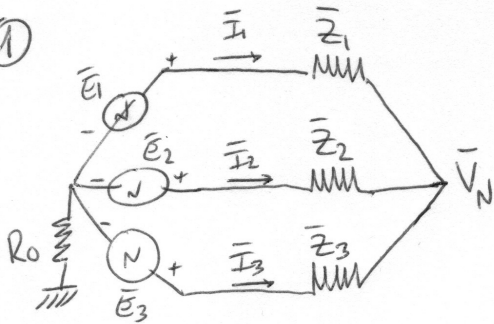


①



Carga

hoje 1/4

$$\begin{aligned} \bar{Z}_1 &= 4,5 \, \Omega \\ \bar{Z}_2 &= 4,0 \, \Omega \\ \bar{Z}_3 &= 5,0 \, \Omega \end{aligned} \Rightarrow \begin{cases} \bar{Z}_d = -j0,28887 \, \Omega \\ \bar{Z}_i = j0,28887 \, \Omega \\ \bar{Z}_h = 4,5 \, \Omega \end{cases}$$

Generador

$$\bar{X}_s = \bar{X}_2 = j0,2 \frac{380^2}{50000} = j0,5776 \, \Omega$$

$$\bar{E}_d = \frac{380}{\sqrt{3}} = 219,4 \, V$$

Aplico ley de Ohm al caso

$$\begin{cases} \bar{E}_d - \bar{X}_s \bar{I}_d = \bar{Z}_h \bar{I}_d + \bar{Z}_i \bar{I}_i + \bar{Z}_d \bar{I}_h \\ -\bar{X}_a \bar{I}_i = \bar{Z}_d \bar{I}_d + \bar{Z}_h \bar{I}_i + \bar{Z}_i \bar{I}_h \\ -3R_0 \bar{I}_h - \bar{X}_0 \bar{I}_h = \bar{Z}_i \bar{I}_d + \bar{Z}_d \bar{I}_i + \bar{Z}_h \bar{I}_h + \bar{V}_N \end{cases}$$

→ Como el neutro de la carga está aislado  $\Rightarrow \bar{I}_h = 0$

$$\begin{cases} \textcircled{1} \bar{E}_d - \bar{X}_s \bar{I}_d = \bar{Z}_h \bar{I}_d + \bar{Z}_i \bar{I}_i \\ \textcircled{2} -\bar{X}_a \bar{I}_i = \bar{Z}_d \bar{I}_d + \bar{Z}_h \bar{I}_i \Rightarrow \bar{I}_i = -\frac{\bar{Z}_d}{\bar{Z}_h + \bar{X}_a} \bar{I}_d \\ \textcircled{3} -\bar{V}_N = \bar{Z}_i \bar{I}_d + \bar{Z}_d \bar{I}_i \end{cases}$$

$$\Rightarrow \text{de } \textcircled{1}, \textcircled{2} \quad \bar{I}_d = \frac{\bar{E}_d}{\bar{Z}_h + \bar{X}_s - \frac{\bar{Z}_i \bar{Z}_d}{\bar{Z}_h + \bar{X}_a}} = 48,15 - j6,230 \, A$$

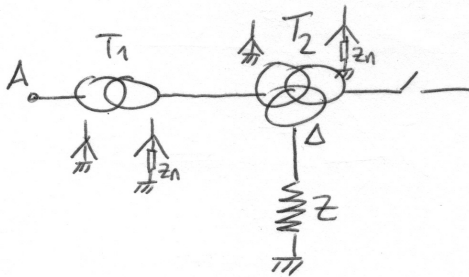
$$\Rightarrow \bar{I}_i = 0,7832 + j2,988 \, A \Rightarrow \text{de } \textcircled{3} \quad \bar{V}_N = -2,661 - j13,67 \, V$$

$$\boxed{V_N = 13,93 \, V}$$

$$\bar{S} = 3\bar{V}_d \hat{I}_d + 3\bar{V}_i \hat{I}_i + 3\bar{V}_h \hat{I}_h^0 = 3(\bar{E}_d - \bar{X}_s \bar{I}_d) \hat{I}_d + 3(-\bar{X}_a \bar{I}_i) \hat{I}_i$$

$$\boxed{\bar{S} = 31689 \, W}$$

②



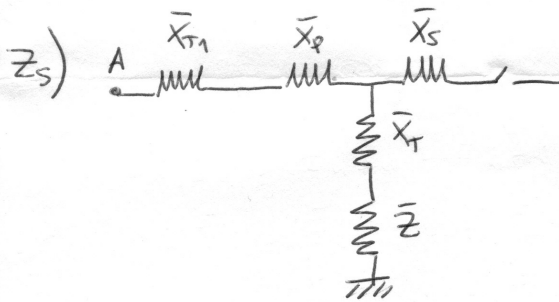
trabalham p.u.

- $U_{b1} = 150 \text{ kV}$
- $U_{b2} = 60 \text{ kV}$
- $U_{b3} = 30 \text{ kV}$
- $U_{b4} = 6 \text{ kV}$
- $S_b = 75 \text{ MVA}$

$$\bar{X}_{T1} = j0,1$$

$$\begin{aligned} \bar{X}_{ps} = j0,05 \\ \bar{X}_{pt} = j0,09 \\ \bar{X}_{st} = j0,12 \end{aligned} \Rightarrow \begin{cases} \bar{X}_p = j0,01 \\ \bar{X}_s = j0,04 \\ \bar{X}_t = j0,08 \end{cases}$$

$$\bar{Z} = j5 / \frac{U_{b4}^2}{S_b} = j10,42$$

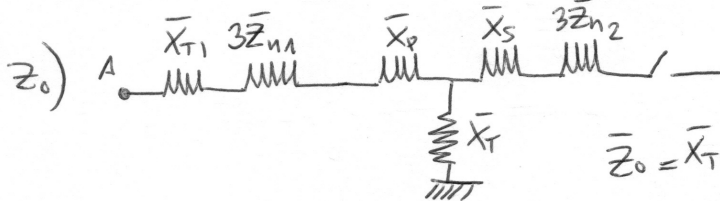


$$\bar{Z}_s = \bar{X}_{T1} + \bar{X}_p + \bar{X}_s + \bar{Z}$$

$$\bar{Z}_s = j10,61 \text{ p.u.}$$

$$\bar{Z}_s = j10,61 \times \frac{U_{b1}^2}{S_b} = j3189 \Omega$$

$$\bar{Z}_a = \bar{Z}_s$$



$$\bar{Z}_0 = \bar{X}_{T1} + 3\bar{Z}_{n1} + \bar{X}_p + \bar{X}_s$$

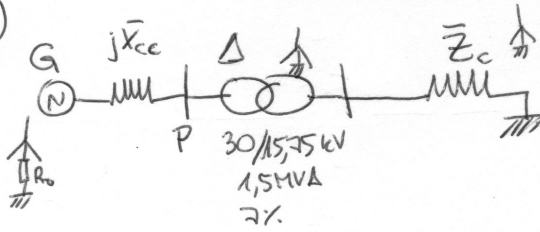
$$\bar{Z}_0 = j0,2525$$

$$\rightarrow \bar{Z}_{n1} = j \frac{U_{b2}^2}{S_b} = j0,0208$$

$$\bar{Z}_0 = j0,2525 \times \frac{U_{b1}^2}{S_b} = j75,75 \Omega$$

3

hoja 3/4



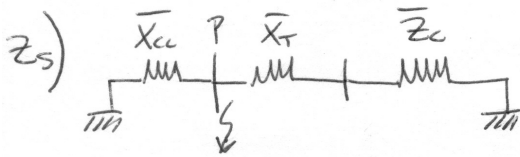
trabajo en 30 kV

$$\bar{X}_{cc} = j6,29 \Omega$$

$$\bar{X}_{TA} = j0,07 \frac{30^2}{1,5} = j42 \Omega$$

$$\bar{Z}_c = (150 + j12,5) \left( \frac{30}{15,75} \right)^2 = 544,2 + j408,2 \Omega$$

a)

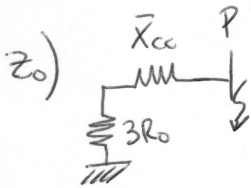


$$\bar{Z}_s = \bar{X}_{cc} \parallel (\bar{X}_T + \bar{Z}_c)$$

$$\bar{Z}_s = 0,0427 + j6,254 \Omega$$

$$\bar{Z}_a = \bar{Z}_s$$

$$\bar{f}_s = \frac{\bar{Z}_s}{\bar{X}_{cc}} = 0,9943 - j0,0068$$



$$\bar{Z}_0 = \bar{X}_{cc} + 3R_0 = 54 + j6,29 \Omega$$

$$\bar{f}_0 = 1$$

CC1FT  $\bar{I} = \frac{\bar{E}_d}{\bar{Z}_s + \bar{Z}_a + \bar{Z}_0} = 285,7 - j99,31 \text{ A} = \bar{I}_d = \bar{I}_i = \bar{I}_u$

Corriente de Tierra =  $\bar{I}_1 \rightarrow \bar{I}_1 = \bar{I}_d + \bar{I}_i + \bar{I}_u = 3\bar{I} = 857,2 - j297,9 \text{ A}$

$\bar{I}_{\text{Tierra}} = 907,5 \text{ A}$

CC2FT

$$\bar{I}_d = \frac{(\bar{Z}_a + \bar{Z}_0) \bar{E}_d}{\bar{Z}_s \bar{Z}_a + \bar{Z}_a \bar{Z}_0 + \bar{Z}_s \bar{Z}_0} = 87,24 - j1398 \text{ A}$$

$$\bar{I}_i = \frac{-\bar{Z}_0 \bar{E}_d}{(\quad)} = 68,34 + j1371 \text{ A}$$

$$\bar{I}_u = \frac{-\bar{Z}_a \bar{E}_d}{(\quad)} = -155,6 + j2712 \text{ A}$$

$$\Rightarrow \begin{cases} \bar{I}_1 = 0 \\ \bar{I}_2 = -2632 + j2432 \text{ A} \\ \bar{I}_3 = 2165 + j5705 \text{ A} \end{cases}$$

③ Continuación

hoja 4/4

$$\text{Corriente tierra} = \bar{I}_2 + \bar{I}_3 = -466,8 + j81,36 \text{ A}$$

$$\boxed{I_{\text{tierra}}_{2FT} = 473,8 \text{ A}}$$

$$\Rightarrow \boxed{\text{Diseño con } I_{cc} = 907,5 \text{ A}}$$

b) Considero CC 1FT.

$$\begin{cases} \bar{I}_{red d} = \bar{f}_s \bar{I}_d + \bar{I}_{ad} \\ \bar{I}_{red i} = \bar{f}_s \bar{I}_i \\ \bar{I}_{red h} = \bar{f}_0 \bar{I}_h \end{cases} \rightarrow \bar{I}_{ad} = \frac{30000}{\sqrt{3} X_T + \bar{Z}_c} = 18,90 - j15,63 \text{ A}$$

$$\begin{cases} \bar{I}_{red d} = 302,3 - j116,3 \text{ A} \\ \bar{I}_{red i} = 283,4 - j100,7 \text{ A} \\ \bar{I}_{red h} = 285,7 - j99,31 \text{ A} \end{cases} \Rightarrow \begin{cases} \bar{I}_{red 1} = 871,5 - j316,3 \text{ A} \\ \bar{I}_{red 2} = -20,69 - j7,176 \text{ A} \\ \bar{I}_{red 3} = 6,388 + j25,55 \text{ A} \end{cases}$$