UNIT-2

(Lecture-6)

Transfer Functions Using Two Port Parameters

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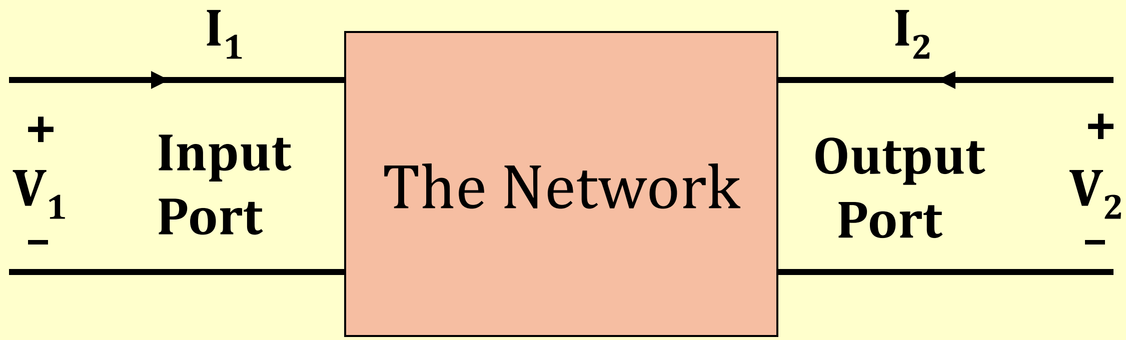
Two Port Networks

Generalities:

The standard configuration of a two port:



The network ?

The voltage and current convention ?

Two Port Networks

Network Equations:

Impedance Z parameters

$$V_1 = z_{11}I_1 + z_{12}I_2$$
$$V_2 = z_{21}I_1 + z_{22}I_2$$

$$V_2 = b_{11}V_1 - b_{12}I_1$$
$$I_2 = b_{21}V_1 - b_{22}I_1$$

Admittance Y parameters

$$I_1 = y_{11}V_1 + y_{12}V_2$$
$$I_2 = y_{21}V_1 + y_{22}V_2$$

Hybrid H parameters

$$V_1 = h_{11}I_1 + h_{12}V_2$$
$$I_2 = h_{21}I_1 + h_{22}V_2$$

Transmission A, B, C, D parameters

$$V_1 = AV_2 - BI_2$$
$$I_1 = CV_2 - DI_2$$

$$I_1 = g_{11}V_1 + g_{12}I_2$$
$$V_2 = g_{21}V_1 + g_{22}I_2$$

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Two Port Networks

Z parameters:

$$z_{11} = \frac{V_1}{I_1}\bigg|_{I_2=0}$$

z_{11} is the impedance seen looking into port 1 when port 2 is open.

$$z_{12} = \frac{V_1}{I_2}\bigg|_{I_1=0}$$

z_{12} is a transfer impedance. It is the ratio of the voltage at port 1 to the current at port 2 when port 1 is open.

$$z_{21} = \frac{V_2}{I_1}\bigg|_{I_2=0}$$

z_{21} is a transfer impedance. It is the ratio of the voltage at port 2 to the current at port 1 when port 2 is open.

$$z_{22} = \frac{V_2}{I_2}\bigg|_{I_1=0}$$

z_{22} is the impedance seen looking into port 2 when port 1 is open.

Two Port Networks

Y parameters:

$$y_{11} = \frac{I_1}{V_1}\Bigg|_{V_2=0}$$

y_{11} is the admittance seen looking into port 1 when port 2 is shorted.

$$y_{12} = \frac{I_1}{V_2}\Bigg|_{V_1=0}$$

y_{12} is a transfer admittance. It is the ratio of the current at port 1 to the voltage at port 2 when port 1 is shorted.

$$y_{21} = \frac{I_2}{V_1}\Bigg|_{V_2=0}$$

y_{21} is a transfer impedance. It is the ratio of the current at port 2 to the voltage at port 1 when port 2 is shorted.

$$y_{22} = \frac{I_2}{V_2}\Bigg|_{V_1=0}$$

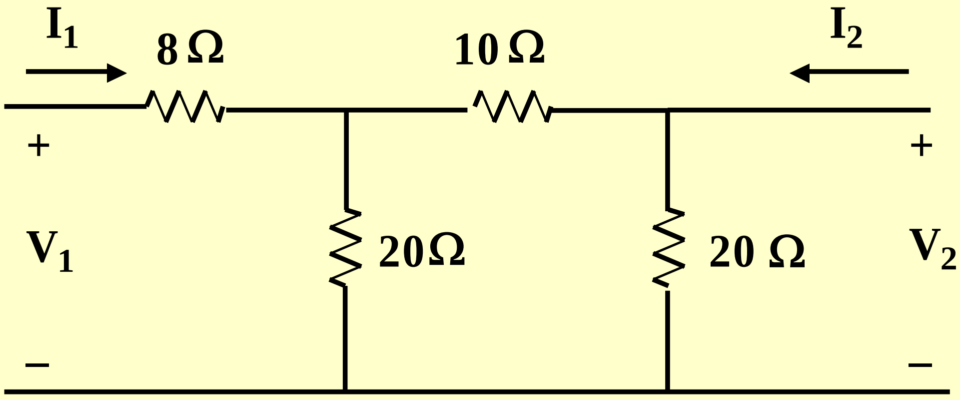
y_{22} is the admittance seen looking into port 2 when port 1 is shorted.

Two Port Networks

Z parameters:

Example 1

Given the following circuit. Determine the Z parameters.



Find the Z parameters for the above network.

Two Port Networks

Z parameters:

Example 1 (cont 1)

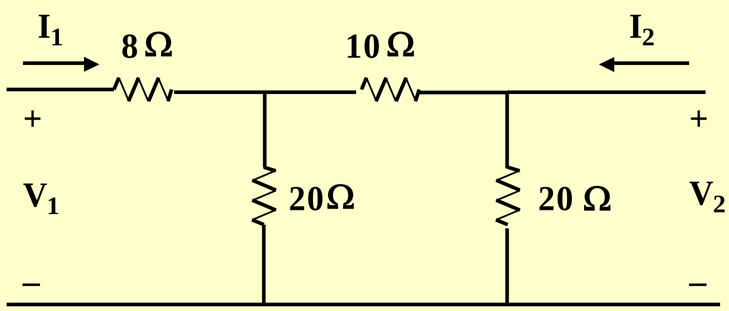
For z_{11}:

$$Z_{11} = 8 + 20||30 = 20\ \Omega$$

For z_{22}:

$$Z_{22} = 20||30 = 12\ \Omega$$

For z_{12}:



$$z_{12} = \frac{V_1}{I_2}\bigg|_{I_1=0}$$

$$V_1 = \frac{20xI_2x20}{20+30} = 8xI_2$$

Therefore:

$$z_{12} = \frac{8xI_2}{I_2} = 8\ \Omega = z_{21}$$

Two Port Networks

Z parameters:

Example 1 (cont 2)

The Z parameter equations can be expressed in matrix form as follows.

$$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} z_{11} & z_{12} \\ z_{21} & z_{22} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$

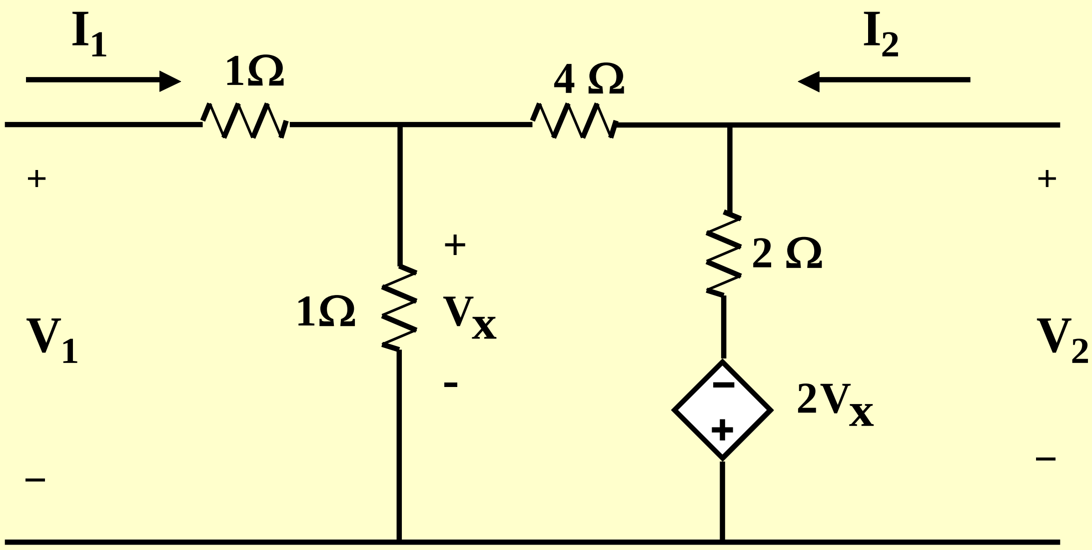
$$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} 20 & 8 \\ 8 & 12 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$

Two Port Networks

Z parameters:

Example 2 (problem 18.7 Alexander & Sadiku)

You are given the following circuit. Find the Z parameters.

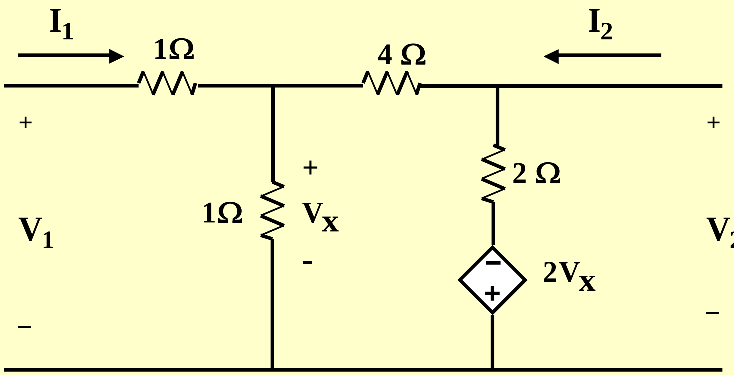


Two Port Networks

Z parameters:

Example 2 (continue)

$$z_{11} = \frac{V_1}{I_1} \Bigg|_{I_2=0}$$

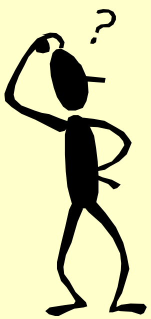


$$I_1 = \frac{V_x}{1} + \frac{V_x + 2V_x}{6} = \frac{6V_x + V_x + 2V_x}{6}$$

$$I_1 = \frac{3V_x}{2} \;; \quad \text{but} \quad V_x = V_1 - I_1$$

Substituting gives;

$$I_1 = \frac{3(V_1 - I_1)}{2} \quad \text{or} \quad \frac{V_1}{I_1} = z_{11} = \frac{5}{3}\ \Omega$$



Other Answers

Z_{21} = -0.667 Ω

Z_{12} = 0.222 Ω

Z_{22} = 1.111 Ω

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