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Unit-2
Lecture-6

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Microwave Engineering

EC - 6th sem (3rd year)

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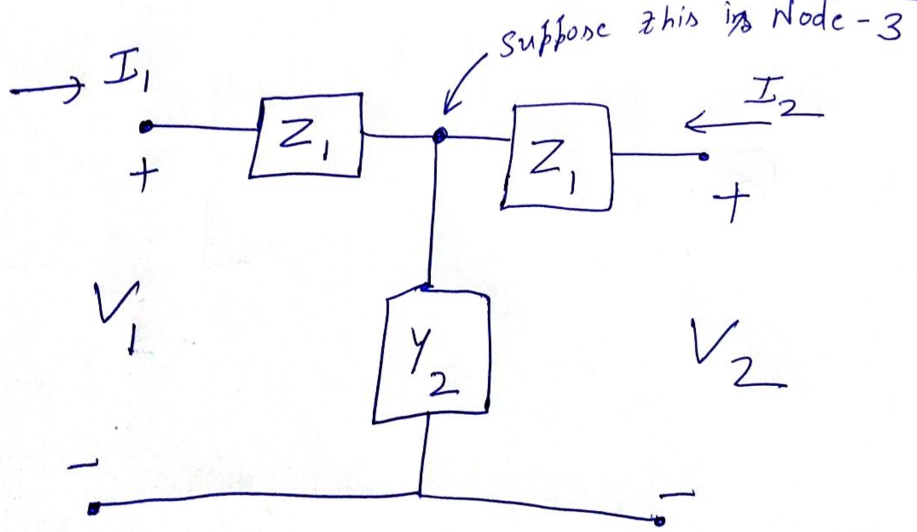
ABCD Parameters for Cascaded Network



⇒ Here, we have two series impedance Z_1 and a shunt admittance Y_2.

At Node-3

$$\frac{V_3 - 0}{Y_2} = \frac{V_1 - V_3}{Z_1} + \frac{V_2 - V_3}{Z_1}$$

↳ So, we can easily solve it.

⇒ But instead ~~insted~~ of solving this by traditional ~~method~~ method, we will use ABCD matrix of series element & shunt element.

Step-1 In this circuit we have 3 different circuit elements. So, we will divide this network into 3 different networks.

Step-2 ~~ABCD~~

For series,

$$\begin{bmatrix} A & B \\ C & D \end{bmatrix} = \begin{bmatrix} 1 & Z \\ 0 & 1 \end{bmatrix}$$ (lecture -3)

For shunt,

$$\begin{bmatrix} A & B \\ C & D \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ Y & 1 \end{bmatrix}$$ (lecture -4)

So, here in this network we have two series networks and one shunt network.

⇒ So, just multiply these matrix one by one.

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$$\begin{bmatrix} A & B \\ C & D \end{bmatrix} = \begin{bmatrix} 1 & Z_1 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 \\ Y_2 & 1 \end{bmatrix} \begin{bmatrix} 1 & Z_1 \\ 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 1 + Z_1 Y_2 & Z_1 \\ Y_2 & 1 \end{bmatrix} \begin{bmatrix} 1 & Z_1 \\ 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 1 + Z_1 Y_2 & Z_1 + Z_1^2 Y_2 + Z_1 \\ Y_2 & Y_2 Z_1 + 1 \end{bmatrix}$$

$$\begin{bmatrix} A & B \\ C & D \end{bmatrix} = \begin{bmatrix} 1 + Z_1 Y_2 & 2Z_1 + Z_1^2 Y_2 \\ Y_2 & 1 + Y_2 Z_1 \end{bmatrix}$$

↳ This is ABCD matrix of a cascaded network.

↳ Advantage of this approach is that we can easily find relation b/w i/p & o/p voltage and current with the help of this ABCD matrix.

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Note:- Like other networks, the cascaded network consisting of impedance & admittance should be symmetrical & reciprocal.

$\Rightarrow$ So, we can easily check whether our answer is correct or not.

$\Rightarrow$ The ABCD matrix of cascaded network is,

$$\begin{bmatrix} A & B \\ C & D \end{bmatrix} = \begin{bmatrix} 1 + Z_1 Y_2 & 2Z_1 + Z_1^2 Y_2 \\ Y_2 & 1 + Y_2 Z_1 \end{bmatrix}$$

Here, $A = D$ $\therefore$ network is symmetrical.

We know that,
For reciprocal network,

$$AD - BC = 1$$

$$\therefore (1 + Z_1 Y_2)(1 + Y_2 Z_1) - (2Z_1 + Z_1^2 Y_2)(Y_2)$$

$$= 1 + \cancel{Y_2 Z_1} + \cancel{Z_1 Y_2} + \cancel{Y_2^2 Z_1^2} - \cancel{2 Z_1 Y_2} - \cancel{Z_1^2 Y_2^2}$$

$= 1$ (Hence, reciprocal network also).

⇒ Thus our ABCD matrix is Correct because the network is both symmetrical & reciprocal.

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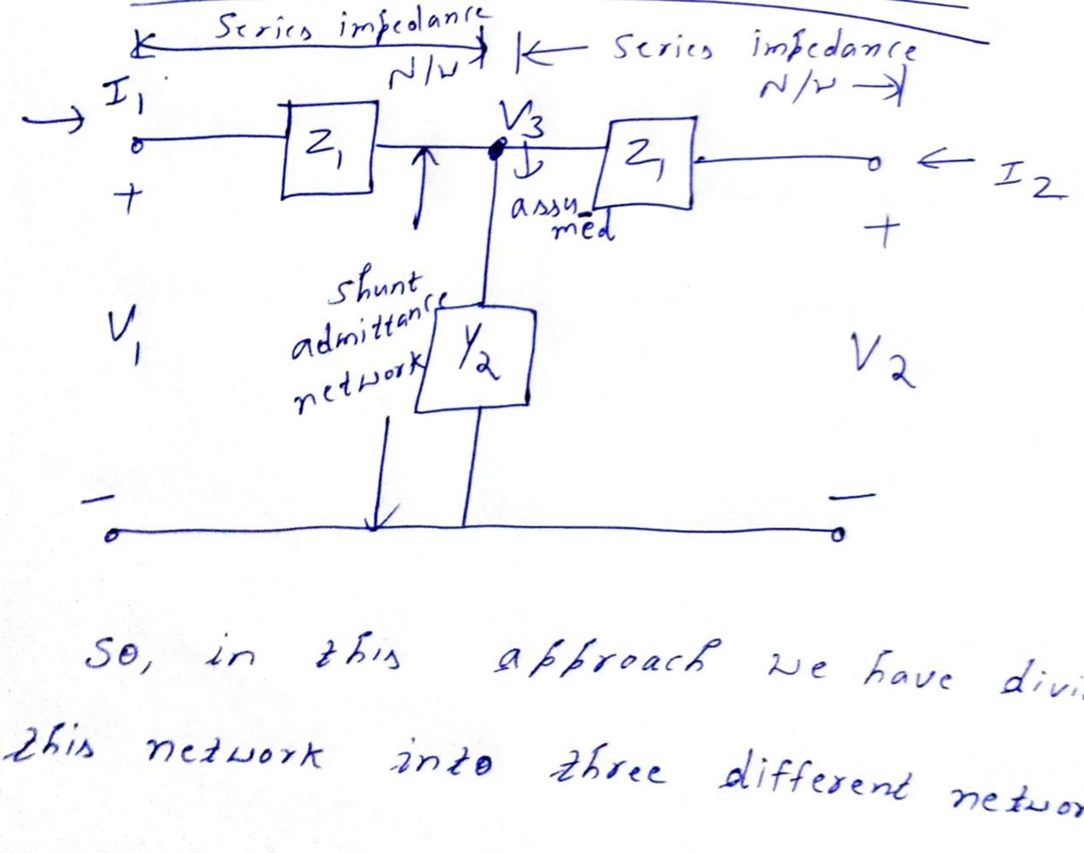
Some additional information



⇒ So, in this approach we have divided this network into three different networks.

⇒ Suppose current I_1 is entering series impedance network on the left side. (Z_1)

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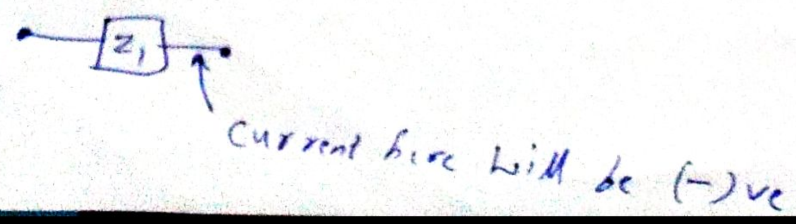

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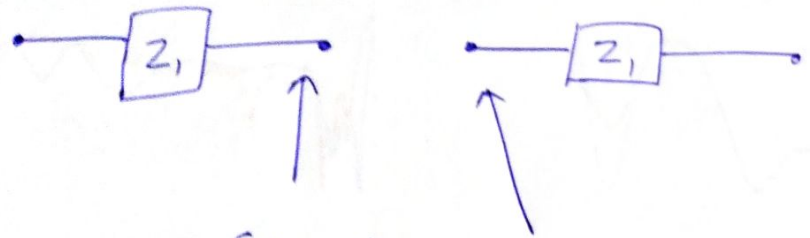
1st N/W 2nd N/W



Current here will be (−)ve

But the same current will be (+)ve here as it is at the i/P port of second series impedance n/w..

⇒ So, we can say that whatever current will be going out will become i/P voltage & i/P current over other network.

⇒ So, these ABCD matrix (Z_1) of first network can be multiplied with ABCD matrix of shunt network (Y_1).

and then with ABCD matrix of series impedance network on right side.