Date : 16/06/19

CHAPTER - 2

TWO-PORT NETWORKS ~~THEOREMS~~

Lecture - 1

Introduction of Two Port Network:

One Port n/w:

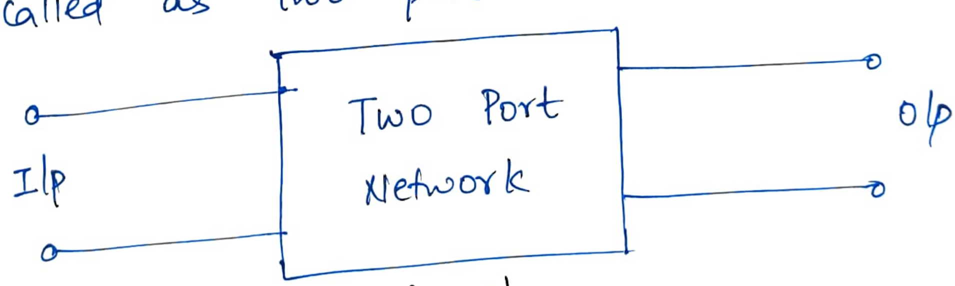
A n/w which has only one port (i.e, i/p port or output port is called as one port network.

fig: One port n/w.

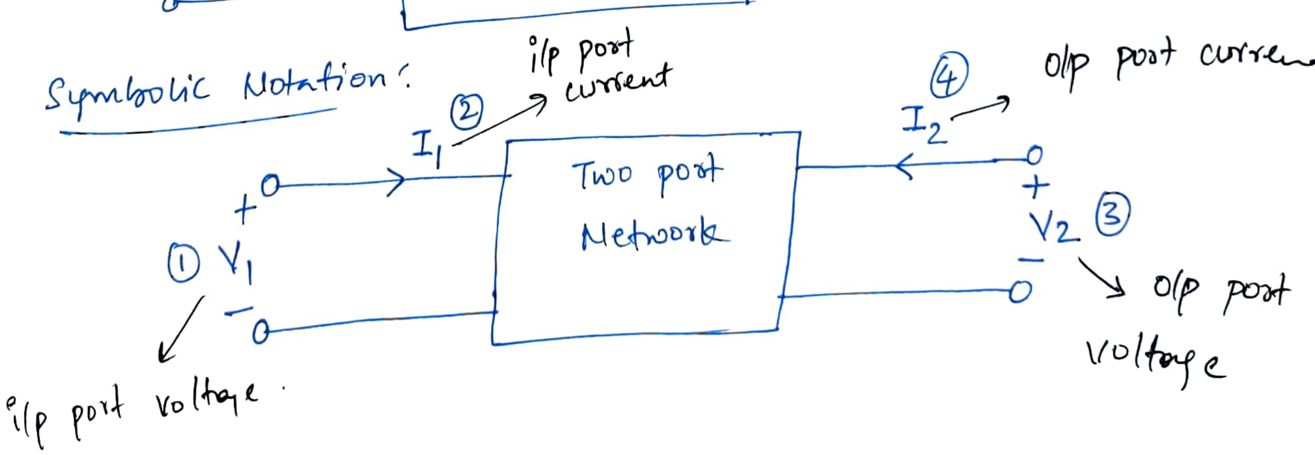
Eg: Generator, Motor etc

Two Port n/w:

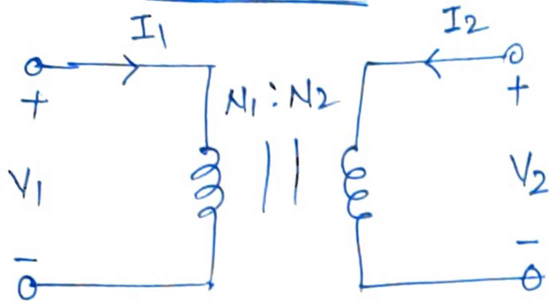
A n/w which has both 2 ports (input & output ports) is called as two port network.



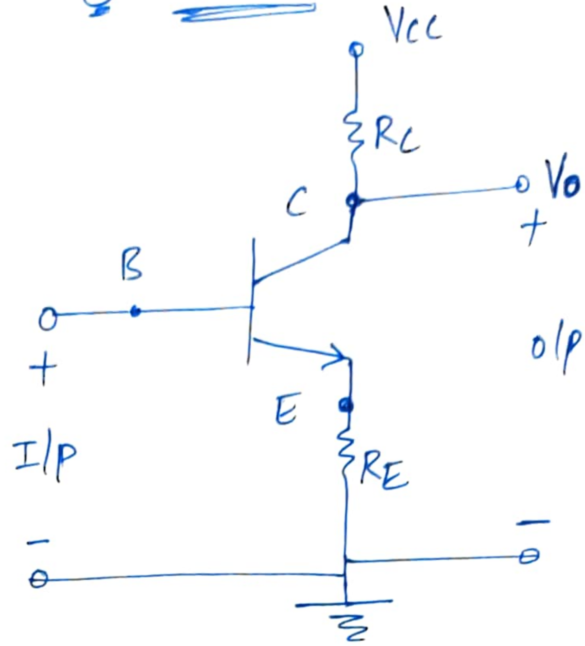
Symbolic Notation:



Eg: ① Transformer

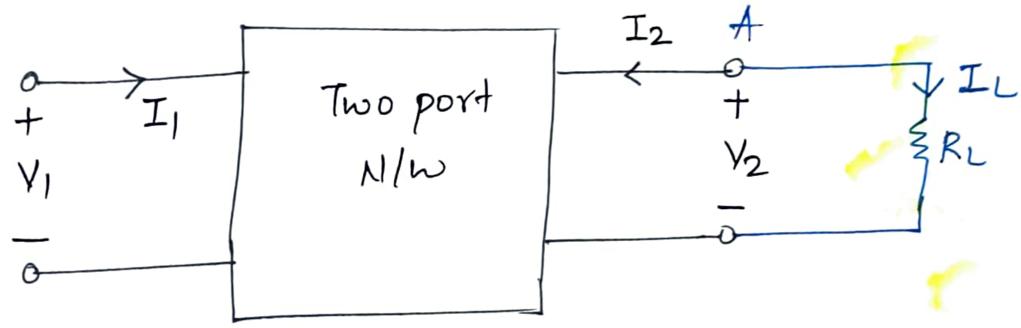


② Transistor:



Important Concept:

Consider



O/p voltage $V_2 = I_L R_L$

By KCL at A $\Rightarrow I_L = -I_2$

So. O/p voltage $V_2 = -I_2 R_L$

VVIMP Concept.

I_L = load current.

R_L = load resistance

I_2 = O/p port current

V_2 = O/p voltage.

Possible Combinations of Two Port n/w:

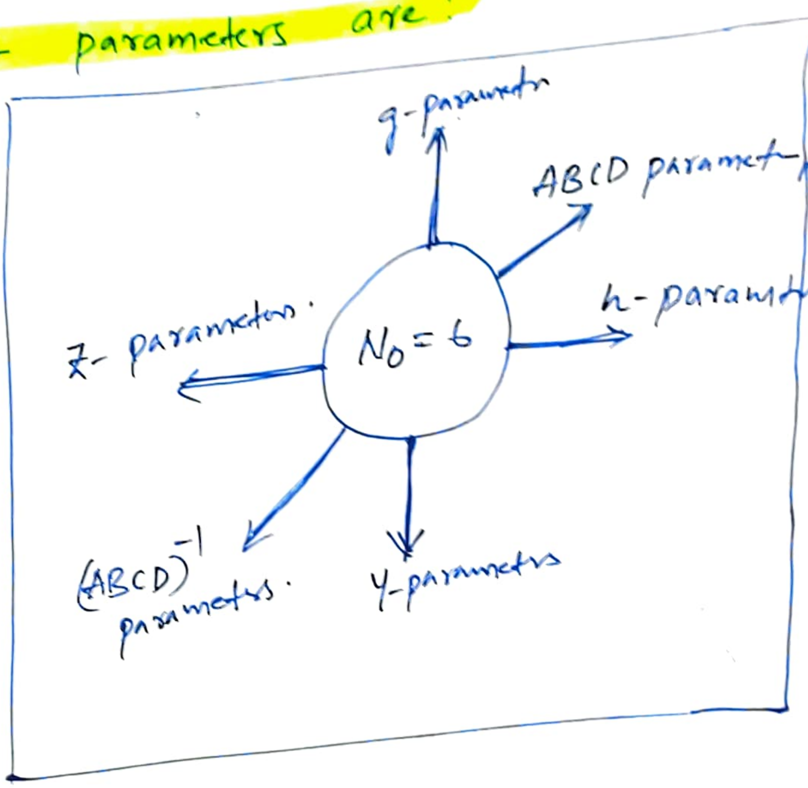
We have 4 variables V_1, I_1, V_2, I_2

We have to select two variables out of 4.
(one i/p & other o/p)

$\boxed{\text{So possible combinations of Two port n/ws} = {}^4C_2 = 6.}$

The possible two port parameters are:

1. Z- parameters
2. Y- parameters
3. h - parameters
4. g- parameters
5. ABCD -parameters
6. Inverse ABCD $(ABCD)^{-1}$ parameters



LECTURE - 2

Introduction to Z- Parameters :

Z - Parameters (or) Impedance Parameters :

$$V_1 = Z_{11} I_1 + Z_{12} I_2 \longrightarrow (1) \Rightarrow \text{i/p KVL eq.n}$$

$$V_2 = Z_{21} I_1 + Z_{22} I_2 \longrightarrow (2) \Rightarrow \text{o/p KVL eq.n}$$

$$V_1 = f(I_1, I_2)$$

$$V_2 = f(I_1, I_2)$$

Here Independent variables $= I_1, I_2$

Dependent Variables $= V_1, V_2$.

Conditions for Existence of Z- parameters :

1. I_1 & I_2 must be independent to each other.

i.e, if $I_1 = f(\text{only } I_2)$ (or) $I_2 = f(\text{only } I_1)$

in this case Z - parameters does not exist.

Z- parameter model: (or) Impedance Model :

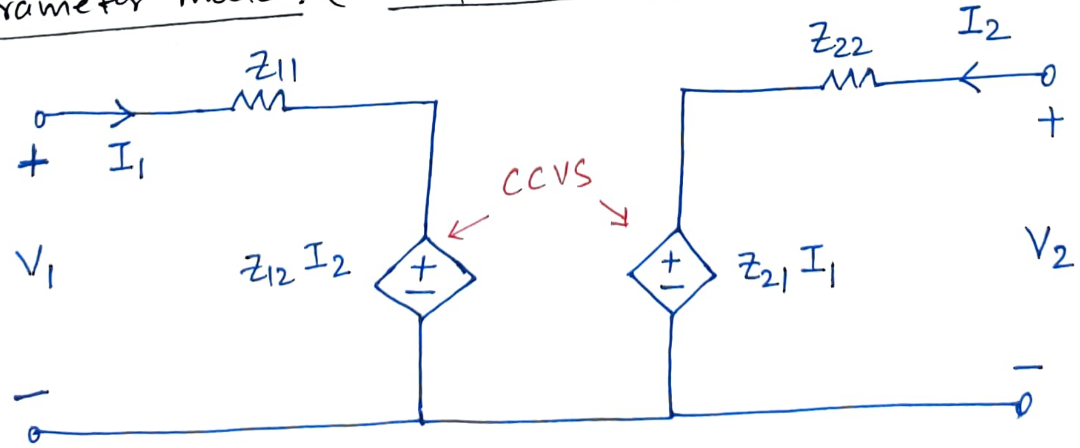


fig: Impedance Model.

$Z_{11} = \frac{V_1}{I_1}\Big|_{I_2=0}$ = Driving point i/p impedance when o/p is open ckt. (O.C)

$Z_{12} = \frac{V_1}{I_2}\Big|_{I_1=0}$ = Transfer i/p impedance when i/p is open ckt (O.C)

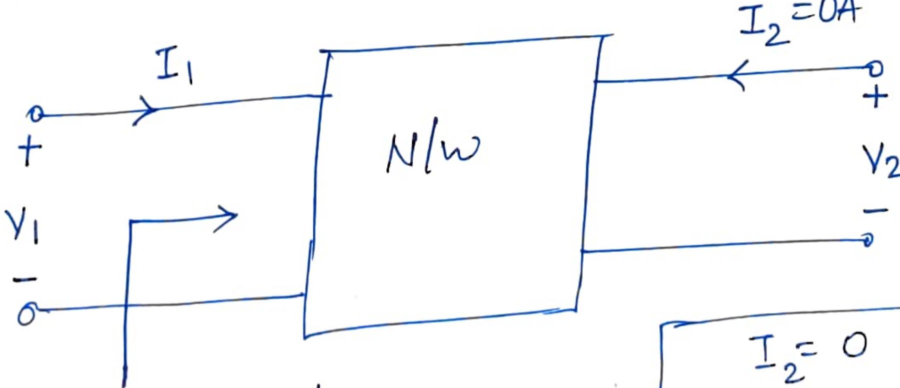
$Z_{21} = \frac{V_2}{I_1}\Big|_{I_2=0}$ = Transfer o/p impedance when o/p is open. ckt (O.C)

$Z_{22} = \frac{V_2}{I_2}\Big|_{I_1=0}$ = Driving point o/p impedance when i/p is open ckt (O.C)

Note: (i) All these impedances are conditional impedances. Because here we finding impedance by opening either i/p or o/p.

→(ii) So, we can conclude that Z-parameter model is open ckt parameter model.

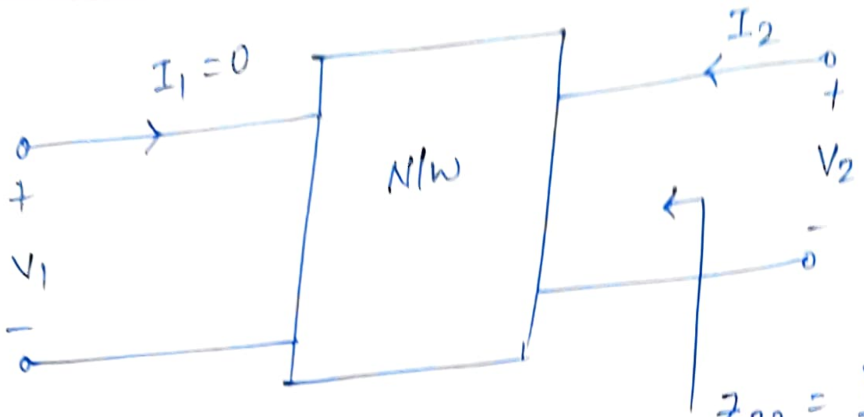
Z_{11} structure (or) Driving pt i/p impedance structure:



$Z_{11} = \frac{V_1}{I_1}\Big|_{I_2=0}$

$I_2 = 0$ because o/p is O.C

Z_{22} structure (or) Driving pt o/p impedance structure



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

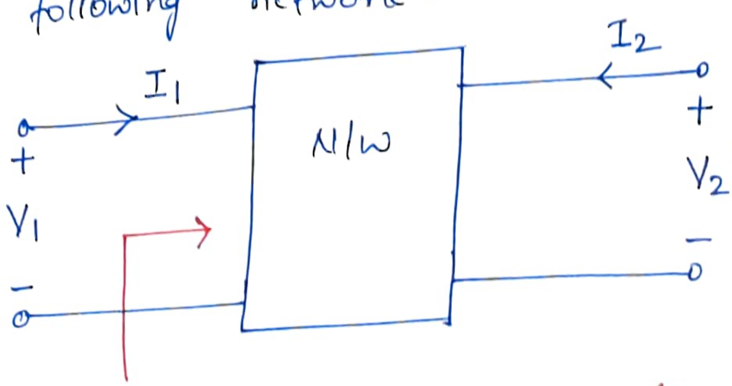
> Here $I_1 = 0$
> because i/p is
> open ckt O.C

Note: 1) We cannot represent Z_{12} & Z_{21} with ⌐ or ⌐ because it is neither on i/p side nor on o/p side. So, we cannot draw structure for Z_{12} & Z_{21} as that of Z_{11} & Z_{22}.

2) ⌐ ⟹ Implies voltage & current at the position of arrow & $Z = \left(\frac{V}{I}\right)$ at position of arrow

$Z = \frac{V}{I}$

Now Consider the following network.



> Here $Z_{in} \neq Z_{11}$

Z_{11} is conditional impedance

$Z_{in} = \frac{V_1}{I_1}$ = unconditional i/p impedance.

Understand the diff b/w Z_{in} & Z_{11}.

Eg: Input impedance in transformer or transistor is unconditional.

Matrix Representation of Z-parameter Model:

$$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix}_{2\times1} = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix}_{2\times2} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}_{2\times1}$$

i.e, $[V] = [Z][I]$

$$Z\text{-matrix} = [Z]_{2\times2} = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix}_{2\times2}.$$

$$\Delta Z = Z_{11}Z_{22} - Z_{12}Z_{21} = \text{Determinant of } Z$$

$$\text{Adj } Z = \begin{bmatrix} Z_{22} & -Z_{12} \\ -Z_{21} & Z_{11} \end{bmatrix} = \text{Adjoint of } Z$$

$$[Z^{-1}] = \frac{\text{Adj } Z}{\Delta Z} = \frac{1}{\Delta Z}\begin{bmatrix} Z_{22} & -Z_{12} \\ -Z_{21} & Z_{11} \end{bmatrix} = \text{Inverse of } Z.$$

Example: Find the Z-parameters for following T n/w?

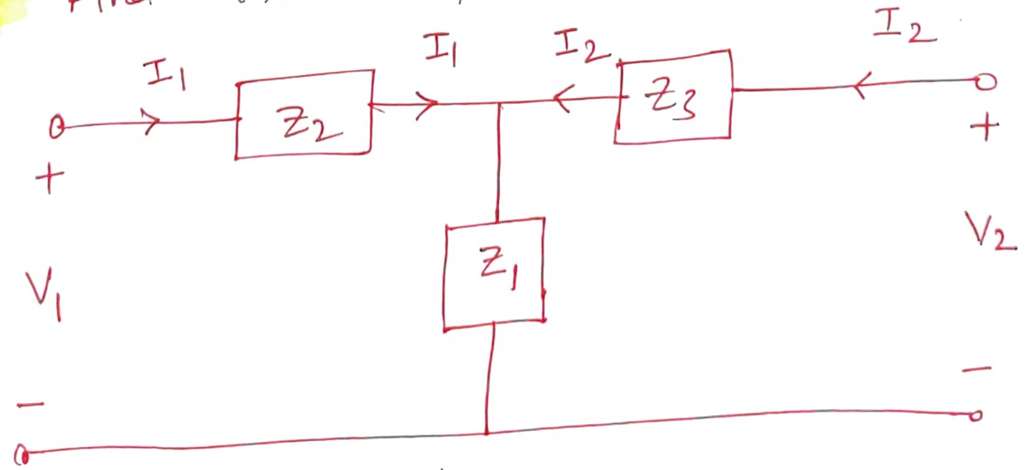
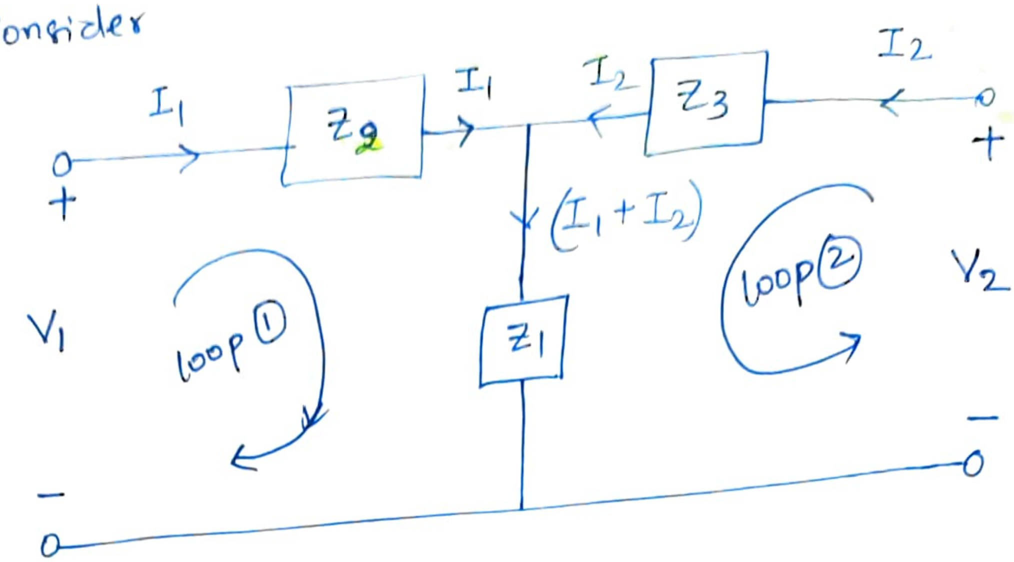


fig T N/w

Sol. Consider



Apply KVL in loop ①

$$V_1 - Z_2 I_1 - (I_1 + I_2) Z_1 = 0$$

$$V_1 - Z_2 I_1 - Z_1 I_1 - Z_1 I_2 = 0$$

$$V_1 = (Z_1 + Z_2) I_1 + (Z_1) I_2 \longrightarrow ①$$

Comparing ① with

$$V_1 = Z_{11} I_1 + Z_{12} I_2 ;$$

we get $\boxed{Z_{11} = Z_1 + Z_2}$ & $\boxed{Z_{12} = Z_1}$

Apply KVL for loop ②

$$V_2 - I_2 Z_3 - (I_1 + I_2) Z_1 = 0$$

$$V_2 = I_1(Z_1) + (Z_1 + Z_3) \cancel{Z_3} I_2 \longrightarrow ②$$

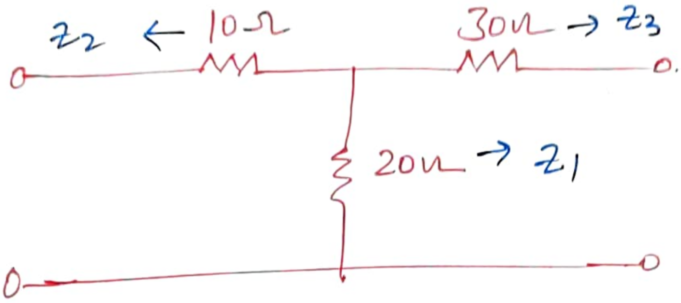
Comparing ② with

$$V_2 = Z_{21} I_1 + Z_{22} I_2$$

$\boxed{Z_{21} = Z_1}$ & $\boxed{Z_{22} = Z_1 + Z_3}$

$$\therefore \quad [Z]_{2\times2} = \begin{bmatrix} Z_1+Z_2 & Z_1 \\ Z_1 & Z_1+Z_3 \end{bmatrix} \rightarrow \text{Remember the result}$$

Eg: Find the Z-parameters for the given n/w.

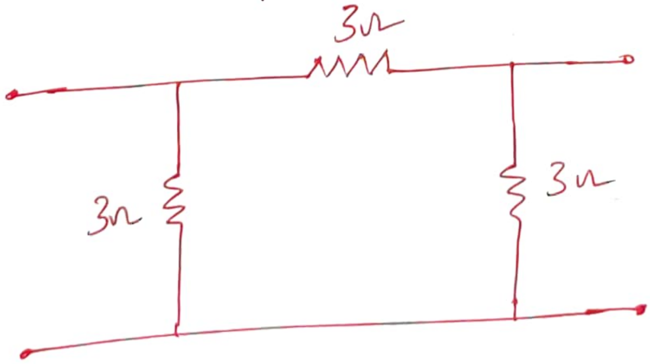


Sol By comparing with the standard n/w.

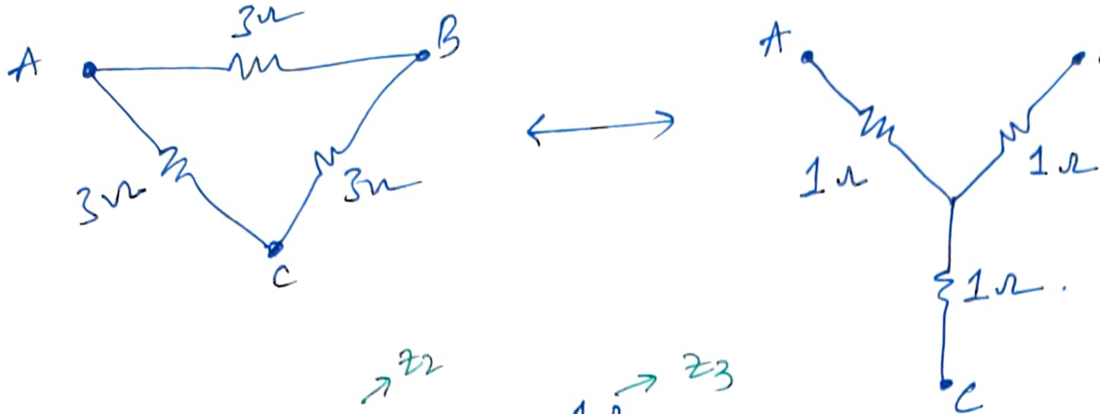
$$[Z]_{2\times2} = \begin{bmatrix} Z_1+Z_2 & Z_1 \\ Z_1 & Z_1+Z_3 \end{bmatrix}$$

$$\therefore \quad [Z]_{2\times2} = \begin{bmatrix} 20+10 & 20 \\ 20 & 20+30 \end{bmatrix} = \begin{bmatrix} 30 & 20 \\ 20 & 50 \end{bmatrix}$$

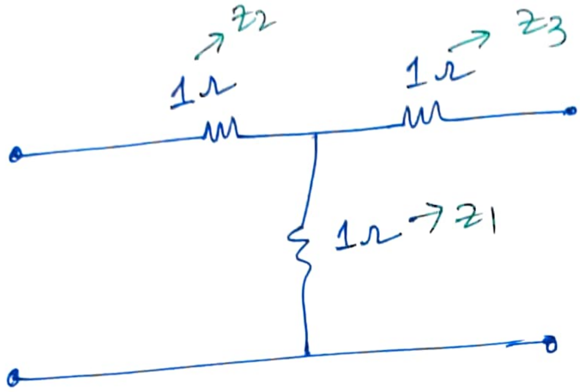
Eg: Find the Z-parameters for the given n/w.



Sol. Convert the given delta n/w to T or star n/w.

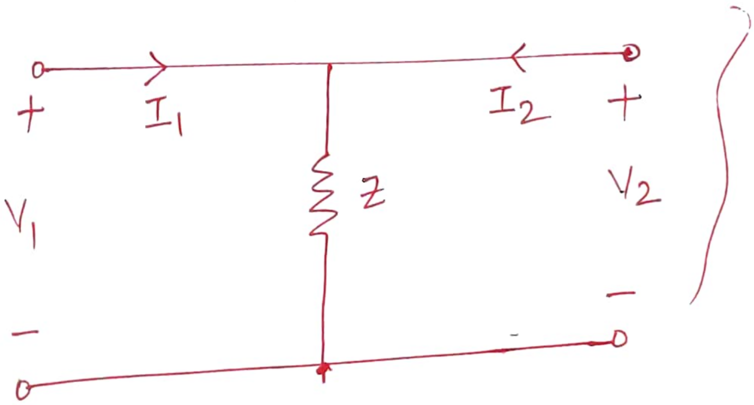


Now.



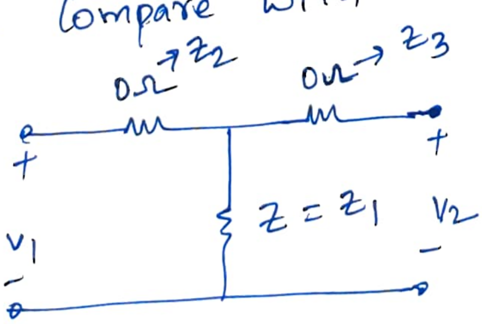
$$[Z]_{2\times2} = \begin{bmatrix} Z_1+Z_2 & Z_1 \\ Z_1 & Z_1+Z_3 \end{bmatrix} = \begin{bmatrix} 1+1 & 1 \\ 1 & 1+1 \end{bmatrix} = \begin{bmatrix} 2 & 1 \\ 1 & 2 \end{bmatrix}$$

Eg: Consider the shunt n/w and find the z-parameter.



→ single shunt element

Sol. Compare with



$$[Z] = \begin{bmatrix} Z_1+Z_2 & Z_1 \\ Z_1 & Z_1+Z_3 \end{bmatrix}$$

$$[Z] = \begin{bmatrix} Z+0 & Z \\ Z & Z+0 \end{bmatrix} = \begin{bmatrix} Z & Z \\ Z & Z \end{bmatrix}$$

Example: Consider the single series element n/w and find the z-parameters for the given n/w

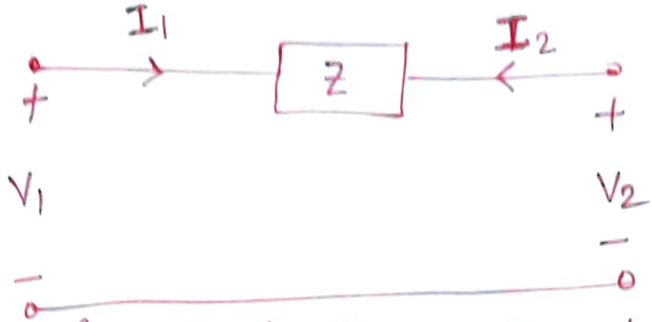
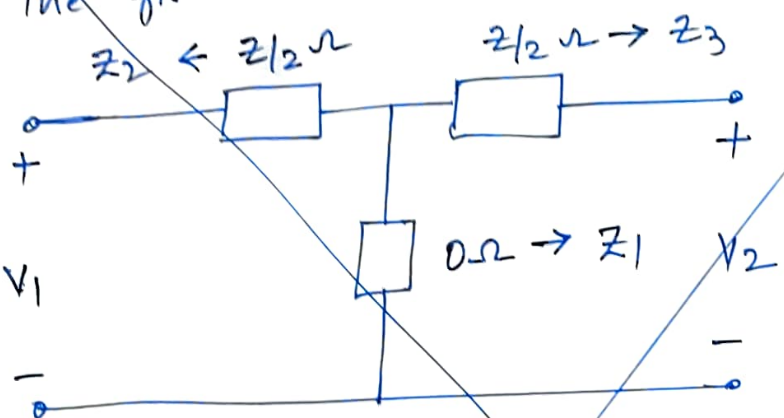


fig: Single Series Element

sol: The given n/w can be transformed as



$$[Z]_{2\times 2} = \begin{bmatrix} Z_1 + Z_2 & Z_1 \\ Z_1 & Z_1 + Z_3 \end{bmatrix} = \begin{bmatrix} 0 + Z/2 & 0 \\ 0 & 0 + Z/2 \end{bmatrix}$$

$$\therefore [Z]_{2\times 2} = \begin{bmatrix} Z/2 & 0 \\ 0 & Z/2 \end{bmatrix}_{2\times 2}$$

from the above n/w. We can say that

$$I_1 + I_2 = 0$$

$$\boxed{I_1 = -I_2}$$

$$Z_{11} = \left.\frac{V_1}{I_1}\right|_{I_2=0} \rightarrow \left(\begin{matrix}\text{If } I_2 = 0 \\ \text{then } I_1 = 0\end{matrix}\right) \quad Z_{11} = \frac{V_1}{0} = \infty$$

$$\boxed{\therefore Z_{11} = \infty}$$

$$Z_{12} = \left.\frac{V_1}{I_2}\right|_{I_1=0} \Rightarrow Z_{12} = \frac{V_1}{0} = \infty \; ; \quad \boxed{\therefore Z_{12} = \infty}$$

$$Z_{21} = \left.\frac{V_2}{I_1}\right|_{I_2=0} \Rightarrow Z_{21} = \frac{V_2}{0} = \infty \; ; \quad \boxed{Z_{21} = \infty}$$

$$Z_{22} = \left.\frac{V_2}{I_2}\right|_{I_1=0} \Rightarrow Z_{22} = \frac{V_2}{0} = \infty \; ; \quad \boxed{\therefore Z_{22} = \infty}$$

$$\therefore [Z]_{2\times 2} = \begin{bmatrix} \infty & \infty \\ \infty & \infty \end{bmatrix}_{2\times 2}.$$

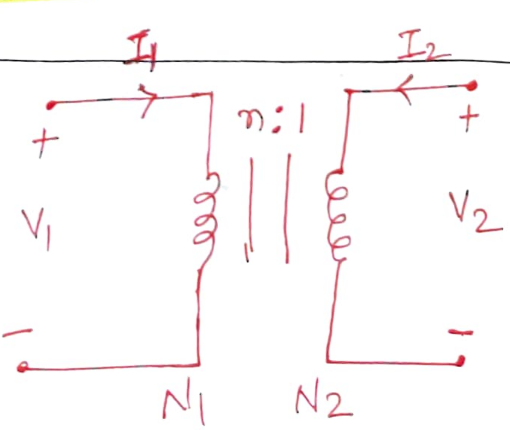
NOTE: For a single series element n/w, Z-parameters do not exist.

→ Here I_1 & I_2 are dependent (i.e, $I_2 = -I_1$)

I_2 can be derived from I_1 in this n/w.

→ We know that for a n/w with dependent currents Z-parameters do not exist.

Eg: Find the Z-parameters for the ideal transformers as shown in the fig.



Sol. Here $\frac{V_1}{V_2} = \frac{n}{1} = \frac{N_1}{N_2} \longrightarrow (1)$

$-\frac{I_2}{I_1} = \frac{n}{1} = \frac{N_1}{N_2} \longrightarrow (2)$.

Here clearly $-I_2 = n I_1$

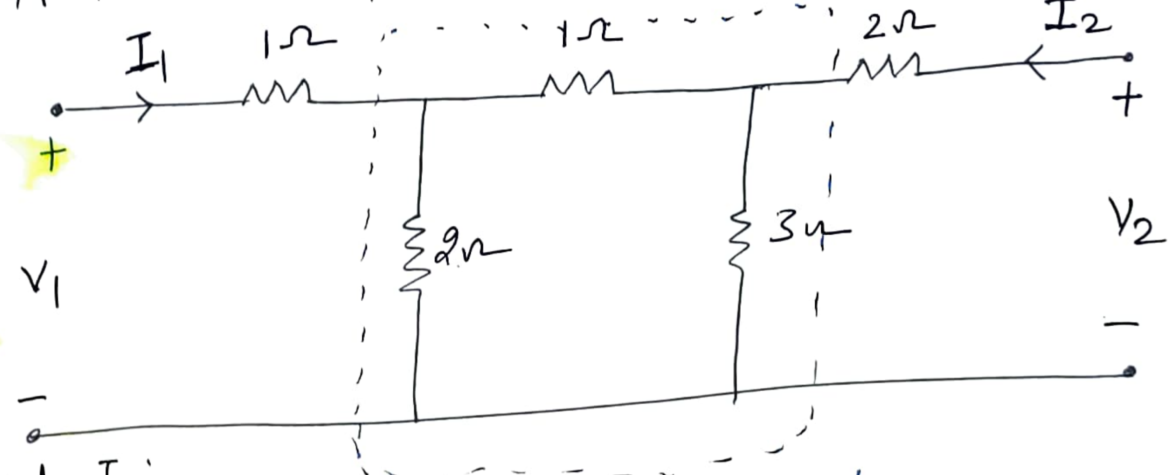
i.e., I_1, I_2 are dependent variables.

So, we can say that 'Z' parameters do not exist for the ideal transformer.

Lecture - 3 :

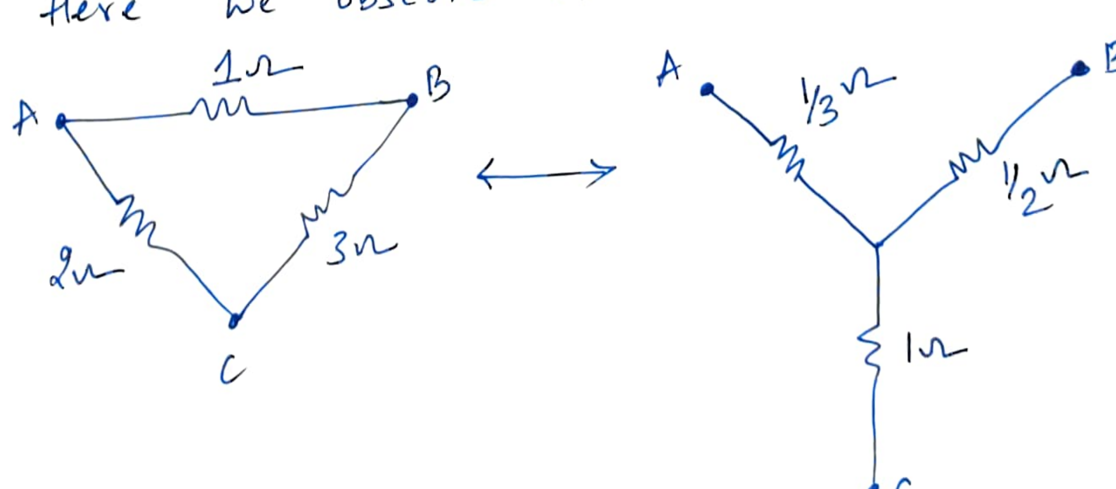
Examples Based On Z- Parameters :

Eg 1: Find the Z-parameters for the following n/w.

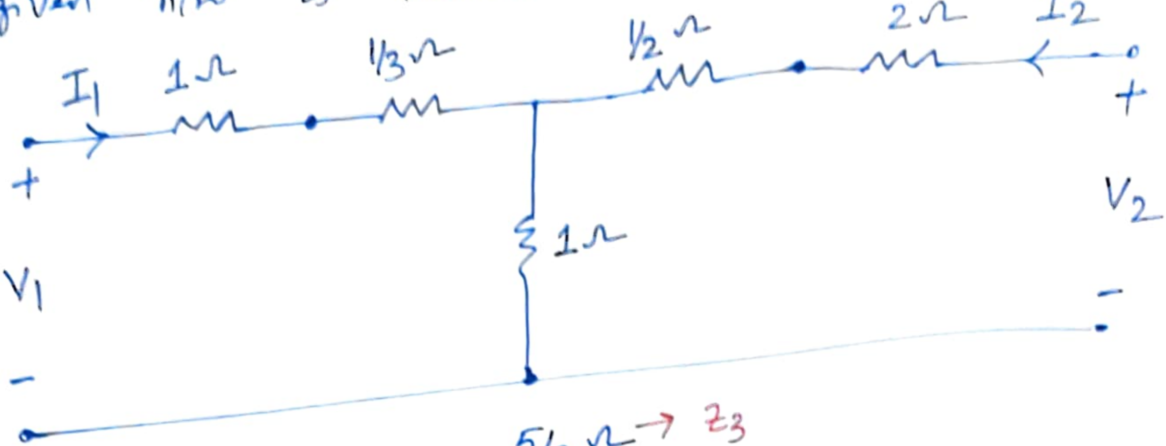


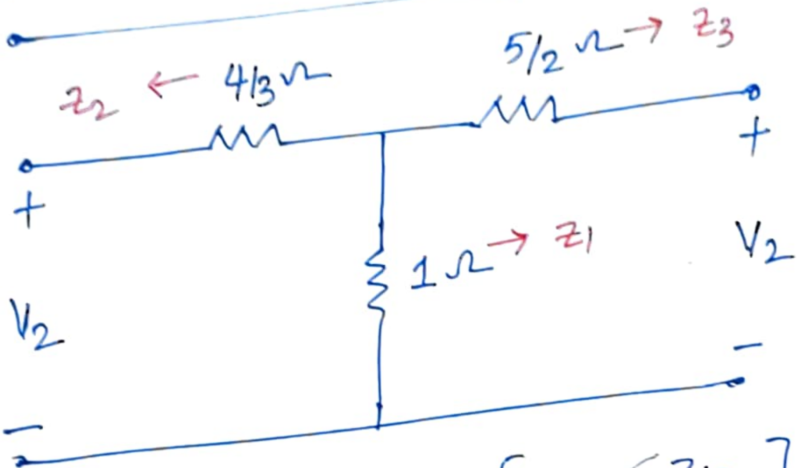
Method - I :

Sol. Here we observe the delta n/w.



The given n/w is transformed as follow.





We have $\cancel{[Z]_{2\times2} = \begin{bmatrix} z_{11} & z_{12} \\ z_{21} & z_{22} \end{bmatrix} = \begin{bmatrix} z_{11}+z & \\ & \end{bmatrix}}$

$$[Z]_{2\times2} = \begin{bmatrix} z_1+z_2 & z_1 \\ z_1 & z_1+z_3 \end{bmatrix} = \begin{bmatrix} 1+\frac{4}{3} & 1 \\ 1 & 1+\frac{5}{2} \end{bmatrix}$$

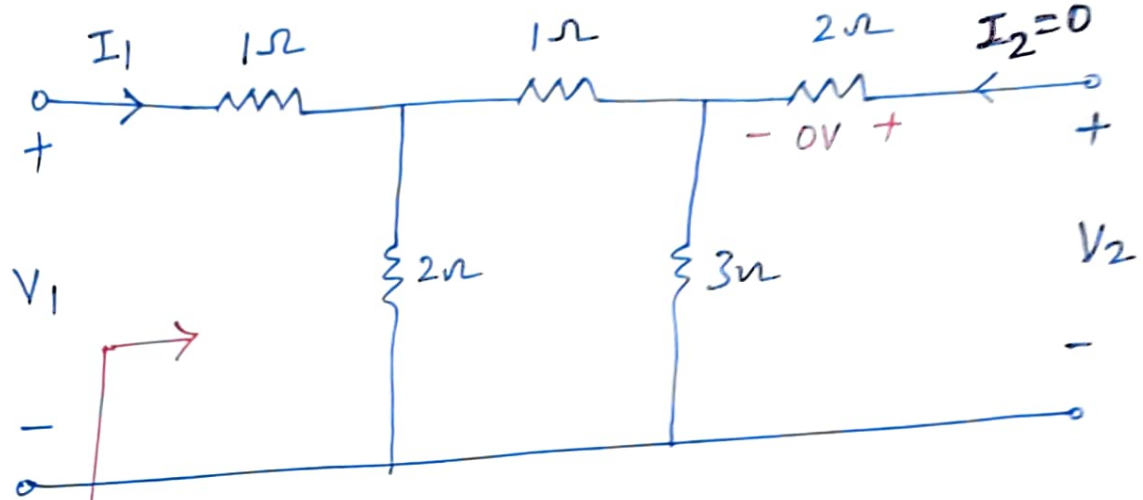
$$[Z]_{2\times2} = \begin{bmatrix} 7/3 & 1 \\ 1 & 7/2 \end{bmatrix}$$

Method – II:

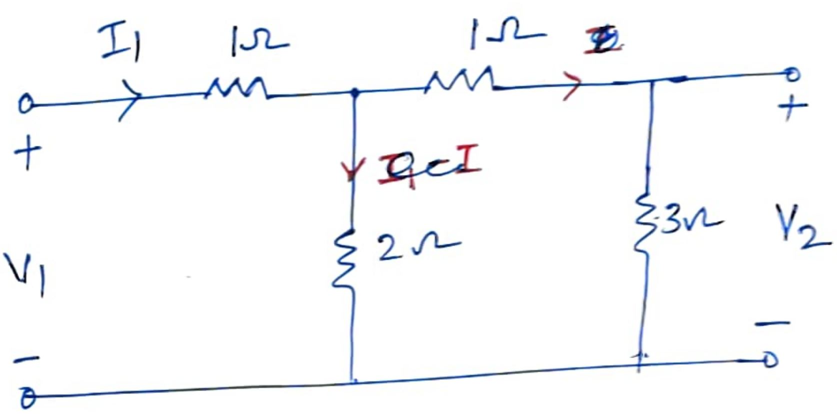
To find z_{11}:

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

From the n/w



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



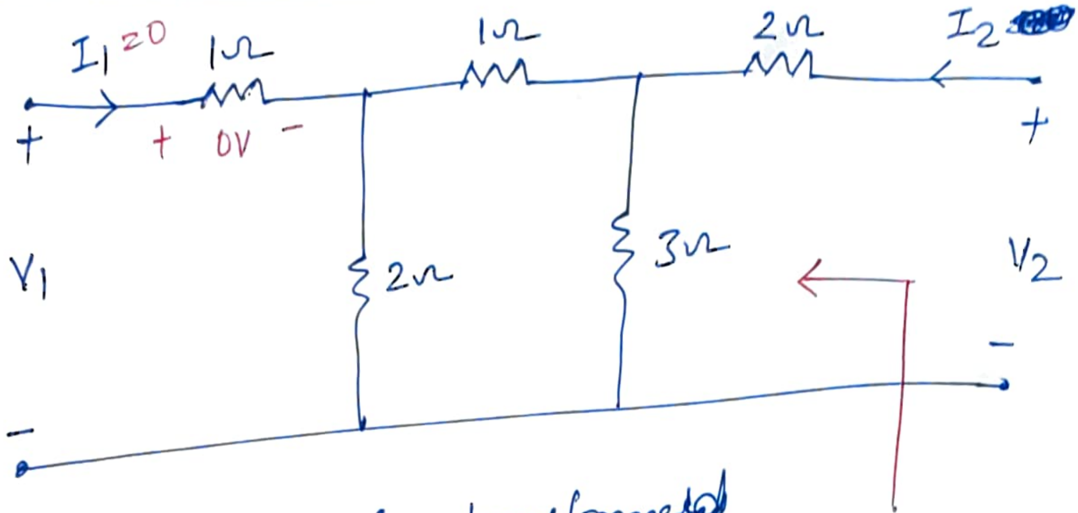
1Ω in series with 3Ω ⇒ 1Ω series 3Ω = 4Ω

& 4Ω ∥ 2Ω So we can conclude that.

$$z_{11} = \left.\frac{V_1}{I_1}\right|_{I_2=0} = (4 \parallel 2) + 1 = \frac{8}{6} + 1 = \frac{4}{3} + 1 = \frac{7}{3}\,\Omega.$$

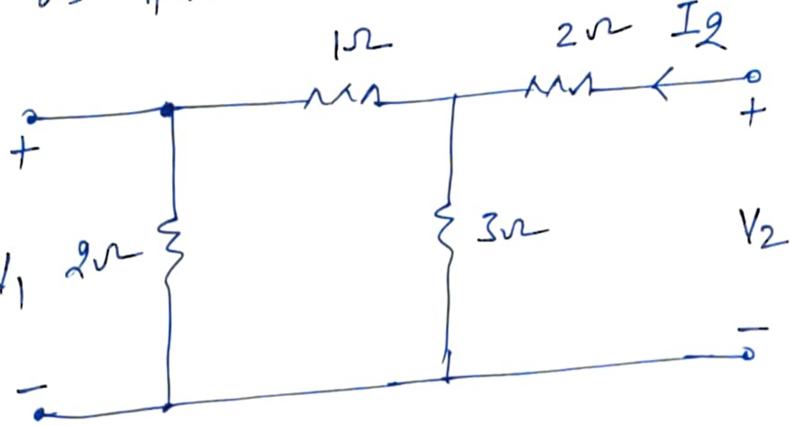
$$\boxed{\therefore\ z_{11} = \frac{7}{3}\,\Omega}$$

(ii) <u>To find z_{22}:</u>



$Z_{22} = \frac{V_2}{I_2}\Big|_{I_1=0}$

The above n/w is transformed as follows.



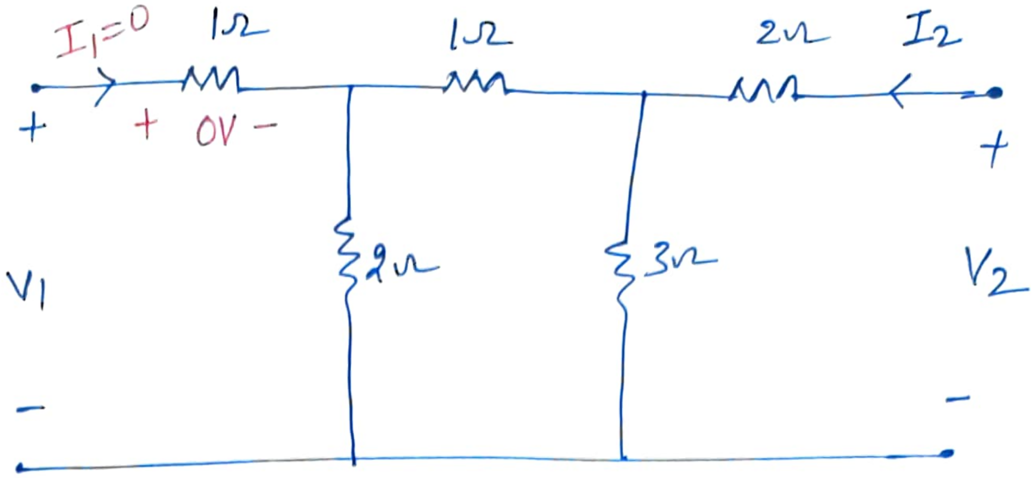
$$\frac{V_2}{I_2} = Z_{22} = \left[(2\Omega + 1\Omega) \parallel 3\Omega\right] + 2$$

$$= (3 \parallel 3) + 2 = \frac{3}{2} + 2 = \frac{7}{2}\Omega$$

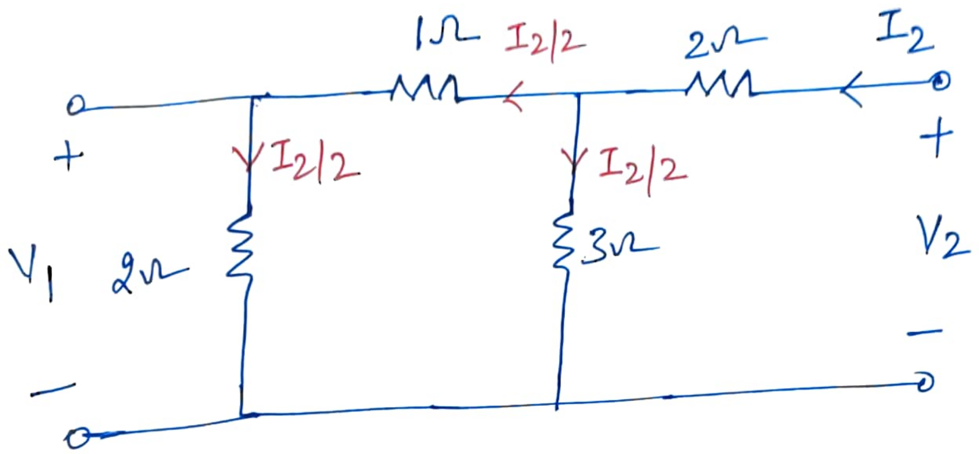
$$\boxed{\therefore\ Z_{22} = \frac{V_2}{I_2} = \frac{7}{2}\Omega}$$

(iii) To find Z_{12}

$$Z_{12} = \frac{V_1}{I_2}\Big|_{I_1=0}$$



The above ckt will be transformed as.



Here $(2\Omega + 1\Omega) \parallel 3\Omega$

$\Rightarrow$ $3\Omega \parallel 3\Omega$.

The current I_2 is divided equally as 3Ω & 3Ω are parallel and voltages across 3Ω & 3Ω are same

Now $V_1 = (2)\left(\frac{I_2}{2}\right)$

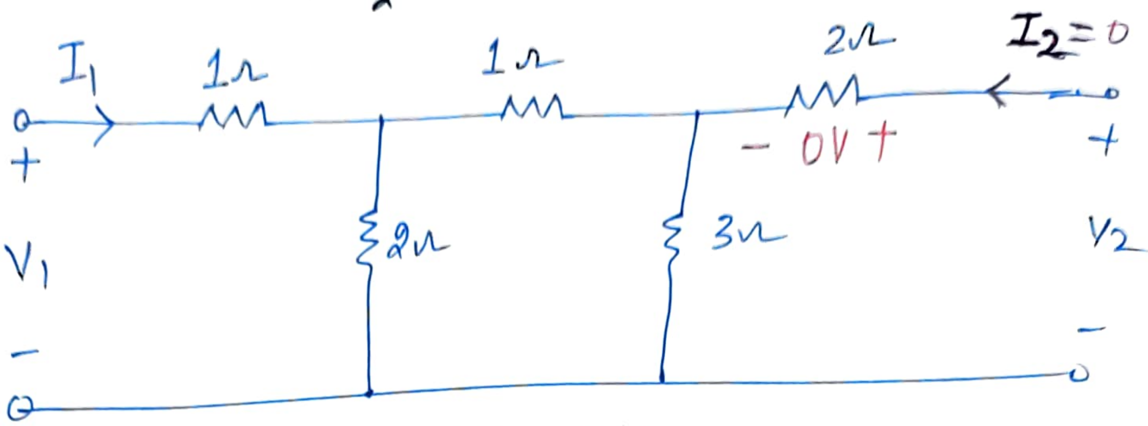
$V_1 = I_2$

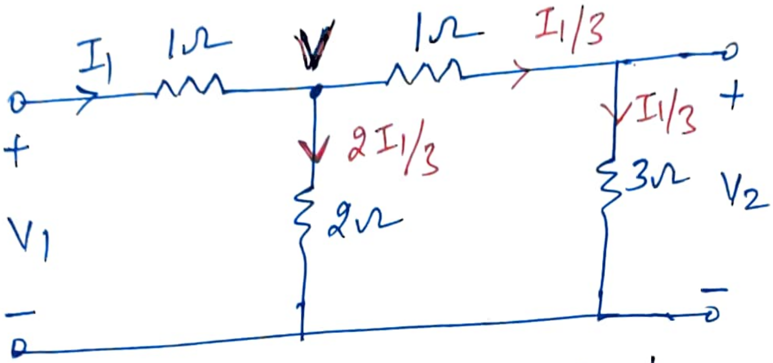
$Z_{12} = \left.\frac{V_1}{I_2}\right|_{I_1=0} = 1\ \Omega$

$\boxed{\therefore Z_{12} = 1\Omega}$

To find Z_{21} :

$$\cancel{\&}\ Z_{21} = \frac{V_2}{I_1}\bigg|_{\cancel{B}I_2=0}$$





Apply nodal analysis at 'V'!

$$-I_1 + \frac{V}{2} + \frac{V}{4} = 0$$

$$\frac{3V}{4} = I_1$$

$$\frac{V}{2} = \frac{2I_1}{3} \rightarrow (1)$$

$$\frac{V}{4} = \frac{I_1}{3} \longrightarrow (2)$$

Now $V_2 = (3)\left(\frac{I_1}{3}\right) = I_1$.

$$V_2 = I_1$$

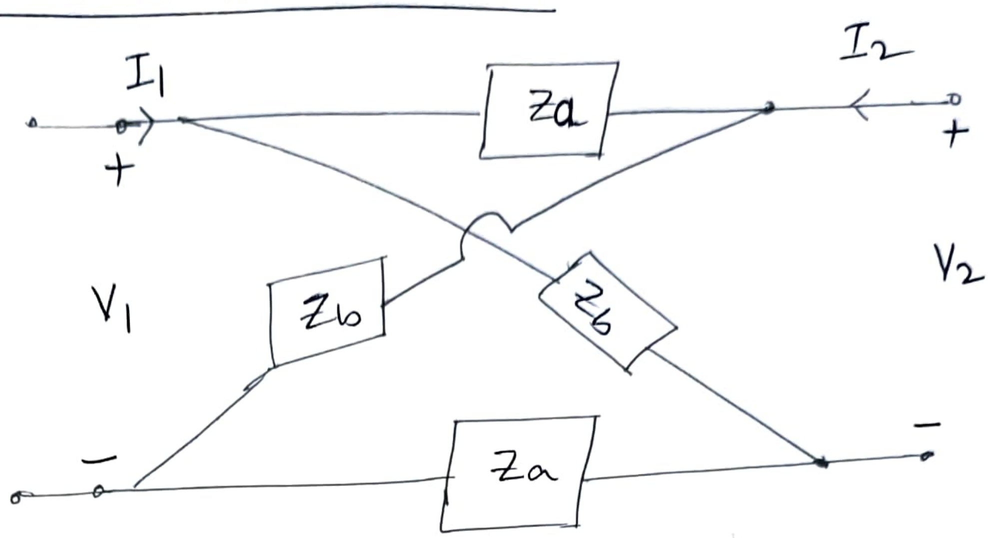
$$Z_{21} = \frac{V_2}{I_1}\bigg|_{I_2=0} = 1\Omega$$

$$\boxed{\therefore\ Z_{21} = 1\Omega}$$

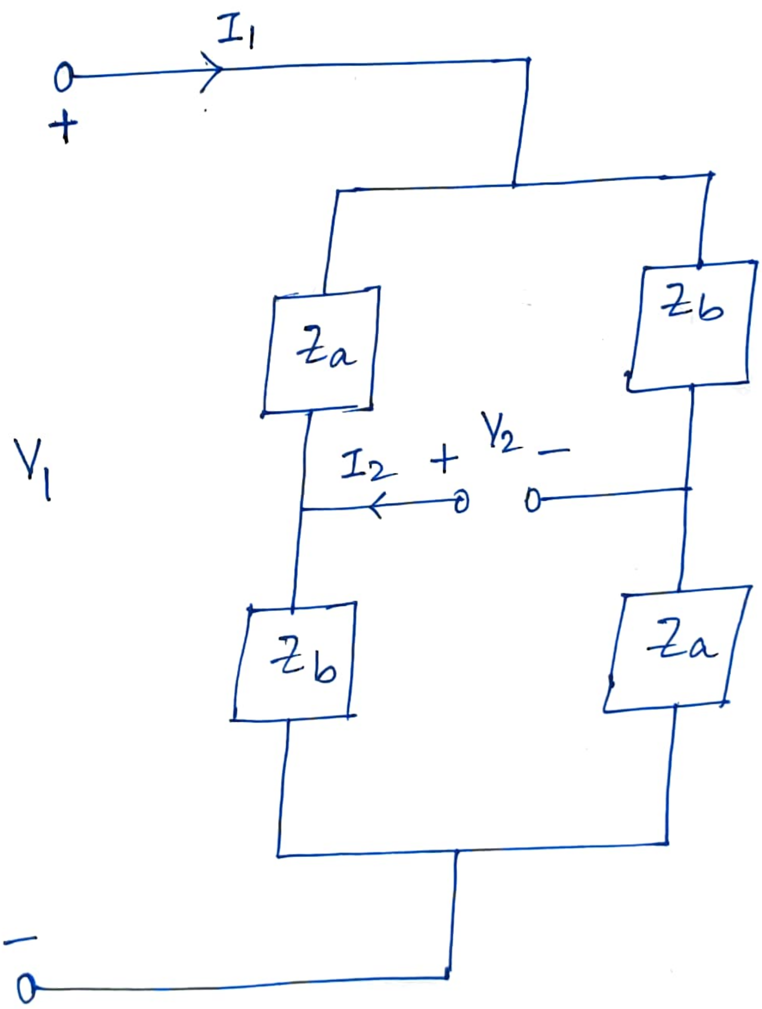
Lecture - 4 :

Z-parameter of Symmetric Lattice Network :

Symmetric Lattice Network :



Modified figure of the above n/w.



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

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

Here o/p is open ckt

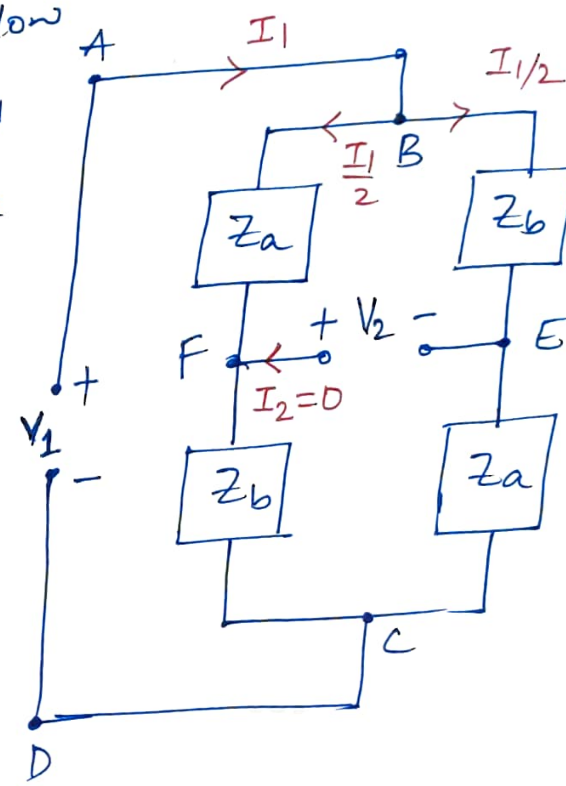
$$Z_{12} = \left.\frac{V_1}{I_2}\right|_{I_1=0A}$$

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

Here i/p is open ckt.

for calc. of Z_{11} & Z_{21} ckt will be same:

The modified ckt is as follow



→ Current will be equally divided because & impedance is same in both paths i.e. (Z_1+Z_2).

Applying KVL in 'ABCD' loop.

$$V_1 - \frac{Z_a I_1}{2} - \frac{Z_b I_1}{2} = 0$$

$$V_1 = \left[\frac{Z_a+Z_b}{2}\right] I_1$$

$$\boxed{Z_{11} = \frac{V_1}{I_1} = \frac{Z_a+Z_b}{2}}$$

Applying KVL in 'BEFB' loop

$$V_2 + \frac{Z_a I_1}{2} - \frac{Z_b I_1}{2} = 0$$

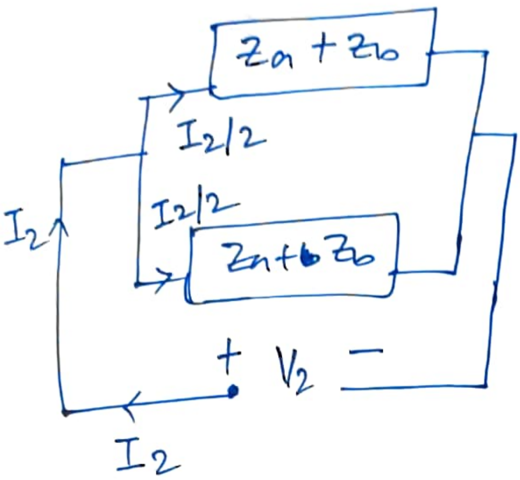
$$V_2 = \left[\frac{Z_b - Z_a}{2}\right] I_1$$

$$\boxed{Z_{21} = \frac{V_2}{I_1} = \frac{Z_b - Z_a}{2}}$$

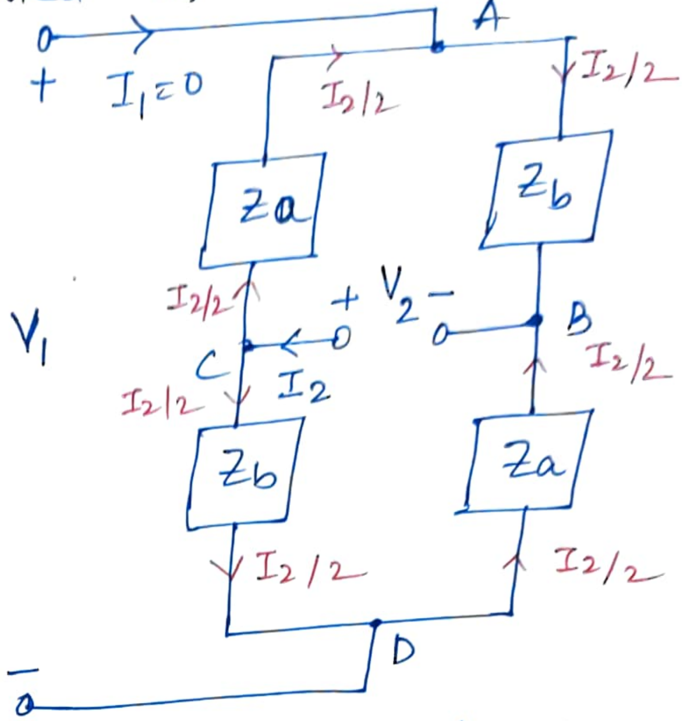
for calc Z_{12} & Z_{22} ckt will be same :

The ckt will be transformed as :

$Z_{12} = \left.\dfrac{V_1}{I_2}\right|_{I_1=0}$; $Z_{22} = \left.\dfrac{V_2}{I_2}\right|_{I_1=0}$



⇐



Here I_2 will be divided equally because of same impedance value.

Applying KVL in 'ABCA' loop

$$V_2 - \frac{Z_a I_2}{2} - \frac{Z_b I_2}{2} = 0$$

$$V_2 = \left(\frac{Z_a + Z_b}{2}\right) I_2$$

$$\boxed{Z_{22} = \frac{V_2}{I_2} = \frac{Z_a + Z_b}{2}}$$

Applying KVL in 'ACDA' loop

$$\frac{Z_a I_2}{2} - \frac{Z_b I_2}{2} + V_1 = 0$$

$$V_1 = \left(\frac{Z_b - Z_a}{2}\right) I_2$$

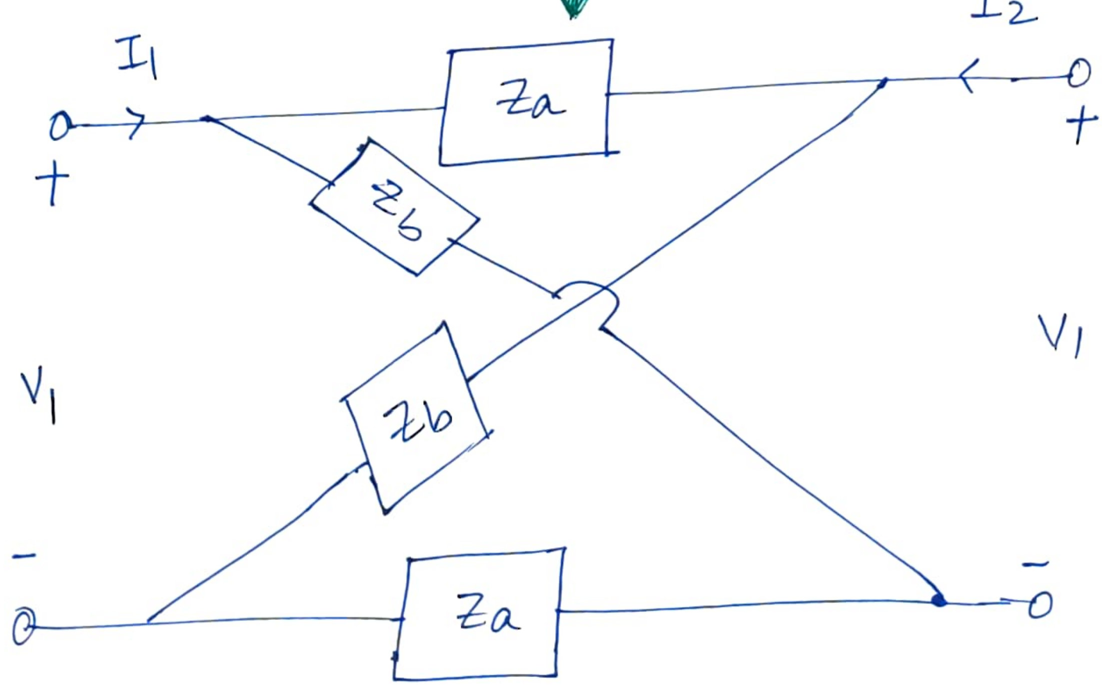
$$Z_{12} = \left.\frac{V_1}{I_2}\right|_{I_1=0} = \left(\frac{Z_b - Z_a}{2}\right)$$

$$\boxed{\therefore \; Z_{12} = \left(\frac{Z_b - Z_a}{2}\right)}$$

$\therefore$ finally the Z-parameters of symmetrical lattice network is given as

$$[Z]_{2\times2} = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix}_{2\times2} = \begin{bmatrix} \left(\frac{Z_a+Z_b}{2}\right) & \left(\frac{Z_b-Z_a}{2}\right) \\ \left(\frac{Z_b-Z_a}{2}\right) & \left(\frac{Z_a+Z_b}{2}\right) \end{bmatrix}_{2\times2}$$

Remember the result for the following ~~symmet~~ symm lattice network



Lecture - 5

Introduction To Y- Parameters :

Y- parameters (or) Admittance Parameters :

$I_1 = y_{11} V_1 + y_{12} V_2 \longrightarrow$ ① : I/p KCL

$I_2 = y_{21} V_1 + y_{22} V_2 \longrightarrow$ ② : O/p KCL

$I_1 = f(V_1, V_2)$

$I_2 = f(V_1, V_2)$

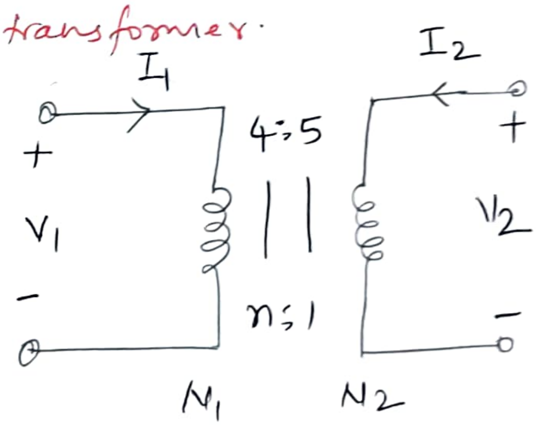
Independent variables = V_1, V_2

Dependent variables = I_1, I_2

Condition for existence of Y- parameters :

1. V_1 & V_2 should be independent from each other
2. Which means V_2 cannot be ~~derived from~~ dependent on V_1 i.e, $V_2 = \alpha V_1$ (or) $V_1 = \alpha V_2$ where (α = constant)

Example: Consider a ideal transformer with $n:1 = 4:5$. find y- parameters of this transformer.



Sol: Here

$$\frac{V_1}{V_2} = \frac{n}{1} = \frac{4}{5}$$

$$-\frac{I_2}{I_1} = \frac{n}{1} = \frac{4}{5}$$

Clearly $\boxed{V_1 = \frac{4}{5} V_2}$ $\Rightarrow$ V_1 & V_2 are dependent variables.

In this case Y-parameters of this transformer does not exist.

$\therefore$ Y-parameters does not exist for ideal transformer

Y-parameter (or) Admittance Model:

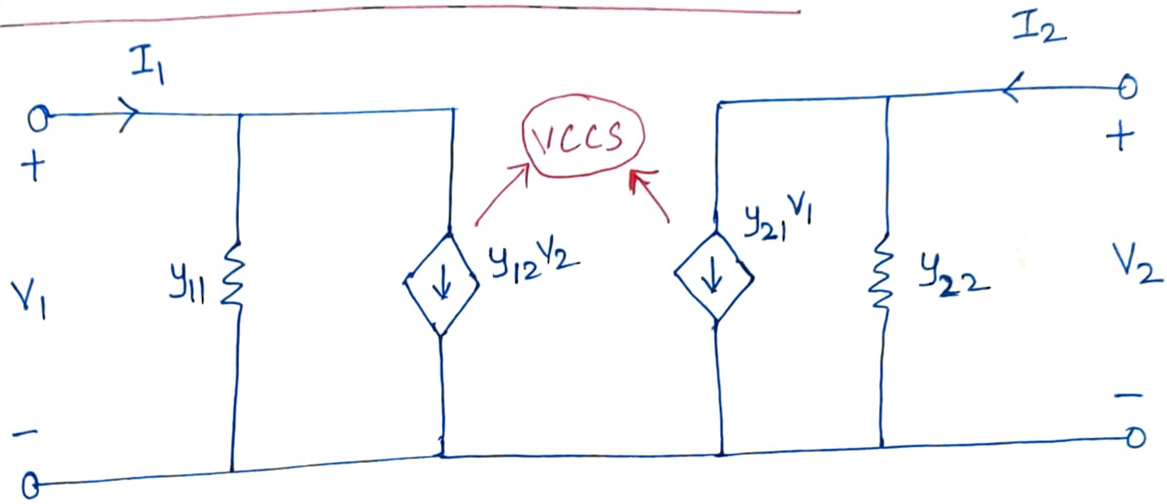


fig: Admittance model:

Matrix form of Y-parameter model:

$$\begin{bmatrix} I_1 \\ I_2 \end{bmatrix}_{2\times1} = \begin{bmatrix} y_{11} & y_{12} \\ y_{21} & y_{22} \end{bmatrix}_{2\times2} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix}_{2\times1}$$

$$[I]_{2\times1} = [Y]_{2\times2} [V]_{2\times1}$$

$$[Y]_{2\times2} = \begin{bmatrix} y_{11} & y_{12} \\ y_{21} & y_{22} \end{bmatrix}$$ $\Rightarrow$ Admittance matrix.

$\Delta y = y_{11} y_{22} - y_{21} y_{12}$ = Determinant of y.

$$Adj\, y = \begin{bmatrix} y_{22} & -y_{12} \\ -y_{21} & y_{11} \end{bmatrix}$$ = Adjoint of y - matrix.

$$[y]^{-1} = \frac{Adj\, y}{\Delta y} \equiv \frac{1}{\Delta y} \begin{bmatrix} y_{22} & -y_{12} \\ -y_{21} & y_{11} \end{bmatrix}$$ ⇒ Inverse of y matrix

Relation b/w y parameter matrix & Z- parameter matrix:

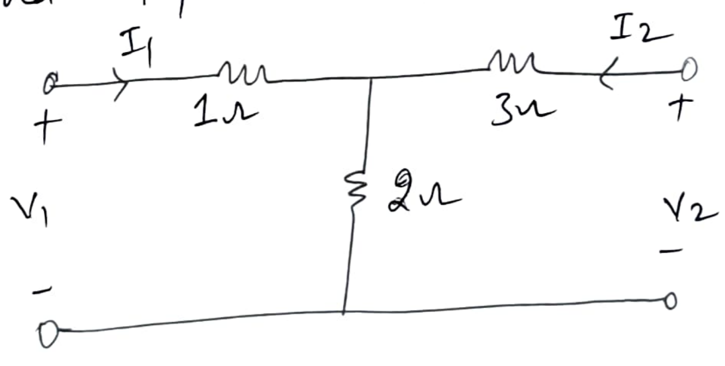
1. $[z] = [y]^{-1}$ → Remember this result

$$\begin{bmatrix} z_{11} & z_{12} \\ z_{21} & z_{22} \end{bmatrix} = \begin{bmatrix} \frac{y_{22}}{\Delta y} & \frac{-y_{12}}{\Delta y} \\ \frac{-y_{21}}{\Delta y} & \frac{y_{11}}{\Delta y} \end{bmatrix}$$ → Donot remember this reslt

2. $[y] = [z]^{-1}$ → Remember this result

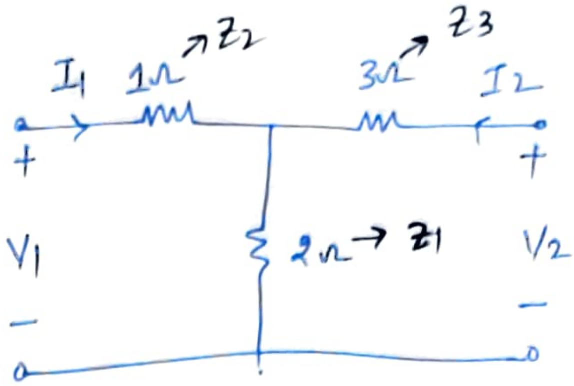
$$\begin{bmatrix} y_{11} & y_{12} \\ y_{21} & y_{22} \end{bmatrix} = \begin{bmatrix} \frac{z_{22}}{\Delta z} & \frac{-z_{12}}{\Delta z} \\ \frac{-z_{21}}{\Delta z} & \frac{z_{11}}{\Delta z} \end{bmatrix}$$ → Do not remember this result

Example: Find y-parameters for the following T n/w.



Sol. We have

$z_1 = 2\Omega \; ; \; z_2 = 1\Omega \; ; \; z_3 = 3\Omega$



We know that

$$[z] = \begin{bmatrix} z_1+z_2 & z_1 \\ z_1 & z_1+z_3 \end{bmatrix}$$

$$[z]_{2\times2} = \begin{bmatrix} 3 & 2 \\ 2 & 5 \end{bmatrix}_{2\times2}$$

But $[y] = [z]^{-1}$.

$\Delta z = 15 - 4 = 11$

$$\text{Adj } z = \begin{bmatrix} 5 & -2 \\ -2 & 3 \end{bmatrix}$$

$$z^{-1} = \frac{\text{Adj } z}{\Delta z}.$$

$$\therefore [y] = z^{-1} = \frac{1}{11}\begin{bmatrix} 5 & -2 \\ -2 & 3 \end{bmatrix} = \cancel{\begin{bmatrix} 3/5 & -2/5 \\ -2/5 & 3/5 \end{bmatrix}}$$

$$\cancel{\therefore [y]_{2\times2} = \begin{bmatrix} 3/5 & -2/5 \\ -2/5 & 3/5 \end{bmatrix}}$$

$$[y] = [z]^{-1} = \frac{1}{11}\begin{bmatrix} 5 & -2 \\ -2 & 3 \end{bmatrix} = \begin{bmatrix} 5/11 & -2/11 \\ -2/11 & 3/11 \end{bmatrix}$$

$$\boxed{\therefore [y]_{2\times2} = \begin{bmatrix} 5/11 & -2/11 \\ -2/11 & 3/11 \end{bmatrix}_{2\times2}}$$

$$y_{11} = \left.\frac{I_1}{V_1}\right|_{V_2=0}$$ = Driving point i/p admittance when o/p is short circuit

$$y_{12} = \left.\frac{I_1}{V_2}\right|_{V_1=0}$$ = Transfer poin i/p admittance when i/p is short circuit

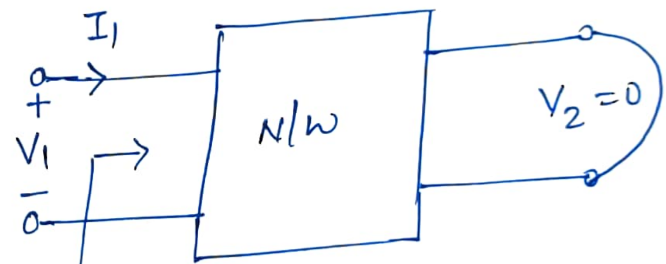
$$y_{21} = \left.\frac{I_2}{V_1}\right|_{V_2=0}$$ = Transfer o/p admittance when o/p is short circuit.

$$y_{22} = \left.\frac{I_2}{V_2}\right|_{V_1=0}$$ = Driving point o/p admittance when i/p is short circuit.

NOTE: 'y' parameters are called as short circuit parameters.

To find y_{11}:

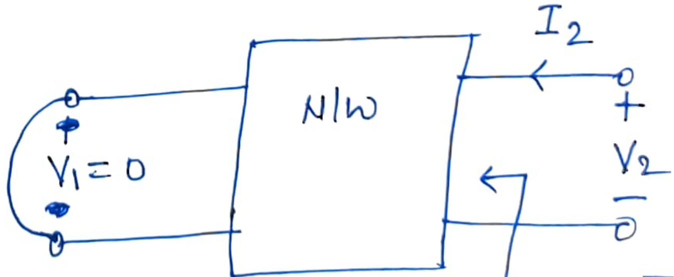
$$y_{11} = \left.\frac{I_1}{V_1}\right|_{V_2=0}$$



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

To find y_{22}:

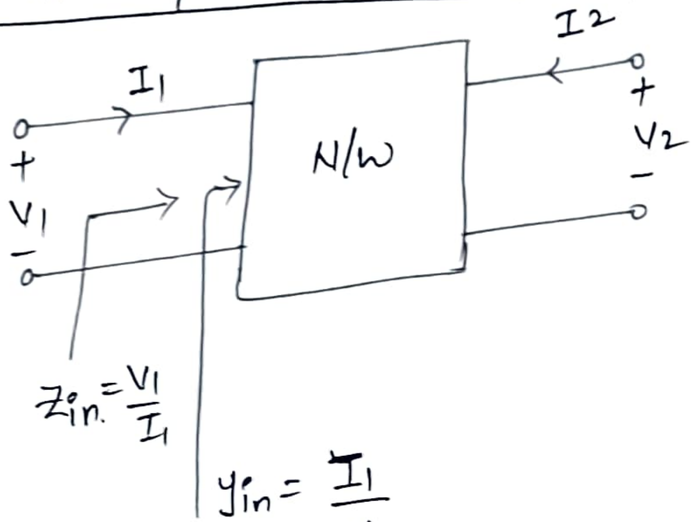
$$y_{22} = \left.\frac{I_2}{V_2}\right|_{V_1=0}$$



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

Note: We cannot represent the figure for calculating transfer i/p & o/p ~~admittance~~ admittances i.e. y_{12} & y_{21}.

UNCONDITIONAL I/p Admittance:



$$\boxed{Z_{in} = \frac{1}{y_{in}}}$$

$$\boxed{\text{Unconditional i/p admittance } (y_{in}) = \frac{I_1}{V_1}}$$

NOTE:

1. All the y-parameters $y_{11}, y_{12}, y_{21}, y_{22}$ are called conditional admittances, because they are obtained by imparting the condition i.e. either $V_1 = 0$ or $V_2 = 0$.

2. y_{11} is different from y_{in}.

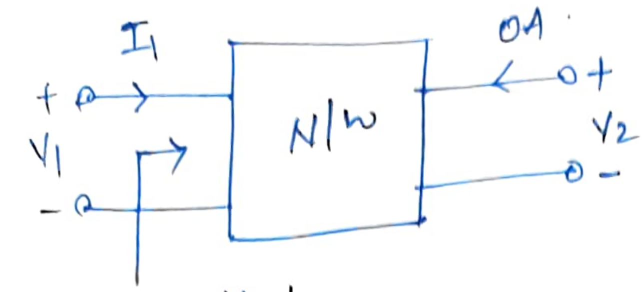
3. $y_{11} \Rightarrow$ Conditional Driving point i/p admittance

$y_{in} =$ unconditional i/p admittance.

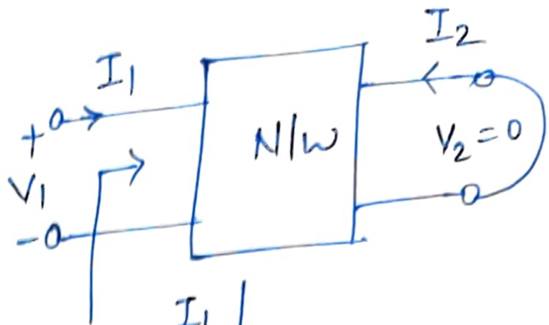
(*) Important Concept

Always $\boxed{Z_{11} \neq \frac{1}{y_{11}}}$ i.e. $\boxed{Z_{11} \neq \frac{1}{y_{11}}}$

Proof:



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



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

Clearly we can say that $Z_{11} \neq \frac{1}{y_{11}}$. As the conditions imparted in both cases are different i.e. $I_2 = 0$ & $V_2 = 0$.

$\therefore$ $\boxed{y_{11} \neq \frac{1}{Z_{11}}}$. Hence proved.

NOTE: But we can say that

$$\boxed{Z_{in} = \frac{1}{y_{in}}}$$

Z_{in} = unconditional i/p impedance

y_{in} = unconditional i/p admittance.