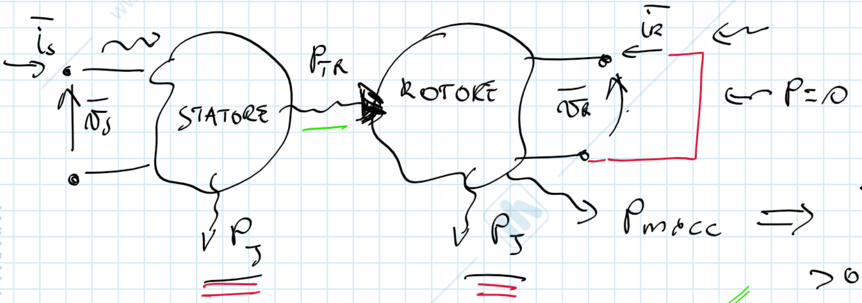
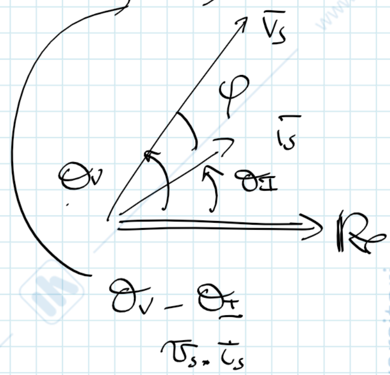
$$\begin{cases} \bar{v}_s = R_s \bar{i}_s + j\omega \frac{3}{2} L_s \bar{i}_s + j\omega \frac{3}{2} L_m \bar{i}_R \\ \bar{v}_R = R_R \bar{i}_R + j(\omega - \omega_m)\frac{3}{2} L_R \bar{i}_R + j(\omega-\omega_m)\frac{3}{2} L_m \bar{i}_s = 0 \end{cases}$$

$P_s = \mathrm{Re}(\bar{v}_s \underline{i}_s)$

$P_R = \mathrm{Re}(\bar{v}_R \underline{i}_R) = 0$





$P_{mecc} \Rightarrow T = \frac{P_{mecc}}{\omega_m}$

$$\mathrm{Re}\Big(\underbrace{R_s \bar{i}_s \underline{i}_s}_{R_s i_s^2} + \underbrace{j\omega\frac{3}{2}L_s \bar{i}_s \underline{i}_s}_{j\omega\frac{3}{2}L_s i_s^2 \Rightarrow \mathrm{Re}=0} + j\omega\frac{3}{2}L_m \bar{i}_R \underline{i}_s\Big) = P_s = \mathrm{Re}(\bar{v}_s \underline{i}_s) \Leftarrow \quad >0$$

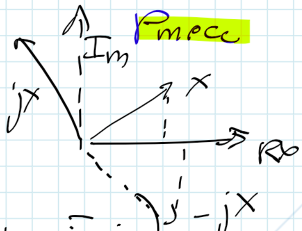
$P_R = \mathrm{Re}(\bar{v}_R \underline{i}_s) = 0$

P_{TR}

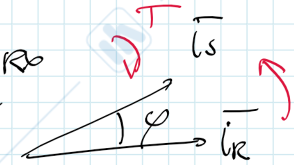
<0

$$\mathrm{Re}\Big(\underbrace{R_R \bar{i}_R \underline{i}_R}_{R_R i_R^2} + \underbrace{j(\omega-\omega_m)\frac{3}{2}L_R \bar{i}_R \underline{i}_R}_{j(\omega-\omega_m)\frac{3}{2}L_R i_R^2 \Rightarrow \mathrm{Re}=0} + j\omega\frac{3}{2}L_m \bar{i}_s \underline{i}_R - \underbrace{j\,\omega_m\frac{3}{2}L_m \bar{i}_s \underline{i}_R}_{P_{mecc}}\Big) = 0$$

P_{TR}



$$\mathrm{Re}\left(j\omega\frac{3}{2}L_m \bar{i}_R \underline{i}_s\right) = -\mathrm{Re}\left(j\omega\frac{3}{2}L_m \bar{i}_s \underline{i}_R\right)$$



$$P_{mecc} = \mathrm{Re}\left(-j\,\omega_m\frac{3}{2}L_m \bar{i}_s \underline{i}_R\right) = -\mathrm{Im}\left(\omega_m\frac{3}{2}L_m \bar{i}_s \underline{i}_R\right)$$

$$= -\omega_m\frac{3}{2}L_m i_s i_R \sin\varphi \Rightarrow \boxed{T = \frac{P_{mecc}}{\omega_m} = -\frac{3}{2}L_m i_s i_R \sin\varphi}$$

$$R_R i_R^2 + \mathrm{Re}\left(j(\omega-\omega_m)\frac{3}{2}L_m \bar{i}_s \underline{i}_R\right) = 0$$

$$\omega_m \frac{R_R i_R^2}{\omega-\omega_m} = -\mathrm{Re}\left(j\frac{3}{2}L_m \bar{i}_s \underline{i}_R\right)\omega_m = \mathrm{Re}\left(-j\,\omega_m\frac{3}{2}L_m \bar{i}_s \underline{i}_R\right)$$

$$\boxed{x = \frac{\omega-\omega_m}{\omega}}$$

$x\omega = \omega - \omega_m$

$\omega_m = (1-x)\omega$

$$\boxed{P_{mecc} = \frac{\omega_m}{\omega-\omega_m}\cdot R_R i_R^2} =$$

$$= \frac{(1-x)\cancel{\omega}}{x\cancel{\omega}}\cdot R_R i_R^2 = \boxed{\frac{(1-x)}{x}R_R i_R^2}$$

$$\boxed{T = \frac{P_{mecc}}{\omega_m}}$$

$\omega_m = 0$

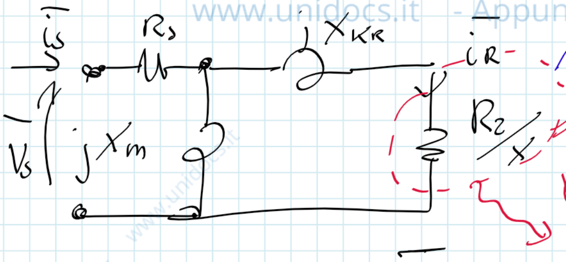
$$\boxed{T = \frac{\frac{\cancel{(1-x)}R_R i_R^2}{x}}{\cancel{(1-x)}\cdot\omega} = \frac{\frac{R_R i_R^2}{x}}{\omega}}$$

P_{mecc}

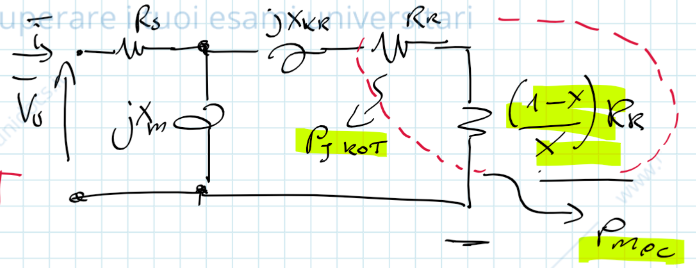
ω_m

$\omega_m = 0 \qquad x = \frac{\omega - 0}{\omega} = \underline{\underline{1}}$

$$T_{av}\left(\begin{matrix}\omega_m = 0\\ x=1\end{matrix}\right) \neq 0 \leftarrow \frac{R_R i_R^2}{\omega}$$

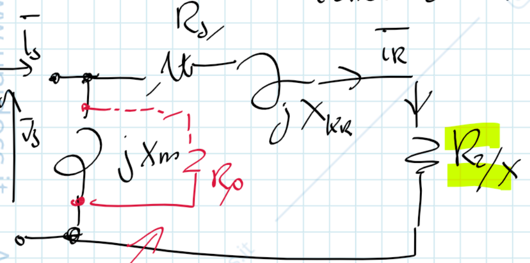


$$P = \frac{\frac{R_R}{x} i_R^2}{\omega} \Rightarrow T$$



$$R_R + \frac{(1-x)R_R}{x} = \frac{\cancel{R_R x} + R_R - \cancel{R_R x}}{x} = \frac{R_R}{x}$$

$\bar{V}_s = \text{cost}$ (alimento a $f = \text{cost} = 50\,Hz$)
terna simmetrica

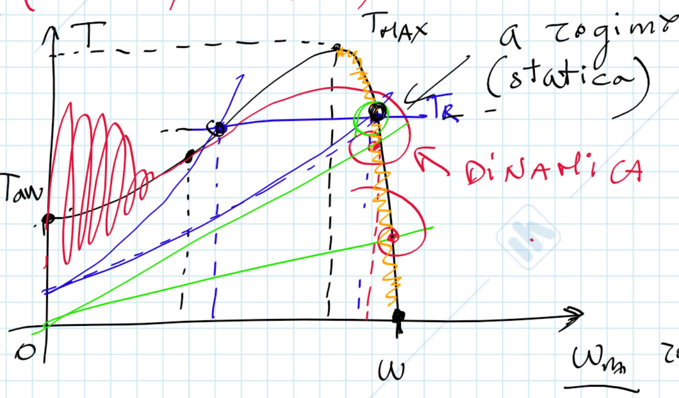


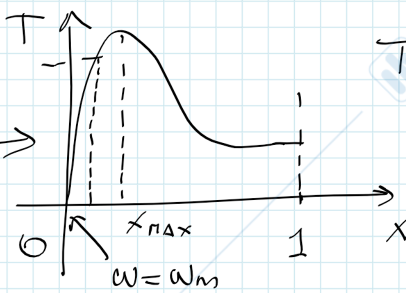
$$\bar{i}_R = \frac{\bar{V}_s}{\left(R_s + \frac{R_2}{x}\right) + jX_{KR}}$$

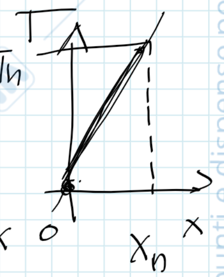
perdite nel ferro (isteresi, corr. parz.)

$$\boxed{P_{TR} = \frac{R_R}{x} \cdot i_R^2} \Rightarrow T = \frac{P_{TR}}{\omega} = \frac{P_{mec}}{\omega_m}$$

$$x = \frac{\omega - \omega_m}{\omega}$$ puls costante

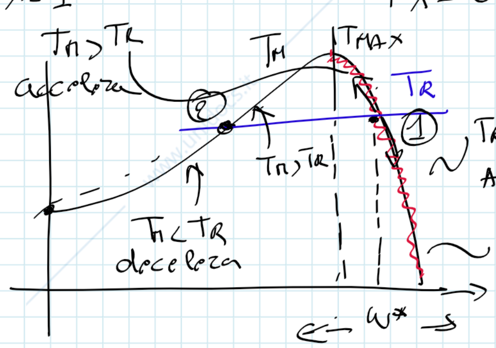






Scorr. nom. 1% ÷ 2%

$x = 1$ — $x = 0$



T_R = coppia res.
T_m = coppia motrice

Tratto di punti a funz. eq. stabile

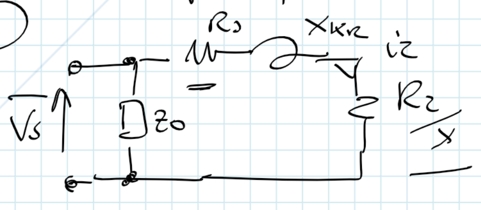
$T_m < T_R \rightarrow$ la macchina decelera

$$X = \frac{\omega - \omega_m}{\omega} < 1$$

$X = 0{,}01 \qquad \omega_m = 99\%\ \omega$

X sulla caratt. stabile (1) è più piccolo di X sulla caratt. inst. (2)

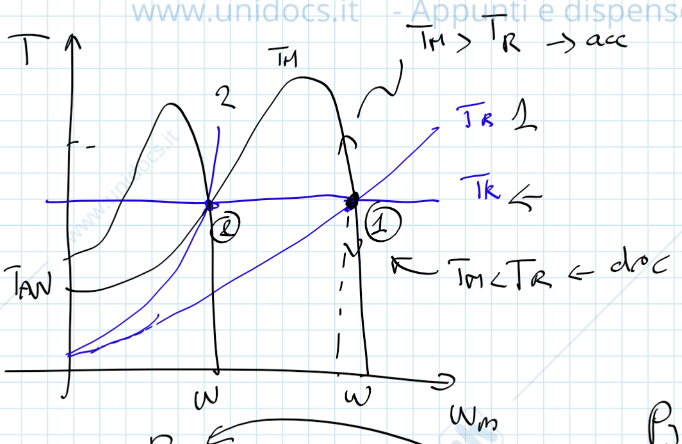
$$\frac{R_2}{X_1} > \frac{R_R}{X_2}$$

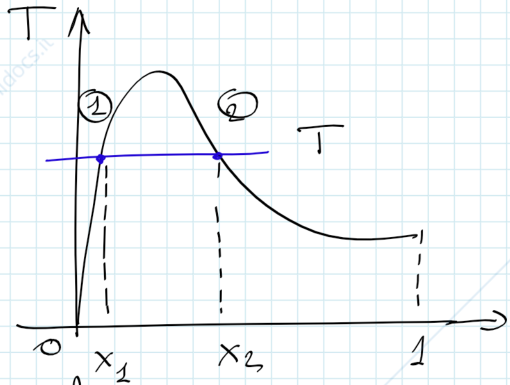


$$T_R = \frac{P_{TR}}{\omega}$$

$i_{R_2} > i_{R_1} \rightarrow$ (2) è un punto con perdite maggiori

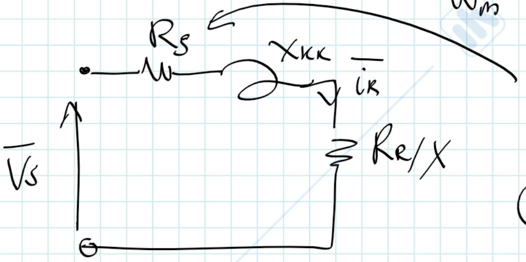
Il tratto stabile può essere approx con una retta





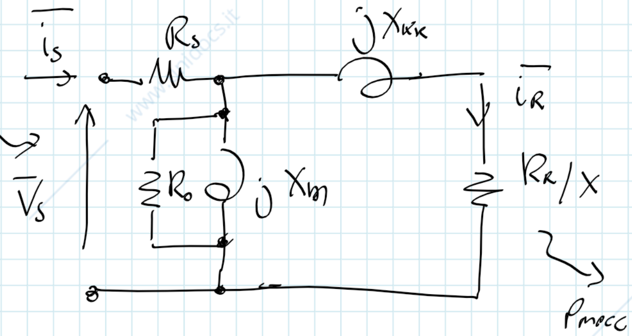
P_J più piccole

$x_1 < x_2 \qquad \frac{R_R}{x_1} > \frac{R_R}{x_2}$



1. i_R più piccola
2. i_R più grande

$$P_{TK} = \frac{R_R}{x_1} i_{R_1}^2 = \frac{R_R}{x_2} i_{R_2}^2$$



R_0 = tiene conto perdite corr. par. / isteresi

~~P_{add} = addizionali~~

DATI TARGA (MOTORE)

V_n = (tensione conc nominale)

$P_n = [W]$ = meccanica NON ASSORBITA $\qquad \eta_n$ = REND.

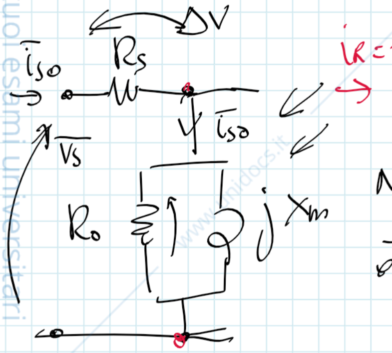
X_n = scorr. nominale

$I_n \qquad$ ($\cos\varphi_n$) $\qquad R_s$ = misurata

PROVA A VUOTO (SENZA CARICO)

$T_{mecc} = 0 \qquad \omega_m = \omega \Rightarrow x = 0 \Rightarrow \infty = R_2/X$

ΔV



Non si trascura R_s perché $\bar{i}_{S0}$ è elevata ($\frac{i_{S0}}{i_n} = 20\%$) è elevata per la presenza del traferro (X_m è abb piccola)

$$\cos\varphi_0 \quad P_0 = \text{potenza persa a vuoto} = \underbrace{R_s i_{S0}^2}_{P_{Joule\ stat.}} + P_{fe} \approx \frac{V_S^2}{R_0}$$

P_{fe} perché trascuro ΔV su R_s

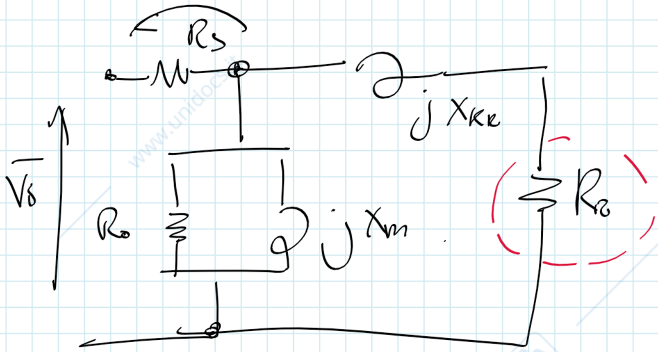
ΔV è trascurabile

$$Q_0 = P_0 \cdot tg\,\varphi_0 \Rightarrow Q_0 = \frac{V_S^2}{X_m}$$

$$V_S = \sqrt{3}\, V_{eff\ fase} = V_{CONCATENATA}$$

$$tg\,\varphi_0 = \frac{Q_0}{P_0}$$

Prova a rotore bloccato (corto circuito) $x = 1$



$\frac{R_R}{x}$ con x piccolo $\frac{R_R}{x} \gg 1$

$x = 0{,}01 \Rightarrow 100\, R_R$

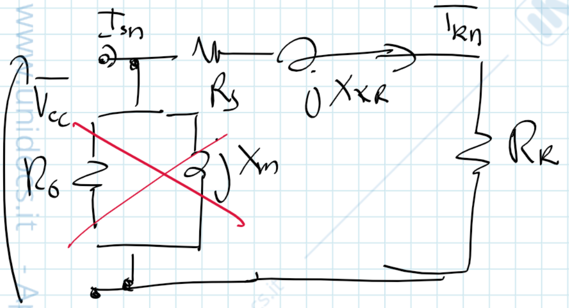
Non posso alimentare a V_{sn}

$V_{cc} \ll V_{sn}$ 10 % ÷ 15 %

$\Downarrow$

i_{Rn} = nominale

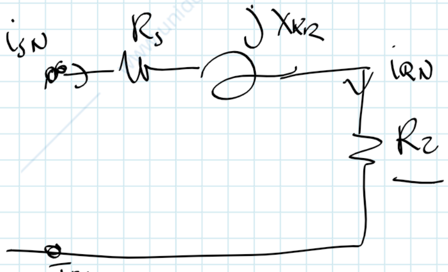
Perdite a vuoto trascurabili

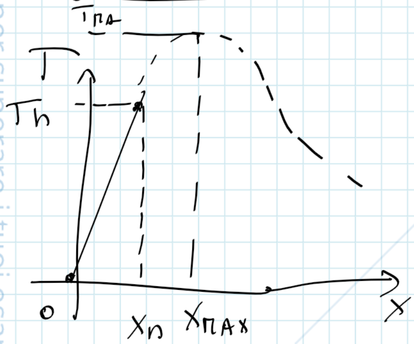


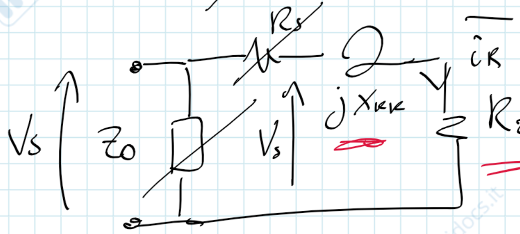
$P_{cc} = (R_s + R_R)\, i_{sn}^2$ $\cos\varphi_{cc}$

$Q_{cc} = P_{cc}\, tg\, \varphi_{cc}$ $Q_{cc} = X_{kR}\, i_{sn}^2$

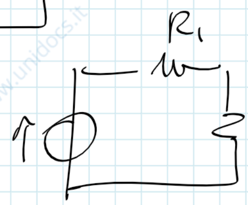
$\boxed{P_{cc\%} = P_{cc} / P_n \text{ (mecc)}}$ $\cancel{P_{cc\%} = P_{cc} / P_{ass}}$







$R_2/x \sim P_{TR}$ MAX



$\sim P_{R2}$

$R_1 = R_2$

MAX Trasf pot.

R_s trascurabile

$$\frac{V_s}{\sqrt{\left(\frac{R_R}{x}\right)^2 + X_{kR}^2}} = i_R$$

$$\frac{R_R}{x_m} = X_{kR} \qquad x_m = \frac{R_R}{X_{kR}}$$

$$i_{R_{MAX}} = \frac{V_s}{\sqrt{X_{kR}^2 + X_{kR}^2}} = \frac{V_s}{\sqrt{2}\, X_{kR}}$$

$$T_{MAX} = \frac{\frac{R_R}{x_m} \cdot i_R^2}{\omega} = \frac{X_{kR} \cdot \frac{V_s^2}{2 X_{kR}^2}}{\omega} = \frac{V_s^2}{2 X_{kR}\, \omega}$$

$$= \frac{V_s^2}{2\, \omega L_{kR}\, \omega} = \frac{V_s^2}{2 \omega^2 L_{kR}}$$