EXAMPLE Q4 part (c) & (d). 2003

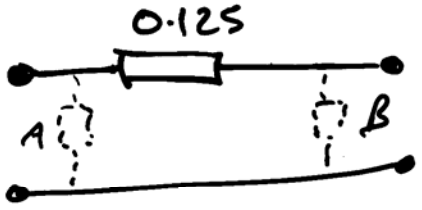
A 60 MVA 132/33 kV STAR-DELTA TRANSFORMER WITH THE STAR WINDING SOLIDLY EARTHED, HAS A NOMINAL TAP IMPEDANCE (Z_{HL}) OF 12.5%. THE TAP CHANGER IS ASSUMED TO BE ON THE 132 kV WINDING. DRAW THE EQUIVALENT CIRCUITS FOR NOMINAL TAP & AND ±10% TAP. (ASSUME IMPEDANCES Z_H & Z_L ARE PROPORTIONAL TO THE SQUARE OF THE NUMBER OF TURNS ON THE WINDING CONCERNED)

SOLUTION

a) ON NOMINAL TAP $Z_{HL} = j0.125 pu$ & $k = 1$

$$A = \frac{Z}{1-k}$$

$$B = \frac{Z}{k(k-1)}$$



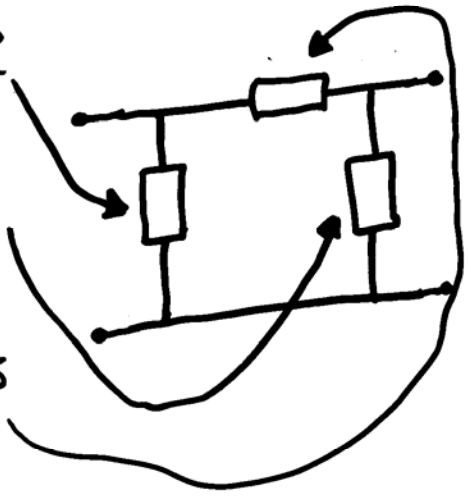
b) ON THE +10% TAP

$$Z_{HL} = k_H^2 Z_{HL\,Nom} = (1.1)^2 . 0.125 = j0.1513$$

$$A = \frac{Z}{1-k} = \frac{j0.1513}{1-1.1} = -j1.513$$

$$B = \frac{Z}{k(k-1)} = \frac{j0.1513}{1.1(1.1-1)} = j1.375$$

$$C = \frac{Z}{k} = \frac{j0.1513}{1.1} = j0.1375$$



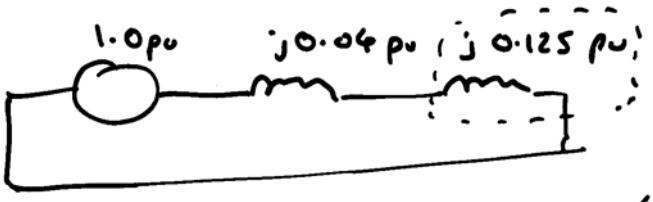
-10% $A = j1.0125$ $B = -j1.125$ $C = j0.1125$

CALCULATE THE 3-ϕ SYMETRICAL FAULT CURRENT FOR EACH TRANSFORMER TAP FOR A FAULT ON THE LV SIDE. ASSUME THE FAULT LEVEL ON THE HV SIDE IS 1500 MVA.

FROM FAULT LEVELS GIVEN WE CAN CALCULATE THE SYSTEM IMPEDANCE:

$$Z_{SYS} = \frac{60}{1500} = j0.04 \text{ pu}$$

ON NOMINAL TAP THE CIRCUIT BECOMES:-

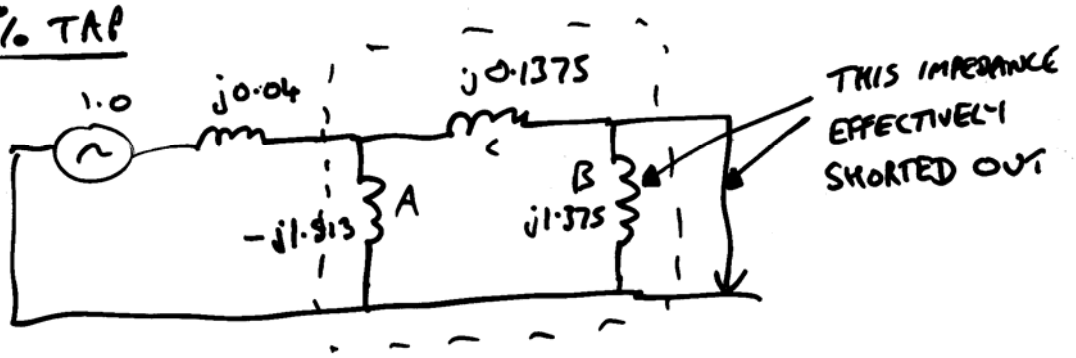


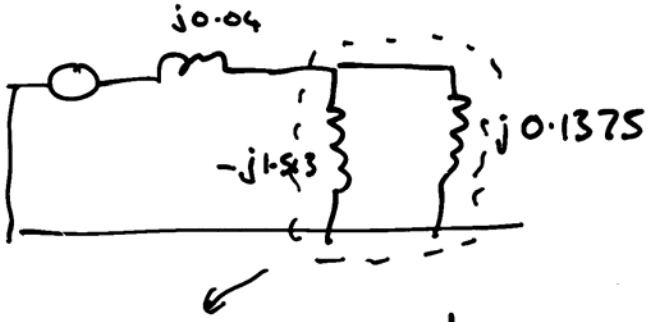
$$I_{f_{pu}} = \frac{1}{j(0.04+0.125)} = \underline{-j\,6.06 \text{ pu}}$$

$$\text{BUT } I_{BASE} = \frac{60 \times 10^6}{\sqrt{3}\ 33000} = \underline{1049.7 \text{ A} \simeq 1050 \text{ A}}$$

$$|I_f| = 6.06 \times 1050 = \underline{\underline{6363 \text{A}}}$$

FOR +10% TAP





$\parallel$ COMBINATION $\quad \dfrac{1}{\dfrac{1}{-j1.513} + \dfrac{1}{j0.1375}}$

$$= \frac{1}{\dfrac{j0.1375 \; -j1.513}{1.513 \times 0.1375}}$$

$$= \frac{1}{\dfrac{-j\,1.3755}{0.208}} = \frac{1}{-j\,6.61}$$

$$= j\,0.151$$

$$I_F = \frac{1}{j(0.04 + 0.151)} = -j\,5.236 \text{ pu}$$

$$|I_F| = I_{BASE} \times I_{pu} = 1050 \times 5.236$$

$$= 5497 \text{ A}$$

for -10%

$$I_F = 7430 \text{ A}$$