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Réseumé

Le système "Per unit"

- tension entre Phase & $U = \sqrt{3}\, V$
- La puissance 3φ: $S = 3V \cdot I = \sqrt{3}\, UI = P + jQ$

$V = ZI$

$$S_{PU} = \frac{S_{actuall}}{S_{Base}} \; ; \; U_{PU} = \frac{U}{U_B} \; ; \; I_{PU} = \frac{I}{I_B} \; ; \; Z_{PU} = \frac{Z}{Z_B}$$

$$U_B = \sqrt{3}\, V_B \; ; \; S_B = \sqrt{3}\, U_B I_B \; ; \; V_B = Z_B \cdot I_B$$

$$U_{PU} = V_{PU} \; ; \; S_{PU} = U_{PU} \cdot I_{PU}$$

Admittance et impédance de Base

$$S = 3VI \Rightarrow S = 3V \cdot \frac{V}{Z} \Rightarrow S = \frac{3V^2}{Z}$$

$$S = 3 \times \left(\left(\frac{U}{\sqrt{3}} \right)^2 \cdot \frac{1}{Z} \right) \Rightarrow \boxed{S = \frac{U^2}{Z}}$$

$$\boxed{S_{B_Z} = \frac{U_B^2}{Z_B}} \Rightarrow \boxed{Z_B = \frac{U_B^2}{S_B}} \text{ et } \boxed{Z_{PU} = \frac{U_{PU}^2}{S_{PU}}}$$

$$Z = \frac{1}{y} \Rightarrow \boxed{y_B = \frac{S_B}{U_B^2}} \text{ et } \boxed{y_{PU} = \frac{S_{PU}}{U_{PU}^2}}$$

$$\boxed{S_{B_y} = y_B \cdot U_B^2}$$

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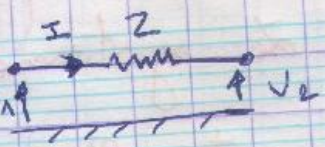
chute de tension :



par Kirchoff)

$$V_1 = V_2 + Z I$$

$$V_{Pu1} = V_{Pu2} + Z_{Pu} \cdot I_{Pu}$$

Changement de Base :

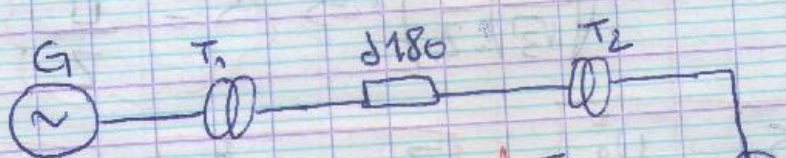
$$Z = Z_{Pu1} \cdot Z_{B1} = Z_{Pu2} \cdot Z_{B2}$$

$$Z_{Pu2} = Z_{Pu1} \cdot \frac{Z_{B1}}{Z_{B2}} = Z_{Pu1} \cdot \frac{U_{B1}^2}{S_{B1}} \cdot \frac{S_{B2}}{U_{B2}^2}$$

(Z_{B1})

$$\text{et } y_{Pu2} = y_{Pu1} \cdot \frac{U_{B2}^2 S_{B1}}{S_{B2} U_{B1}^2}$$

Exemple :



G :
- S = 20,4 VA
- U = 13,8 KV
- $Z_{Pu1} = j0,2\ Pu$

M ⇒ S = 30 KV
U = 18 KV
$Z_{Pu} = j0,2\ Pu$

T1 :
- S = 25,4 VA
- U = 13,8 - 220 KV
- $Z_{Pu1} = j0,1\ Pu$

T2 :
- S = 30 VA
- U = 220 - 18 KV
- $Z_{Pu1} = j0,1\ Pu$

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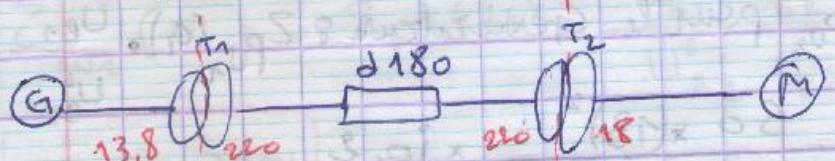
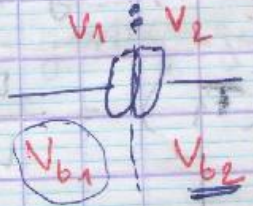
avec $S_{b_2}(G) = S_{b_2}(T_1) = S_{b_2}(T_2) =$ 50 kVA

et $V_{b_1} = 13,8$ KV pour le generateur

R: On divise le schema en 3 zone



1- calcul V_{b_2} , V_{b_3}



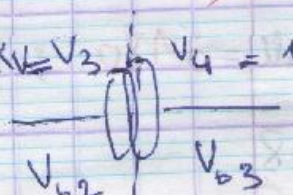
- $V_{b_2} = V_{b_1} \cdot \frac{V_2}{V_1}$

$V_{b_2} = 13,8 \cdot \frac{220}{13,8}$

$V_{b_2} = 220$ KV

- $V_{b_3} = V_{b_2} \cdot \frac{V_3}{V_4} = 220 \cdot \frac{18}{220}$

$V_{b_3} = 18$ KV



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2. calculer Z_{PU_2} de chaque

$$Z_{PU_2} = Z_{PU_1} \cdot \frac{U_{B1}^2 \, S_{B2}}{U_{B2}^2 \, S_{B1}}$$

Alor Z_{PU_2} pour le Generateur & $Z_{PU_1}(G) \cdot \frac{U_{B1}^2 \, S_{B2}}{U_{B2}^2 \, S_{B1}}$

- $Z_{PU_2}(G) = \frac{50 \times (13.8)^2}{20 \times (13.8)^2} \times j0,2$

$$Z_{PU_2}(G) = j0,5 \, PU$$

- $Z_{PU_2}(T_1) = \frac{U_{B1}^2 \, S_{B2}}{U_{B2}^2 \, S_{B2}} Z_{PU_1} = \frac{(13,8)^2 \times 50}{(13.8)^2 \times 25} \times j0,1$

$$Z_{PU_2}(T_1) = j\,0,2\,PU$$

- Z_{PU_2} (La ligne ($\delta 180$)) ; $Z_{PU_2} = \frac{Z_{actual}}{Z_{Base}}$

$Z_{actuell} = \delta 180$; $Z_B = \frac{U_{B2}^2}{S_{B2}} = \frac{220\,KV}{50\,KV}$

$Z_B = 968$

$Z_{PU2}(L) = \delta \frac{180}{968} \Rightarrow$ $Z_{PU2}(L) = 0,186\,PU$

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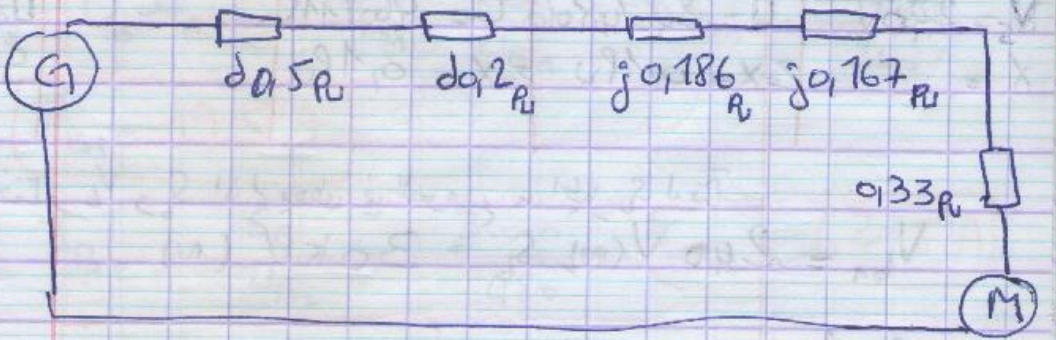
- $ZP_{U_2}(T_2) = ZP_{U_1} \cdot \frac{U_{B_1}^2 \cdot S_{B_2}}{S_{B_1} \, U_{B_2}^2} = 0,1 \, \frac{50 \times 220^2}{30 \times 220^2}$

$ZP_{U_2}(T_2) = j\,0,167$

- $Z_{PU_2}(M) = Z_{PU_1}(M) \cdot \frac{U_{B_1}^2 \, S_{B_2}}{U_{B_2}^2 \, S_{B_1}}$

$Z_{PU_2} = 0,133_{pu}$

Le schema equivalent



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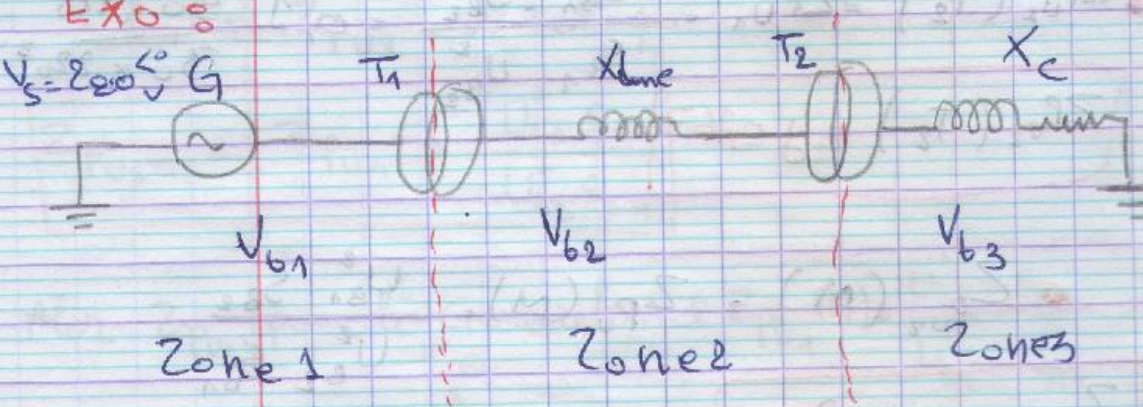
N → New, O → old

EXO :



G	T_1	T_2	Line	ch
S = 30KVA	S = 30KV(o)	S = 20KVA Hz	$X_{Line} = 2\Omega$	$Z = X_c = 9,1\Omega$
V_s = 220V	U = 240/480	U = 460/115		U = 115(o)
X =	Z = X = 0,1Pu	Z = X = 0,1Pu		S =

نختار V_b و S_b انا لم يعطى في الموضوع من اكبر S_b لدينا

$V_{b1} = 240\ V_{(N)}$, $S_b = 30kV\ (N)$

- Calcule V_{b2}, V_{b3}

$$V_{b2} = V_{b1} \cdot \frac{V_2}{V_1} \Rightarrow V_{b2} = V_{b1} \cdot \frac{480}{240}$$

$$\boxed{V_{b2} = 480\ V\ (N)}$$

$$V_{b3} = V_{b2} \cdot \frac{V_4}{V_3} = 480 \times \frac{115}{460}$$

$$\boxed{V_{b3} = 120\ V\ (N)}$$

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- calcul les impidance de Base :

$$Z_{B1} = \frac{U_{B1}^2}{S_{B1}} \Rightarrow Z_{B1} = \frac{(240)^2}{30000} \Rightarrow \boxed{Z_{B1} = 1,92\,\Omega}$$

$$Z_{B2} = \frac{U_{B2}^2}{S_B} = Z_{B2} = \frac{480^2}{30000} \Rightarrow \boxed{Z_{B2} = 7,68\,\Omega}$$

$$Z_{B3} = \frac{120^2}{30000} = \boxed{Z_{B3} = 0,48\,\Omega}$$

- calcul les courant de Base :

$$S_B = U_B I_B \Rightarrow I_{B1} = \frac{S_{B1}}{U_{B1}} \Rightarrow I_{B1} = \frac{30000}{240}$$

$$\boxed{I_{B1} = 125\,A}$$

$$I_{B2} = \frac{S_B}{U_{B2}} = \frac{30000}{480} \Rightarrow \boxed{I_{B2} = 62,5\,A}$$

$$\boxed{I_{B3} = 250\,A}$$

- changement de Base : N → Nouv , O → old

$$Z_{PU}(N)(T_2) = Z_{PU}(O)(T_2) \times \left[\frac{U_b(O)}{U_b(N)}\right]^2 \frac{S_b(N)}{S_b(O)}$$

$$Z_{PU}(N)_{T_2} = 0,1 \times \left[\frac{460}{480}\right] \times \frac{30000}{20000}$$

$$\boxed{Z_{PU}(N)_{T_2} = 0,137\,PU}$$

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La partie 2 eme de transf (2)

- or $\rightarrow Z_{pu}N(T_2) = Z_{pu}(0)T_2 \times \left[\frac{115}{120}\right]^2 \times \frac{30K}{20K}$

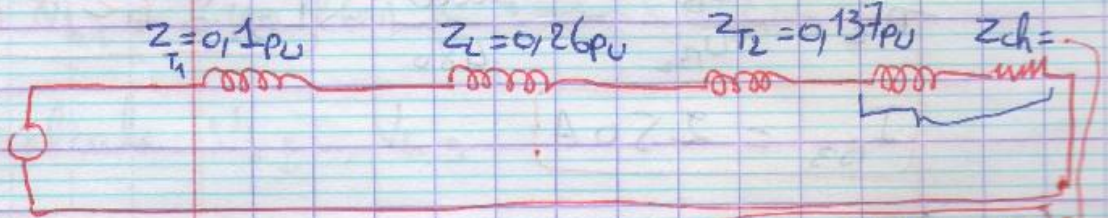
$$\boxed{Z_{pu}(N)T_2 = 0,137_{pu}}$$

- $Z_{pu}(\text{line}) = \frac{Z(old)}{Z_{b2}} = \frac{2}{7,168} \Rightarrow \boxed{Z_{pu}(\text{line}) = 0,26}$

- $Z_{pu}(\text{charge}) = \frac{Z(old)}{Z_{b3}} = \boxed{1,87 + j0,417}$

- $V_{s\,pu} = \frac{V_s}{V_{b1}} = \frac{220}{240} \Rightarrow \boxed{V_{spu} = 0,916_{pu}}$

- Le schema équivalant :



$$Z_{ch} = 1,87 + j0,417$$

- $I_{ch} = \frac{V_{s\,pu}}{j(Z_{eq})}$

$j(Z_{eq}) = j(0,1 + 0,26 + 0,137 + 1,87 + j0,417)$

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$$I_h = \frac{0,916}{(-0,417 + 2,368j)}$$

$$I_h = \frac{916\,\angle 0^\circ}{2,4\,(99,98^\circ)}$$

$$I_h = 0,38 \angle -99,98^\circ$$

A, B → J

2 Fnc AB

↓

2 Fnc B B