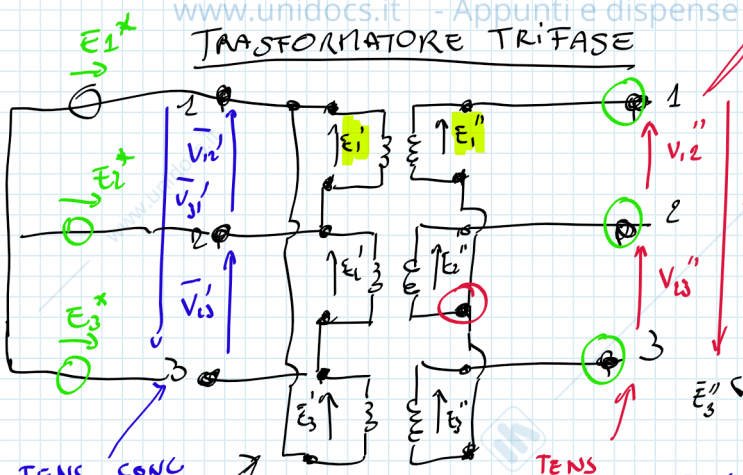
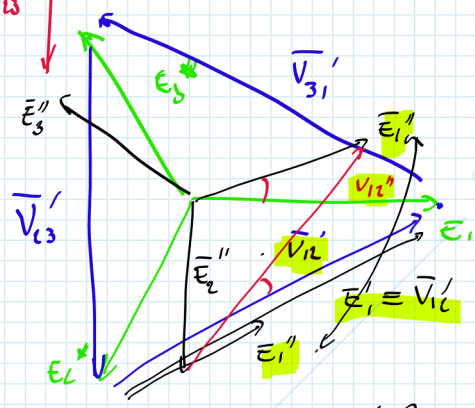
TRASFORMATORE TRIFASE



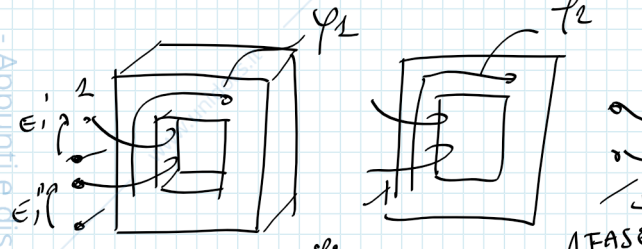
$\bar{V}_{1L}'' = \bar{E}_1'' - \bar{E}_L''$

Posso avere uno sfasamento tra le Tensioni prim e secondari (concatenati)



$K = \frac{E_1'}{E_1''}$

sono in fase



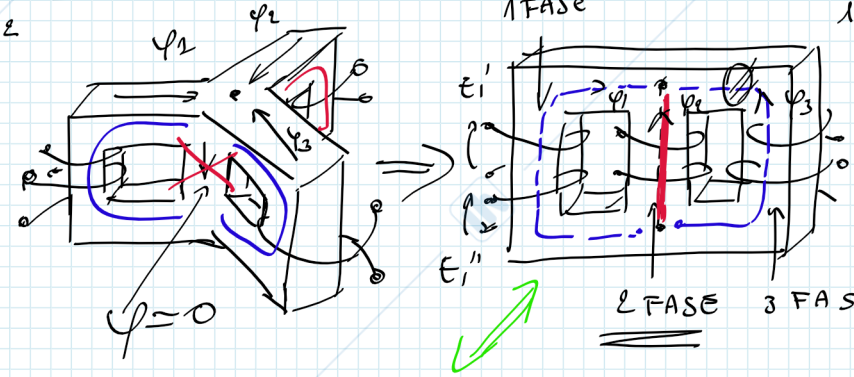
$\varphi_1 = \varphi \sin \omega t$

$\varphi_2 = \varphi \sin(\omega t - \frac{2}{3}\pi)$

$\varphi_3 = \varphi \sin(\omega t + \frac{2}{3}\pi)$

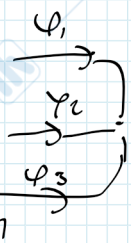
$\varphi_1, \varphi_2, \varphi_3$ sono $\sim$ = sfasati di 120°

1 FASE



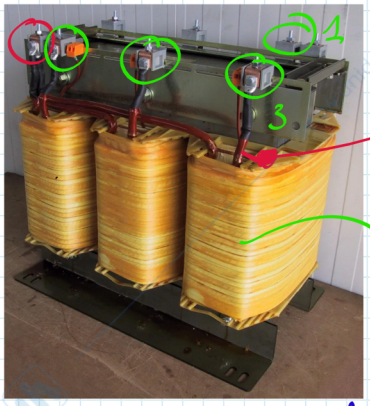
$\varphi_1 + \varphi_2 + \varphi_3 = 0$

NUCLEO A 3 COLONNE



$\varphi = 0$

2 FASE 3 FASE

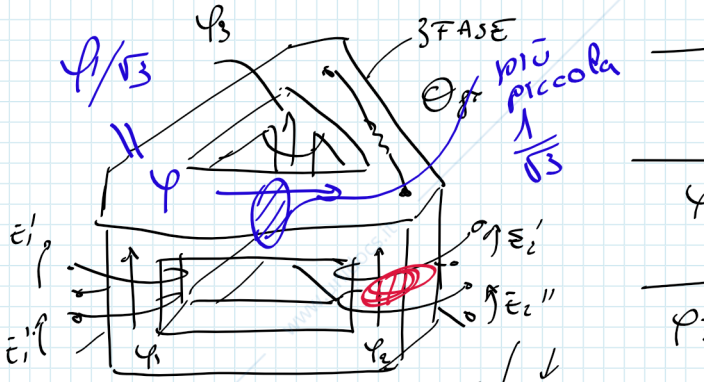


$e = \frac{d\varphi}{dt} \Rightarrow \varphi$ sinus.

$\varphi = \varphi_3 \sin \omega t$

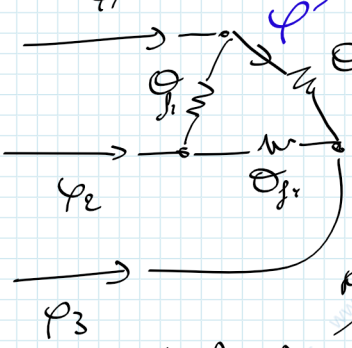
$e = \omega \varphi \cos \omega t$

$\varphi = \frac{e}{\omega}$



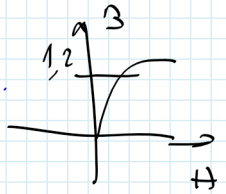
$\varphi = \varphi_1 / \sqrt{3}$

$\varphi = \frac{\varphi_1}{\sqrt{3}}$



$\varphi_1 = \varphi_2 = \varphi_3$ sfasati di 120°

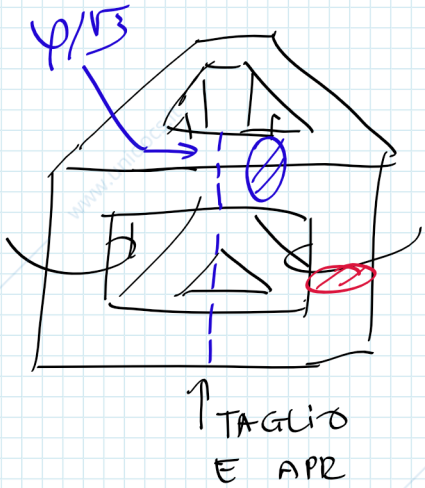
per avere meno forza

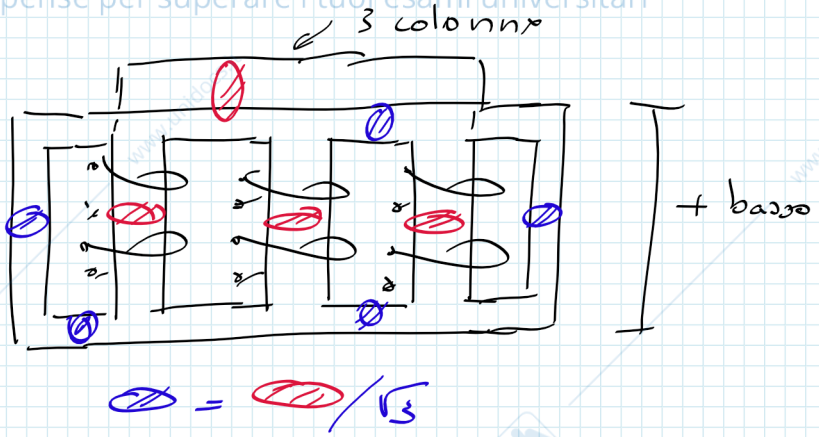


$e = \frac{d\varphi}{dt}$ ← dal generatore ← Impongo $\varphi_1, \varphi_2, \varphi_3$

$\varphi = BA$ = 1,2 T

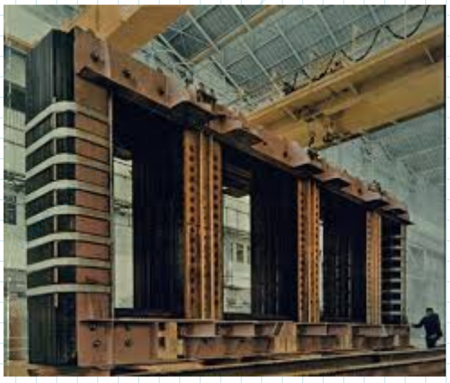
Voglio fare un sistema con la A più piccola



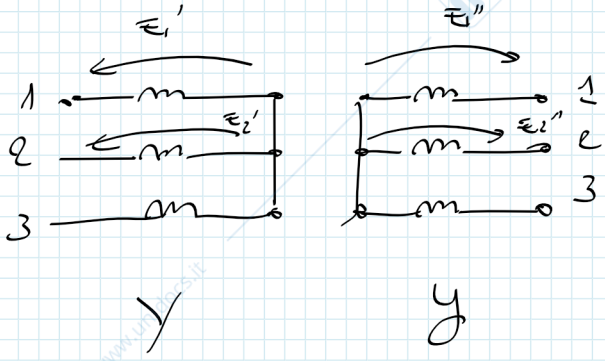


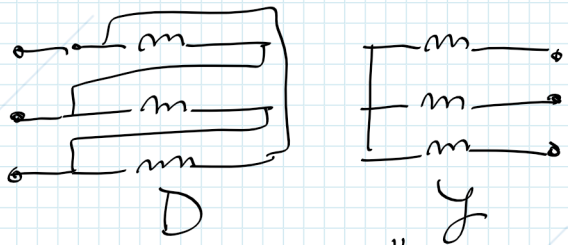
NUCLEO A 5 COLONNE

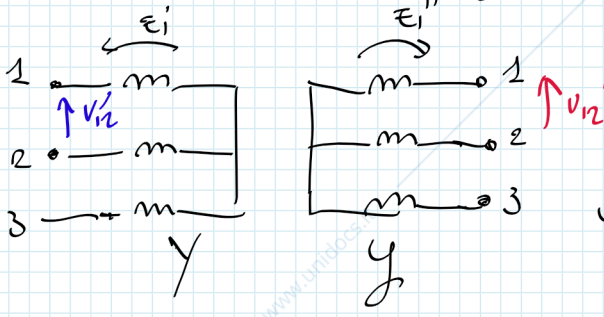
/Si usa solo x trasf di grossa potenza/

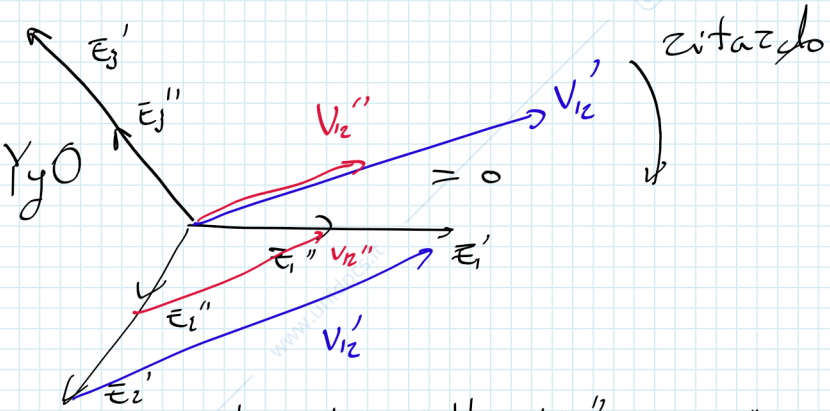


CIRCUITO MAGNETICO ⇒ Solo aspetti costruttivi ⇒ può scomporsi come tre trasf. monofase

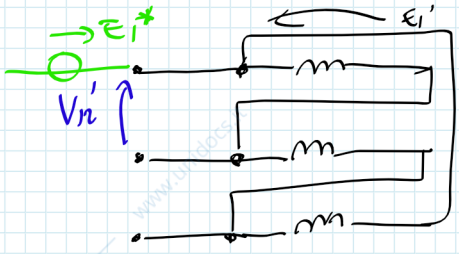


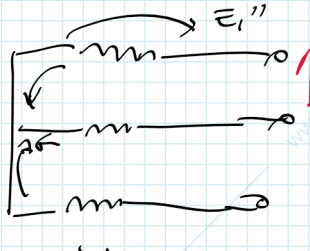






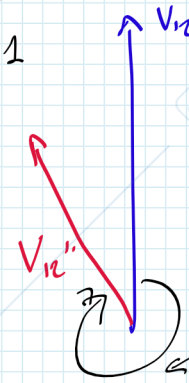
INDICE ORARIO = sfasamento di ritardo della V_{12}'' rispetto a V_{12}' / 30°

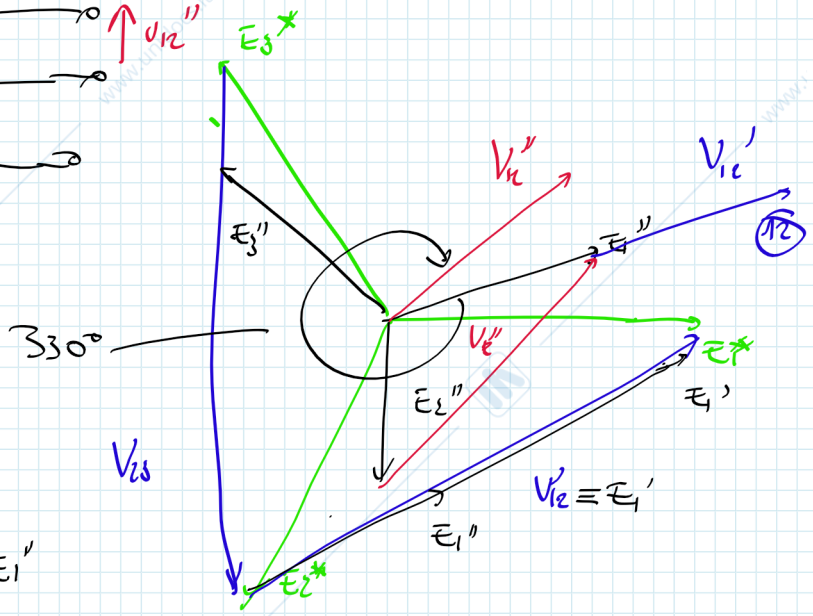


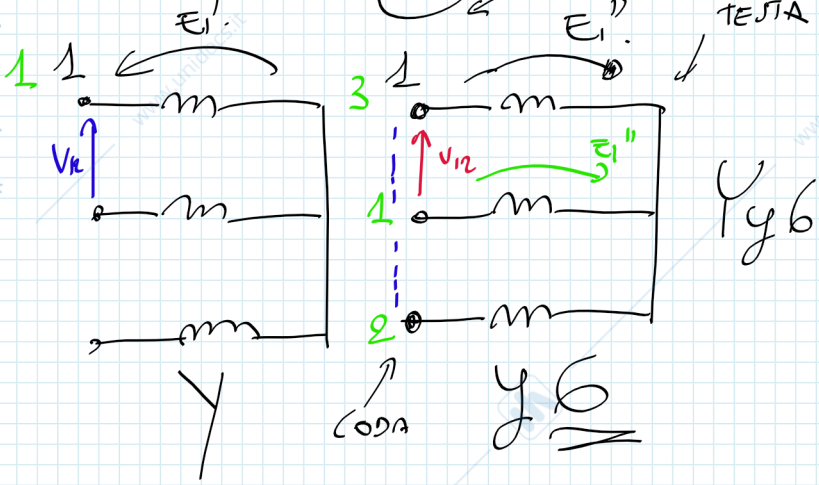


Dy11

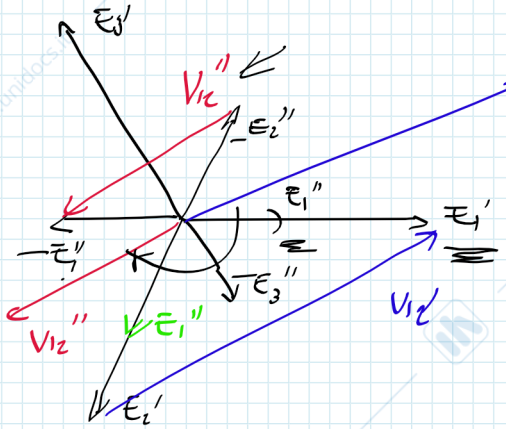
11







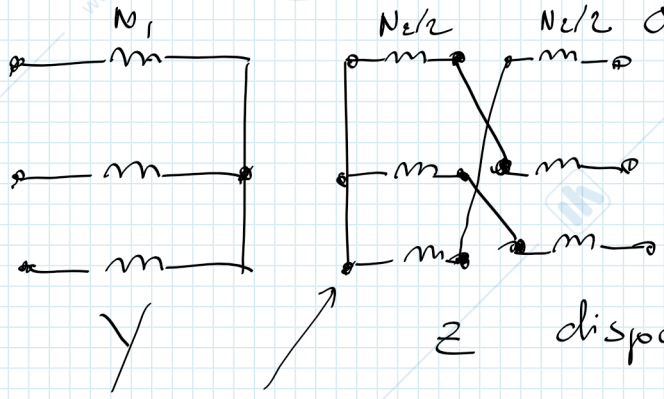
y6



Yy o Dd ⇒ tutti gli indici orari pari

Dy o Yd ⇒ // // // // dispari

Avvolgimento a zig-zag



stella

INDICE ORARIO = Sfasamento di ritardo della tensione concatenata sec. risp. alla primaria (V_{1c}'' rispetto V_{12}') / 30°

Ottengo un indice orario dispari

Come andiamo a modellare un trafo trifase?

con tre trafo monofase identici ⇒ posso studiare 1 solo e sfas. di 120° ⇐ molt tutto

MODELLO TRASFORMATORE TRIFASE (SIMMETRICO / EQ)

TARGA

K = RAPPORTO DI TRASFORMAZIONE = $\frac{V'_{12n}}{V''_{12n}}$ (concatenata primaria / concatenata sec.)

$V_{1n} = V'_{12n}$ = tensione concatenata nominale primaria $= \sqrt{3}\, E'_{1n}$

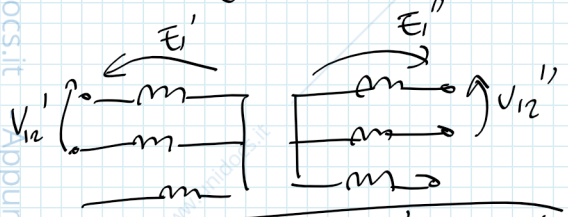
$V_{2n} = V''_{12n}$ = tensione concatenata nominale secondaria (380 V)

valori efficaci

simmetrico

$v''_{12}(t) = \sqrt{2}\, V''_{12n} \cos(\omega t)$

$v''_{23}(t) = \sqrt{2}\, V''_{12n} \cos\left(\omega t - \frac{2\pi}{3}\right)$

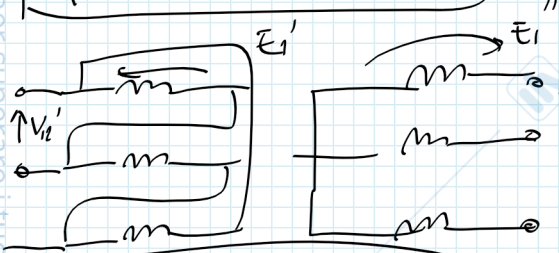


$K_{spire} = \frac{N_1}{N_2} = \frac{E'_1}{E''_1}$

Questo sempre!

$K_{yy} = \frac{V'_{12}}{V''_{12}} = \frac{\sqrt{3}\, E'_1}{\sqrt{3}\, E''_1} = \frac{E'_1}{E''_1} = \frac{N_1}{N_2}$

RAPP. DI TRASFORMAZIONE



$K_{spire} = \frac{N_1}{N_2} = \frac{E'_1}{E''_1}$

$K_{Dy} = \frac{V'_{12}}{V''_{12}} = \frac{E'_1}{\sqrt{3}\, E''_1} = \frac{1}{\sqrt{3}} \cdot \frac{N_1}{N_2} = \frac{K_{spire}}{\sqrt{3}}$

$K_{yy} = K_{Dd} = K_{spire}$

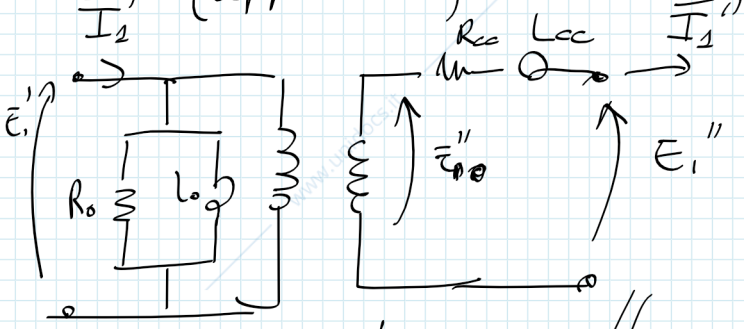
$K_{Dy} = \frac{K_{spire}}{\sqrt{3}}$

$K_{yd} = \sqrt{3}\, K_{spire}$

$K = \frac{V_{1n}}{V_{2n}}$ ← 1 primaria, ← 2 secondaria

Si intende sempre a vuoto V_{20n}

A_n = potenza nominale (apparente) $= 3E_{1n} I_{1n} = \sqrt{3}\, V_{1n} I_{1n} = \sqrt{3}\, V_{2n} I_{2n} = 3E_{2n} I_{2n}$



1 FASE !!

$I'_1 = I_{1n}$ se nominale

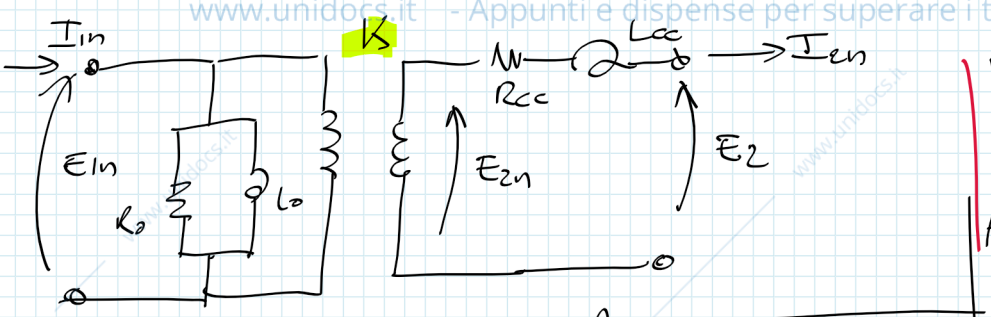
$I''_1 = I_{2n}$ " "

$E'_1 = E_{1n}$ " "

↑ primario

$E''_{10} = E_{2n}$ " "

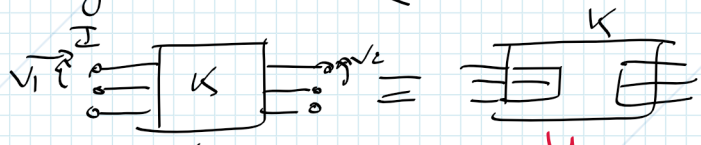
↑ secondario



$V_{1n} = \sqrt{3}\, E_{1n}$ ←
$V_{2n} = \sqrt{3}\, E_{2n}$ ←
$A_n = \sqrt{3}\, V_{1n} I_{1n} = \sqrt{3}\, V_{2n} I_{2n}$
$= 3\, E_{1n} I_{1n}$

$$A_{n\,monofase} = \frac{A_n}{3}$$

K = rapp. di trasformazione (a prescindere dal collegamento)
$= V_{1n} / V_{2n}$



come se avessi trasformato in un Y_y equivalente

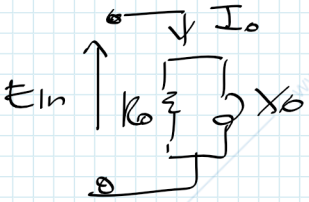
PROVE

- Prova a vuoto → R_0, X_0 → $P_{0\%}, I_{0\%}$
- Prova di corto circuito → R_{cc}, X_{cc} → $P_{cc\%}, V_{cc\%}$

PROVA A VUOTO

$$P_0 = \frac{P_{0\%}}{100} \cdot A_n = 3\, E_{2n} \cdot I_0 \cos\varphi_0 = \sqrt{3}\, V_{1n} I_0 \cos\varphi_0 \qquad P_{0\,monof.} = P_0/3$$

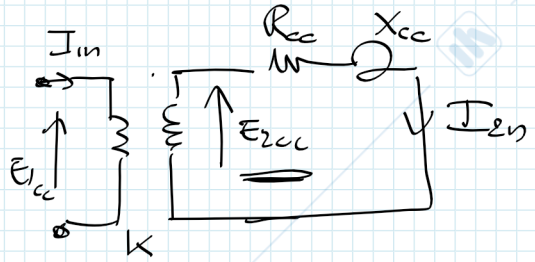
$$I_0 = \frac{I_{0\%}}{100} \cdot I_{1n}$$



PROVA IN C.C.

$$P_{cc} = \frac{P_{cc\%}}{100} \cdot A_n = 3\, E_{2cc} I_{2n} \cos\varphi_{cc} = \sqrt{3}\, V_{2cc} I_{2n} \cdot \cos\varphi_{cc}$$

$$V_{2cc} = \frac{V_{cc\%}}{100} \cdot V_{2n} \Rightarrow E_{2cc} = \frac{V_{2cc}}{\sqrt{3}}$$ (tensione conc.)



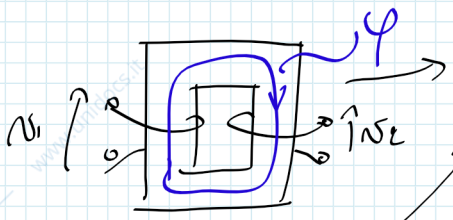
$A_n = \sqrt{3}\, V_{1n} I_{2n} = 3\, E_{1n} I_{2n}$

Quando poi si risolve → V concatenate → P trifase

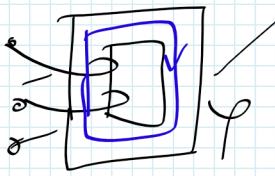
se trovo una E ⇒ $V = \sqrt{3}E$ // // // $P = P_{monof} = 3P$

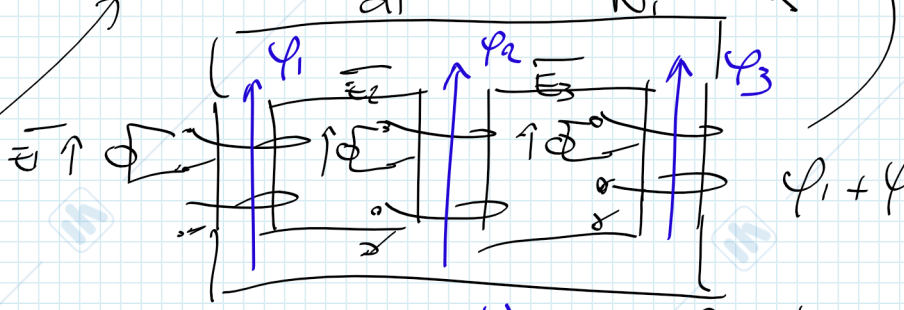
PROCEDURA: divido le $P/3$ e le $V/\sqrt{3}$ → risolto monofase → moltiplico $3P$ $\sqrt{3}E$

I rimangono invariate



$$\begin{cases} \mathcal{E}_1 = \dfrac{d\psi}{dt} = N_1 \dfrac{d\varphi}{dt} \\ \mathcal{E}_2 = N_2 \dfrac{d\varphi}{dt} = N_2 \cdot \dfrac{\mathcal{E}_1}{N_1} = \dfrac{\mathcal{E}_1}{K} \end{cases}$$





$$\varphi_1 + \varphi_2 + \varphi_3 = 0$$

$$\varphi_1 = \varphi \cos(\omega t)$$

$$\varphi_2 = \varphi \cos\left(\omega t - \frac{2\pi}{3}\right)$$

$$e_1 = E \sin(\omega t)$$

$$e_2 = E \sin\left(\omega t - \frac{2\pi}{3}\right)$$