

POWER SYSTEM PROTECTION

UNIT I

POWER SYSTEM COMPONENTS

Power system analysis

The evaluation of power system is called as power system analysis

Functions of power system analysis

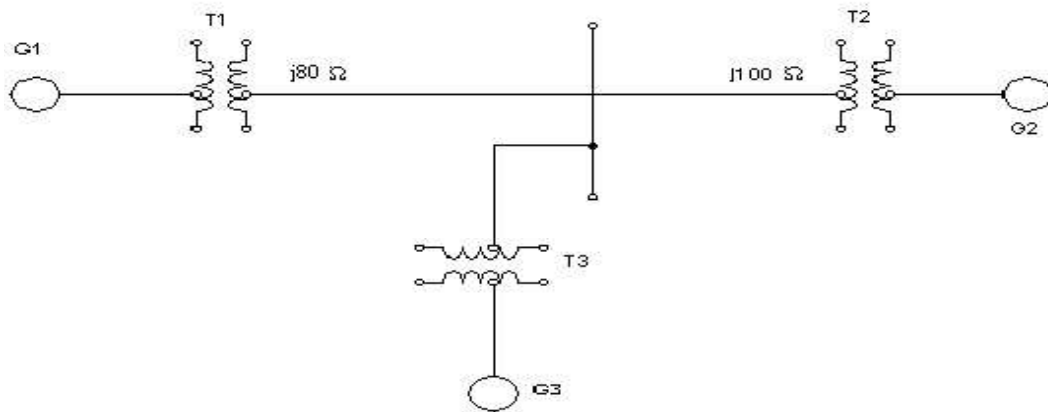
- To monitor the voltage at various buses, real and reactive power flow between buses.
- To design the circuit breakers.
- To plan future expansion of the existing system
- To analyze the system under different fault conditions
- To study the ability of the system for small and large disturbances (Stability studies)

COMPONENTS OF A POWER SYSTEM

1. Alternator
2. Power transformer
3. Transmission lines
4. Substation transformer
5. Distribution transformer
6. Loads

SINGLE LINE DIAGRAM

A single line diagram is diagrammatic representation of power system in which the components are represented by their symbols and interconnection between them are shown by a straight line. Even though the system is three phase system, the ratings and the impedances of the components are also marked on the single line diagram.



Purpose of using single line diagram

The purpose of the single line diagram is to supply in concise form of the significant information about the system.

Per unit value.

The per unit value of any quantity is defined as the ratio of the actual value of the any quantity to the base value of the same quantity as a decimal.

$$\text{per unit} = \frac{\text{actual value}}{\text{base value}}$$

Need for base values

The components or various sections of power system may operate at different voltage and power levels. It will be convenient for analysis of power system if the voltage, power, current and impedance rating of components of power system are expressed with reference to a common value called base value.

Advantages of per unit system

- i. Per unit data representation yields valuable relative magnitude information.
- ii. Circuit analysis of systems containing transformers of various transformation ratios is greatly simplified.
- iii. The p.u systems are ideal for the computerized analysis and simulation of complex power system problems.
- iv. Manufacturers usually specify the impedance values of equivalent in per unit of the equipments rating. If the any data is not available, it is easier to assume its per unit value than its numerical value.

- v. The ohmic values of impedances are referred to secondary is different from the value as referred to primary. However, if base values are selected properly, the p.u impedance is the same on the two sides of the transformer.
- vi. The circuit laws are valid in p.u systems, and the power and voltages equations are simplified since the factors of $\sqrt{3}$ and 3 are eliminated.

Change the base impedance from one set of base values to another set

Let Z =Actual impedance , Ω

Z_b =Base impedance , Ω

$$\text{Per unit impedance of a circuit element} = \frac{Z}{Z_b} = \frac{Z}{\frac{(kV_b)^2}{MVA_b}} = \frac{Z \times MVA_b}{(kV_b)^2} \quad (1)$$

The eqn 1 show that the per unit impedance is directly proportional to base megavoltampere and inversely proportional to the square of the base voltage.

Using Eqn 1 we can derive an expression to convert the p.u impedance expressed in one base value (old base) to another base (new base)

Let $kV_{b,old}$ and $MVA_{b,old}$ represents old base values and $kV_{b,new}$ and $MVA_{b,new}$ represent new base value

Let $Z_{p.u,old}$ =p.u. impedance of a circuit element calculated on old base

$Z_{p.u,new}$ =p.u. impedance of a circuit element calculated on new base

If old base values are used to compute the p.u. impedance of a circuit element ,with impedance Z then eqn 1 can be written as

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

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

If the new base values are used to compute the p.u. impedance of a circuit element with impedance Z , then eqn 1 can be written as