Announcements : - Tutorial Sheet on 2 port posted
- Tutorial class on Wed

Last Week - 2 port parameters (Z, Y, H, G, T)

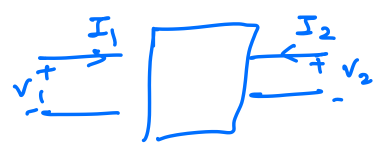
Transmission Parameters (ABCD)

$$V_1 = A\ V_2 + B\ (-I_2)$$

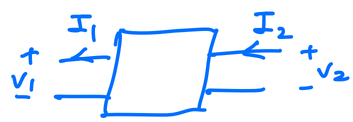
$$I_1 = C\ V_2 + D\ (-I_2)$$

Inverse Transmission Parameters (T')

$$\begin{bmatrix} V_2 = A'\ V_1 + B'\ (-I_1) \\ I_2 = C'\ V_1 + D'\ (-I_1) \end{bmatrix}$$



$$A' = \left.\frac{V_2}{V_1}\right|_{I_1 = 0}$$ (Forward voltage ratio)



$$C' = \left.\frac{I_2}{V_1}\right|_{I_1 = 0}$$ o/p ckt transfer admittance

$$B' = \left.\frac{V_2}{-I_1}\right|_{V_1 = 0}$$ short ckt transfer impedance.

$$D' = \left.\frac{I_2}{-I_1}\right|_{V_1 = 0}$$ (Forward current ratio]

$$Z = Y^{-1}$$

$$H = G^{-1}$$

$$T = (T')^{-1}$$

Z-parameters in terms of transmission parameters.

$$V_1 = A V_2 + B(-I_2) \qquad V_1 = Z_{11} I_1 + Z_{12} I_2$$
$$I_1 = C V_2 + D(-I_2) \qquad V_2 = Z_{21} I_1 + Z_{22} I_2$$

$$C V_2 = I_1 + D I_2$$
$$V_2 = \frac{1}{C} I_1 + \frac{D}{C} I_2$$

$$Z_{21} = \frac{1}{C} \qquad Z_{22} = \frac{D}{C}$$

$$V_1 = A\left(\frac{1}{C} I_1 + \frac{D}{C} I_2\right) + B(-I_2)$$
$$= A/C \; I_1 + \frac{AD}{C} I_2 - B I_2$$
$$= \frac{A}{C} I_1 + \frac{(AD - BC)}{C} I_2$$

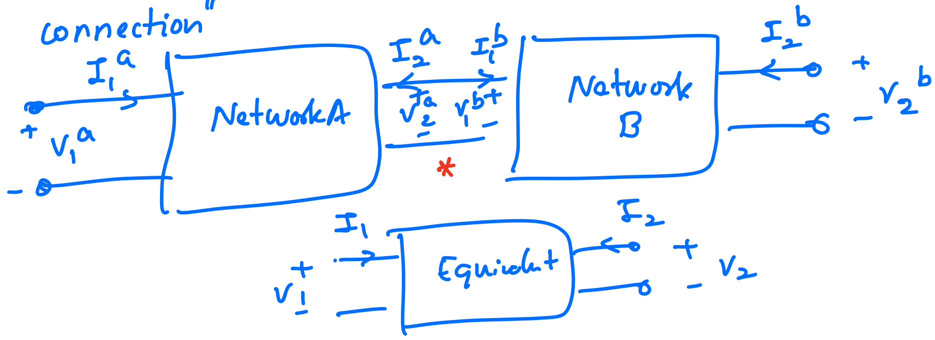
$$T = \begin{bmatrix} A & B \\ C & D \end{bmatrix} \qquad \Delta T = AD - BC$$

$$V_1 = \frac{A}{C} I_1 + \frac{\Delta T}{C} I_2 \quad : \quad Z_{11} = A/C, \quad Z_{12} = \frac{\Delta T}{C}$$

$$\begin{bmatrix} A & B \\ C & D \end{bmatrix} \longrightarrow Z = \begin{bmatrix} A/C & \Delta T/C \\ \frac{1}{C} & D/C \end{bmatrix}$$

Interconnection of 2 port network.

"Cascade connection"



$V_1 = V_1^a \qquad V_2 = V_2^b$

$I_1 = I_1^a \qquad I_2 = I_2^b$

$V_2^a = V_1^b \qquad I_2^a = -I_1^b$

$$\begin{array}{c} V_1 \\ I_1 \end{array} \begin{pmatrix} V_1^a \\ I_1^a \end{pmatrix} = \underbrace{\begin{pmatrix} A_a & B_a \\ C_a & D_a \end{pmatrix}}_{\text{Network } A} \begin{pmatrix} V_2^a \\ -I_2^a \end{pmatrix} \begin{array}{c} V_1^b \\ I_1^b \end{array}$$

$$\begin{pmatrix} V_1^b \\ I_1^b \end{pmatrix} = \begin{pmatrix} A_b & B_b \\ C_b & D_b \end{pmatrix} \begin{pmatrix} V_2^b \\ -I_2^b \end{pmatrix} \begin{array}{c} V_2 \\ -I_2 \end{array}$$

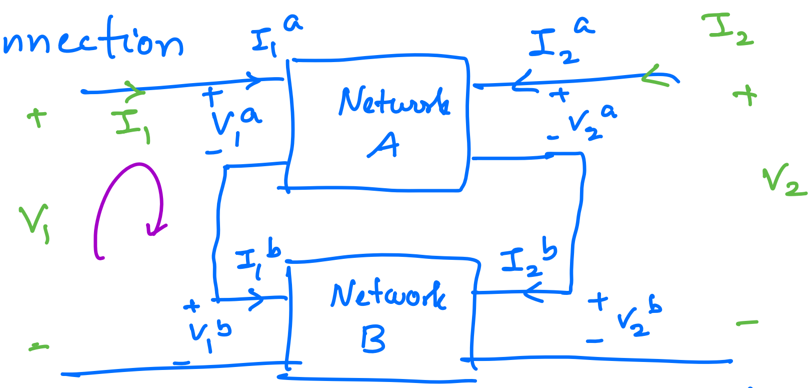
$$\begin{pmatrix} V_1 \\ I_1 \end{pmatrix} = \begin{pmatrix} A_a & B_a \\ C_a & D_a \end{pmatrix} \begin{pmatrix} A_b & B_b \\ C_b & D_b \end{pmatrix} \begin{pmatrix} V_2 \\ -I_2 \end{pmatrix}$$

$$[T] = [T_a]\,[T_b]$$

Inverse transmission

$$[T'] = [T'_b]\,[T'_a] \quad [\text{Exercise!}]$$

Series connection



$I_1 = I_1^a = I_1^b$

$I_2 = I_2^a = I_2^b$

$$\left\{ \begin{array}{l} V_1 = V_1^a + V_1^b \\ V_2 = V_2^a + V_2^b \end{array} \right.$$

$$\begin{pmatrix} V_1^a \\ V_2^a \end{pmatrix} = \begin{pmatrix} Z_{11}^a & Z_{12}^a \\ Z_{21}^a & Z_{22}^a \end{pmatrix} \begin{pmatrix} I_1^a \\ I_2^a \end{pmatrix}$$

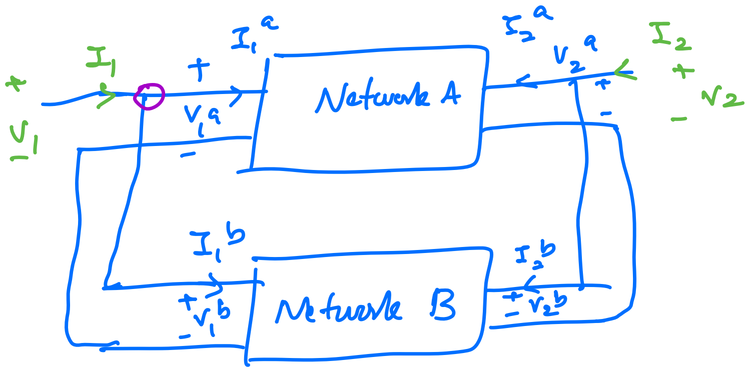
$$\begin{pmatrix} V_1^b \\ V_2^b \end{pmatrix} = \begin{pmatrix} Z_{11}^b & Z_{12}^b \\ Z_{21}^b & Z_{22}^b \end{pmatrix} \begin{pmatrix} I_1^b \\ I_2^b \end{pmatrix}$$

$$\begin{pmatrix} V_1 \\ V_2 \end{pmatrix} = \begin{pmatrix} V_1^a \\ V_2^a \end{pmatrix} + \begin{pmatrix} V_1^b \\ V_2^b \end{pmatrix}$$

$$= \left(\begin{pmatrix} Z_{11}^a & Z_{12}^a \\ Z_{21}^a & Z_{22}^a \end{pmatrix} + \begin{pmatrix} Z_{11}^b & Z_{12}^b \\ Z_{21}^b & Z_{22}^b \end{pmatrix} \right) \begin{pmatrix} I_1 \\ I_2 \end{pmatrix}$$

$$[Z] = [Z_a] + [Z_b]$$

Parallel Connection



$$V_1 = V_1^a = V_1^b$$

$$V_2 = V_2^a = V_2^b$$

$$\begin{cases} I_1 = I_1^a + I_1^b \\ I_2 = I_2^a + I_2^b \end{cases}$$

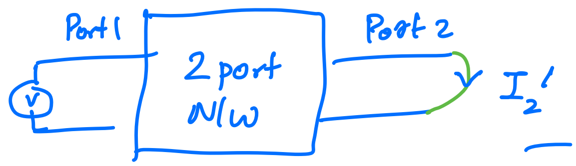
$$\begin{array}{l} \begin{pmatrix} I_1^a \\ I_2^a \end{pmatrix} = \begin{pmatrix} y_{11}^a & y_{12}^a \\ y_{21}^a & y_{22}^a \end{pmatrix} \begin{pmatrix} V_1^a \\ V_2^a \end{pmatrix} \end{array} \begin{array}{l} V_1 \\ V_2 \end{array}$$

$$\begin{array}{l} \begin{pmatrix} I_1^b \\ I_2^b \end{pmatrix} = \begin{pmatrix} y_{11}^b & y_{12}^b \\ y_{21}^b & y_{22}^b \end{pmatrix} \begin{pmatrix} V_1^b \\ V_2^b \end{pmatrix} \end{array} \begin{array}{l} V_1 \\ V_2 \end{array}$$

$$\begin{pmatrix} I_1 \\ I_2 \end{pmatrix} = \begin{pmatrix} I_1^a \\ I_2^a \end{pmatrix} + \begin{pmatrix} I_1^b \\ I_2^b \end{pmatrix}$$

$$[Y] = [Y_a] + [Y_b]$$

Reciprocity



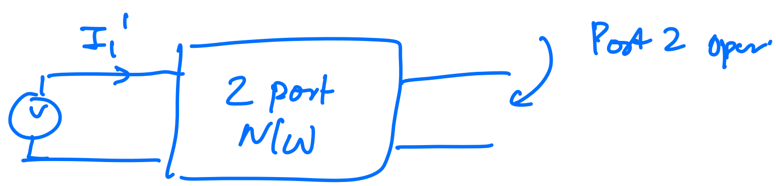
$I_1' = I_2' \Rightarrow$ Network is reciprocal

Equivalent defn

$V_1' = V_2'$

$\Rightarrow$ N/w is reciprocal

Symmetry



$I_1' = I_2' \Rightarrow$ Network is symmetrical

Network being symmetrical / reciprocal

$\Rightarrow$ Network parameters