EEE- 601
POWER SYSTEM ANALYSIS
Unit-1

Per Unit

per unit=actual value/base value

Let KVA_b=Base KVA

kV_b=Base voltage

Z_b=Base impedance in Ω

$$Z_b = \frac{(kV_b)^2}{MVA_b} = \frac{(kV_b)^2}{\frac{KVA_b}{1000}}$$

Changing the base of per unit quantities

Let z = actual impedance(Ω)

Z_b = base impedance (Ω)

$$Z_{p.u} = \frac{Z}{Z_b} = \frac{Z}{\frac{(kV_b)^2}{MVA_b}} = \frac{Z * MVA_b}{(kV_b)^2}$$

Let $kV_{b,old}$ & $MVB_{b,old}$ represent old base values

$kV_{b,new}$ & $MVB_{b,new}$ represent new base values

$$Z_{p.u,old} = \frac{Z * MVA_{b,old}}{\left(kV_{b,old}\right)^2} \rightarrow (1)$$

$$Z = \frac{Z_{p.u,old} * MVA_{b,old}}{\left(kV_{b,old}\right)^2} \rightarrow (2)$$

$$Z_{p.u,new} = \frac{Z * MVA_{b,new}}{\left(kV_{b,new}\right)^2} \rightarrow (3)$$

$$Z_{p.u,new} = Z_{p.u,old} * \frac{\left(kV_{b,old}\right)^2}{\left(kV_{b,new}\right)^2} * \frac{MVA_{b,new}}{MVA_{b,old}}$$

ADVANTAGES OF PER UNIT CALCULATIONS

- The p.u impedance referred to either side of a 1Φ transformer is same
- The manufacturers provide the impedance value in p.u
- The p.u impedance referred to either side of a 3Φ transformer is same regardless of the 3Φ connections Y-Y,Δ-Y
- p.u value always less than unity.

IMPEDANCE DIAGRAM

- This diagram obtained by replacing each component by their 1Φ equivalent circuit.

Following approximations are made to draw impedance diagram

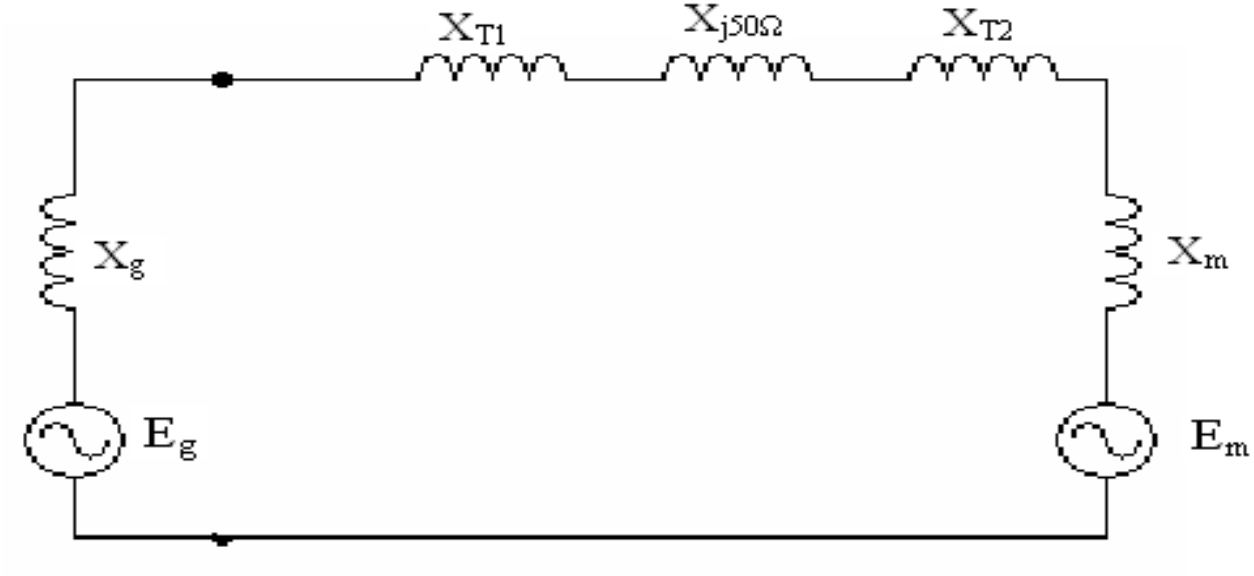
1. The impedance b/w neutral and ground omitted.
2. Shunt branches of the transformer equivalent circuit neglected.

REACTANCE DIAGRAM

- It is the equivalent circuit of the power system in which the various components are represented by their respective equivalent circuit.

- Reactance diagram can be obtained after omitting all resistances & capacitances of the transmission line from impedance diagram.

REACTANCE DIAGRAM FOR THE GIVEN POWER SYSTEM NETWORK



PROCEDURE TO FORM REACTANCE DIAGRAM FROM SINGLE DIAGRAM

1. Select a base power kVA_b or MVA_b
2. Select a base voltage kV_b
3. The voltage conversion is achieved by means of transformer kV_b on LT section= kV_b on HT section x LT voltage rating/HT voltage rating
4. When specified reactance of a component is in ohms

   p.u reactance=actual reactance/base reactance

$$X_{p.u,new} = X_{p.u,old} * \frac{\left(kV_{b,old}\right)^2}{\left(kV_{b,new}\right)^2} * \frac{MVA_{b,new}}{MVA_{b,old}}$$

Thank you