NETWORK THEORY

LECTURE 1

SECTION C

TOPIC COVERED :RELATIONSHIP OF TWO-PORT VARIABLES, SHORT-CIRCUIT ADMITTANCE PARAMETERS, OPEN CIRCUIT IMPEDANCE,PARAMETERS

RELATIONSHIP OF TWO-PORT VARIABLES

S.No	*Two port parameters*	*function*	*Matrix equation*
1.	Open circuit Impedance [*Z*]	$(V_1, V_2) = f(I_1, I_2)$	$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$
2.	Short circuit admittance [*Y*]	$(I_1, I_2) = f(V_1, V_2)$	$\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} Y_{11} & Y_{12} \\ Y_{21} & Y_{22} \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix}$
3.	Transmission or chain [*T*]	$(V_1, I_1) = f(V_2, -I_2)$	$\begin{bmatrix} V_1 \\ I_1 \end{bmatrix} = \begin{bmatrix} A & B \\ C & D \end{bmatrix} \begin{bmatrix} V_2 \\ -I_2 \end{bmatrix}$
4.	Inverse Transmission [*T*′]	$(V_2, I_2) = f(V_1, -I_1)$	$\begin{bmatrix} V_2 \\ I_2 \end{bmatrix} = \begin{bmatrix} A' & B' \\ C' & D' \end{bmatrix} \begin{bmatrix} V_1 \\ -I_1 \end{bmatrix}$
5.	Hybrid parameter [*h*]	$(V_1, I_2) = f(I_1, V_2)$	$\begin{bmatrix} V_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{bmatrix} \begin{bmatrix} I_1 \\ V_2 \end{bmatrix}$
6.	Inverse hybrid [*g*]	$(I_1, V_2) = f(V_1, I_2)$	$\begin{bmatrix} I_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} g_{11} & g_{12} \\ g_{21} & g_{22} \end{bmatrix} \begin{bmatrix} V_1 \\ I_2 \end{bmatrix}$

OPEN CIRCUIT IMPEDANCE [Z] PARAMETER

The terminal characteristics of a two-port network, having linear elements and dependent sources may be written in the s-domain as

$$\left.\begin{aligned} V_1 &= Z_{11}I_1 + Z_{12}I_2 \\ V_2 &= Z_{21}I_1 + Z_{22}I_2 \end{aligned}\right\} \text{ or } \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} \quad \text{...(5.1)}$$

The coefficients Z_{ij} have the dimension of impedance and are called the Z-parameters of the network. The equivalent circuit of a two port network in terms of Z-parameters is shown in Fig. 5.2.

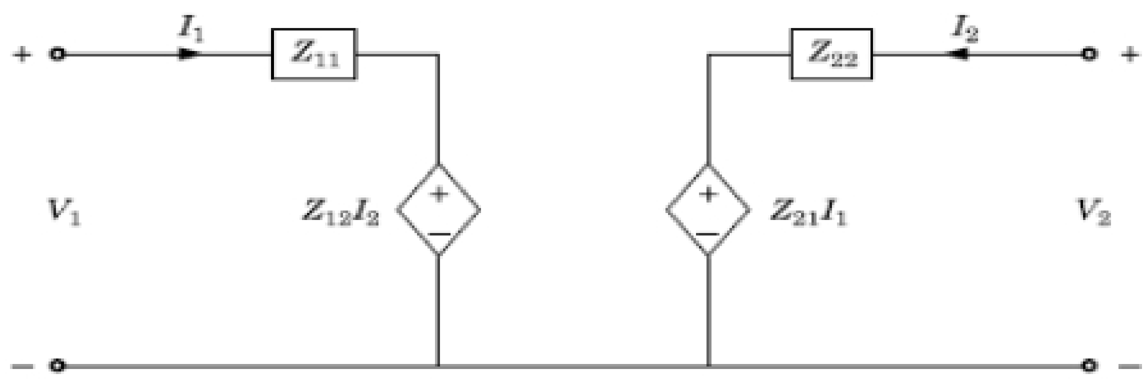

Fig. 5.2 Equivalent circuit of a two port networks in terms of Z-parameters

Calculation of Z-parameters: The Z-parameters are also called open-circuit impedance parameters since they may be measured at one terminal while the other terminal is open. They are

$$Z_{11} = \left.\frac{V_1}{I_1}\right|_{I_2=0}$$

$$Z_{12} = \left.\frac{V_1}{I_2}\right|_{I_1=0}$$

$$Z_{21} = \left.\frac{V_2}{I_1}\right|_{I_2=0}$$

and

$$Z_{22} = \left.\frac{V_2}{I_2}\right|_{I_1=0}$$

SHORT CIRCUIT ADMITTANCE [Y] PARAMETER

The terminal characteristics may also be written as in eq. 5.2, where I_1 and I_2 are expressed in terms of V_1 and V_2.

$$\left.\begin{aligned} I_1 &= Y_{11}V_1 + Y_{12}V_2 \\ I_2 &= Y_{21}V_1 + Y_{22}V_2 \end{aligned}\right\} \text{ or } \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} Y_{11} & Y_{12} \\ Y_{21} & Y_{22} \end{bmatrix} \begin{bmatrix} V_2 \\ V_2 \end{bmatrix} \quad ...(5.2)$$

The coefficients Y_{ij} have the dimension of admittance which are called the Y-parameters. The Y-parameters or short-circuit admittance parameters because they may be measured at one port while the other port is short circuited. The equivalent circuit of a two port network in terms of Y-parameters is shown in Fig. 5.16.

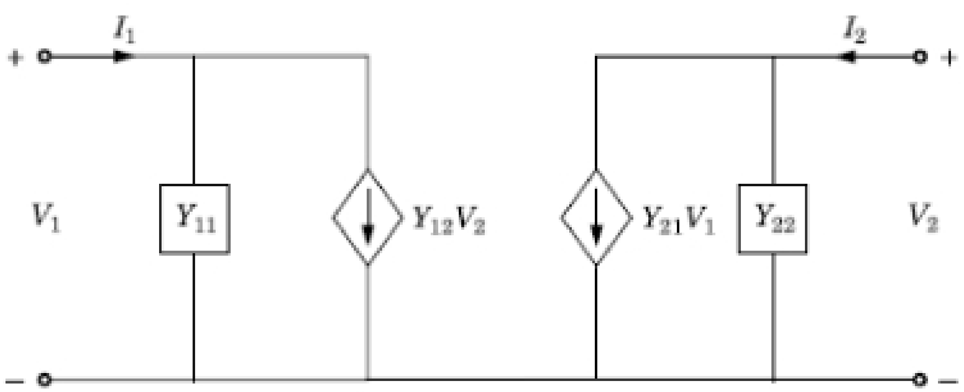

Fig. 5.16 Equivalent circuit of a two-port network in terms of Y parameters.

Calculation of Y parameters. The Y parameters are

$$Y_{11} = \left.\frac{I_1}{V_1}\right|_{V_2=0}$$

$$Y_{12} = \left.\frac{I_1}{V_2}\right|_{V_1=0}$$

$$Y_{21} = \left.\frac{I_2}{V_1}\right|_{V_2=0}$$

$$Y_{22} = \left.\frac{I_2}{V_2}\right|_{V_1=0}$$

HYBRID PARAMETERS

Hybrid parameters are defined by voltage of input port (V_1) and currrent of output port (I_2) in terms of input port (I_1) and voltage of output port (V_2) i.e.,

$$\left.\begin{aligned} V_1 &= h_{11}\, I_1 + h_{12}\, V_2 \\ I_2 &= h_{21} I_1 + h_{22}\, V_2 \end{aligned}\right\} \text{ or } \begin{bmatrix} V_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{12} \end{bmatrix} \begin{bmatrix} I_1 \\ V_2 \end{bmatrix} \quad \text{... (5.3)}$$

The equivalent circuit of a two port network in terms of h-parameters is shown in Fig. 5.26.

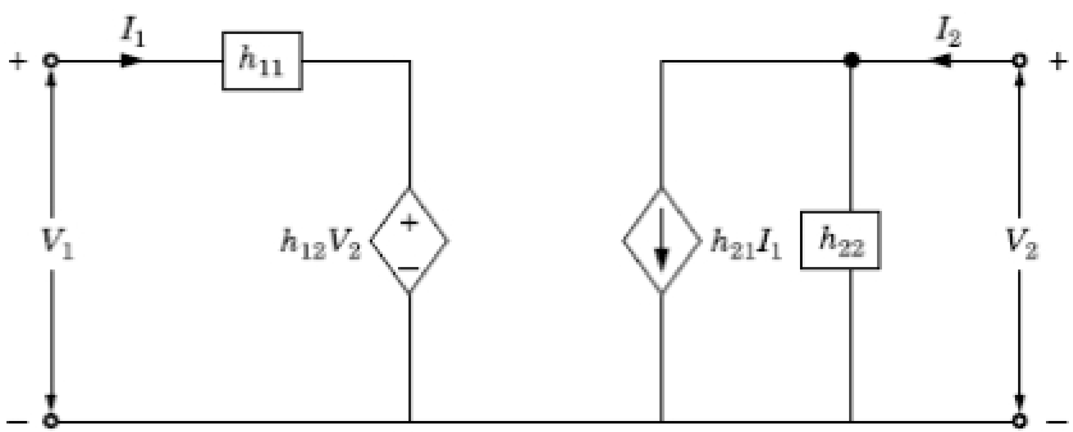

Fig. 5.26