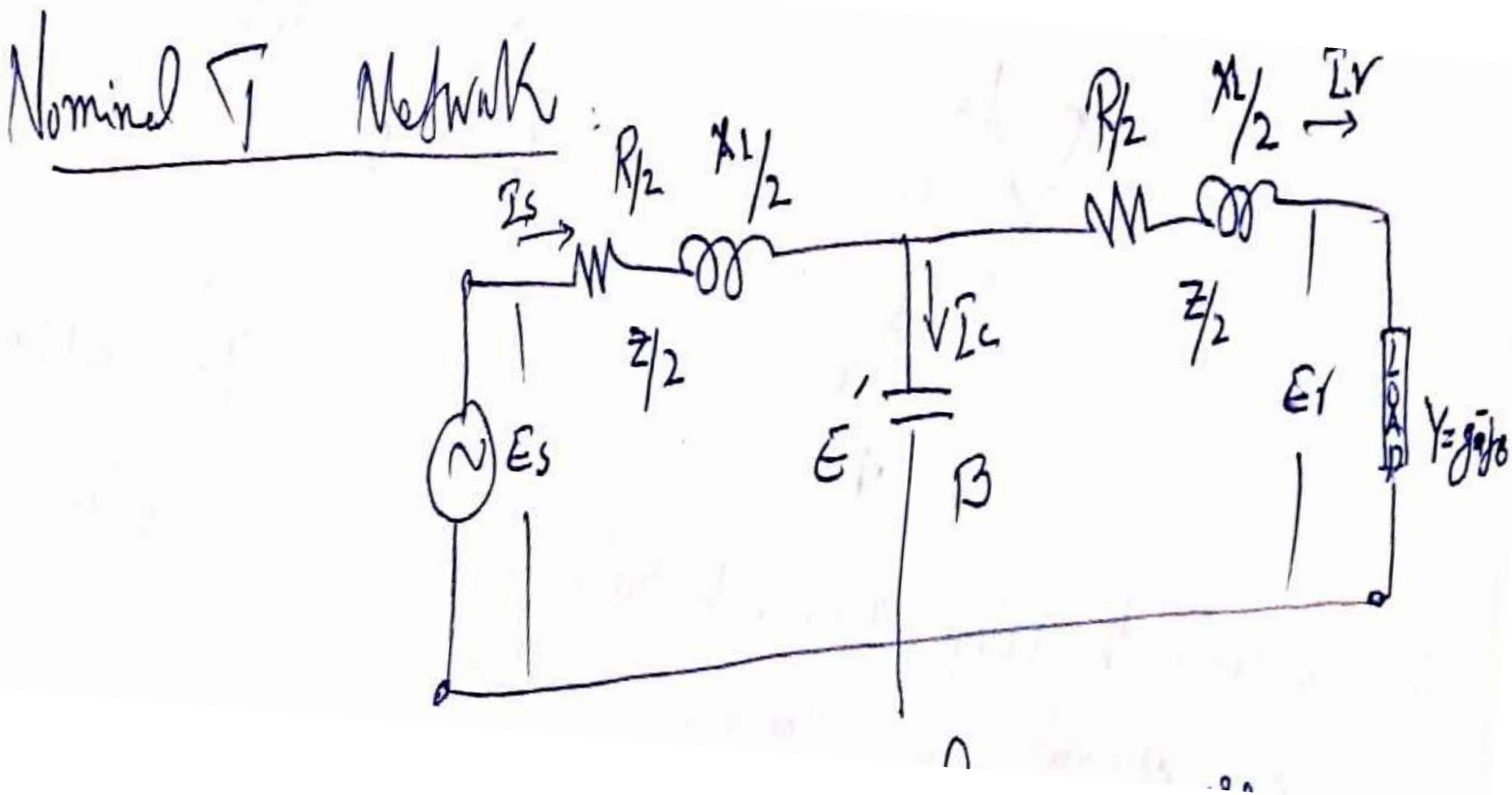
Performance of Medium Transmission lines

- As in the performance of short Tx lines we neglect the current as the voltage magnitude as well the length is small.
- If length is more then 50 miles or 80 Km as well the voltage impressed go beyond 20 kv then we would have sufficient charging current.
- Different models are available for representing Medium Tx line analysis.

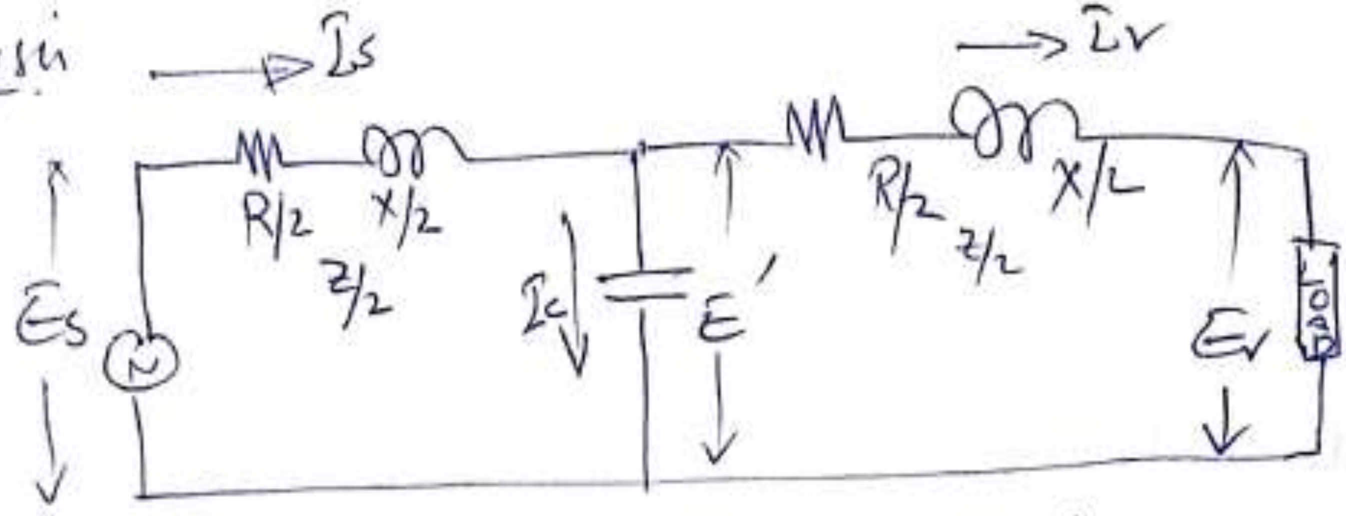
Medium Tx line Models

- Two commonly used methods are,
- 1. Nominal T Network
- 2. Nominal π Network

Nominal T Network



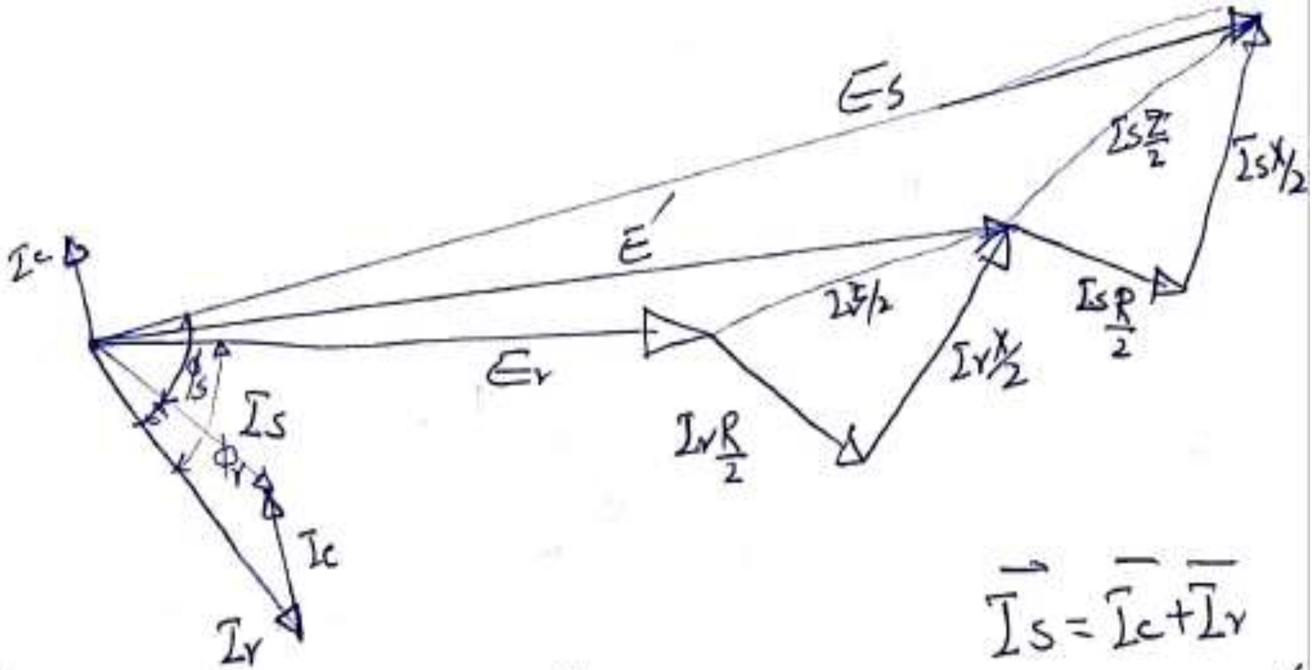
Analysis



Let the receiving side parameters are known

i.e E_r, I_r & ϕ_r.

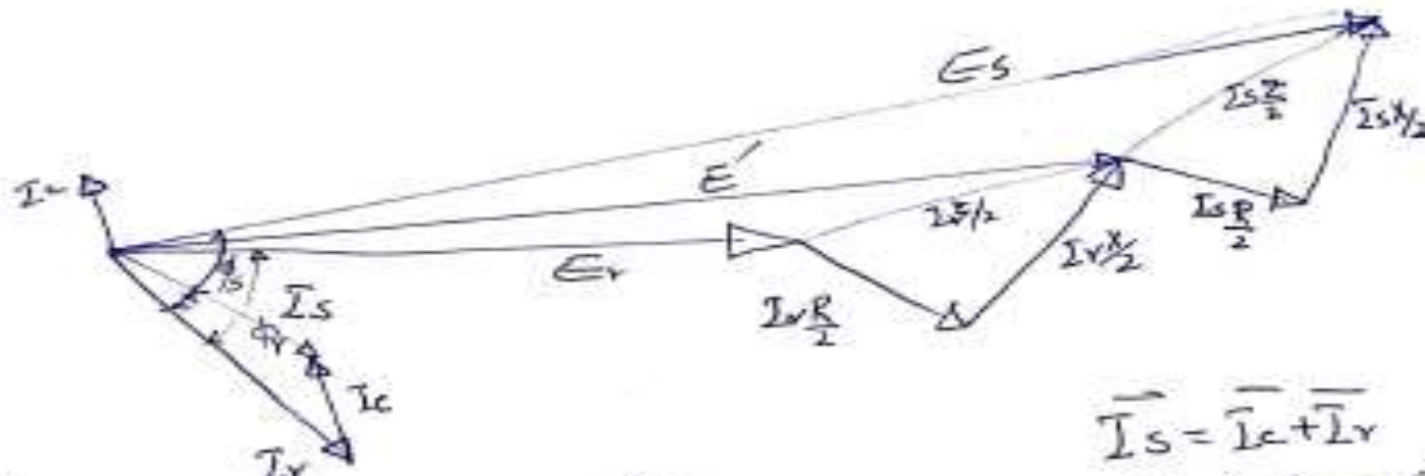
Phasor Diagram T network



$\vec{I}_s = \bar{I}_c + \bar{I}_r$

$I_c \angle 90^\circ$ to E'

Alternatively, the Voltage & Current relations may be expressed in symbolic notations.



$$\overline{I_s} = \overline{I_c} + \overline{I_r}$$

$I_c \angle 90^\circ$ to E'

Alternatively, the Voltage & Current relations may be expressed in symbolic notations. The Basic Equation from vector diagram

$$E_s = E' + \frac{I_s Z}{2}$$

$$E' = E_r + \frac{Z I_r}{2}$$

$$I_s = I_r + I_s \qquad I_s = E'Y = E'B$$

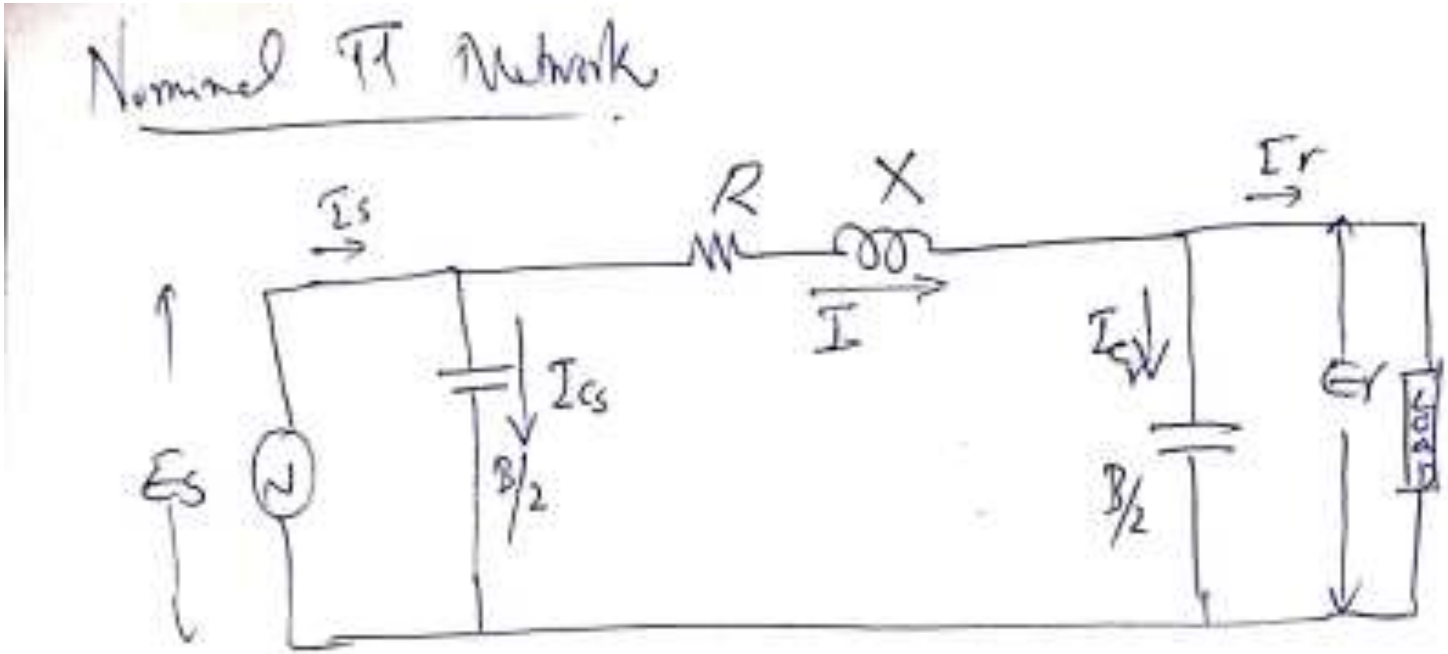
$$I_s = I_r + E'Y$$

from which, in term of E_r & I_r

$$E_s = E_r\left(1 + \frac{ZY}{2}\right) + I_r Z\left(1 + \frac{ZY}{4}\right)$$

$$I_s = I_r\left(1 + \frac{ZY}{2}\right) + E_r Y$$

Nominal Pi Method

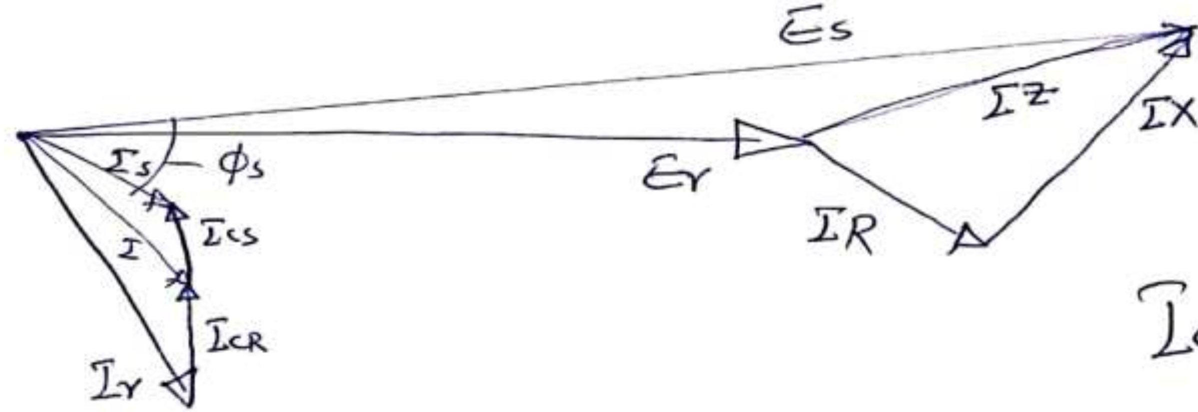


$$\bar{I} = \bar{I}_{cr} + \bar{I}_r$$

$$\bar{I}_{cr} = \frac{B}{2} E_r$$

$$\bar{I}_s = \bar{I}_{cs} + \bar{I}$$

Phasor Diagarm



$$I_{cs} = \frac{B}{2} E_s$$

$$E_s = E_r + I Z$$

$$I = I_r + I_{cr} = I_r + \frac{E_r Y}{2}$$

$$I_s = I + I_{cs} = I + \frac{E_s Y}{2}$$

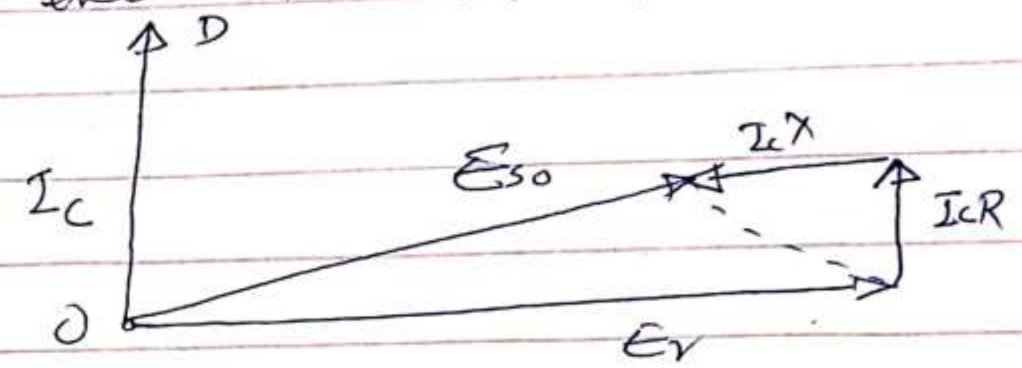
from which

$$E_s = E_r\left(1 + \frac{ZY}{2}\right) + I_r Z$$

$$I_s = I_r\left(1 + \frac{ZY}{2}\right) + I_r\left(1 + \frac{ZY}{4}\right)$$

Capacitance effect in Open Circuited line.
(Ferranti effect)

This is because of the emf of Self Inductance of the Charging Current being in phase with the Voltage Impressed at the Sending end of the line.



Charging Current $I_c = \omega C E_r \, l/2$ $C \to$ Capacitance/mile
$l \to$ length of line

$$\Delta E_c = I_c X = \omega L I_c l$$
$$= \frac{\omega^2 L C l^2 E_r}{2}$$