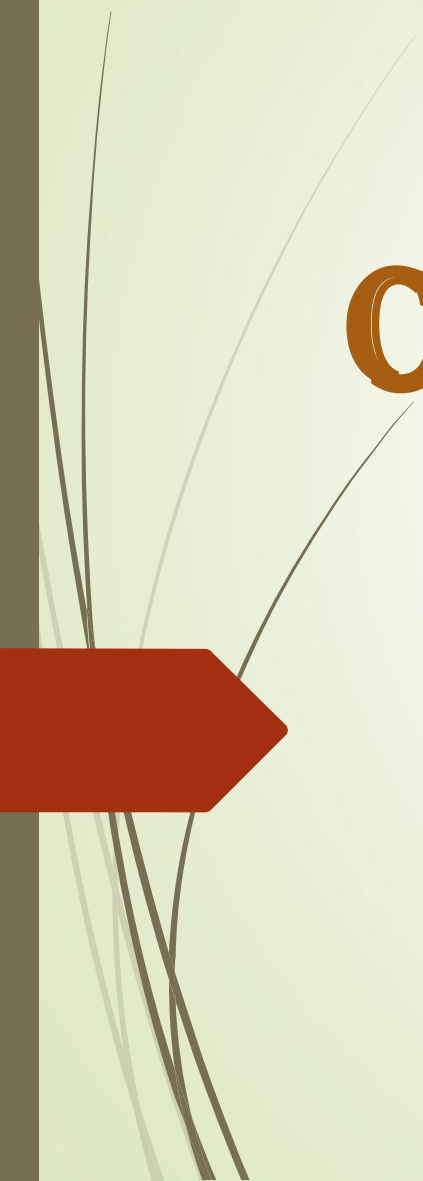




BEEE203L

CIRCUIT THEORY

DR. P. VIJAYAPRIYA
PROFESSOR/ SELECT

MODULE – VII

TWO PORT NETWORKS

Contents

- Open circuit impedance parameters
- Short circuit admittance parameters
- Transmission parameters
- Hybrid parameters
- Relationship between parameter sets
- Interconnection of two port networks

Transmission Parameters

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(ABCD or 'T' Parameters)

Another set of parameters relates the variables at the input port to those at the output port is *ABCD parameters* or *transmission parameters*

$$V_1 = AV_2 - BI_2$$

$$I_1 = CV_2 - DI_2$$

- Here, the negative sign is used with I_2 and not for parameters B and D.

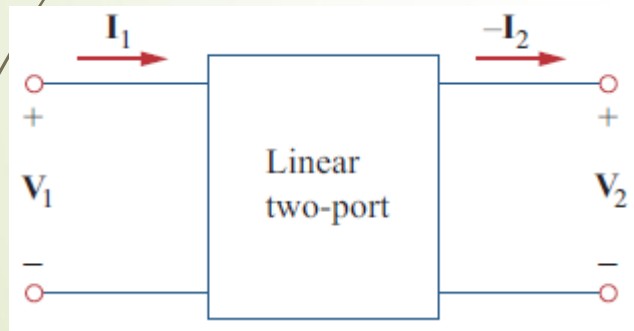
$$A = \left. \frac{V_1}{V_2} \right|_{I_2=0}, \quad B = - \left. \frac{V_1}{I_2} \right|_{V_2=0}$$

$$C = \left. \frac{I_1}{V_2} \right|_{I_2=0}, \quad D = - \left. \frac{I_1}{I_2} \right|_{V_2=0}$$

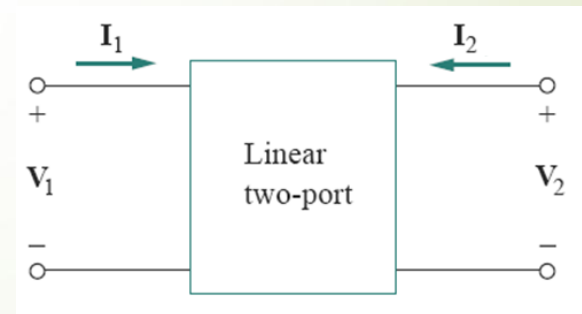
$$\begin{bmatrix} V_1 \\ I_1 \end{bmatrix} = \begin{bmatrix} A & B \\ C & D \end{bmatrix} \begin{bmatrix} V_2 \\ -I_2 \end{bmatrix}$$

The reason the current I_2 carries a negative sign is that in transmission field, the output current is assumed to be coming out of the output port instead of going into the port.

- A is Open-circuit voltage ratio or reverse voltage gain with the output port open-circuited.
- B is Negative short-circuit transfer impedance
- C is Open-circuit transfer admittance
- D is Negative short-circuit current ratio or reverse current gain with the output port short-circuited.



$$\begin{aligned} V_1 &= AV_2 - BI_2 \\ I_1 &= CV_2 - DI_2 \end{aligned}$$



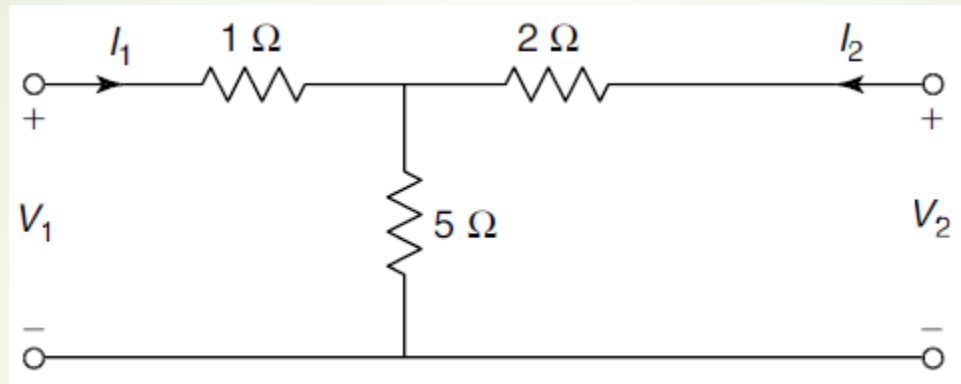
$$\begin{aligned} V_1 &= AV_2 + BI_2 \\ I_1 &= CV_2 + DI_2 \end{aligned}$$

When $A = D$, the two-port network is said to be *symmetrical*. For reciprocal networks, $AD - BC = 1$

Problems

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P.7.10 Find the transmission parameters for the network shown in Fig.



Solution:

Applying KVL to Mesh 1, $V_1 = 6I_1 + 5I_2$

Applying KVL to Mesh 2, $V_2 = 5I_1 + 7I_2$

$$5I_1 = V_2 - 7I_2$$

$$I_1 = \frac{1}{5}V_2 - \frac{7}{5}I_2$$

...(1)

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So first equation becomes

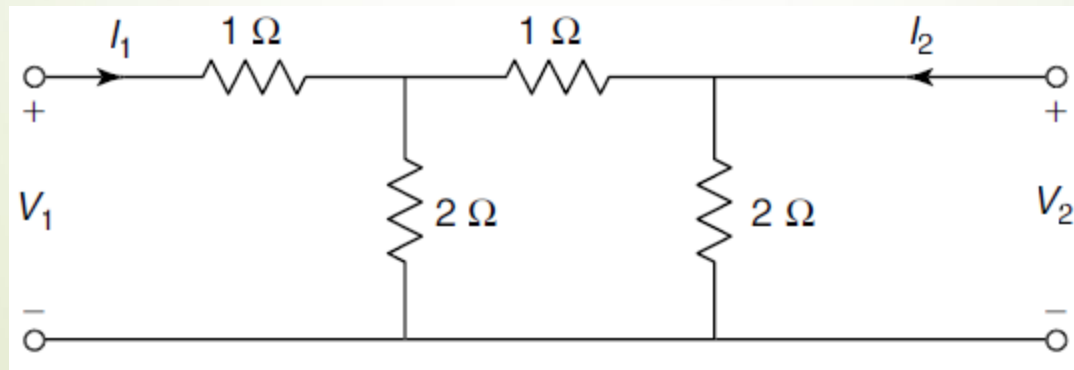
$$V_1 = 6\left(\frac{1}{5}V_2 - \frac{7}{5}I_2\right) + 5I_2 = \frac{6}{5}V_2 - \frac{17}{5}I_2 \quad \dots(2)$$

From equation (1) and (2) we get

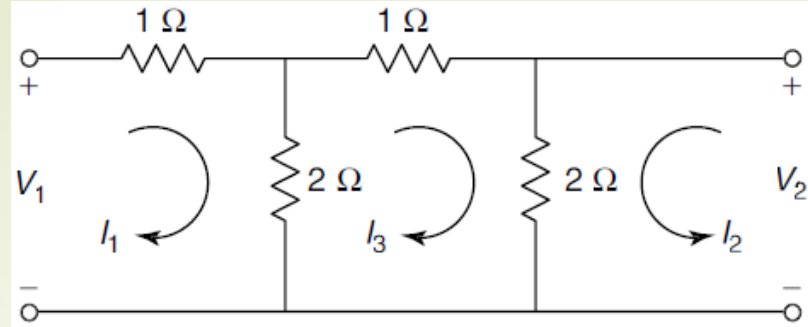
$$\begin{bmatrix} A & B \\ C & D \end{bmatrix} = \begin{bmatrix} \frac{6}{5} & \frac{17}{5} \\ \frac{1}{5} & \frac{7}{5} \end{bmatrix}$$

P.7.11

Obtain ABCD parameters for the network shown in Fig



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Solution:

Applying KVL to Mesh 1, $V_1 = 3I_1 - 2I_3$

Applying KVL to Mesh 2, $V_2 = 2I_2 + 2I_3$

Applying KVL to Mesh 3,

$$-2(I_3 - I_1) - I_3 - 2(I_3 + I_2) = 0$$

$$5I_3 = 2I_1 - 2I_2$$

$$I_3 = \frac{2}{5}I_1 - \frac{2}{5}I_2$$

Substituting I_3 in V_1

$$\begin{aligned} V_1 &= 3I_1 - 2\left(\frac{2}{5}I_1 - \frac{2}{5}I_2\right) \\ &= \frac{11}{5}I_1 + \frac{4}{5}I_2 \end{aligned}$$

Substituting I_3 in V_2

$$\begin{aligned} V_2 &= 2I_2 + 2\left(\frac{2}{5}I_1 - \frac{2}{5}I_2\right) \\ &= \frac{4}{5}I_1 + \frac{6}{5}I_2 \end{aligned}$$

Rearranging we get

$$\begin{aligned} \frac{4}{5}I_1 &= V_2 - \frac{6}{5}I_2 \\ I_1 &= \frac{5}{4}V_2 - \frac{3}{2}I_2 \end{aligned} \quad \dots(1)$$

Substituting I_1 in V_1

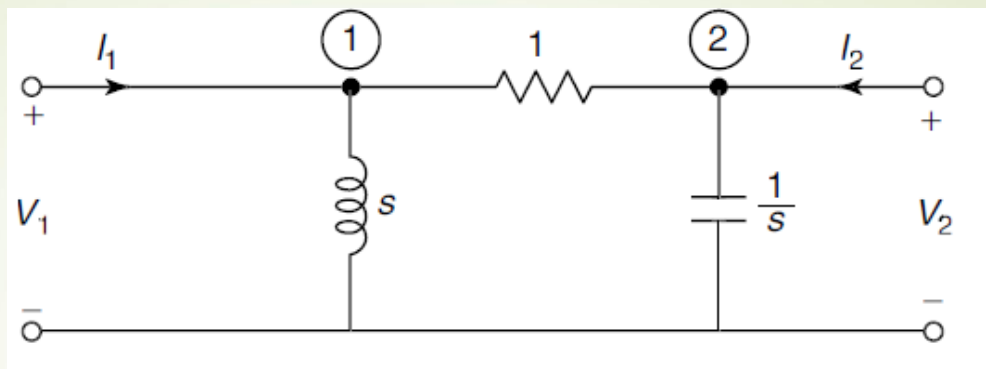
$$\begin{aligned} V_1 &= \frac{11}{5}\left(\frac{5}{4}V_2 - \frac{3}{2}I_2\right) + \frac{4}{5}I_2 \\ &= \frac{11}{4}V_2 - \frac{5}{2}I_2 \end{aligned} \quad \dots(2)$$

From (1) to (2) we get

$$\begin{bmatrix} A & B \\ C & D \end{bmatrix} = \begin{bmatrix} \frac{11}{4} & \frac{5}{2} \\ \frac{5}{4} & \frac{3}{2} \end{bmatrix}$$

P.7.12 Determine the transmission parameters for the network shown in Fig.

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Solution

Applying KCL at Node 1,

$$\begin{aligned} I_1 &= \frac{V_1}{s} + (V_1 - V_2) \\ &= \frac{s+1}{s} V_1 - V_2 \end{aligned}$$

Applying KCL at Node 2,

$$\begin{aligned} I_2 &= \frac{V_2}{\frac{1}{s}} + (V_2 - V_1) \\ &= (s+1) V_2 - V_1 \end{aligned} \quad \dots(1)$$

$$V_1 = (s+1) V_2 - I_2$$

Substituting V_1 in I_1 we get

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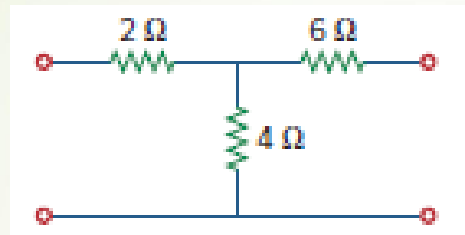
$$\begin{aligned} I_1 &= \frac{s+1}{s} [(s+1) V_2 - I_2] - V_2 \\ &= \left[\frac{(s+1)^2}{s} - 1 \right] V_2 - \frac{s+1}{s} I_2 \\ &= \left(\frac{s^2 + s + 1}{s} \right) V_2 - \left(\frac{s+1}{s} \right) I_2 \end{aligned}$$

...(2)

From (1) and (2) we get

$$\begin{bmatrix} A & B \\ C & D \end{bmatrix} = \begin{bmatrix} s+1 & -1 \\ \frac{s^2 + s + 1}{s} & \frac{s+1}{s} \end{bmatrix}$$

P.7.13 Obtain the T parameters of the network shown below



Answer: **A** = 1.5, **B** = 11 Ω, **C** = 250 mS, **D** = 2.5.

P.7.14 Obtain the T parameters of the network shown below

