Lecture 2

Per-Unit Quantities

Per unit quantities are quantities that have been normalized to a base quantity. In general,

$$Z_{pu} = \frac{Z_{actual}}{Z_{base}}$$ per-unit (p.u)

Choice of the base value Z_{base} is normally a rated value which is often one of the normal full-load operations of power component in a power network.

Let us look at two of the most common per unit formula which are widely used when per unit calculations are involved.

(i) Base impedance (Z_{base})

For a given single-line (one-line) diagram of a power network, all component parameters are expressed in 3-ϕ quantity whether it is the rating (capacity) expressed as MVA or voltage as kV. Let begin with 3-ϕ base quantity of

$$S_{base} = \sqrt{3} V_{base} I_{base} \qquad \text{----- (i)}$$

where *Vbase* = line voltage, *Ibase*= line or phase current

Per phase base impedance,

$$Z_{base} = \frac{V_{base} / \sqrt{3}}{I_{base}}$$ -----(ii) This is line-to-neutral impedance

Combining (i) and (ii) yields,

$$Z_{base} = \frac{V_{base} / \sqrt{3}}{S_{base} / \sqrt{3} V_{base}}$$

$$\boxed{Z_{base} = \frac{[kV_{base}]^2}{MVA_{base}}}$$

where kV_{base} and MVA_{base} are 3-ϕ qualtities

(ii) Changing base impedance (*Znew*]

Sometimes the parameters for two elements in the same circuit (network) are quoted in per-unit on a different base. The changing base impedance is given as,

$$\boxed{Z_{NEW}(pu) = Z_{OLD} \times \frac{\left[kV_{base\ OLD}\right]^2}{\left[kV_{base\ NEW}\right]^2} \times \frac{MVA_{base\ NEW}}{MVA_{base\ OLD}}}$$