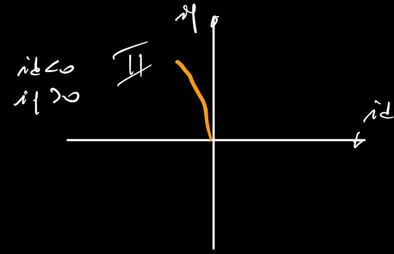
$$L_{app} = \frac{\lambda_0}{i_0} \qquad l_{dif} = \left.\frac{d\lambda}{di}\right|_{i_0}$$

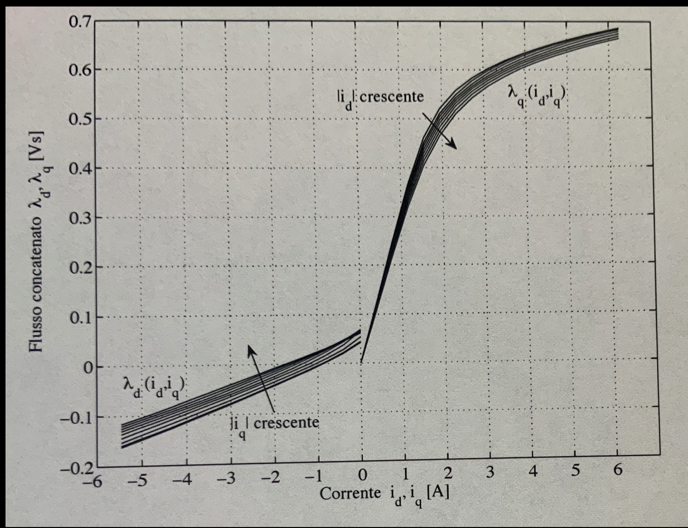
Entrambe dipendono da i_0!

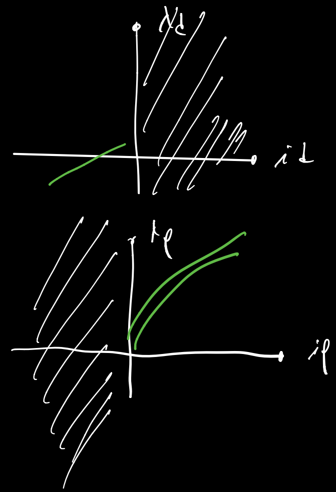
$$v = \frac{d\lambda}{dt} = \frac{d}{dt}\left[L_{app}(i)\, i(t)\right] = \frac{dL_{app}(i)}{dt} i(t) + L_{app}(i) \frac{di}{dt}$$

$$= \frac{dL_{app}(i)}{di} \frac{di}{dt} i(t) + L_{app}(i) \frac{di}{dt}$$

$$= \underbrace{\left[L_{app}(i) + \frac{dL_{app}(i)}{di} i(t)\right]}_{l_{dif}} \frac{di(t)}{dt}$$



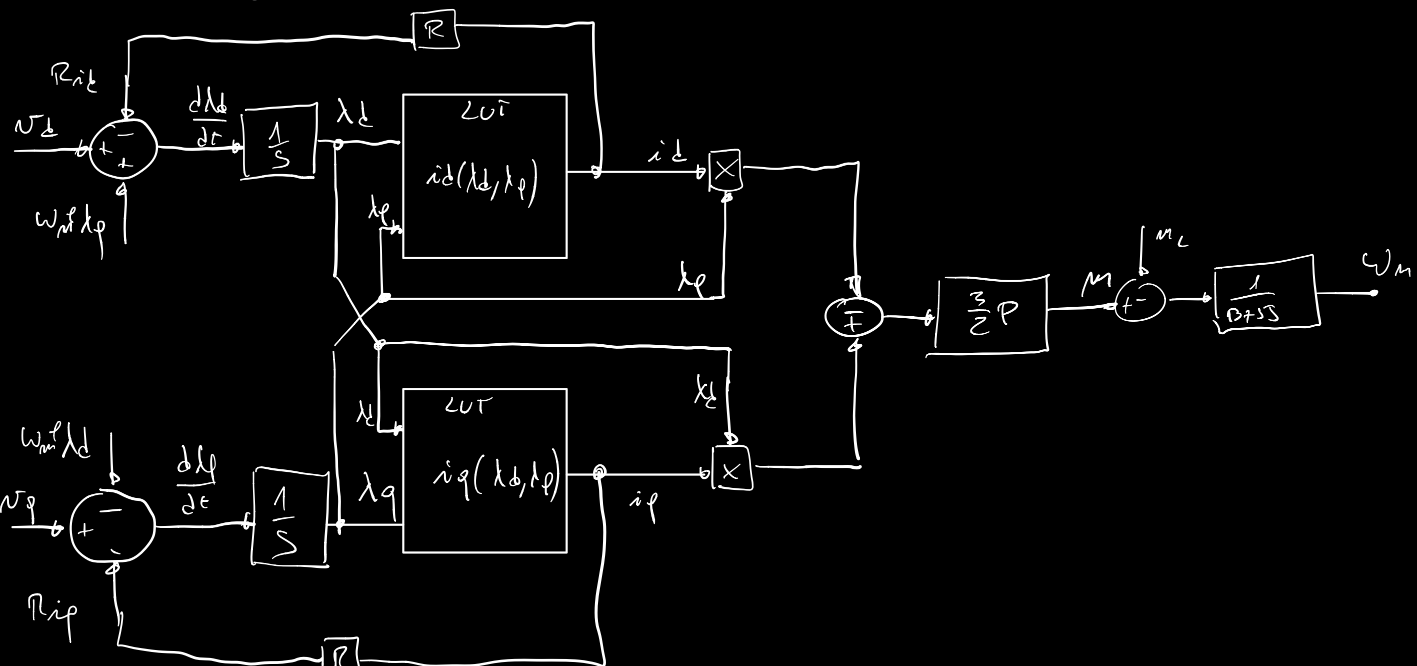


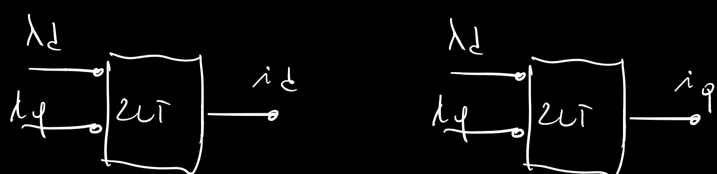


$$\begin{cases} v_d = R i_d + \dfrac{d\lambda_d}{dt} - \omega_m^e \lambda_q \\ v_q = R i_q + \dfrac{d\lambda_q}{dt} + \omega_m^e \lambda_d \end{cases}$$

$$\begin{cases} \lambda_d = \lambda_d(i_d, i_q) \\ \lambda_q = \lambda_q(i_d, i_q) \end{cases}$$

$$m = \frac{3}{2} p \left(\lambda_d i_q - \lambda_q i_d \right)$$





INDUTTANZE APPARENTI / DIFFERENZIALI

$$\lambda_d(i_d, i_q) = L_d(i_d, i_q)\, i_d + \lambda_d(0, i_q)$$ λ_m

$$\lambda_q(i_d, i_q) = L_q(i_d, i_q)\, i_q + \lambda_q(i_d, 0) = 0$$ [(PMAREL) RILUTTANZA + PM]

INDUTTANZE APPARENTI

$$\begin{cases} L_d(i_d, i_q) = \dfrac{\lambda_d(i_d, i_q) - \lambda_d(0, i_q)}{i_d} \\[2ex] L_q(i_d, i_q) = \dfrac{\lambda_q(i_d, i_q) - \lambda_q(i_d, 0)}{i_q} \end{cases}$$

$$\begin{cases} \dfrac{d\lambda_d}{dt} = \boxed{\dfrac{\partial \lambda_d}{\partial i_d}} \dfrac{di_d}{dt} + \boxed{\dfrac{\partial \lambda_d}{\partial i_q}} \dfrac{di_q}{dt} \\[2ex] \dfrac{d\lambda_q}{dt} = \boxed{\dfrac{\partial \lambda_q}{\partial i_d}} \dfrac{di_d}{dt} + \boxed{\dfrac{\partial \lambda_q}{\partial i_q}} \dfrac{di_q}{dt} \end{cases}$$

$$\frac{d}{dt}\begin{bmatrix} \lambda_d \\ \lambda_q \end{bmatrix} = \begin{bmatrix} l_{dd} & l_{dq} \\ l_{qd} & l_{qq} \end{bmatrix} \frac{d}{dt}\begin{bmatrix} i_d \\ i_q \end{bmatrix}$$

$$l_{dd} = \frac{\partial \lambda_d}{\partial i_d} \qquad l_{qq} = \frac{\partial \lambda_q}{\partial i_q} \qquad l_{dq} = \frac{\partial \lambda_d}{\partial i_q} = \frac{\partial \lambda_q}{\partial i_d} = l_{qd}$$

Note: se SATURAZIONE $\nexists$ $l_{dq} = l_{qd} = 0$

l_{xx} sono funzioni di (i_d, i_q)