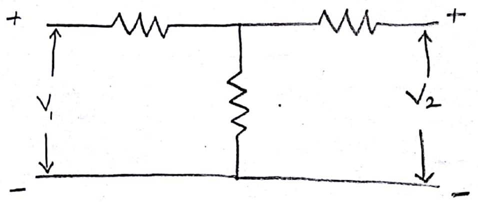
Aim : To determine 'z' & 'Y' parameters of the given two port network.



Observations

Circuit	V_1 (V)	I_1 (mA)	V_2	I_2	Practical Value (Ω^{-1})
Input short circuit	0	3.2	10.21	6.6	$Y_{12} = 0.313 \times 10^{-3}$ $Y_{22} = 0.646 \times 10^{-3}$
Output short circuit	10.22	6.5	0	3.2	$Y_{11} = 0.636 \times 10^{-3}$ $Y_{21} = 0.313 \times 10^{-3}$

Calculations

$V_1 = 10.22V ; V_2 = 0V \Rightarrow I_1 = \frac{10.22}{1.5 \times 10^3} = 6.813$ mA

$I_2 = 3.4065$ mA

$Y_{11} = \frac{I_1}{V_1} = \frac{6.81 \times 10^{-3}}{10.22} = 0.666 \times 10^{-3}$

$Y_{21} = \frac{I_2}{V_1} = \frac{3.4065 \times 10^{-3}}{10.22} = 0.333 \times 10^{-3} \Omega^{-1}$

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Experiment 1(a)

Aim : To determine y parameter of the given two port network.

Apparatus : Two port T-network, ammeter, voltmeter, Power supply, wires.

For 'y'-parameter, I_1 & I_2 are defined and V_1 & V_2 are expressed in terms of I_1 & I_2.

$I_1 = Y_{11} V_1 + Y_{12} V_2$

$I_2 = Y_{21} V_1 + Y_{22} V_2$

in matrix form:

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

Case I : $Y_{11} = I_1/V_1$ when $V_2 = 0$ & Y_{11} is called short circuit input impedance.

Case II : $Y_{21} = I_2/V_1$ when $V_2 = 0$ & Y_{21} is short circuit reverse transfer admittance.

Case III : $Y_{12} = I_1/V_2$ when $V_1 = 0$ forward transfer admittance.

Calculations

$V_1 = 0V, \quad V_2 = 10.21\,V$

$I_1 = 3.4065 \; mA$

$I_2 = 6.813 \; mA$

$$Y_{12} = \frac{I_1}{V_2} = \frac{3.4065 \times 10^{-3}}{10.21} = 0.33 \times 10^{-3} \; \Omega^{-1}$$

$$Y_{22} = \frac{I_2}{V_2} = \frac{6.813 \times 10^{-3}}{10.21} = 0.667 \times 10^{-3} \; \Omega^{-1}$$

Theoretical Values

$Y_{11} = 0.66 \times 10^{-3} \; \Omega^{-1}$

$Y_{21} = 0.33 \times 10^{-3} \; \Omega^{-1}$

$Y_{12} = 0.33 \times 10^{-3} \; \Omega^{-1}$

$Y_{22} = 0.667 \times 10^{-3} \; \Omega^{-1}$

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Case 4 : $Y_{22} = I_2/V_2$ when $V_1 = 0$ & Y_{22} is short circuit output admittance.

These parameters are called short circuit admittance parameters.

Percentage Error

$$Y_{11} = \frac{|0.66 - 0.636| \times 10^{-3} \times 100}{0.66 \times 10^{-3}} = 4.5\%$$

$$Y_{21} = \frac{|0.33 - 0.31| \times 10^{-3} \times 100}{0.333 \times 10^{-3}} = 6\%$$

$$Y_{12} = \frac{|0.333 - 0.313| \times 10^{-3} \times 100}{0.33 \times 10^{-3}} = 6\%$$

$$Y_{22} = \frac{|0.667 - 0.646| \times 10^{-3} \times 100}{0.667 \times 10^{-3}} = 3.148\%$$

Result

Theoretical & practical values of y-parameter have been verified.

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Experiment – 1(b)

- **Aim** – To Calculate & verify z – parameters of two port network.

- **Apparatus**: Power Supply, voltmeter, ammeter, two port T – network.

- **Theory**

Expressing two port voltage in terms of current

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

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

Case I

When output is open circuit & $I_2 = 0$

$Z_{11} = V_1 / I_1$, Z_{11} is input impedance.

Case II

When output is open circuit & $I_2 = 0$

$Z_{21} = V_2 / I_1$, Z_{21} is forward transfer impedance

Case – III

When output is open ckt. & $I_1 = 0$

$Z_{12} = \dfrac{V_1}{I_2}$, Z_{12} is reverse transfer impedance.

Case IV

$Z_{22} = \dfrac{V_2}{I_2}$, Z_{22} is open ckt. impedance.

Theoretical Values

$Z_{11} = 2\ k\Omega$

$Z_{21} = 1\ k\Omega$

$Z_{12} = 1\ k\Omega$

$Z_{22} = 2\ k\Omega$

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- Percentage Error

$$Z_{11} = \frac{2 \times 10^3 - 1.9 \times 10^3}{2 \times 10^3} \times 100 = 5\%$$

$$Z_{21} = \frac{|1 - 0.91| \times 10^3}{1 \times 10^3} \times 100 = 9\%$$

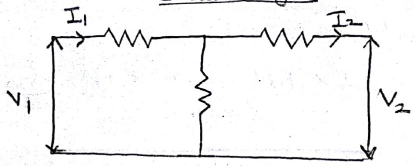
$$Z_{22} = \frac{|2 - 2.05| \times 10^3}{2 \times 10^3} \times 100 = 2.5\%$$

$$Z_{12} = \frac{|1 \times 10^3 - 0.96 \times 10^3|}{1 \times 10^3} \times 100 = 3.02\%$$

- Result

Theoretical & practical values of z Parameter have been verified.

Circuit Diagram



Observations

	V_1	V_2	I_1	I_2
O/P Port Open Circuit	8.1V	4.01V	4.1mA	0mA
O/P Port Short Circuit	8V	0V	5.1mA	2.7mA

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Experiment 2

Aim: To calculate & verify "ABCD" parameters of a two port network.

Apparatus: Breadboard, resistance, supply, voltmeter, ammeter, wires.

Theory

The ABCD parameters serve to relate the voltage & current at one port to voltage & current at the other port.

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

In matrix form,

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

For a given network, these parameters are determined

$$A = \frac{V_1}{V_2}, \quad I_2 = 0$$

$A \rightarrow$ Reverse voltage gain with output port (open circuited).

$$C = \frac{I_2}{V_2}, \quad I_2 = 0$$

$C \rightarrow$ Transfer Impedance with output port (open circuited).

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Calculations

$A = \frac{V_1}{V_2} = \frac{8.1}{4.01} = 2.02$

$C = \frac{I_1}{V_2} = \frac{4.1 \times 10^{-3}}{4.02} = 1.02 \times 10^{-3}$ at $I_2 = 0$

$B = \frac{V_1}{-I_2} = \frac{8}{2.7 \times 10^{-3}} = 2.96 \times 10^{3}$ at $V_2 = 0$

$D = \frac{I_1}{-I_2} = \frac{5.1 \times 10^{-3}}{2.7 \times 10^{-3}} = 1.88$ at $V_2 = 0$

Percentage Error

$A = \frac{|2.02 - 2|}{2} \times 100 = 1\%$

$B = \frac{|2.96 \times 10^{3} - 3 \times 10^{3}|}{3 \times 10^{3}} \times 100 = 1.3\%$

$C = \frac{|1.02 \times 10^{-3} - 10^{-3}|}{10^{-3}} \times 100 = 2\%$

$D = \frac{|1.86 - 2|}{2} \times 100 = 6\%$

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$B = \frac{V_1}{-I_2}$, $V_2 = 0$ $D = \frac{I_1}{-I_2}$, $V_2 = 0$

B → Transfer Impedence with output port short circuited.
D → Reverse current gain with o/p port short.
These parameter are called transmission parameters.

- Procedure

1. Make the circuit according to the network.
2. Calculate "ABCD" parameters.
3. Verify the result with theoretical values.

- Result

The theoretical and experimental values of "ABCD" parameters are calculated & verified.

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Experiment 3

- **Aim**: To determine hybrid parameters of two-port network.

- **Apparatus**: Hybrid Parameters Kit, Multimeter.

Theory

Expressing 2-port voltage in terms of h-parameters:

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

In matrix form –

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

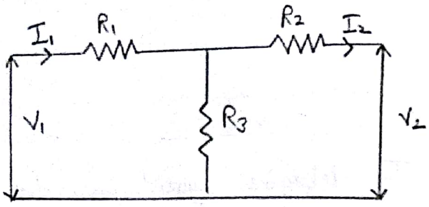
Case I: $h_{11} = \dfrac{V_1}{I_1}$, when $V_2 = 0$ [h_{11} = input impedence with output short circuit]

Case II: $h_{21} = \dfrac{I_2}{V_1}$, when $V_2 = 0$ [h_{21} = forward current gain with output port SC]

Case III: $h_{12} = \dfrac{V_1}{V_2}$, when $I_1 = 0$ [h_{12} = Rev. voltage gain with I/P port open circuited]

Case IV: $h_{22} = \dfrac{I_2}{V_2}$, when $I_1 = 0$ [h_{22} = o/p admittance with I/P port open circuited]

$R_1 = R_2 = R_3 = 1\Omega$



Circuit Diagram

Observations

Circuit	V_1 (V)	I_1 (mA)	V_2 (V)	I_2 (mA)
I/P Open Circuit	4.93	0	10	4.8
O/P Short Circuit	10	0.3	3.1	0

Calculations

Input Open Circuit

$V_1 = 4.82\,V \quad V_2 = 10V \quad I_2 = 13.5\,mA$

$h_{11} = \frac{4.82}{30} = 0.482, \quad h_{22} = \frac{18.5\times10^{-3}}{10} = 1.3\times10^{-3}$

Output Short Circuit

$I_1 = 18\,mA \quad I_2 = 14.5\,mA \quad V_1 = 10V$

$h_{11} = \frac{10}{18\times10^{-3}} = 0.55\times10^{3} \quad h_{21} = \frac{12.5\times10^{-3}}{18\times10^{-3}} = 0.8$

- **Percentage Error**

$h_{11} = \frac{0.55\times10^{3} - 0.55\times10^{3}}{0.55\times10^{3}}\times100 = 0\%$

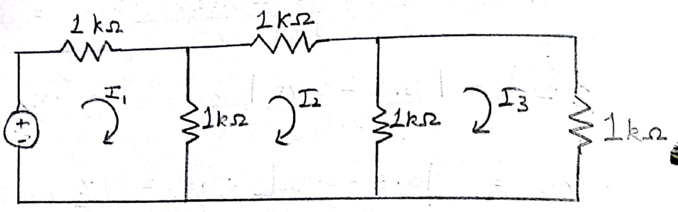
$h_{21} = \frac{|0.8-0.75|}{0.8}\times100 = 3.7\%$

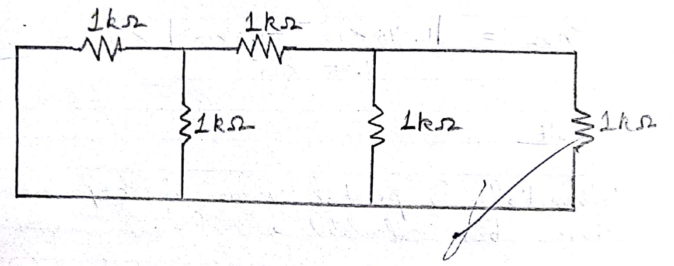
$h_{12} = \frac{|0.5-0.482|}{0.5}\times100 = 4\%$

$h_{22} = \frac{|1.45\times10^{-3}-1.3\times10^{-3}|}{1.45\times10^{-3}}\times100 = 3.3\%$

- **Result**

Theoretical & practical values of h-parameters have been calculated & verified.





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Experiment 4

- **Aim**: Verification of Reciprocity Theorem.
- **Apparatus**: Experimental Training Board, Connecting wires ammeter.
- **Theory**

Reciprocity Theorem states that a linear network is said to be reciprocal if it remains invariant due to interchange of position of cause & effect in the network.

If we consider two loops A & B of a network N and if an ideal voltage source E in loop A produces a current I in loop B, then interchanging the positions, if an identical source in loop B produces the same current I in loop A, the network is said to be reciprocal.

- **Procedure**

1. Make the circuit as per circuit dig. in fig 1.
2. Measure the loop currents I_1, I_2 & I_3.
3. Now Connect the circuit as per fig. 2
4. Measure the loop currents I_1', I_2', I_3'.

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Observations

Current	Magnitude (mA)
I_1	7.5
I_2	2.1
I_3	1.0
I_1'	1.0
I_2'	2.1
I_3'	7.5

$I_1 = I_3'$

$I_2 = I_2'$

$I_3 = I_1'$

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- Observations –

$I_1 = 7.5\,mA$ $\quad$ $I_1' = 1.0\,mA$

$I_2 = 2.1\,mA$ $\quad$ $I_2' = 2.1\,mA$

$I_3 = 1.0\,mA$ $\quad$ $I_3' = 7.5\,mA$

- Result

Since $I_1 = I_3'$

$I_2 = I_2'$

$I_3 = I_3'$

∴ Reciprocity Theorem is verified.

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Experiment - 5

- **Aim** : Determination of ABCD parameters for a cascade connection.
- **Apparatus** : Breadboard, resistance, power supply, wires, multimeter.
- **Theory** : The transmission parameters serve to relate the voltage & current at our port to voltage & current at the other port.

In equation form, $V_1 = AV_2 - BI_1$
$I_1 = CV_2 - DI_1$

In matrix form,

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

In two port networks, they are said to be connected in cascade. The output port of the first become the input port of the second.
For the network N_a the transmission parameters equation are -

$$\begin{bmatrix} V_{Ia} \\ I_{Ia} \end{bmatrix} = \begin{bmatrix} A_a & B_a \\ C_a & D_a \end{bmatrix} \begin{bmatrix} V_{2a} \\ -I_{2a} \end{bmatrix}$$

for the network N_b, the transmission Parameter equations are, Observation Table

(1) For a circuit N_a,

	V_{1a}	V_{2a}	I_{1a} (mA)	$-I_{2a}$
o/c	10.05	5 V	5.0	0
s/c	10.05	0	6.4	3.2

(2) For circuit N_b

	V_{1b}	V_{2b}	I_{1b} (mA)	I_{2b} (mA)
s/c	10.05	0	6.3	3.2
o/c	10.05	5	5.6	0

3) For a cascade

	V_1	V_2	I	I_2
S/c	10.05	0	5.56	0.817
o/c	10.05	1.432	5.5	0

$$\begin{bmatrix} V_{1b} \\ I_{1b} \end{bmatrix} = \begin{bmatrix} A_b & B_b \\ C_b & D_b \end{bmatrix} \begin{bmatrix} V_{2b} \\ -I_{2b} \end{bmatrix}$$

For the cascade connections as shown in the fig

$I = I_{1a}$, $-I_{2a} = I_{1b}$, $I_2 = I_{2b}$, $V_1 = V_{1a}$, V_{2a}

The overall transmission parameters of the combined network N_a & N_b.

$$\begin{bmatrix} V_1 \\ I_1 \end{bmatrix} = \begin{bmatrix} V_{1a} \\ I_{1a} \end{bmatrix} \begin{bmatrix} A_a & B_a \\ C_a & D_a \end{bmatrix} \qquad \begin{bmatrix} V_{2a} \\ -I_{2a} \end{bmatrix} = \begin{bmatrix} A_a & B_a \\ C_a & D_a \end{bmatrix} \begin{bmatrix} V_{1b} \\ I_{1b} \end{bmatrix}$$

$$\begin{bmatrix} A_a & B_a \\ C_a & D_a \end{bmatrix} \begin{bmatrix} A_b & B_b \\ C_b & D_b \end{bmatrix} \begin{bmatrix} V_{2b} \\ -I_{2b} \end{bmatrix} = \begin{bmatrix} A_a & B_a \\ C_a & D_a \end{bmatrix} \begin{bmatrix} A_b & B_b \\ C_b & D_b \end{bmatrix} \begin{bmatrix} V_2 \\ -I_2 \end{bmatrix}$$

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

$$\begin{bmatrix} A & B \\ C & D \end{bmatrix} = \begin{bmatrix} A_a & B_a \\ C_a & D_a \end{bmatrix} \begin{bmatrix} A_b & B_b \\ C_b & D_b \end{bmatrix}$$

Result

The cascade connection parameters has been verified.

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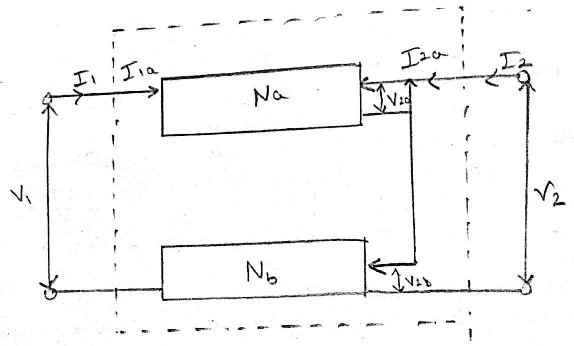

For $N_a = N_b$

	V_1	V_2	I_1	I_2
Port 1-1' open	12	5.96	6.4	0
Port 2-2' open	5.98	12	0	6.4

For Series

	V_1	V_2	I_1	I_2
Port 1-1' open	12	5.99	2.99	0
Port 2-2' open	6.03	12	0	3.006

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Experiment - 6

- **Aim**: Determination of Z-parameters for series-series connection.

- **Apparatus**: Breadboard, resistance, power supply, multimeter.

- **Theory**

A given two port network with some degree of complexity can be built up from simpler two port networks whose ports are inter connected in certain ways. Its so much easier to design simple blocks & to interconnect them to design a complex network in one piece. They are basically connected in :- series-series, series-parallel, parallel series, paral.-par.

Z - parameters for network A

$$\begin{bmatrix} V_1 \\ V_{2a} \end{bmatrix} = \begin{bmatrix} Z_{11a} & Z_{12a} \\ Z_{21a} & Z_{22a} \end{bmatrix} \begin{bmatrix} I_{1a} \\ I_{2a} \end{bmatrix}$$

Z - parameters for network B

$$\begin{bmatrix} V_{1b} \\ V_2 \end{bmatrix} = \begin{bmatrix} Z_{11b} & Z_{12b} \\ Z_{21b} & Z_{22b} \end{bmatrix} \begin{bmatrix} I_{1b} \\ I_{2b} \end{bmatrix}$$

The two networks are in series.

Calculations

For $N_a = N_b$

$Z_{11b} = Z_{11a} = \frac{V_{1a}}{I_{1a}} = 1875$

$Z_{12b} = \frac{V_{2a}}{I_{1a}} = 931 \quad I_{2a} = 0$

$Z_{22b} = Z_{22a} = \frac{V_{2a}}{I_{2a}} = 1875 \quad I_{1a} = 0$

$Z_{21b} = Z_{12a} = \frac{V_{1a}}{I_{2a}} = 934 \quad I_{1a} = 0$

For Z - series

$Z_{11} = V_1/I_1 = \frac{12}{2.992 \times 10^{-3}} = 4010 \quad I_2 = 0$

$Z_{21} = \frac{V_2}{I_1} = \frac{5.99}{2.99 \times 10^{-3}} = 2002 \quad I_2 = 0$

$Z_{12} = V_1/I_2 = \frac{6.03}{3.006 \times 10^{-3}} = 2006 \quad I_1 = 0$

$Z_{22} = \frac{V_2}{I_2} = \frac{12}{3.006 \times 10^{-3}} = 3992 \quad I_1 = 0$

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$I_1 = I_{1a} = I_{1b} \qquad I_2 = I_{2a} = I_{2b}$

$V_1 = V_{1a} + V_{1b} \qquad V_2 = V_{2a} + V_{2b}$

Now, $V_1 = V_{1a} + V_{1b}$

$= (Z_{11a} + Z_{11b})I_1 + (Z_{12a} + Z_{12b})I_2$

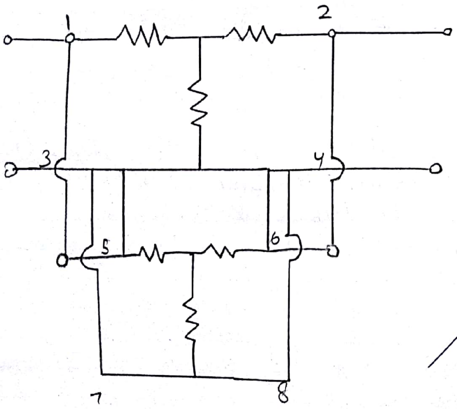
& $V_2 = (Z_{21a} + Z_{21b})I_1 + (Z_{22a} + Z_{22b})I_2$

- Procedure

1. Make the circuit acc. to the network ($N_a = N_b$)
2. Calculate Z-param. of block N_a & N_b.
3. Connect N_a & N_b in series.
4. Find Z parameters of the series block.

- Result

The theoretical & practical values of Z-Parameters for a series-series connection & hence calculated & verified.



Experiment 7

- **Aim**: To determine Y – parameters of a given parallel connection.

- **Apparatus**: Breadboard, power supply, resistance, multimeter.

- **Theory**

Parallel Combination

Y – parameters equations for network N_a

$I_{1a} = Y_{11a} V_{1a} + Y_{12a} V_{2a}$

$I_{2a} = Y_{21a} V_{1a} + Y_{22a} V_{2a}$

Y – parameter equation for network N_b,

$I_{1b} = Y_{11b} V_{1b} + Y_{12b} V_{2b}$

$I_{2b} = Y_{21b} V_{1b} + Y_{22b} V_{2b}$

for parallel connection

$V_1 = V_{1a} = V_{1b}$

$V_2 = V_{2a} = V_{2b}$

$I_1 = I_{1a} + I_{1b}$

$I_2 = I_{2a} = I_{2b}$

By combining these equations,

$I_1 = I_{1a} + I_{1b}$

Observation Table

For circuit Na,

V_{1a}	V_{2a}	I_{1a}	I_{2a}
12	0	8.5	4.2
0	12	4.2	8.5

For circuit Nb,

V_{1b}	V_{2b}	I_{1b}	I_{2b}
12	0	16.97	8.51
0	12	8.51	16.97

For parallel combination,

V_1	V_2	I_1	I_2
0	5.03V	1.608	4.7
5.01V	0	4.7	1.6

Calculations

For Na, $Y_{11a} = I_{1a}/V_{1a} \Big]_{V_{2a}=0}$

$Y_{12a} = I_{1a}/V_{2a} \Big]_{V_{1a}=0}$

$Y_{21a} = I_{2a}/V_{1a} \Big]_{V_{2a}=0}$

$Y_{22a} = I_{2a}/V_{2a} \Big]_{V_{1a}=0}$

For N_b, $Y_{11b} = I_{1b}/V_{1b} \Big]_{V_{2b}=0}$

$Y_{12b} = I_{1b}/V_{1b} \Big]_{V_{1b}=0}$

$Y_{21b} = I_{2b}/V_{1b} \Big]_{V_{2b}=0}$

$Y_{22b} = I_{2b}/V_{1b} \Big]_{V_{1b}=0}$

For parallel circuit,

$Y_{11} = I_1/V_1 \Big]_{V_2=0}$

$Y_{12} = I_1/V_2 \Big]_{V_1=0}$

$Y_{21} = I_2/V_1 \Big]_{V_2=0}$

$Y_{22} = I_1/V_2 \Big]_{V_1=0}$

$= (Y_{11a}V_{1a} + Y_{12a}V_{2a}) + (Y_{11b}V_{1b} + Y_{12b}V_{2b})$

$= (Y_{11a} + Y_{11b})V_1 + (Y_{12a} + Y_{12b})V_2$

And, $I_2 = I_{2a} + I_{2b}$

$= (Y_{21a}V_{1a} + Y_{22a}V_{1b}) + (Y_{21b}V_{1b} + Y_{22b}V_{2b})$

$= (Y_{21a} + Y_{21b})V_1 + (Y_{22a} + Y_{22b})V_2$

In matrix form,

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

where, $Y_{11} = Y_{11a} + Y_{11b}$

$Y_{21} = Y_{21a} + Y_{21b}$

$Y_{12} = Y_{12a} + Y_{12b}$

$Y_{22} = Y_{22a} + Y_{22b}$

where result may be generelized for any no. of two port network connected in parallel - connected two port network is simply the sum of Y-parameters of each individual two port network connected in parallel.

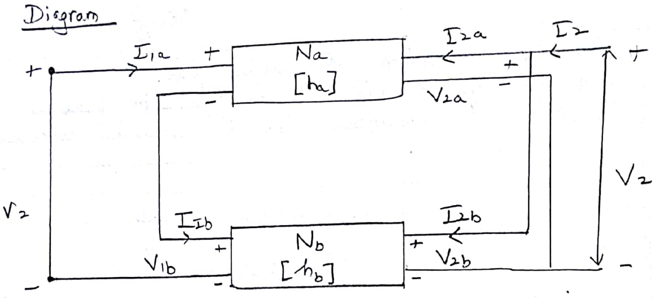
- Procedure.

1. Make the circuit according to the network.
2. Find Y-parameters of circuit Na.

3. Find Y - Parameters of circuit N_b.

4. Connected the circuit N_a & N_b in parallel & find Y - Parameters for the parallel connection.

Diagram



S - P connection of two port network

Observations

Circuit	V_1 (V_2)	V_2 (v)	I_1 (mA)	I_2 (mA)
Na = Nb	4.93 10	10 3.1	0 6.3	4.8 0
Series Parallel	10.01 19.7	20.1 6.3	0 6.3	9.6 0

telco Dt.: Pg.:

Experiment 8

- Aim : To design series – parallel & determine hybrid parameters for the given two-port network.
- Equipments : Hybrid parameters kits, multimers.
- Theory : A given two-port network with some degree of complexity can be built up from simpler two-port network whose ports are interconnected in certa[in] way. It is much easier to design a complex network in one piece. They are connected in s-s, s-p, p-s, p-p connection. The s-p connections are used to determine the hybrid parameters. The two port networks are said to be connected in s-p if the input ports are connected in series while the output ports are connected in ~~ser~~ paral[lel]

$V_1 = V_{1a} + V_{1b}$
$I_1 = I_{1a} + I_{1b}$
$V_2 = V_{2a} \mp V_{2b}$
$I_2 = I_{2a} + I_{2b}$

For network Na

$V_{1a} = h_{11} I_1 a + h_{12a} V_2 a$
$I_{2a} = h_{21a} I_{1a} + h_{22a} V_{2a}$

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Calculations

For $N_a = N_b$,

$h_{11} = \frac{V_1}{I_1} = \frac{10}{6.3\times10^{-3}} = 1.58\times10^{-3}\,\Omega$

$h_{21} = \frac{I_2}{I_1} = \frac{4.93}{3.1} = 0.49$

$h_{12} = \frac{V_1}{V_2} = \frac{4.03}{10} = 0.493$

$h_{22} = \frac{I_2}{V_2} = \frac{4.8\times10^{-3}}{10} = 0.48\times10^{-3}\,\mho$

For Series-parallel Connected Network,

$h_{11} = \frac{V_1}{I_1} = \frac{19.7}{6.93\times10^{-3}} = 3.129\times10^{-3}\,\Omega$

$h_{21} = \frac{I_2}{I_1} = \frac{10.01\times10^{-3}}{6.3\times10^{-3}} = 1.25$

$h_{12} = \frac{V_1}{V_2} = \frac{10.09}{19.7} = 1.091$

$h_{22} = \frac{I_2}{V_2} = \frac{9.6\times10^{-3}}{20.1} = 1.12\times10^{-3}\,\mho$

For network N_b,

$V_{1b} = h_{11b} I_{1b} + h_{12b} V_{2b}$

$I_{2b} = h_{21b} I_{1b} + h_{22b} V_{2b}$

As per connection, the final parameters can be evaluated as –

$h_{11} = h_{11a} + h_{11b}$

$h_{12} = h_{12a} + h_{12b}$

$h_{21} = h_{21a} + h_{21b}$

$h_{22} = h_{22a} + h_{22b}$

- Procedure

1. Make the circuit according to the network.
2. Calculate "h" parameters using the circuit N_a.
3. Calculate "h" parameters using the circuit N_b.
4. Verify the result with the theoretical values.

- Result

Hence, the theoretical & experimental values of 'h' parameters are calculated & verified.

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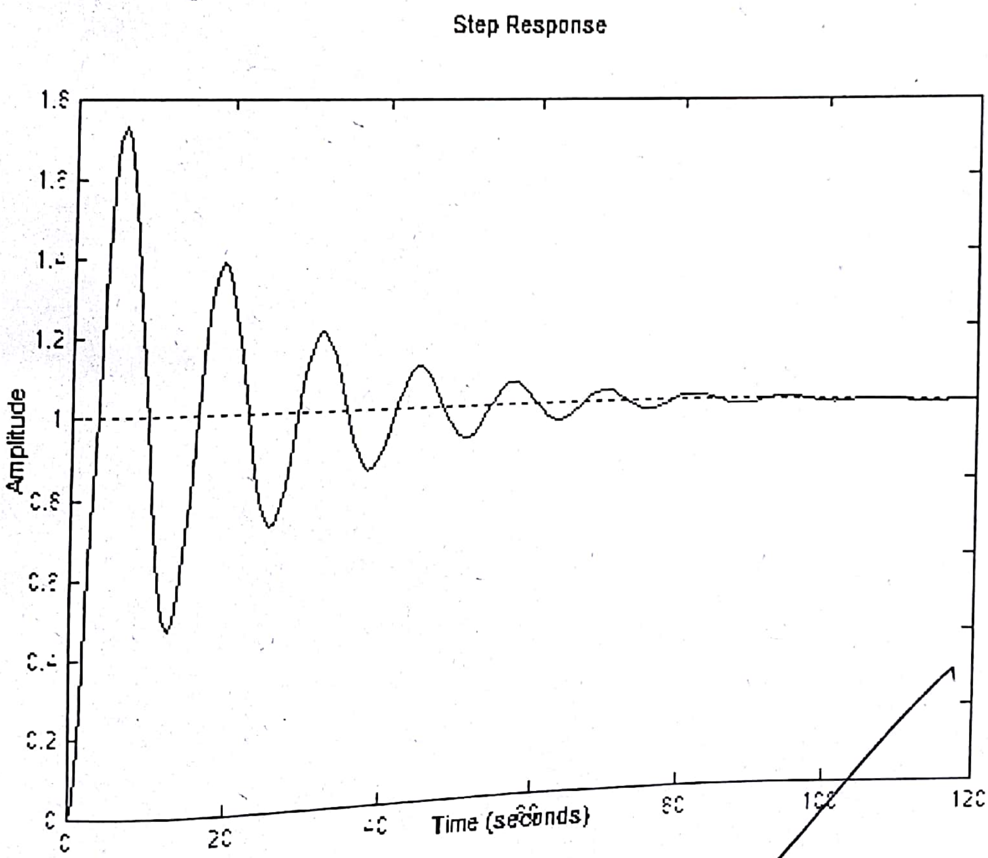
EXPERIMENT 9

AIM : Transient response of RLC series circuit.

```
>> R=0.1;

>> R=0.2;

>> L=2;

>> C=2;

>> NEM=[1];

>> DEN=[L*C,R*C,1];

>> SYS=tf(NEM,DEN);

>> step(SYS)
```



RESULT- R, L, C circuit experiment was successfully performed.