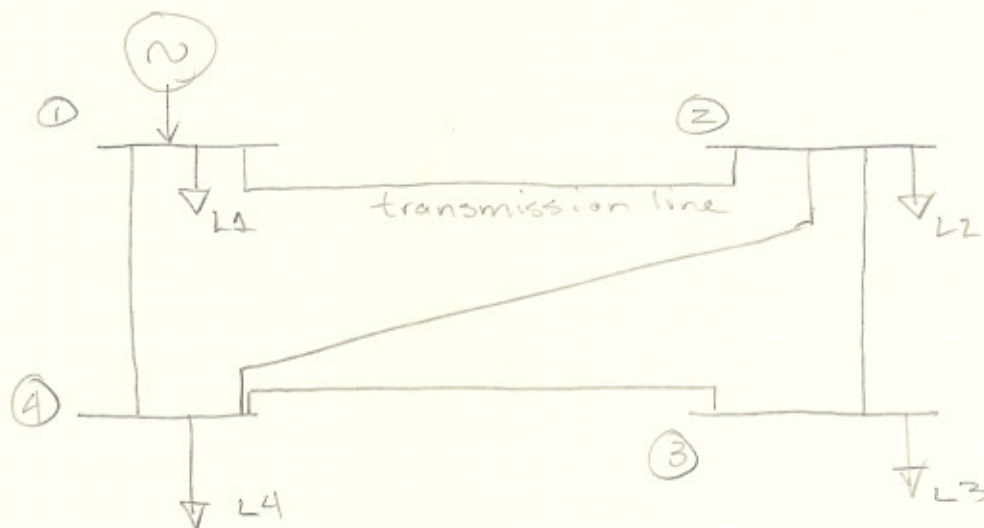


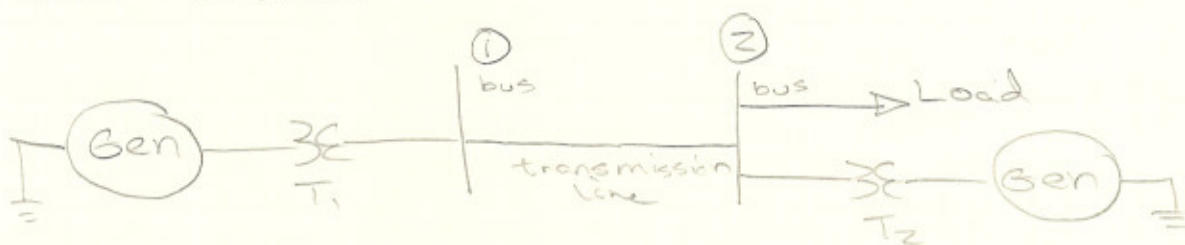
note: a signal line will be used to represent a 3 $\phi$  bus.



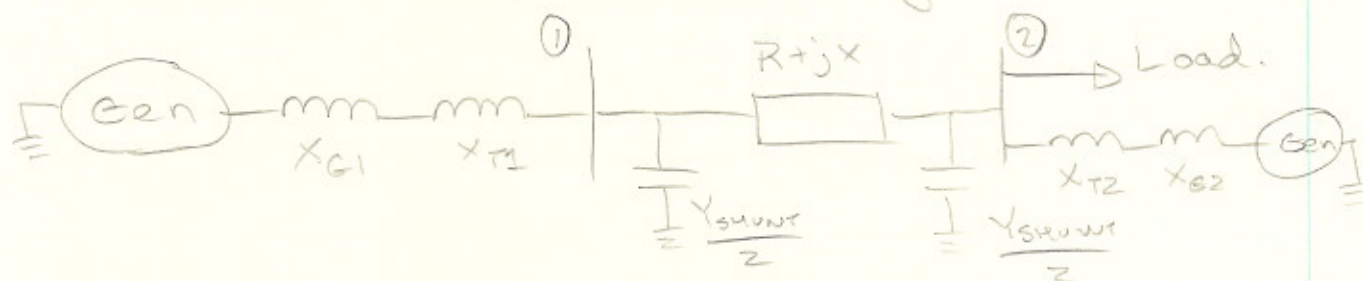
$$\sum I_i \approx 0$$

### NETWORK MODELING

in transmission network analysis, the network is represented by one line diagram as shown below:



this one line diagram can be represented by one line impedance diagram



## PER UNIT SYSTEM

this system is similar to the percent system except that all quantities are expressed as decimal fractions instead of percentages.

Base quantities then have the values of unity instead of 100%. Consider the following example

Ex:



Base Impedance is  $40 \Omega \rightarrow \frac{40}{40} = 1 \text{ P.U. } \Omega$

Base Voltage is  $200\text{V} \rightarrow \frac{200}{200} = 1 \text{ PU Volt.}$

Base Current is  $5\text{A} \rightarrow \frac{5}{5} = 1 \text{ PU Current.}$

Base VA is  $1000 \text{ VA} \rightarrow \frac{1000}{1000} = 1 \text{ PU VA.}$

note: that only  $Z$  are required, if  $Z$  are given the rest may be found easily.

if  $Z = 50 \Omega \rightarrow 1.2 \text{ P.U. impedance}$

$I = 4\text{A} \rightarrow 0.8 \text{ PU current}$

$V = 150\text{V} \rightarrow 0.75 \text{ PU Voltage.}$

The per unit has the distinct advantage that with it all basic circuits relations apply. For example if

$$I = 0.8 \text{ pu}(4\text{A})$$

$$|\bar{Z}| = 1.5 \text{ pu}(60 \Omega)$$

$$\text{then } |\bar{V}| = 1.2 \text{ pu}(240\text{V})$$

Summary, when expressed in per unit quantities

$$V_{base} = V_b = Z_{base} I_{base} = Z_b I_b$$

note: base value is understood to be magnitude

$$(VA)_b = V_b I_b$$

Actual values are related to base values by

$$Z_{ohm} = Z_{pu} \cdot Z_b$$

The PU system simplifies many of the problems of circuit analysis in conventional form using volts and amperes, the solution of a system involving power lines of several different voltage levels require all impedances, which are to be added, to be transformed to a single voltage level. In PU system different voltage levels entirely disappear and a power network involving generators, motors, transmission lines and transformers (of different voltage levels) reduce to a system of simple PU impedances.