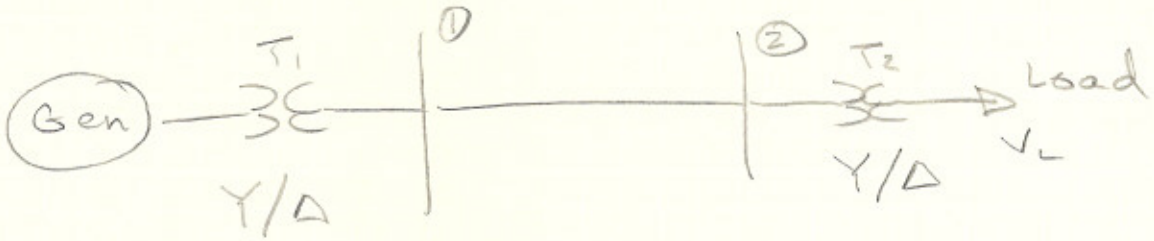


short line

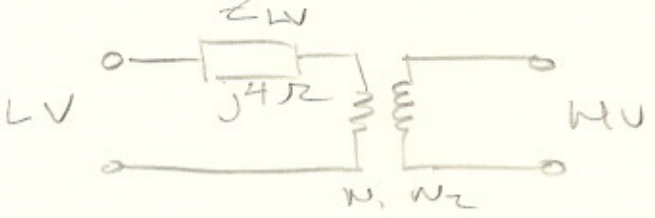
(Pi ω open shunts)

medium line

(Pi)

TRANSFORMERS (P.U. system)

consider the following transformer system w/ all series impedances referred to the low voltage side



let us assume that the transformer is rated @ 200/400 V and 2000 VA, and choose base quantities to be rated quantities.

find primary PU impedances of the transformer

- low voltage side
- high voltage side.

$$Z_b = \frac{V_b}{I_b} \cdot \frac{V_b}{V_b} = \frac{V_b^2}{VA_b}$$

$$(Z_{xmer})_{pu} = \frac{Z_\Omega}{Z_b}$$

$(VA)_b = 2000\ VA$
$V_b = 200\ V$ } LV side.

then

$$I_b = \frac{2000}{200} = 10A$$

$$Z_b = \frac{200}{10} = 20\Omega$$

Impedance of transformer (LVS) is

$$Z_{pu} = \frac{Z_\Omega}{Z_b} = \frac{j4\Omega}{20} = 0.2j\ pu.$$

Referred to the high voltage side

$$(Z_{xmer})_{HV} = \left(\frac{N_2}{N_1}\right)^2 Z_{LV} = 2^2\, 4j = 16j\,\Omega$$

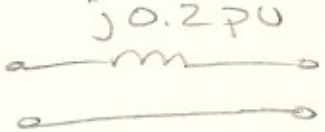
$(VA)_b = 2000\ VA$
$V_b = 400\ V$ } HVS

$$I_b = \frac{2000}{4000} = 5A$$

$$Z_b = \frac{400}{5} = 80\Omega$$

$$(Z_{pu})_{HVS} = 0.2j\ pu.$$

∴ the equivelent cct of the Xmer is thus

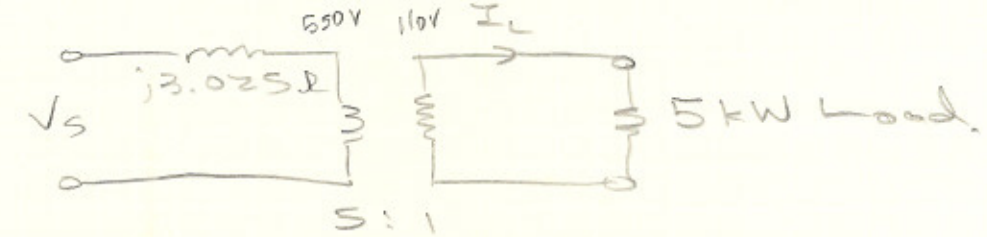


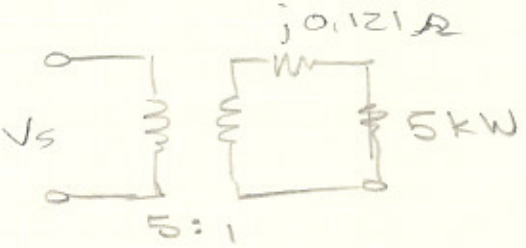
LINES & CABLES

$$Z_{PU} = \frac{Z_{OHM}}{Z_b} = Z_{OHM}\left(\frac{(VA)_b}{V_b^2}\right)$$

EX: Given the following 10 kA transformer w impedance reffered to

- HVS
- LVS





determine and sketch the PU impedance diagram choosing the transformer rating to be our base qualities.

SOL: HVS

$$V_b = 550V$$

$$(VA)_b = 10^4 \text{ VA}$$

$$Z_b = \frac{(550)^2}{10^4} = 30.25\,\Omega$$

$$I_b = \frac{(VA)_b}{V_b} = \frac{10^4}{550} = 18.18\,A$$

$$(Z_{xmer})_{PU} = \frac{j3.025}{30.25} = 0.1j \text{ PU}$$

load @ 5kW, 550V and 1.0 pF

$$P_{LOAD} = \frac{5000}{10^4} = 0.5 \text{ PU}$$

$$I_{PU} = \frac{0.5}{V_{PU}} = 0.5$$

$$I_{ACT} = 0.5 \times 18.18 = 9.09 \text{ A.}$$

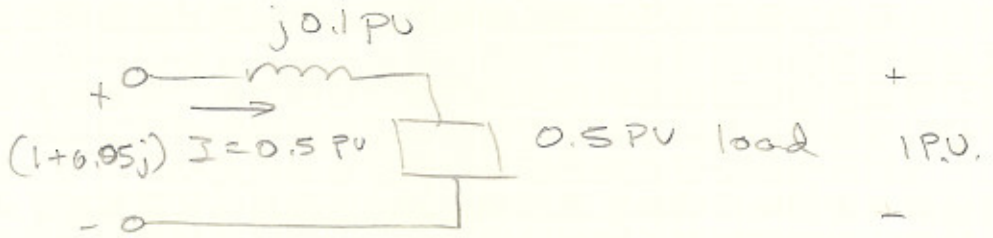
voltage behind transformer leakage reactance is then

$$V_{PU} = 1.0 + j\,0.1(0.5)$$

$$V_{actual} = 550(1.0 + 0.05j)$$

$$= 550 + j\,27.5 \text{ V}$$

PU impedance diagram.



SOL: LVS

$$V_b = 110 \text{ V}$$

$$(VA)_b = 10^4 \text{ VA}$$

$$Z_b = 1.21 \Omega$$

$$I_b = 90.91 \text{ A}$$

load in P.U.

$$\frac{5000}{10^4} = 0.5$$

load voltage in PU

$$\frac{110}{110} = 1.0 \text{ PU}$$

current in PU

$$\frac{0.5}{1} = 0.5 \text{ PU}$$

$I_{act} = 45.45$

voltage behind reactance

$$V_{PU} = 1.0 + j0.1(0.5)$$

$$V_{act} = 110(1.0 + j0.05) = 110 + j5.5V$$

diagram will remain the same.