Sekolah Pendidikan Profesional dan Pendidikan Berterusan (SPACE)

JABATAN KEJURUTERAAN ELEKTRIK
PUSAT PENGAJIAN DIPLOMA (PPD), SPACE
UNIVERSITI TEKNOLOGI MALAYSIA
KUALA LUMPUR

ELECTRICAL ENGINEERING LABORATORY 2

(DDWE 2701)

CIRCUIT THEORY 2

THEORY & PRELIMINARY LABORATORY 4

TWO PORT NETWORK

Student name	**:**
Lecturer	**:**
Date	**:**

No.	PO	CO	Student Marks	Marks
1	PO1	CO1		/10

Submit the completed preliminary report to the lecturer in the lab before the lab session starts.

THEORY

A two port network as shown in Figure 1 is defined as a network having two pairs of terminals. known as terminals 1-1' and 2-2'. Current I_1 leaves terminal 1, enters the two-port network and exits at terminal 1'. Similarly, current I_2, leaves terminal 2, enters the two-port network and exits at terminal 2'.

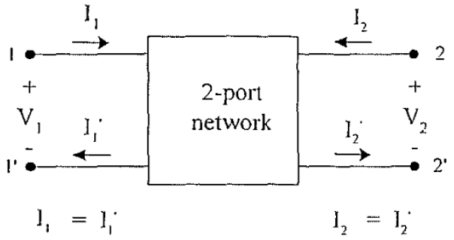

Figure 1

The parameters of the two port network describe the network behavior in terms of the voltage and current at each port. Four types of two-port parameters that are commonly used are impedance-parameter Z, admittance-parameter Y, hybrid-parameter hand transmission-parameter, T or ABCD. The two-port network equations that relate the variables in the network are given below.

Z-parameters : (1)

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

Y-parameters: (2)

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

h-parameters : (3)

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

ABCD-parameters: (4)

$$V_1 = A V_2 - B I_2$$
$$I_1 = C V_2 - D I_2$$

Z-parameters can be determined using open-circuit conditions at terminals 1-1' and 2-2'. When terminals 2-2'are opened, $I_2 = 0$, thereby using equation (1), Z_{11} and Z_{21} can be determined as follows:

$$z_{11} = \left.\frac{V_1}{I_1}\right|_{I_2=0} \qquad z_{21} = \left.\frac{V_2}{I_1}\right|_{I_2=0}$$

When terminals 1-1'are opened, $I_1 = 0$, then by using equation (1), Z_{12} and Z_{22} can be determined as follows:

$$z_{12} = \left.\frac{V_1}{I_2}\right|_{I_1=0} \qquad z_{22} = \left.\frac{V_2}{I_2}\right|_{I_1=0}$$

Y-pararneters can be determined using short-circuit conditions at terminals 1-1' (V_1=0) and terminals 2-2' (V_2=0). To obtain h-parameters and ABCD-parameters, both short-circuit and open-circuit conditions are required. The equations for all the parameters are given in Attachment 1.

The T-network as shown in Figure 2 is the simplest form of a two port network. Z-parameters of the T-network can be simply determined using mesh analysis.

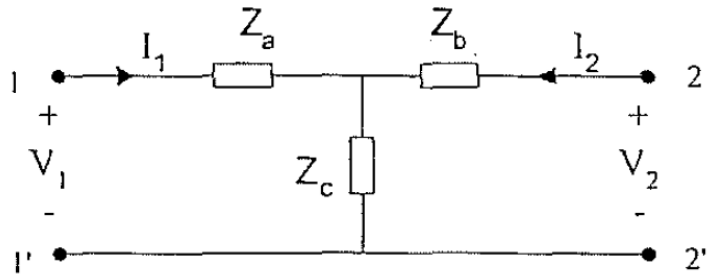

Figure 2 : T-network

Another form of a two-port network is the π-network as shown in Figure 3. Y-parameters of the π-network can be easily determined by using nodal analysis.

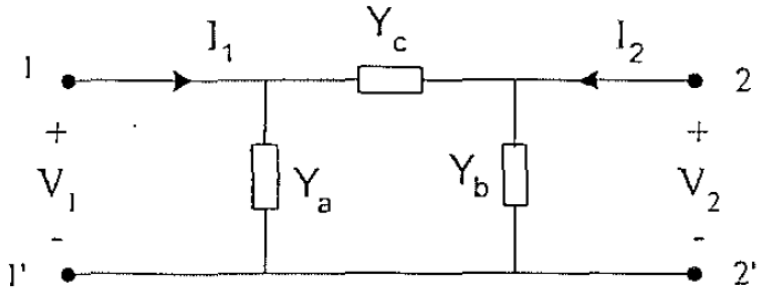

Figure 3 : π-network

PRELIMINARY WORK

1. Given a T-network as shown in Figure 4, determine the Z-parameters using mesh analysis.

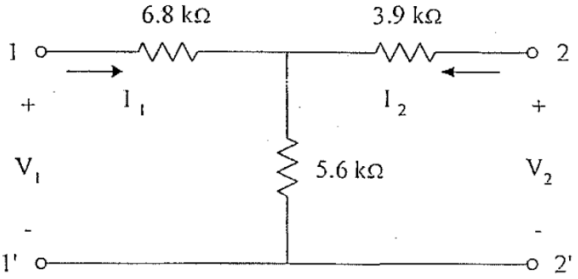

Figure 4

Answer

PO1	CO1	..... /5m

2. Given a π-network as shown in Figure 5, determine Y-parameters using node analysis.

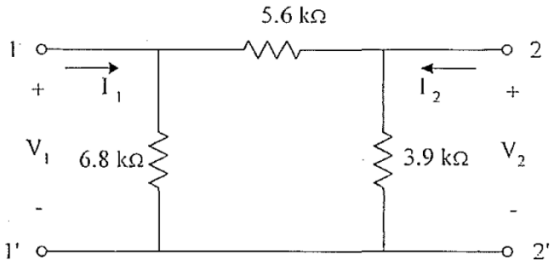

Figure 5

Answer

PO1	CO1	..... /5m

ATTACHMENT 1 : 2-PORT NETWORK PARAMETERS

Z – parameters

$$z_{11} = \left.\frac{V_1}{I_1}\right|_{I_2 = 0} \qquad z_{21} = \left.\frac{V_2}{I_1}\right|_{I_2 = 0} \qquad z_{12} = \left.\frac{V_1}{I_2}\right|_{I_1 = 0} \qquad z_{22} = \left.\frac{V_2}{I_2}\right|_{I_1 = 0}$$

Y-parameters

$$y_{11} = \left.\frac{I_1}{V_1}\right|_{V_2 = 0} \qquad y_{21} = \left.\frac{I_2}{V_1}\right|_{V_2 = 0} \qquad y_{12} = \left.\frac{I_1}{V_2}\right|_{V_1 = 0} \qquad y_{22} = \left.\frac{I_2}{V_2}\right|_{V_1 = 0}$$

h-parameters

$$h_{11} = \left.\frac{V_1}{I_1}\right|_{V_2 = 0} \qquad h_{21} = \left.\frac{I_2}{I_1}\right|_{V_2 = 0} \qquad h_{12} = \left.\frac{V_1}{V_2}\right|_{I_1 = 0} \qquad h_{22} = \left.\frac{I_2}{V_2}\right|_{I_1 = 0}$$

ABCD-parameters

$$A = \left.\frac{V_1}{V_2}\right|_{I_2 = 0} \qquad B = \left.\frac{-V_1}{I_2}\right|_{V_2 = 0} \qquad C = \left.\frac{I_1}{V_2}\right|_{I_2 = 0} \qquad D = \left.\frac{-I_1}{I_2}\right|_{V_2 = 0}$$