Circuits & Systems lab

ETEC 253

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EXPERIMENT - 1

Aim : To determine and verify 'Z' parameters of the given two port network.

Apparatus Required : Power Supply, 2 port kits, patch cords, connecting leads, Voltmeter, ammeter, etc.

Theory :
Z- Parameter - It is also called as open - circuit impedance parameter and unit is (Ω) ohm.
Impedance parameter is commonly used in the synthesis of filter and also useful in design and analysis of impedance matching network and power distribution network.
The two-port network may be voltage-driven / current driven.
The terminal voltage can related to the terminal current as :

$V_1 = Z_{11} I_1 + Z_{12} I_2$ — (1)

$V_2 = Z_{21} I_1 + Z_{22} I_2$ — (2)

In 2 parameters of a two port, the input and output currents I_1 and I_2.
V_1 and V_2 ⟶ dependant variables
I_1 and I_2 ⟶ Independant variables
Z-parameters we need to determine Z_{11}, Z_{12}, Z_{21} and Z_{22}

Aim : To calculate and verify Z parameters of a two - port network

CIRCUIT DIAGRAM :

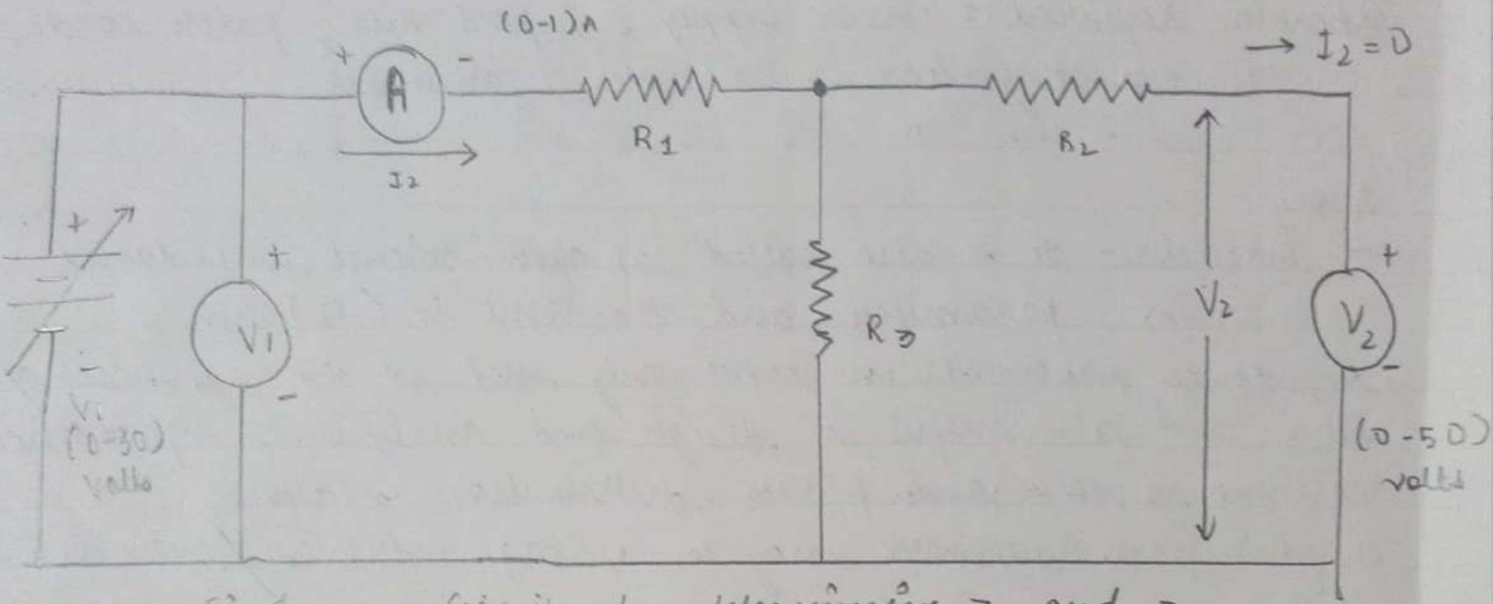


Fig 1. Circuit for determining Z_{11} and Z_{21}

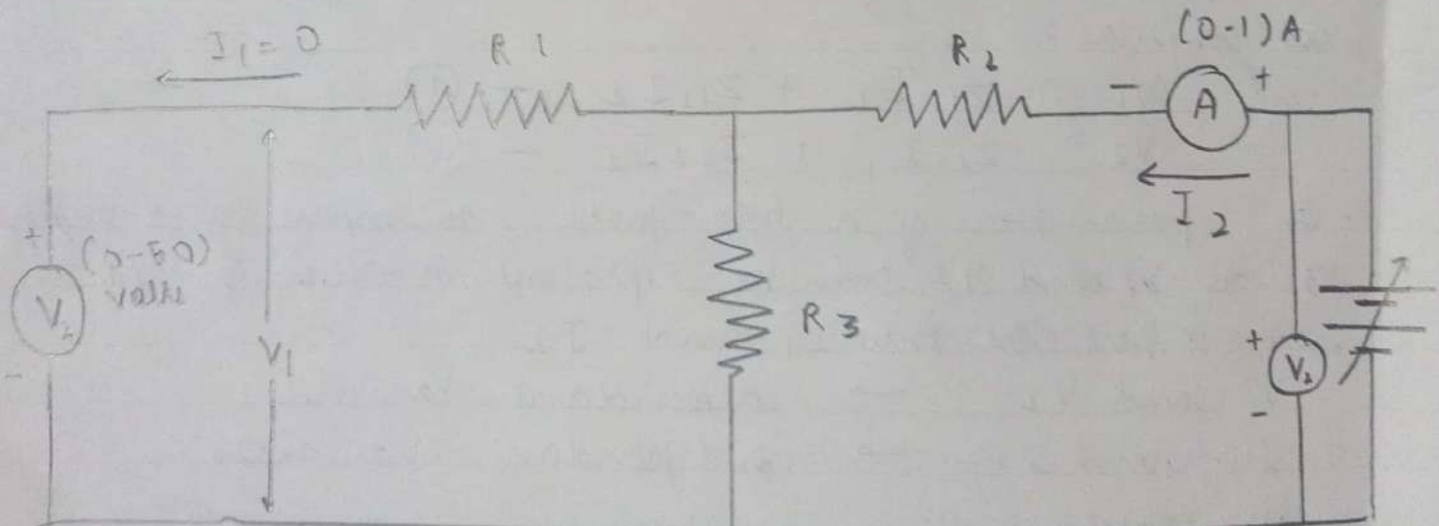
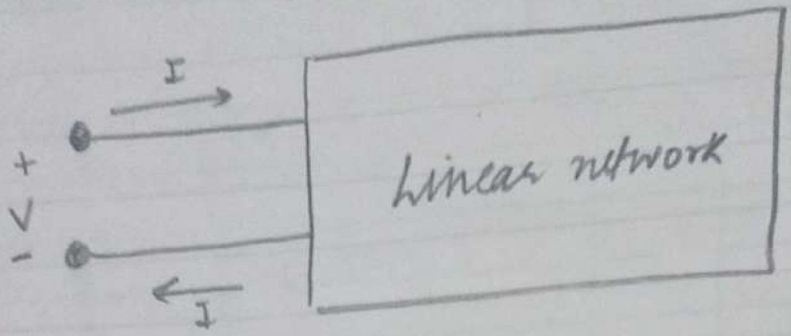
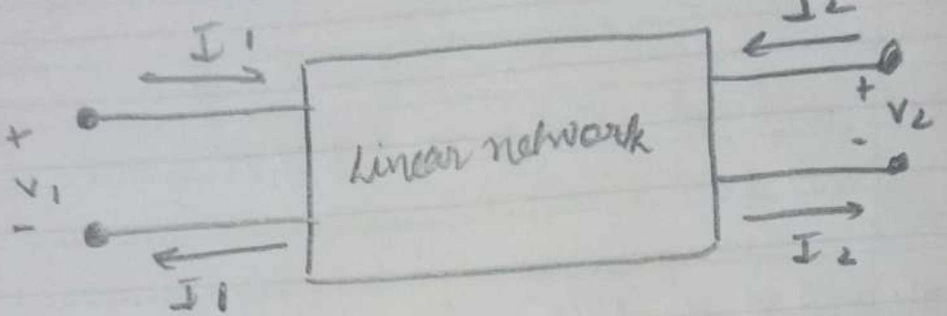


Fig 2. Circuit for determining Z_{12} and Z_{22}

Diagrams

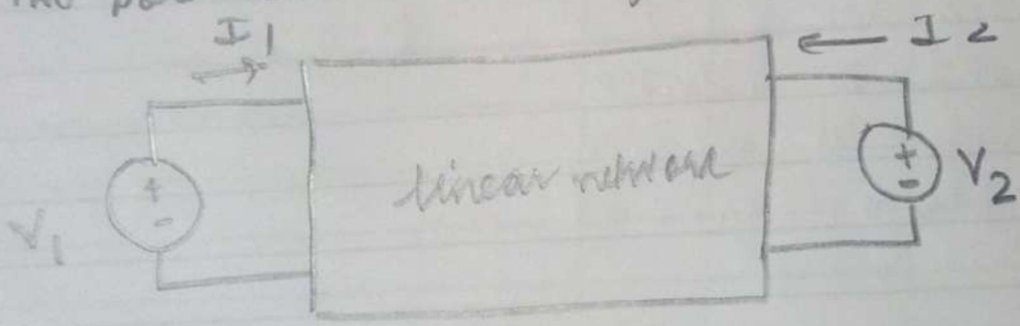


one-port network

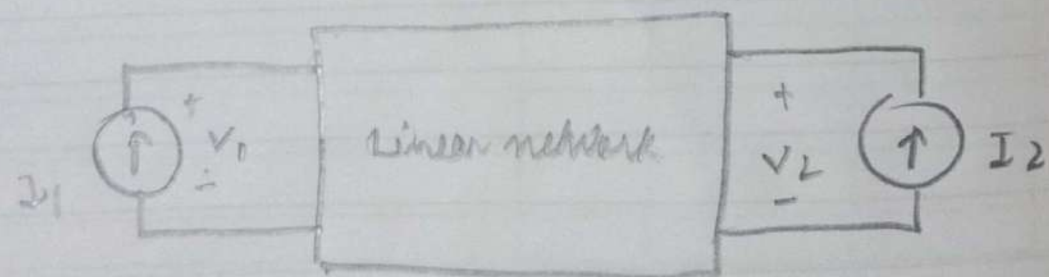


Two-port network

Two port network driven by Voltage



Two port network driven by current



matrix form, $\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$

1) $I_1 = 0$ (input-port open circuited)
2) $I_2 = 0$ (output-port open circuited)

$$Z_{11} = \frac{V_1}{I_1}\Big|_{I_2=0} \quad Z_{12} = \frac{V_1}{I_2}\Big|_{I_1=0} \quad Z_{21} = \frac{V_2}{I_1}\Big|_{I_2=0} \quad Z_{22} = \frac{V_2}{I_2}\Big|_{I_1=0}$$

Z_{11} : Open circuit input impedance
Z_{12} : Open circuit transfer impedance from port 1 to 2
Z_{21} : Open circuit transfer impedance from port 2 to 1
Z_{22} : Open circuit output impedance

Procedure :
1. Connect the circuit as shown in figure and switch 'ON' the experimental board
2. First open the output terminal and supply 5V to the input circuit.
3. Secondly, open input terminal and supply 5V to the output terminal. Measure input voltage and output current using multimeter.
4. Calculate values of Z parameters using eqn (1) and (2)
5. Switch off the supply after taking the reading

Precautions :
1) Make the connections according to circuit diagram.
2) Power supply should be switched off while taking the readings

OBSERVATIONS :

	When O/P is Open Circuited $I_2 = 0$					When I/P is open ckt $I_1 = 0$				
S.no.	V_1 (V)	V_2 (V)	I_1 (mA)	$Z_{11} = V_1/I_1$ (Ω)	$Z_{12} = V_2/I_1$ (Ω)	V_1 (V)	V_2 (V)	I_2 (mA)	$Z_{12} = V_1/I_2$ (Ω)	$Z_{22} = V_2/I_2$ (Ω)
1.	11	5	5	$11/5 = 2.2$	$5/5 = 1$	3.5	8	4	$3.5/4 = 0.875$	$8/4 = 2$

CALCULATIONS :

$Z_{11} = 2.2\ \Omega$; $Z_{21} = 1\ \Omega$

$Z_{12} = 0.875\ \Omega$; $Z_{22} = 2\ \Omega$

Error = 0.125

If $Z_{11} = Z_{22}$; the network is called SYMMETRICAL NETWORK
If $Z_{21} = Z_{12}$; the network is called RECIPROCAL NETWORK

RESULT :

The Z parameter of the two port network has been calculated and verified.

3. connections should be tight
4. Note the readings carefully

Result :
The Z-parameter of two-port network has been calculated and verified

VIVA VOICE

Ques 1. Define Z parameters?
Ans In Z parameter, the input and output voltages V_1 and V_2 can be expressed in terms of input and output currents I_1 and I_2

Ques 2. List the ~~4~~ parameters used in Z-parameter representation
Ans The 4 variables are I_1, I_2, V_1 and V_2

Ques 3. List the 2 dependent variables used in Z-parameter representation
Ans The 2 ~~in~~dependent variables are V_1 and V_2

Ques 4. List 2 independent variables used in Z-parameter.
Ans The 2 independent variables are I_1 and I_2

Ques 5. Define the input driving point impedance.
Ans The input driving point impedance is
defined as the ratio of input voltage to the input current.

Ques 6. Define output driving point impedance.
Ans It is defined as ratio of input voltage to output current

Ques 7 Define reverse impedance transfer.
Ans The reverse transfer impedance is defined as ratio of input voltage to output current

Ques 8. Define forward transfer impedance.
Ans The forward transfer impedance is defined as the ratio of output voltage to input current

Ques 9. Write condition for reciprocity.
Ans condition for reciprocity is $Z_{12} = Z_{21}$

Ques 10. Write condition for symmetry.
Ans condition for symmetry is $Z_{11} = Z_{22}$

EXPERIMENT - 2

Aim : To Calculate and verify 'Y' parameters of two-port network.

Apparatus Required : Power Supply, Two port kits, Patch cords, connecting lead, Voltmeter, Ammeter, etc.

Theory :
Y- PARAMETER - Y-parameter also called short circuit Admittance parameter and unit is siemens (S).
Y - Parameter is used in power, electronics and telecommunication. These parameters are used to describe the electrical behaviour of linear electrical networks. The two-port network may be voltage-driven or current driven.

The terminal voltage can be related to the terminal current as

$$I_1 = y_{11} V_1 + y_{12} V_2 \quad — (1)$$
$$I_2 = y_{21} V_1 + y_{22} V_2 \quad — (2)$$

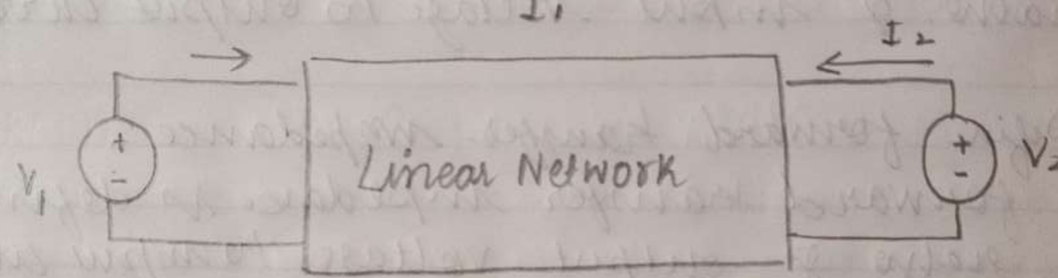
In matrix form as :

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

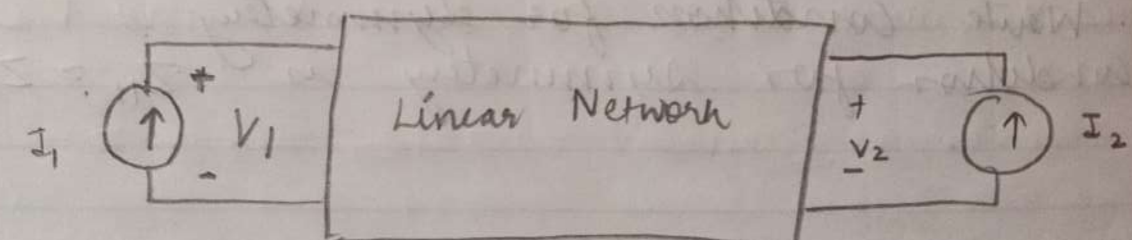
Aim: To calculate and verify 'Y' parameters of two-port network.

CIRCUIT DIAGRAMS

TWO-PORT NETWORK DRIVEN BY VOLTAGE SOURCE:



TWO-PORT NETWORK DRIVEN BY CURRENT SOURCES



$$I_1 = Y_{11} V_1 + Y_{12} V_2 \quad — \quad (1)$$

$$I_2 = Y_{21} V_1 + Y_{22} V_2 \quad — \quad (2)$$

The y-parameter that we want to determine are Y_{11}, Y_{12}, Y_{21}, Y_{22}. The values of the parameters can be evaluated by setting.

1) $V_1 = 0$ (input port short-circuited)
2) $V_2 = 0$ (output port short-circuited)

Thus,

$$Y_{11} = \left.\frac{I_1}{V_1}\right|_{V_2=0} \qquad Y_{12} = \left.\frac{I_1}{V_2}\right|_{V_1=0}$$

$$Y_{21} = \left.\frac{I_2}{V_1}\right|_{V_2=0} \qquad Y_{22} = \left.\frac{I_2}{V_2}\right|_{V_1=0}$$

where,

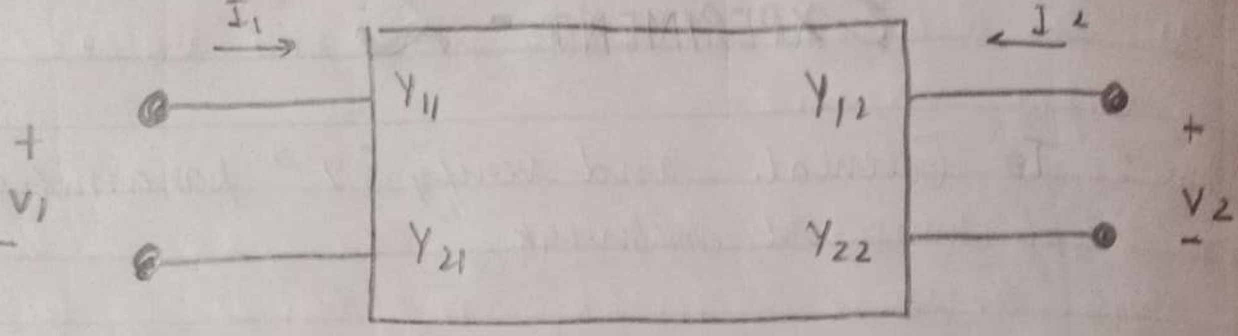
Y_{11} = short circuit input admittance
Y_{12} = short-circuited transfer admittance from port 1 to port 2
Y_{21} = short-circuit transfer admittance from port 2 to port 1
Y_{22} = short circuit output admittance

Procedure :

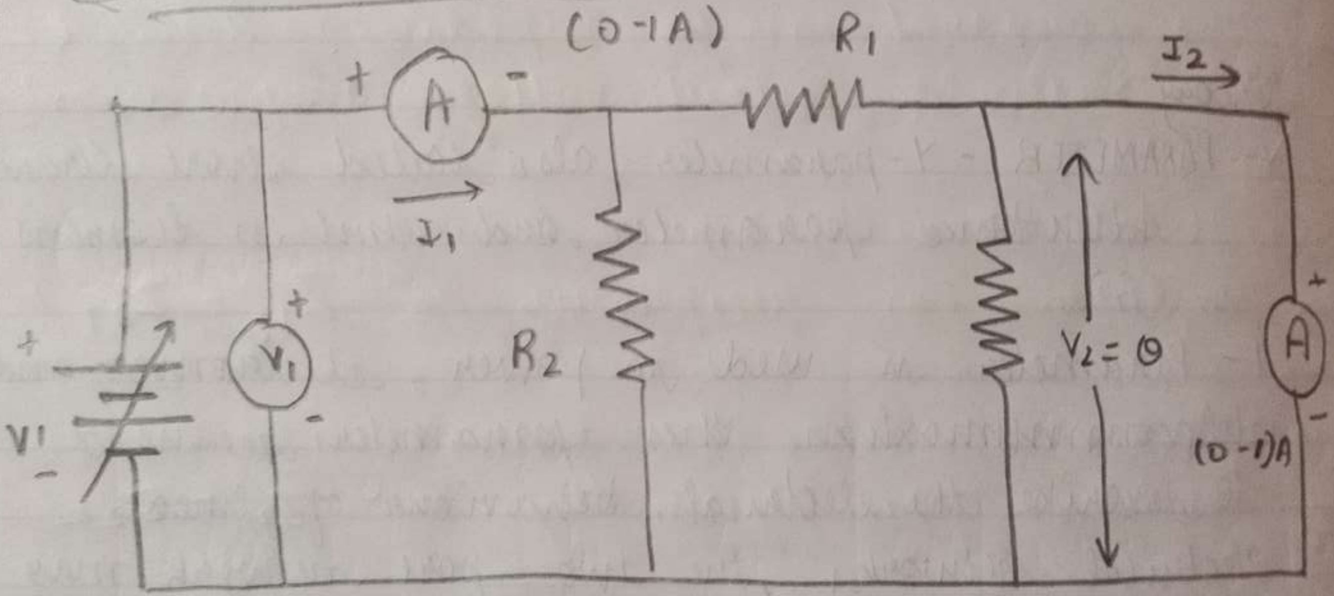
a) Connect the variable voltage to port 1 and keep the port 2 short circuited i.e. $V_2 = 0$ as shown in the figure. Set of voltages on V_1 and measure V_1, I_2 and I_1 for each setting and tabulate Y_{11} and Y_{21}

b) ~~Connect~~ the variable voltage to port 2 and keep the port 1 short circuited i.e. $V_1 = 0$, as

The 'black box' is replaced with Y-parameter is as shown below:



CIRCUIT DIAGRAMS



Circuit for determining Y_{11} and Y_{21}

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

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

shown in the figure. Set different voltages at V_2 and measure V_2, I_1, I_2 for each setting and tabulate Y_{12} and Y_{22}

Precautions :

a) Make the connections according to the circuit diagram. Power supply should be switched off.

b) connections should be tight

c) Note the readings carefully.

Result :

The 'Y' parameter of the two port network has been calculated and verified.

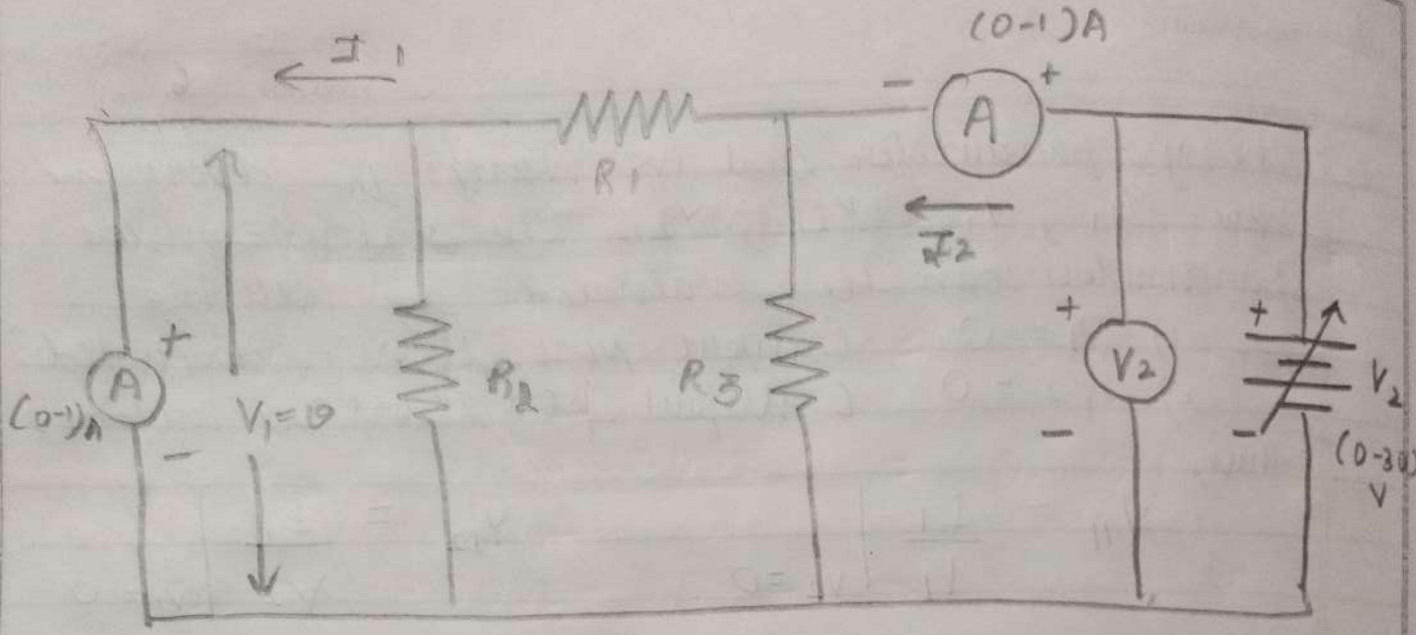
VIVA QUESTIONS

Ques 1. Define Y parameters?

Ans In Y- parameters the input and output currents I_1 and I_2 can be expressed in terms of input and output voltages V_1 and V_2

Ques 2. List the four variables used in Y parameter representation

Ans The four variables are I_1, I_2, V_1 and V_2.



Circuit for determining Y_{12} and Y_{22}

OBSERVATIONS

S.no.	When O/P is short ckt $V_2 = 0$					When I/P is short ckt $V_1 = 0$				
	V_1 (V)	I_1 (mA)	I_2 (mA)	Y_{11} I_1/V_1 (℧)	Y_{21} I_2/V_2 (℧)	V_2 (v)	I_1 mA	I_2 mA	Y_{12} I_1/V_2 (℧)	Y_{22} I_2/V_1 (℧)
1.	2.5	5	2.7	0.002	0.00108	4.5	4.4	7.5	0.0009	0.0016
2.	10	17.5	9	0.00175	0.0009	5	5	10	0.001	0.002

Ques 3. List the two dependent variables used in Y-parameter representation.

Ans The two dependent variables are I_1 and I_2.

Ques 4. List the two independent variables used in Y-parameter representation.

Ans The two independent variables are V_1 and V_2

Ques 5. Define input driving point admittance.

Ans The input driving point admittance is defined as the ratio of input current to the input Voltage.

Ques 6. Define output driving point admittance.

Ans The output driving point admittance is defined as the ratio of output current to the output voltage

Ques 7. Define reverse transfer admittance.

Ans The reverse transfer ratio is defined as ratio of input current to the output voltage.

Ques 8. Define forward transfer admittance.

Ans The forward transfer ratio is defined as ratio of output current to input voltage.

Calculations :

$$Y_{11} = \frac{0.002 + 0.00175}{2} = 0.001875 \; ℧$$

$$Y_{21} = \frac{0.00108 + 0.0009}{2} = 0.00099 \; ℧$$

$$Y_{12} = \frac{0.0009 + 0.001}{2} = 0.00095 \; ℧$$

$$Y_{22} = \frac{0.0016 + 0.002}{2} = 0.0018 \; ℧$$

$Y_{21} \approx Y_{12}$ Error = 0.00004

$\therefore$ The circuit is reciprocal

Result :

The 'Y' parameters of the two-port network has been calculated and verified.

Ques 9. Write the condition for reciprocity
Ans Condition for reciprocity is $Y_{12} = Y_{21}$

Ques 10. Write the condition for symmetry.
Ans Condition for symmetry is $Y_{11} = Y_{22}$

EXPERIMENT - 3

Aim : To calculate and verify 'h' parameters of two-port network.

Apparatus Required : Power Supply, 2 port kits patch cords, connecting leads, voltmeter, ammeter, etc.

Theory :

H- Parameter : In these network there are four parameters called the hybrid parameters or H-parameters, ~~called~~ the one is measured in terms of ohm one in mho and other two are dimension less. Since these parameters has mixed dimension, so they are called as hybrid parameters.

The terminal Voltage can be related to the terminal current as :

$$V_1 = h_{11} I_1 + h_{12} V_2 \quad \text{—} \quad (1)$$

$$I_2 = h_{21} I_1 + h_{22} V_2 \quad \text{—} \quad (2)$$

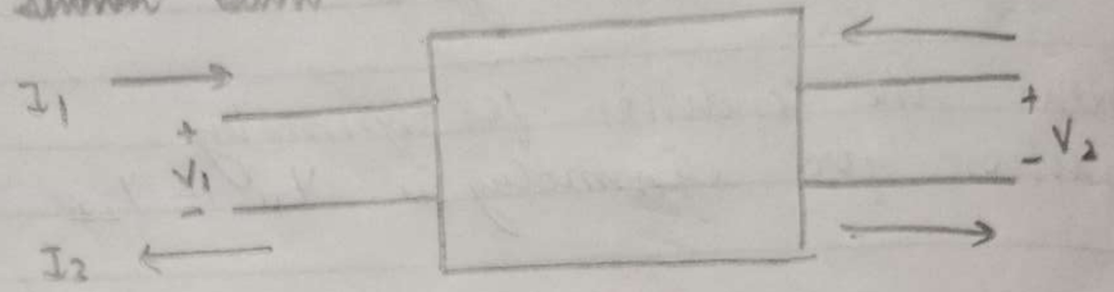
In matrix form as :

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

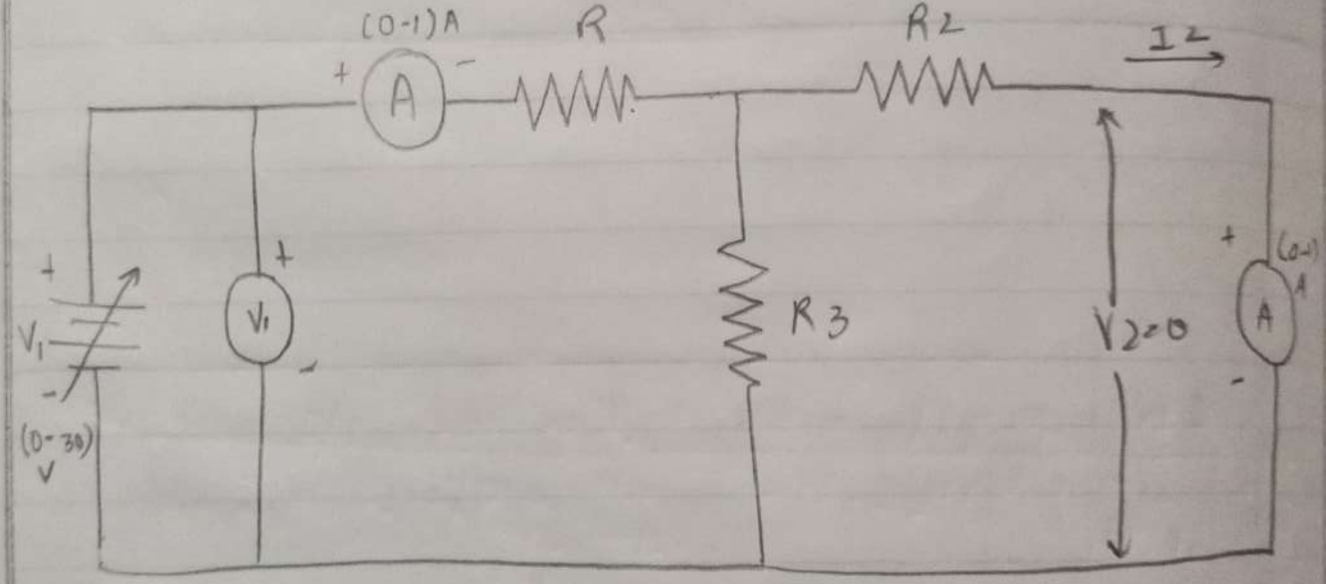
The h-parameter that we want to determine are h_{11}, h_{12}, h_{21}, h_{22}. The value of the parameters can be evaluated by setting :

Aim : To calculate and verify "h" parameters of two port network.

The "black box" is replace with z-parameter is as shown below



Circuit Diagram



circuit for determining h_{11} and h_{22}

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

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

1) $V_2 = 0$ (output port short circuited)
2) $I_1 = 0$ (input port open circuited)

Thus,

$$h_{11} = \frac{V_1}{I_1}\bigg|_{V_2=0}, \quad h_{12} = \frac{V_1}{V_2}\bigg|_{I_1=0}, \quad h_{21} = \frac{I_2}{I_1}\bigg|_{V_2=0}, \quad h_{22} = \frac{I_2}{V_2}\bigg|_{I_1=0}$$

where,

h_{11} = Short-circuit input impedance

h_{12} = Open-circuit reverse voltage gain

h_{21} = Short-circuit forward current gain

h_{22} = open-circuit output ~~admpedan~~ admittance

Procedure

a) Connect the variable voltage to port 1 and keep the port 2 short circuited i.e. $V_2 = 0$ as shown in the figure. Set different voltages on V_1 and measure V_1, I_2 and I_1 for each setting and tabulate h_{11} and h_{21}.

b) Connect the variable voltage to port 2 and keep the port 1 open circuit i.e. $I_1 = 0$ as shown in the figure. Set different voltages at V_2 and measure V_2, I_2, V_1 for each setting and tabulate h_{12} and h_{22}.

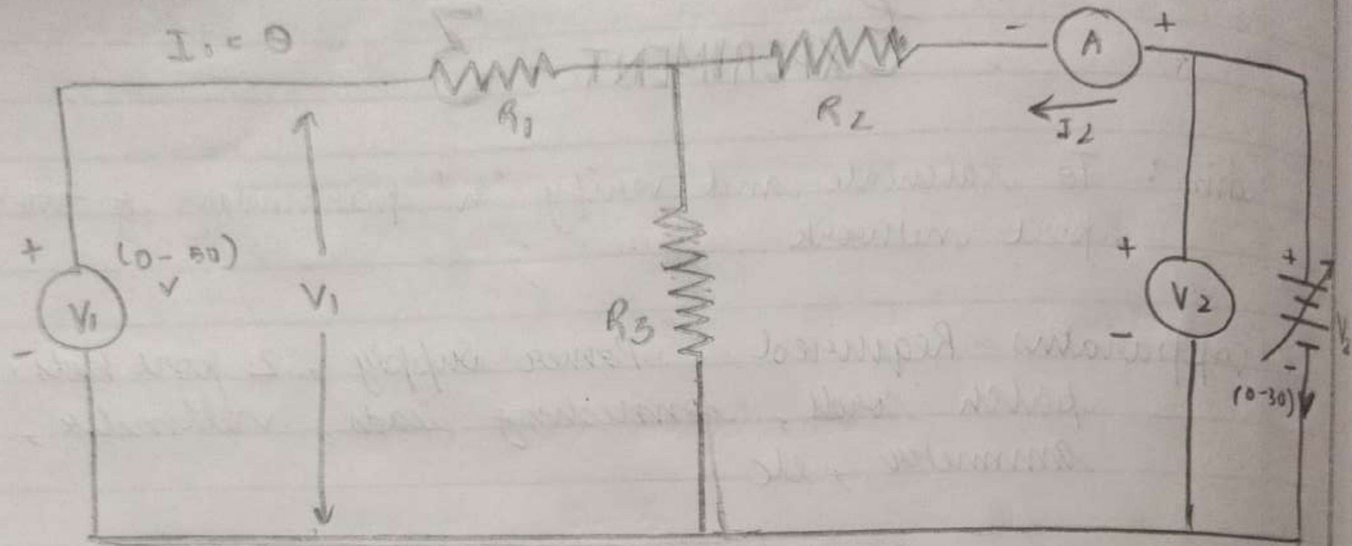
Precautions :

a) Make the connections according to the circuit diagram. Power supply should be switched off.

b) Connections should be tight.

c) Note the readings carefully.

circuit for determining h_{12} and h_{22}



OBSERVATIONS :

S.no.	When O/P is short Ckt $V_2 = 0$					When I/P is open ckt $I_1 = 0$				
	V_1(V)	I_1(mA)	I_2(mA)	h_{11} V_1/I_1 (Ω)	h_{21} I_2/I_1	V_2(V)	I_2(mA)	V_1(V)	h_{12} V_1/V_2	h_{22} I_2/V_2 (℧)
1.	8.5	5	+3.25	1.7 V/mA = 1700 Ω	+0.65	10	5	5	0.5	0.5 mA/V = 0.0005 ℧

$h_{12} = h_{21}$ $\quad\therefore$ Circuit is reciprocal (≈ 0.5)

Result :
The "h" parameters of the two port network has been calculated and verified

VIVA VOICE

Ques1. Define h parameters ?
Ans In "h" parameters of a two port network Voltage of the input port are expressed in terms of the current of the input port and voltage of the the output port

Ques2. List the four variables used in h parameter representation
Ans The four variables are V_1, V_2, I_1 and I_2

Ques3. List the two dependent variables used in h-parameter representation
Ans The two dependent variables are V_1 and I_2.

Ques4. List the two independant variables used in h-parameter representation.
Ans ∴ The two independent variables are I_1 and V_2

Ques5. Define input impedance.
Ans $h_{11} = V_1 / I_1$

Result :

The 'h' parameter of the two port network has been calculated and verified.

$h_{11} = 1700\,\Omega$ $h_{21} = 0.65$

$h_{12} = 0.3$ $h_{22} = 0.0005\,\mho$

circuit is reciprocal

Error = 0.15

Experiment :

Date

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Ques 6. Define output admittance.

Ans $h_{22} = I_2/V_2$

Ques 7. Define forward current gain.

Ans $h_{21} = I_2/I_1$

Ques 8. Define reverse voltage gain.

Ans $h_{12} = V_1/V_2$

Ques 9. Write the condition for reciprocity

Ans condition for reciprocity is $h_{12} = h_{21}$

Ques 10. Write the condition for symmetry.

Ans condition for symmetry is $h_{11} = h_{22}$.

Experiment - 4

Aim: To calculate and verify 'ABCD' parameters of two-port network.

Apparatus Required: Power supply, two port kits, patch cords, connecting leads, voltmeter, ammeter, etc

Theory:

T(ABCD) - PARAMETER

- T- Parameter or ABCD - parameter is a another set of parameters relates the variables at the input port to those at the output port.
- T- parameter also called transmission parameters because these parameters are useful in the analysis of transmission lines because these parameters are express sending-end variables (V_1 and I_1) in terms of receiving end variables (V_2 and $-I_2$)

The terminal voltages can be related to terminal current

$$V_1 = A V_2 + B(-I_2) \quad \text{— (1)}$$

$$I_1 = C V_2 + D(-I_2) \quad \text{— (2)}$$

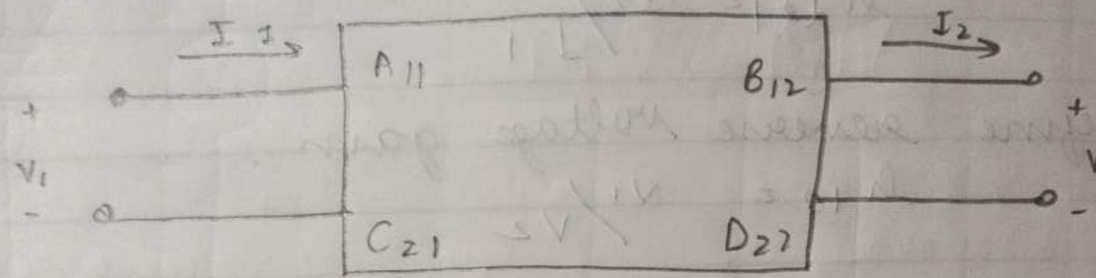
In matrix form as

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

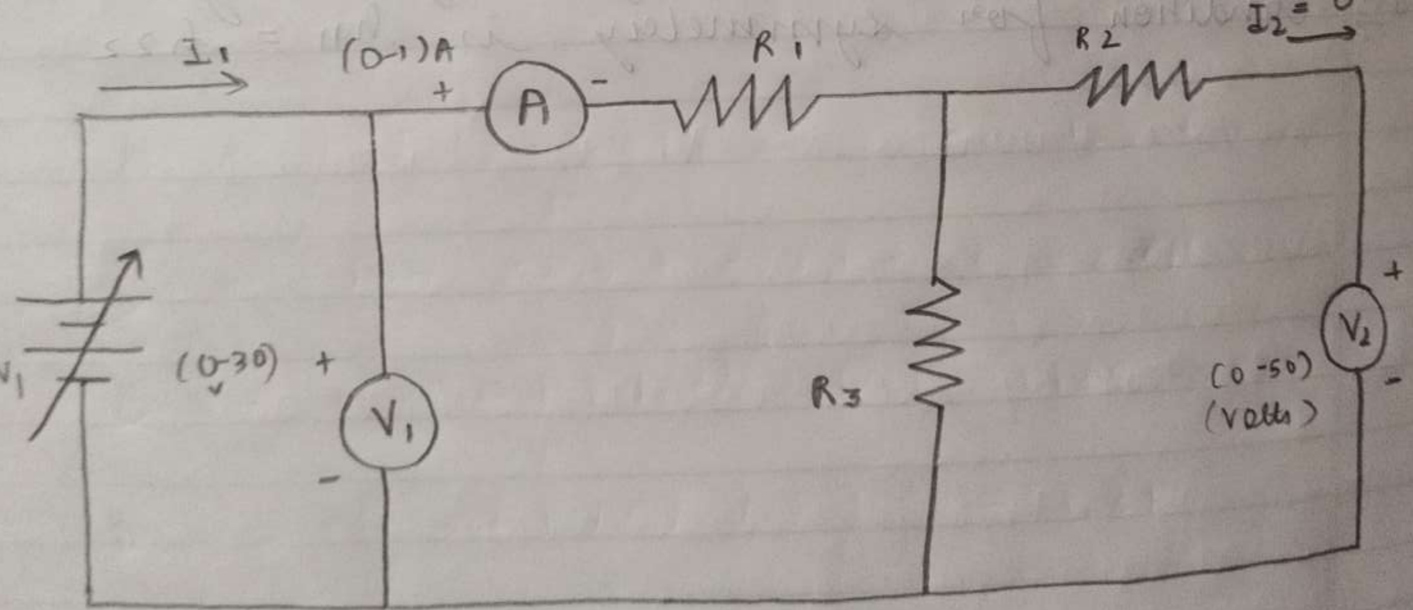
The T- parameter that we want to determine

Aim: To calculate and verify 'ABCD' parameters of the two port network.

The "black box" that we want to replace with T-parameters is shown below.



CIRCUIT DIAGRAM :



circuit for determining A and C

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

are A, B, C and D where A and D are dimensionless, B is in ohm (Ω) and C is in Siemens (S)

The values can be evaluated by setting
- $I_2 = 0$ (output port open circuit)
- $V_2 = 0$ (output port short circuit)

Thus,

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

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

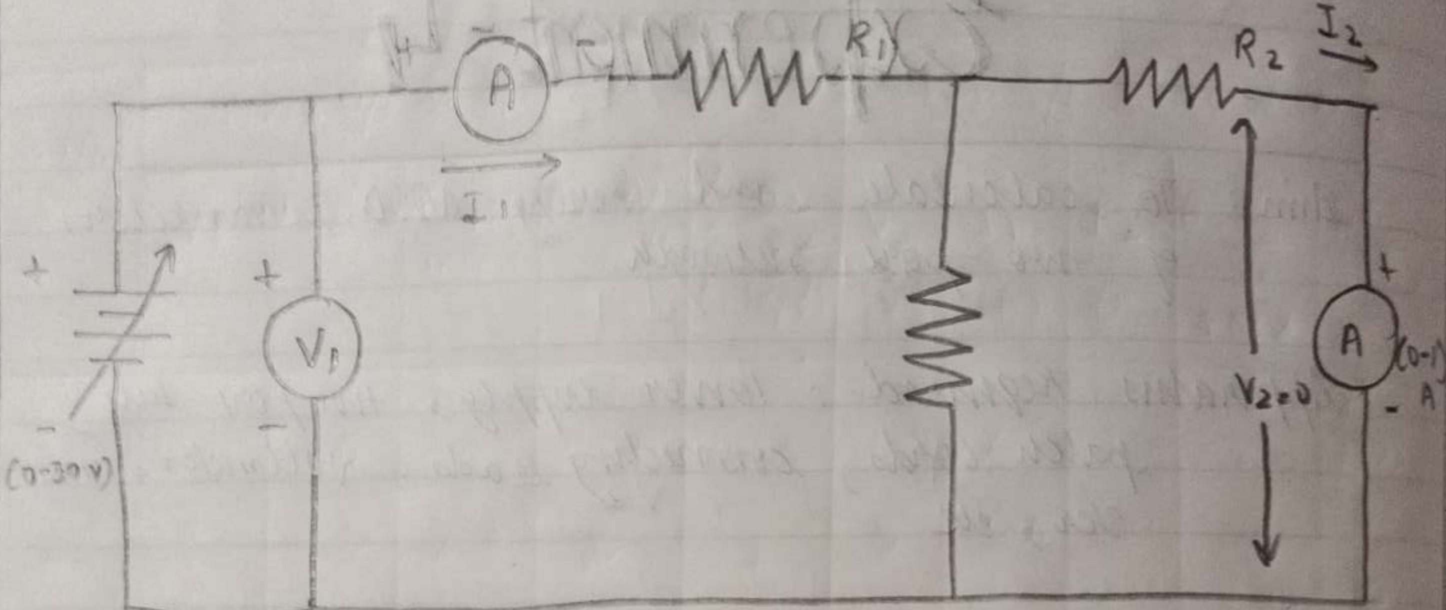
In the term of the transmission parameter, a network is recoprocal if:

$$AD - BC = 1$$

Procedure :

a) connect the variable voltage to port 1 and keep port - 2 open circuit i.e. $I_2 = 0$ as shown in figure. Set different voltages on V_1 and measure V_1, V_2 and I_1 for each setting and tabulate A and C.

b) Connect the variables voltages to port 1 and keep the port 2 short circuit i.e. $V_2 = 0$ as shown in the figure. Set different voltages at V_1 and measure V_1, I_2, I_1 for each setting and tabulate B and D circuit for determining B and D



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

$$A = \frac{1.67 + 2 + 1.87 + 2}{4} = 1.885$$

$$B = \frac{-2.5 + -2.5 + -2.14 + 2.22}{4} = 2.34 \text{ mA/V}$$

$$C = \frac{1.33 + 1 + 1.25 + 1}{4} = 1.145 \text{ mA/V}$$

$$D = \frac{-(2 + 2 + 1.57 + 1.67)}{4} = 1.81$$

Error $(A - D) = 0.075$

Precautions :

a) Make the connections according to the circuit diagram Power supply should be switched off.

b) Connections should be tight.

c) Note the readings carefully.

Result :

The "T (ABCD)" parameters of the two port network has been calculated and verified.

VIVA VOICE

Ques 1. Define transmission parameters.

Ans In these parameters the voltage and current at the sending end terminals can be expressed in terms of voltage and current at the recieving end.

Ques 2. Why ABCD parameters are also called as the transmission parameters?

Ans ABCD parameters are also called as transmission parameters because these are used in the analysis power transmission lines.

Ques 3. Where they are used?

Ans Transmission lines theory and cascade network.

OBSERVATIONS :

S. no.	When O/P is open ckt $I_2 = 0$					When O/P is closed ckt $V_2 = 0$				
	V_1 (V)	V_2 (V)	I_1 (mA)	$A = V_1/V_2$	$C = \frac{I_1}{V_2}$ (mA/V)	V_2 (V)	I_1 (mA)	I_2 (mA)	$B = \frac{V_2}{I_2}$ mA/V	$D = \frac{I_1}{I_2}$
1.	2.5	1.5	2	1.67	1.33	2.5	2mA	1mA	-2.5	-2
2.	5	2.5	2.5	2	1	5	4mA	2mA	-2.5	-2
3.	7.5	4	4.5	1.87	1.25	7.5	5.5	3.5	-2.14	-1.57
4.	10	5	5	2	1	10	7.5	4.5	-2.22	-1.67

$A \equiv D \ (\approx 2)$

$\Rightarrow$ The circuit is symmetric

Result :

The 'T (ABCD)' parameters of the two port network has been calculated and verified

Ques 4. Define reverse voltage ratio (A).
Ans It is defined as the ratio of sending end volt-age to the receiving end voltage.

Ques 5. Define transfer impedance (B).
Ans It is defined as the ratio of sending end voltage to the receiving end current with the receiving end current with the receiving end current assumed to be in reverse direction

Ques 6. Define transfer admittance (C).
Ans It is defined as the ratio of sending end current to the receiving end voltage.

Ques 7. Define reverse current ratio (D).
Ans It is defined as the ratio of sending end current to the receiving end current with the receiving end current assumed to be in reverse direction

Ques 8. Write the units of parameters B and C
Ans Unit of parameter B is ohm and C is mho.

Ques 9. Write the units of parameters A and D
Ans Both parameters A and D are unit less.

Ques 10. Write the condition for symmetry and reciprocity.
Ans condition for symmetry → $A = D$
condition for reciprocity → $AD - BC = 1$

Experiment - 5

Aim : Interconnection of a T network and a pie network in cascade form and determination of ABCD Parameters and verification of results.

Apparatus and Auxiliaries : D.C. power supply (0-12V), Carbon Resistors of 1K - 6K, Panel type DC voltmeter (0-20V), Pannel type DC Ammeter (0-25 mA), connecting wires or patch cords.

Theory :

→ When input voltage and current are expressed in terms of output voltage and load current, the parameters are known as Transmission Parameters

→ ABCD parameters are same as transmission parameters and for any resistive network, there values are always positive.

→ When two or more than 2 networks are connected in cascade, their T-parameter matrices get multiplied.

CASCADE : output of first subsystem acts as input for the second.

Interconnection constraints

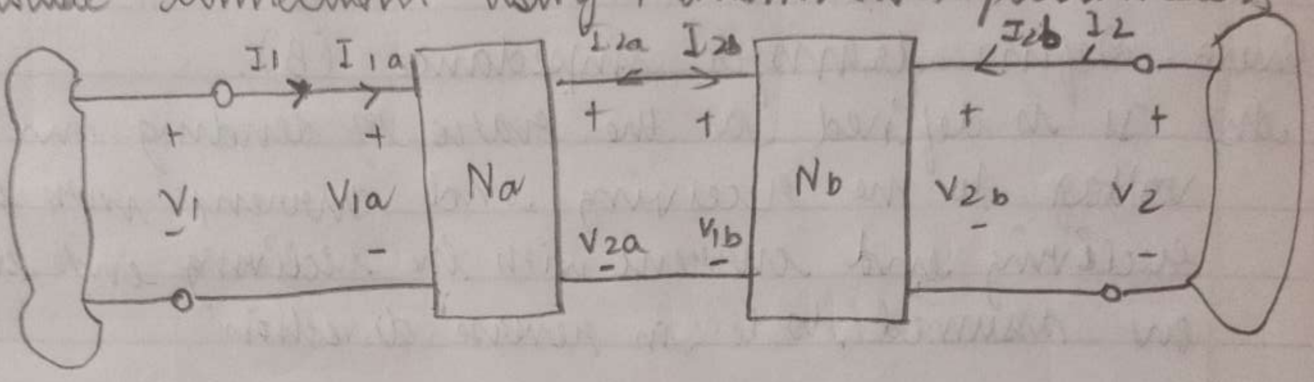
$I_{2a} = -I_{1b}$ $\quad$ $V_{2a} = V_{1b}$

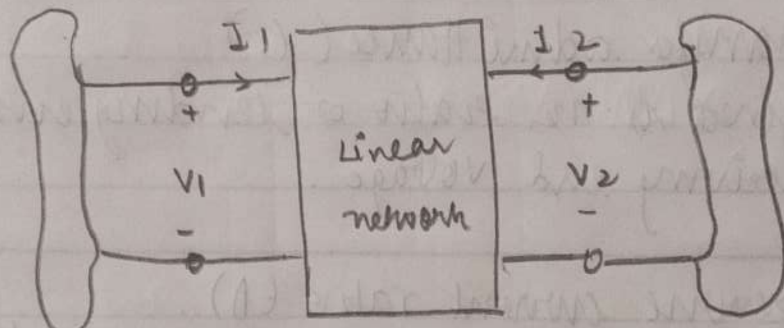
$V_1 = V_{1a}$ $\quad$ $V_2 = V_{2b}$

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

Aim: Interconnection of a T-network and a π-network in cascade form and determination of ABCD parameters and verification of results

Cascade connection using transmission parameters





$$V_1 = AV_2 - BI_2$$

$$I_1 = CV_2 - DI_2$$

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

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

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

$$\begin{bmatrix} V_1 \\ I_1 \end{bmatrix} = \begin{bmatrix} A_a & B_a \\ C_a & D_a \end{bmatrix} \begin{bmatrix} A_b & B_b \\ C_b & D_b \end{bmatrix} \begin{bmatrix} V_2 \\ -I_2 \end{bmatrix}$$

Permissibility of cascade interconnection :

→ Both 3 terminal, and 4 terminal two port networks can be connected in cascade without any problem or complication

→ Always the output port of first network is connected to the input port of the second network and so on.

Application of Cascade Interconnection :

→ Transmission line utilizes the concept of cascade connection by treating a long line as a cascaded network of short lines

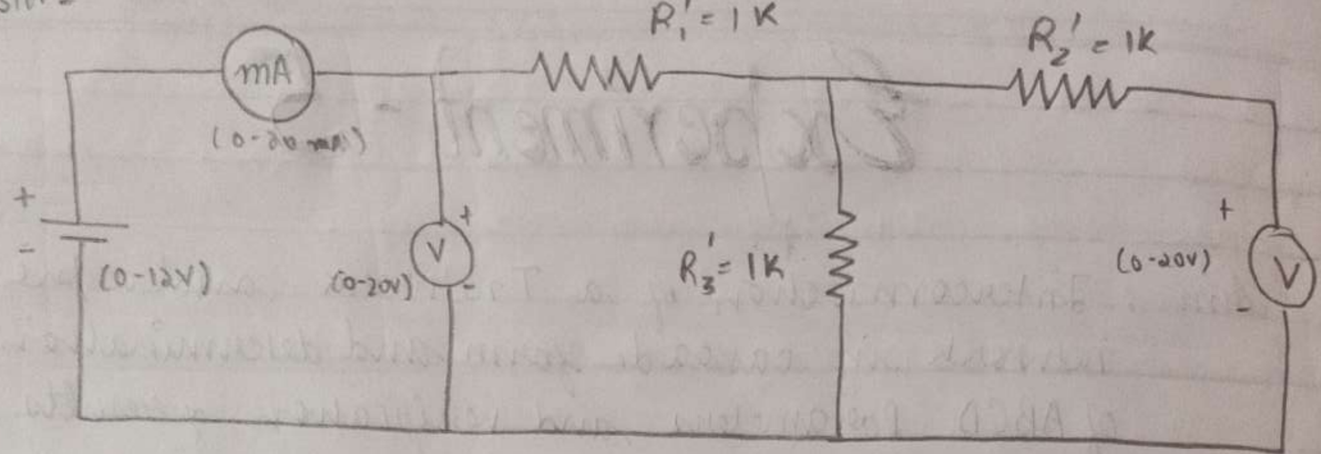
→ Cascade amplifiers used in analog circuits also based on the concept of cascade connection where the output of first stage of amplifier becomes the second stage and so on. It results in magnification of voltage gain, and current gain, etc.

Procedure :

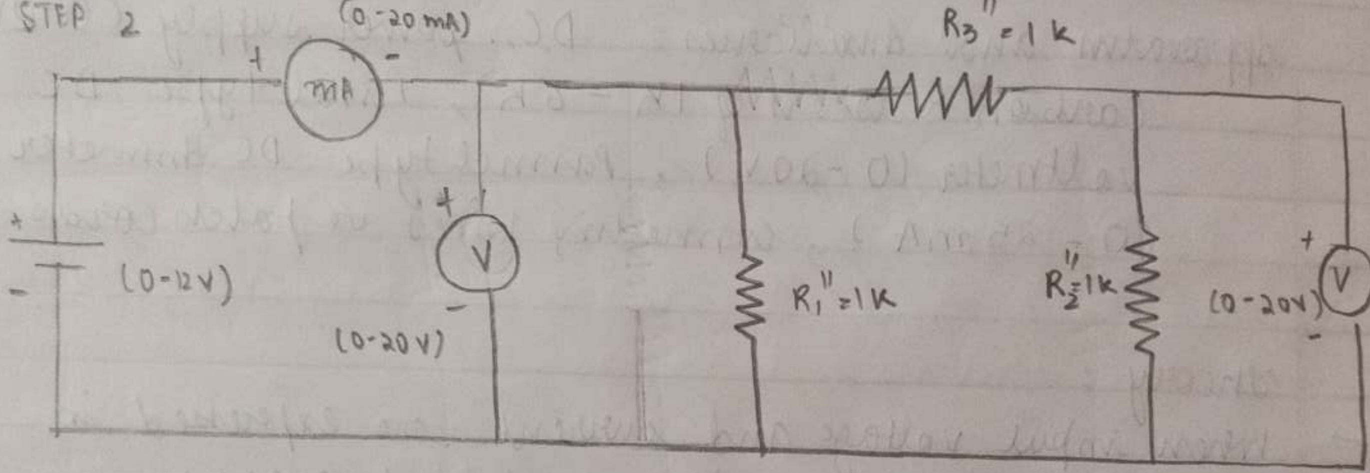
Connect the circuit as shown in step 1, step 2, step 3, step 4, step 5 and step 6.

CASCADE CONNECTION OF NETWORKS

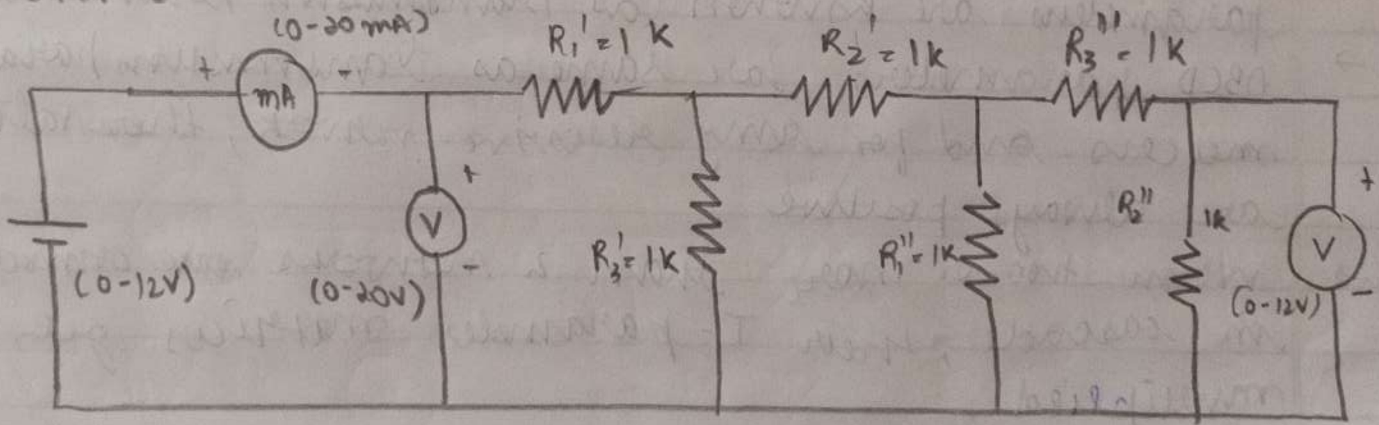
STEP 1



STEP 2



STEP 3

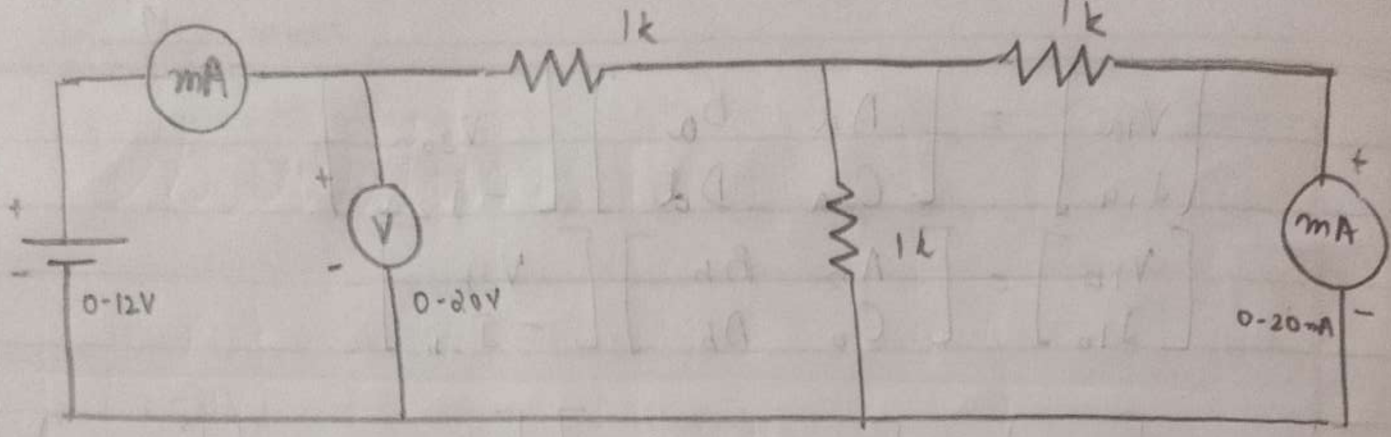


$V_1 = V_{1a} = 11V$

$I_1 = I_{1a} = 6 mA$

$V_2 = V_{2b} = 1V$

STEP 4.

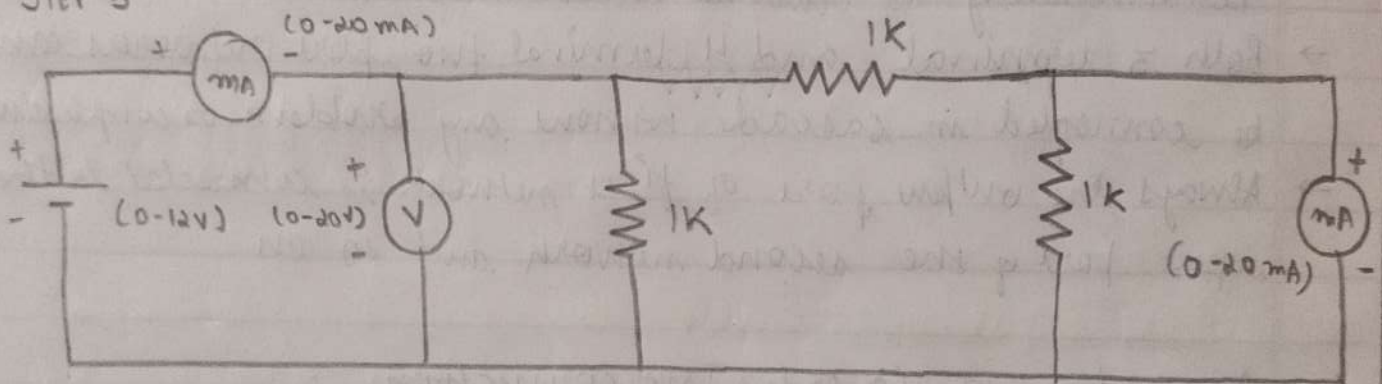


$V_{1a} = 12V$

$I_{1a} = 7.5mA$

$-I_{2a} = 4mA$

STEP 5

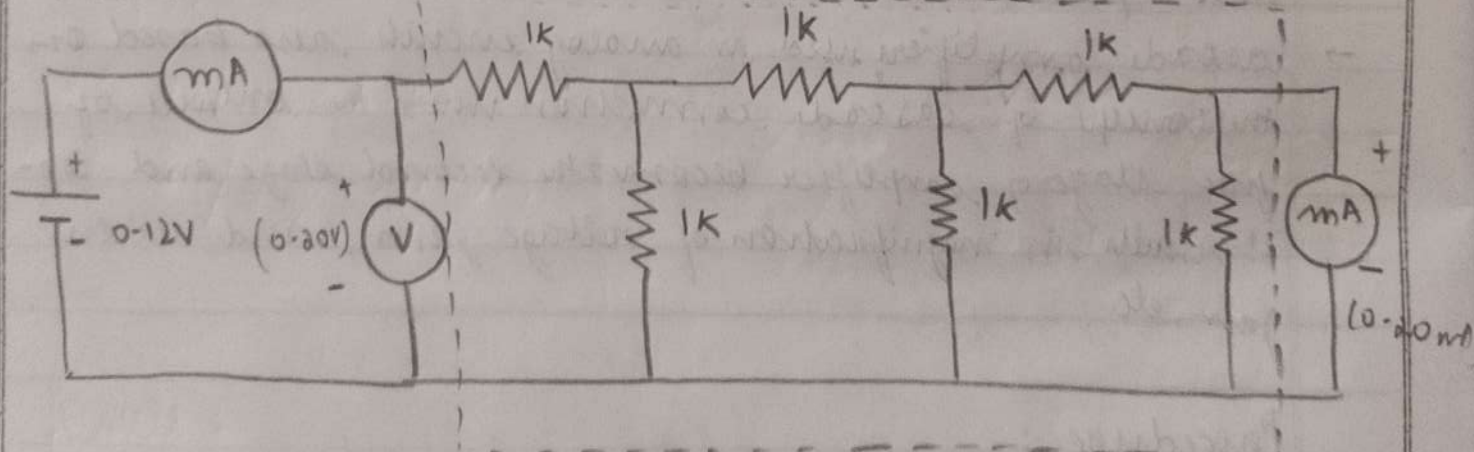


$V_{1b} = 12V$

$I_{1b} = 7.5mA$

$-I_{2b} = 4mA$

STEP 6



LADDER NETWORK

⇒ Interconnect again in cascade

Experiment :   Date ____ Page No. 20

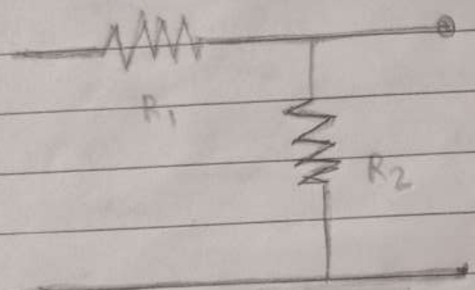
Result :

$$[T] = \begin{bmatrix} 13.84 & 8.548 \\ 7.81 & 4.92 \end{bmatrix}$$

$AD - BC = 1.33 \approx 1$

Hence, verified

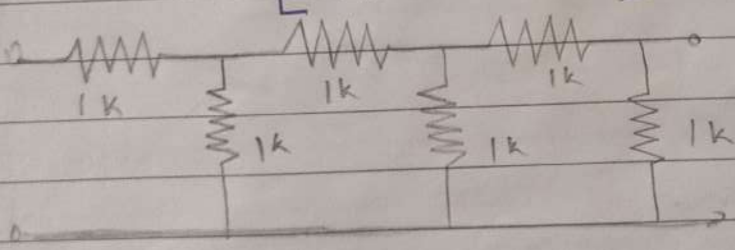
Theoretical Verification :



$$\Rightarrow [T_a] = \begin{bmatrix} 1+\frac{R_1}{R_2} & R_1 \\ \frac{1}{R_2} & 1 \end{bmatrix}$$

as $R_1 = 1k \quad R_2 = 1k$

$$[T_a] = \begin{bmatrix} 2 & 1000\Omega \\ 1\times 10^{-3}\mho & 1 \end{bmatrix} \text{ or } \begin{bmatrix} 2 & 1k \\ 1m\mho & 1 \end{bmatrix}$$



Three such networks in cascade

$$[T] = [T_a][T_b][T_c] = \begin{bmatrix} 2 & 1k \\ 1m\mho & 1 \end{bmatrix}\begin{bmatrix} 2 & 1k \\ 1m\mho & 1 \end{bmatrix}\begin{bmatrix} 2 & 1k \\ 1m\mho & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 2 & 1k \\ 1m\mho & 1 \end{bmatrix}\begin{bmatrix} 5 & 3k \\ 3m\mho & 2 \end{bmatrix} = \begin{bmatrix} 13 & 2k \\ 1m\mho & 5 \end{bmatrix}$$ Ans

Sources of Error :

1. Parallax error in taking readings.
2. Zero error of instruments
3. The resistance of connecting wire (lead also)

Observations:

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6
$V_{1a} = 11V$	$V_{1b} = 11V$	$V_2 = V_{2b} = 1V$	$V_{1a} = 12V$	$V_{1b} = 12V$	$V_1 = V_{1a} = 12V$
$I_{1a} = 5mA$	$I_{1b} = 15mA$	$V_1 = V_{1a} = 11V$	$I_{1a} = 7.5mA$	$I_{1b} = 22.5\,mA$	$I_1 = I_{1a} = 7mA$
$V_{2a} = 5V$	$V_{2b} = 5V$	$I_1 = I_{1a} = 6mA$	$-I_{2a} = 4mA$	$-I_{2b} = 11mA$	$-I_2 = -I_{2a} = 1.5mA$

Calculations:

Step 1: $A_a = V_{1a}/V_{2a} = 2.2$ $C_a = I_{1a}/V_{2a} = 1\,mMho$	**Step 3:** $A = V_1/V_2 = 11$ $C = I_1/V_1 = 6\,mMho$	**Step 5.** $B_b = V_{1b}/-I_{2b} = 1.09k\Omega$ $D_b = I_{1b}/-I_{2b} = 2.045$
Step 2: $A_b = V_{1b}/V_{2b} = 2.2$ $C_b = I_{1b}/V_{2b} = 3\,mMho$	**Step 4.** $B_a = V_{1a}/-I_{2a} = 3k\Omega$ $D_a = I_{1a}/-I_{2a} = 1.875$	**Step 6.** $B = V_1/-I_b = 8k\Omega$ $D = I_1/-I_2 = 4.67$

4. The internal resistance of the supply.
5. High "least count" of the instruments

Precautions :

1. Never connect ammeter directly across the supply (even by mistake else it will get damaged and you would be fined)
2. Keep the pot of the power supply at zero position initially and gradually increase the voltage
3. Connecting wires must be properly connected (because current cannot flow through air gap).
4. Don't pull the connecting cords, as it would get damaged.

VIVA - VOICE

Ques1. Why are chain parameters (ABCD) known as transmission parameters?

Ans. A, B, C, D are the constants also known as transmission parameters or chain parameter. These are used for the analysis of electric network. It is used for determining performance of input, output voltage and current of transmission network

Ques2. What is difference between transmission and inverse transmission parameter?

Ans. Transmission and inverse transmission parameter are duals for each other. The quantities V 2 and

Result

$$[T] = T_A \times T_B = \begin{bmatrix} A_a & B_a \\ C_a & D_a \end{bmatrix} \times \begin{bmatrix} A_b & B_b \\ C_b & D_b \end{bmatrix}$$

$$= \begin{bmatrix} 2.2 & 3 \\ 1 & 1.87 \end{bmatrix} \begin{bmatrix} 2.2 & 1.09 \\ 3 & 2.05 \end{bmatrix}$$

$$= \begin{bmatrix} 13.84 & 8.548 \\ 7.81 & 4.92 \end{bmatrix}$$

$$AD - BC = (13.84 \times 4.92) - (8.548 \times 7.81)$$

$$= 68.0928 - 66.75988$$

$$= 1.33$$

$$\approx 1$$

I_2 are expressed in terms of V_1 and I_1 in inverse transmission parameter. The resulting parameter (A', B', C', D') are inverse transmission parameter.

$$V_2 = A_1' V_1 + B'(-I_1)$$
$$I_2 = C' V_1 + D'(-I_1)$$

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

$$A' = \frac{V_2}{V_1}, \quad I_1 = 0$$

$$C' = \frac{I_2}{V_1}, \quad I_1 = 0$$

forward voltage ratio with sending end open circuited

transfer admittance with sending end open circuited.

Ans 3 How do we convert T-parameter to Z-parameter and T to T' parameter?

Ans Two-port network in T-parameter and Z-parameter are

T- PARAMETER

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

Z- PARAMETER

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

Hence, modified equation becomes

$$V_2 = Z_{12} I_2 = Z_{21} I_1$$
$$I_1 = \left(\frac{1}{Z_{21}}\right) V_2 = \left(\frac{Z_{12}}{Z_{21}}\right) I_2$$

$$I_1 = CV_2 - DI_2$$

$$\boxed{C = \frac{1}{Z_{21}}} \quad \boxed{D = \frac{Z_{12}}{Z_{21}}}$$

$$V_1 = AV_2 - BI_2 = \left(\frac{Z_{11}}{Z_{22}}\right)V_2 - \left(\frac{Z_{11}Z_{22} - Z_{12}Z_{21}}{Z_{21}}\right)I_2$$

$$\Rightarrow \boxed{A = \frac{Z_{11}}{Z_{21}}}$$

$$\boxed{B = \frac{Z_{11}Z_{22} - Z_{12}Z_{21}}{Z_{21}}}$$

T-parameter matrix: $\begin{bmatrix} A & B \\ C & D \end{bmatrix} = \begin{bmatrix} Z_{11}/Z_{21} & \frac{(Z_{11}Z_{22} - Z_{12}Z_{21})}{Z_{21}} \\ 1/Z_{21} & Z_{22}/Z_{21} \end{bmatrix}$

Ques 4. Write down symmetry condition of t to T' parameter

Ans $\frac{V_s}{I_1} = \frac{V_s}{I_2}$ $\quad \frac{A}{C} = \frac{D}{C} \Rightarrow A = D$

Ques 5. Write down reciprocity condition of T and T' parameter

Ans $\frac{V_s}{I_1'} = \frac{V_s}{I_2'}$ $\quad \frac{B}{AD - BC} = B$

$\Rightarrow AD - BC = 1$

Ques 6. What are the application of ABCD parameter in:

i) Electrical power system
They are a part of power system dealing in transmission of electrical power from one place to another.

ii) Communication system

i) They are used for determining the performance of input output voltage and current transmission networks in communication system.

iii) Electronic circuit.
They provide link between the supply and receiving end voltages and current, considering the circuit elements to be linear in nature

Ques 7. Does the equivalent circuit to T parameter exists? Why?
Ans NO, the equivalent circuit of T parameter doesn't exists because both the equations of T-parameter are for one port only. So, this specific need calls for expressing V_1, I_1 in terms of V_2, I_2 but there exists no equivalent circuit

Ques 8. Why is transmission line simplified into a 2-port network?
Ans · A 2-port network specifies the understanding and calculations. Hence, transmission line are simplified in 2-port networks.

Experiment - 6

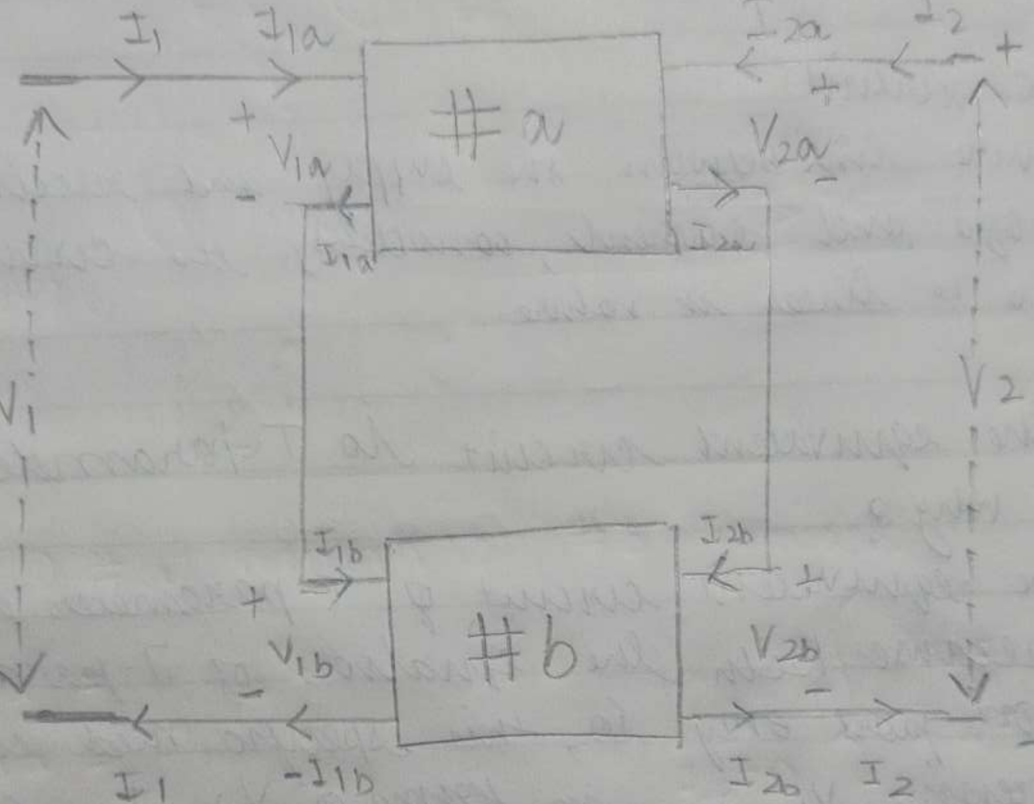
Aim: Interconnection of two 2-port networks in series-series interconnection and determination of overall z parameter. Also verification of the result.

Apparatus and auxiliaries:
D.C. Power Supply (Variable), Carbon Resistors of 1k ohm and 1/4W - 6, Panel Type DC Voltmeter (0-20V), panel type DC Ammeter (0-25mA), connecting wires of Patch cords

Theory:
A complicated circuit can be viewed as an inter-connection of two or more, similar or dissimilar types of network (called basic building blocks) such that the analysis of the circuit can be easily carried out by expressing the input and output quantities in the form of two simple equations
when these simple equations are those pertaining to z parameter, and the currents in each of the building block on input side is same and the current on output side is also same, the interconnection is known as Series - series interconnection

Procedure:

Aim: Interconnection of 2 2-port network in series series interconnection and determination of overall z parameters. Also verification of the result.



SERIES - SERIES INTERCONNECTION

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

→ $I_1 = I_{1a} = I_{1b}$ → $I_2 = I_{2a} = I_{2b}$

Connect the circuit as shown in steps 1, 2, 3, 4, 5 and 6.

Result :

By Observation

$$[Z] = \begin{bmatrix} 3.83 & 2.2 \\ 1.67 & 4.8 \end{bmatrix}$$

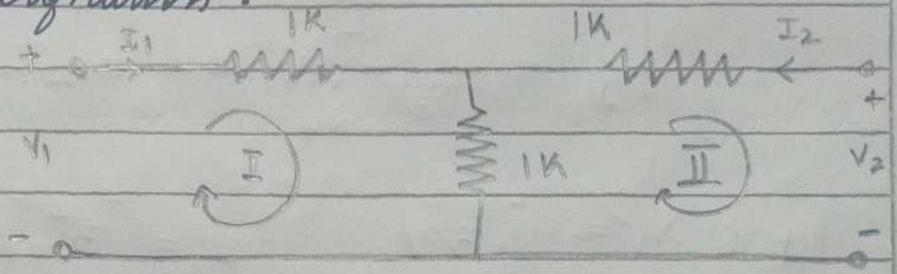
All in $k\Omega$

By Calculation

$$[Z] = \begin{bmatrix} 4 & 2 \\ 2 & 4 \end{bmatrix}$$

Theoretical Verification :

Applying KVL in 2 loops



Applying KVL in loop I

$$V_1 - I_1 \times 1 - 1 \times (I_1 \times I_2) = 0$$

where I_1 and I_2 are in mA

$$\Rightarrow V_1 = 2I_1 + I_2 \quad \text{— (1)}$$

Applying KVL in loop II

$$V_2 - I_2 \times 1 - 1(I_1 + I_2) = 0$$

$$\Rightarrow V_2 = I_1 + 2I_2 \quad \text{— (2)}$$

Z parameter equations $\Rightarrow$

$$V_1 = Z_{11} I_1 + Z_{12} I_2 \quad \text{— (3)}$$

$$V_2 = Z_{21} I_1 + Z_{22} I_2 \quad \text{— (4)}$$

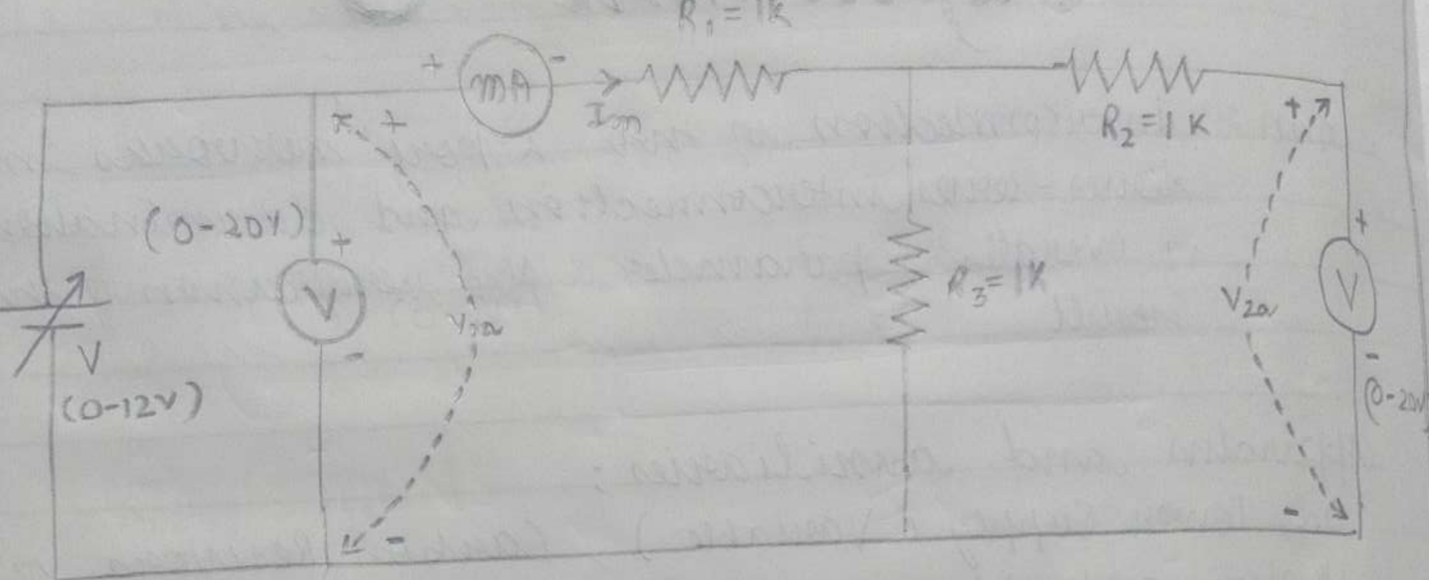
Comparing (1) and (3)

$$Z_{11} = 2K$$

$$Z_{12} = 1K$$

Procedure :

Step 1 and 2 :-

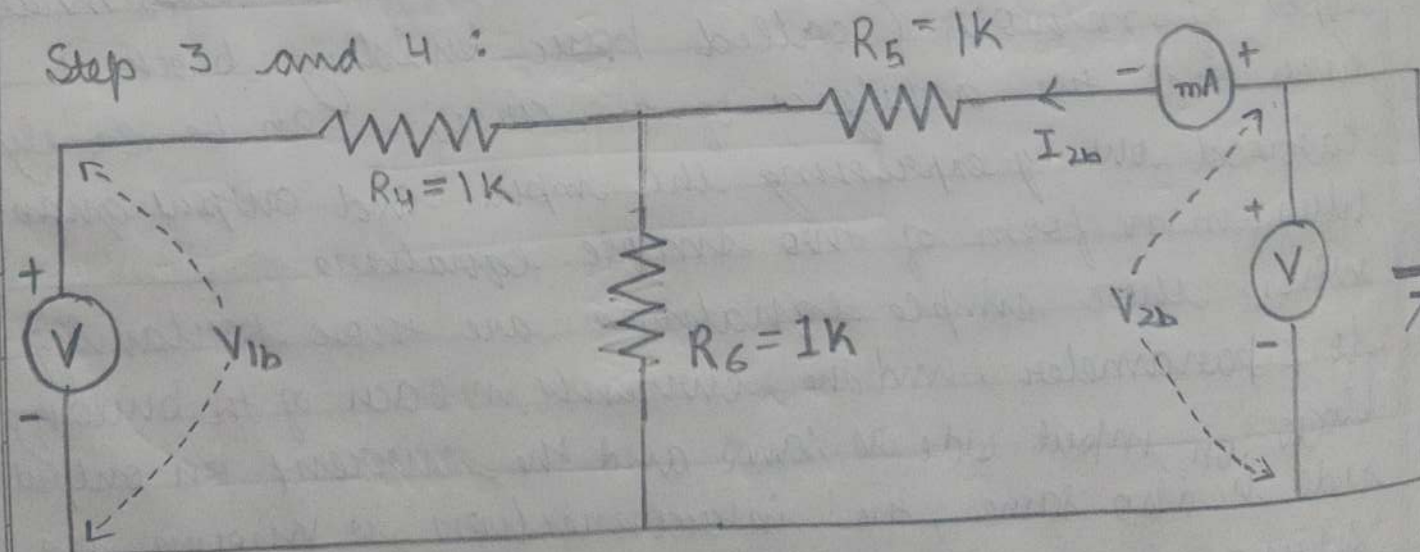


1) #a network ; #b network

$I_{2a} = 0$ $\begin{cases} V_{1a} = 11.5 \text{ V} \\ I_{1a} = 5 \text{ mA} \\ V_{2a} = 5 \text{ V} \end{cases}$

with $I_{2b} = 0$ $\begin{cases} V_{1b} = 11.5 \text{ V} \\ I_{1b} = 5 \text{ mA} \\ V_{2b} = 5 \text{ V} \end{cases}$

Step 3 and 4 :



2) #a network ; #b network

Experiment :

Date

Comparing ③ and ④

$Z_{21} = 1K$

$Z_{22} = 2K$

Precautions :

1) Never connect ammeter directly across the supply
2) Keep the pot of the power supply at zero position initially and gradually increase the voltage.
3) Connecting wires must be properly connected.
4) Don't pull the connecting cords as it would get damaged.

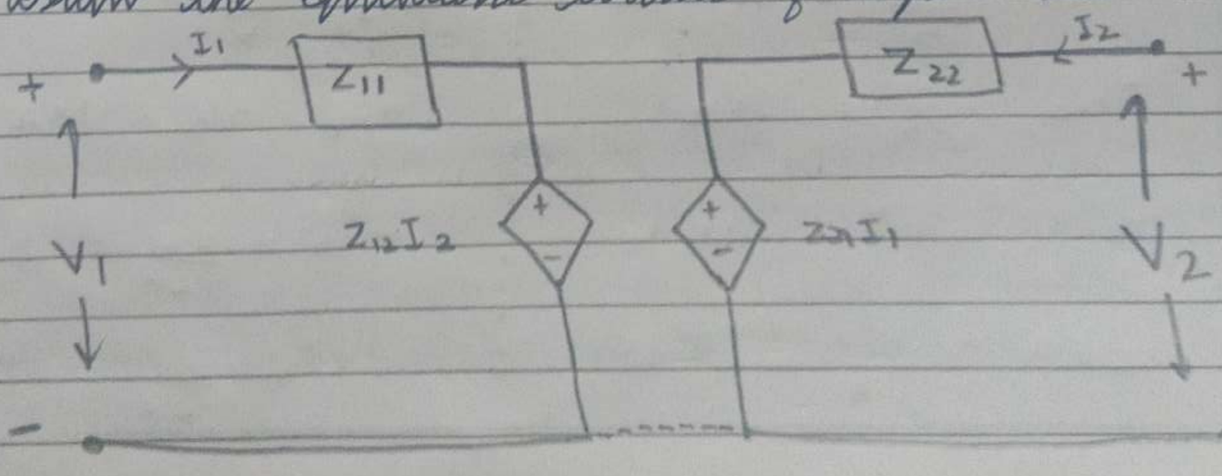
Sources of Error :

1) Parallax error in taking readings.
2) Zero error of instruments
3) The resistance of connecting wires.
4) The internal resistance of the supply.
5) High L.C. of the instruments

VIVA - VOCE

Ques 1. Draw the equivalent circuit of Z-parameter.

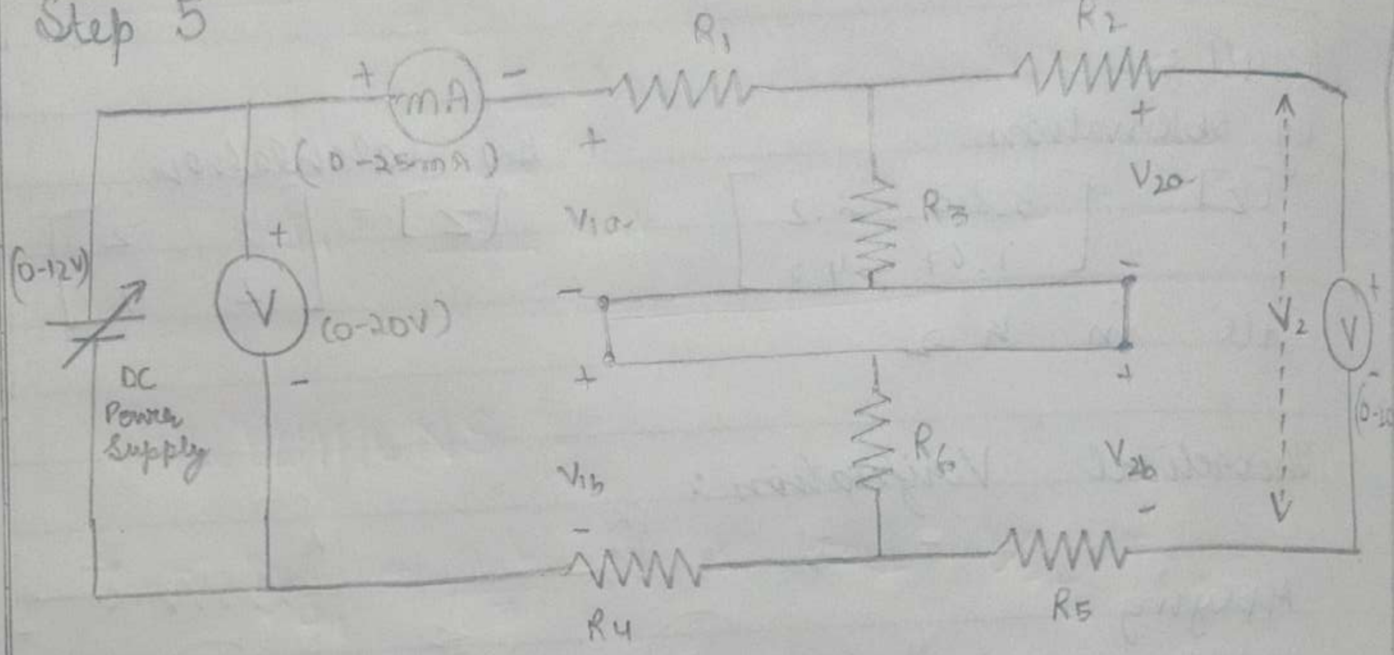
Ans



with $I_{1a} = 0$ $\begin{cases} V_{2a} = 11.5V \\ I_{2a} = 5mA \\ V_{1a} = 5.5V \end{cases}$

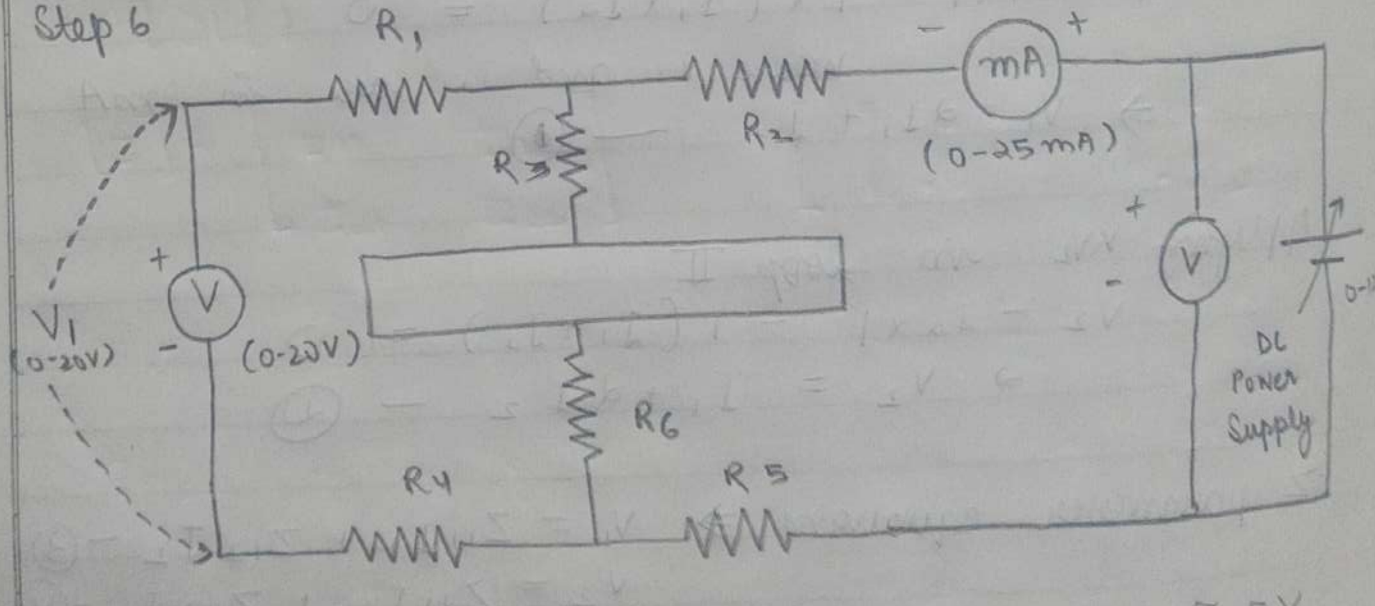
with $I_{1b} = 0$ $\begin{cases} V_{2b} = 11.5V \\ I_{2b} = 5mA \\ V_{1b} = 5.5V \end{cases}$

Step 5



$V_1 = 11.5V$ $I_1 = 3mA$ $V_2 = 5V$

Step 6



$I_2 = 2.5mA$ $V_2 = 12V$ $V_1 = 5.5V$

Ques 2. Why is it necessary to connect common terminals together in series interconnection?

Ans It is necessary because this has an effect of increasing overall voltage and capacity remains the same

Ques 3. What would happen if series-series interconnection is carried out without taking laterally inverted network of second network?

Ans By lateral inversion of second network, the output voltage increases but without it, the overall voltage can't be increased

Ques 4. Show that in the series-series interconnection the Z-parameter matrices get added up.

Ans The Z parameter of the series connected combined network can be written as

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

where,

$Z_{11} = Z_{11a} + Z_{11b}$ $\quad$ $Z_{21} = Z_{21a} + Z_{21b}$

$Z_{12} = Z_{12a} + Z_{12b}$ $\quad$ $Z_{22} = Z_{22a} + Z_{22b}$

or in matrix form

$$[Z] = [Z_a] + [Z_b]$$

Ques 5. Give some examples where two or more networks are connected in series-series pattern.

Observation Table :

When output port is open	When input port is open
$I_2 = 0$	$I_1 = 0$
$V_1 = \underline{11.5}$ V	$V_2 = \underline{12}$ V
$V_2 = \underline{5}$ V	$V_1 = \underline{5.5}$ V
$I_1 = \underline{3}$ mA	$I_2 = \underline{2.5}$ mA

CALCULATIONS :

$$Z_{11} = V_1/I_1 = \frac{11.5}{3} = 3.83\ k\Omega$$

$$Z_{12} = V_1/I_2 = \frac{5.5}{2.5} = 2.2\ k\Omega$$

$$Z_{21} = V_2/I_1 = \frac{5}{3} = 1.67\ k\Omega$$

$$Z_{22} = V_2/I_2 = \frac{12}{2.5} = 4.8\ k\Omega$$

RESULT :

$$[Z] = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} = \begin{bmatrix} 3.83 & 2.2 \\ 1.67 & 4.8 \end{bmatrix} \text{ All in } k\Omega$$

$$Z_{11a} = \frac{11.5}{5} = 2.3\ k\Omega$$

$$Z_{21a} = 5/5 = 1\ k\Omega$$

$$Z_{12a} = \frac{5.5}{5} = 1.1\ k\Omega$$

$$Z_{22a} = \frac{11.5}{5} = 2.3\ k\Omega$$

$$Z_{11b} = \frac{11.5}{5} = 2.3\ k\Omega$$

$$Z_{21b} = 5/5 = 1\ k\Omega$$

$$Z_{12b} = \frac{5.5}{2.5} = 2.2\ k\Omega$$

$$Z_{22b} = \frac{12}{2.5} = 4.8\ k\Omega$$

Ans It is used in cascade connections, electronic circuits, communication systems, electrical power system, etc.

Ques 6. With the help of interconnection of two or more networks, show that series-series interconnection is best suited where z-parameters play an important role.

Ans As from the circuit we can see that

$$[Z] = \begin{bmatrix} Z_{11a} + Z_{11b} & Z_{12a} + Z_{12b} \\ Z_{21a} + Z_{21b} & Z_{22a} + Z_{22b} \end{bmatrix}$$

Hence, the Z-parameter play an important role for series-series interconnection, they are the sum of z-parameters of the individual network in series.

Ques 7. How will you connect two lattice networks in series-series fashion, assuming that you have an AC source.

Ans Applying an AC to series-series ~~incon~~ interconnection will result in same connection but the values will be changed.

By **Observation**

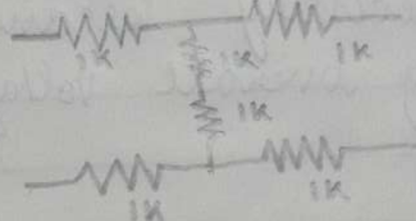
$$[Z] = \begin{bmatrix} 3.83 & 2.2 \\ 1.69 & 4.8 \end{bmatrix}$$

All in kΩ

By **Calculations**

$$[Z] = \begin{bmatrix} 4 & 2 \\ 2 & 4 \end{bmatrix}$$

All in kΩ



Hence verified.

Experiment - 7

Aim : Interconnection of 2 two port network in parallel - parallel interconnection and determination of overall Y- parameter.

Apparatus required :
D.C. power supply (variable), carbon resistors of 1kΩ and 1/4 W - 6, Panel type DC voltmeter (0-20V), panel type DC Ammeter (0-25 mA), connecting wires and patch cords.

Theory :
In a parallel-parallel interconnection both input and output ports are connected in parallel.
The overall Y-parameter matrix for parallel connected two-port network is simply the sum of Y-parameters matrices of each individual two port networks connected in parallel.

$$[Y] = [Y_a] + [Y_b]$$

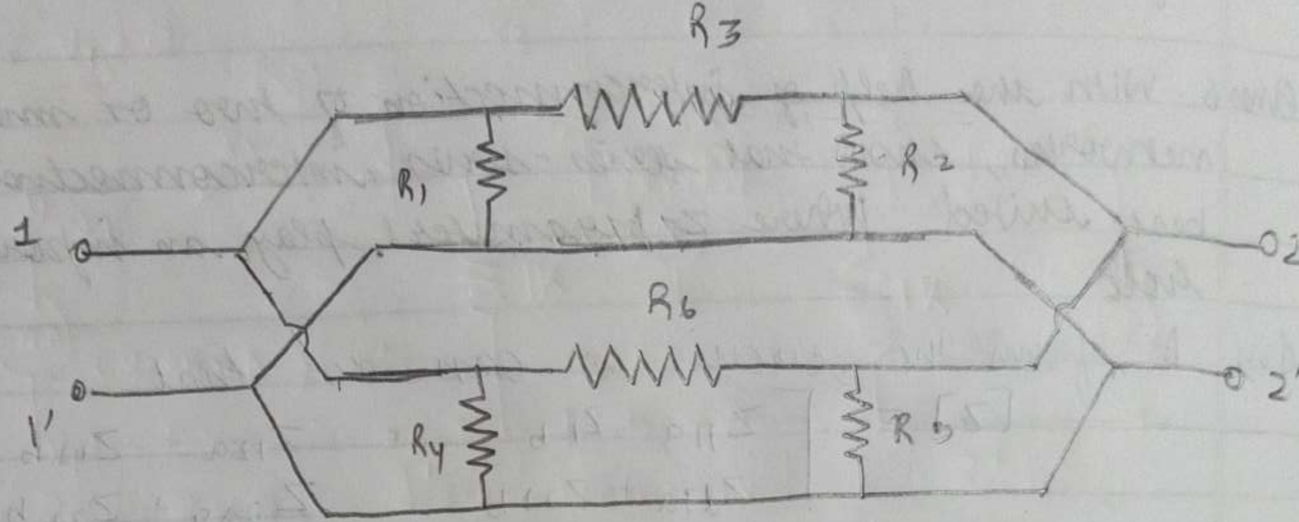
The figure shows two two-port networks Na and Nb. The resultant of two admittance connection is $Y_1 + Y_2$. So, in parallel connection the parameters are Y parameter

$$\begin{bmatrix} I_{1a} \\ I_{2a} \end{bmatrix} = \begin{bmatrix} Y_{11a} & Y_{12a} \\ Y_{21a} & Y_{22a} \end{bmatrix} \begin{bmatrix} V_{1a} \\ V_{2a} \end{bmatrix}$$ for network Na
lly from Nb

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

Equating $[Y] = [Y_a] + [Y_b]$

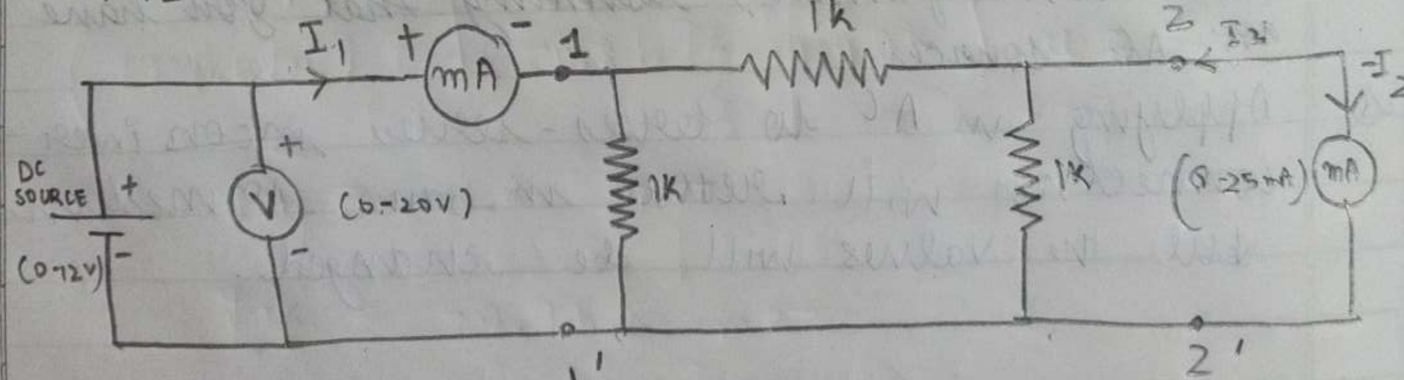
Aim : Interconnection of 2 two port networks in parallel parallel interconnection and determination of overall y-parameter



Parallel - Parallel Interconnection

DETERMINATION OF SHORT CIRCUIT ADMITTANCE PARAMETER

with $V_2 = 0$



$V_1 = 7.5\,V$

$I_1 = 13.5\,mA$

$-I_2 = 6\,mA$

$$\begin{cases} I_1 = y_{11}V_1 + y_{12}V_2 \\ I_2 = y_{21}V_1 + y_{22}V_2 \end{cases}$$

Experiment :

Date

Precautions :

1) Never connect ammeter directly across the supply.
2) Keep the pot of the power supply at zero position initially and gradually increase the voltage
3) Connecting wires must be properly connected
4) Don't pull the connecting wires cords as it would get damaged

Sources of Error :

1) Parallax error in taking readings
2) Zero error of instruments
3) The resistance of connecting wires
4) The internal resistance of the supply
5) High Least Count of the instruments

Result :

By observation,

$$[Y] = \begin{bmatrix} 3.6 & -1.904 \\ -1.6 & 3.810 \end{bmatrix} \text{(m℧)}$$

By Calculation,

$$[Y] = \begin{bmatrix} 3.7 & -1.72 \\ -1.8 & 3.63 \end{bmatrix} \text{(m℧)}$$

% error in each case

$y_{11} = 2.78\%$

$y_{12} = 9.67\%$

$y_{21} = 12.5\%$

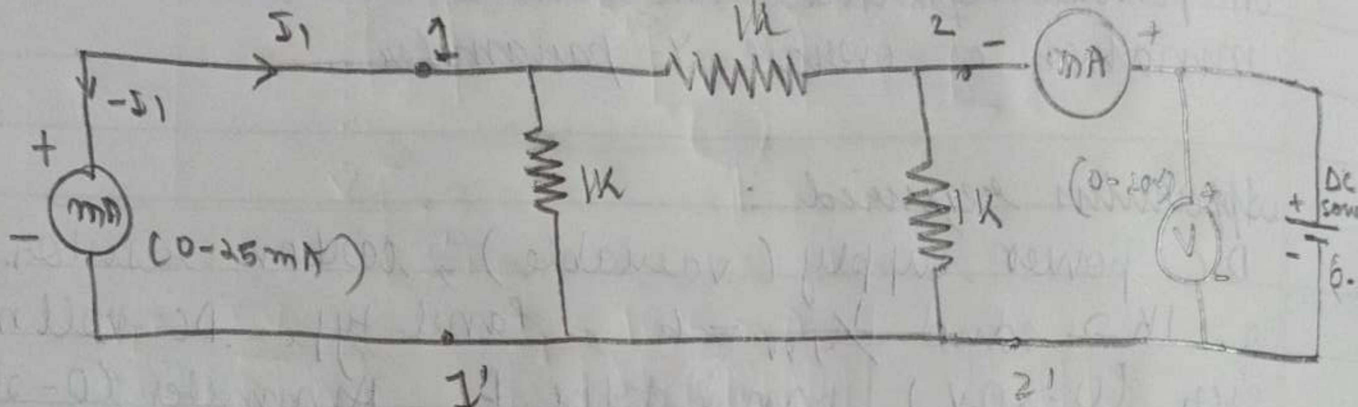
$y_{22} = 4.72\%$

Error = $\underline{1.85}\%$

$$y_{11} = \left.\frac{I_1}{V_1}\right|_{V_2=0} = \left(\frac{13.5}{7.5}\right) = 1.8 \, m\mho$$

$$y_{21} = \left.\frac{I_2}{V_1}\right|_{V_2=0} = \left(\frac{-6}{7.5}\right) = -0.8 \, m\mho$$

With $V_1 = 0$



$V_2 = 10.5 \, V$

$I_2 = 20 \, mA$

$-I_1 = 10 \, mA$

$$y_{12} = \left.\frac{I_1}{V_2}\right|_{V_1=0} = \frac{(-10)}{10.5} = -0.952 \, m\mho$$

$$y_{22} = \left.\frac{I_2}{V_2}\right|_{V_1=0} = \frac{20}{10.5} = 1.905 \, m\mho$$

$$[Y] = \begin{bmatrix} 1.8 & -0.952 \\ -0.8 & 1.905 \end{bmatrix} \text{ all in } m\mho$$
(experimental)

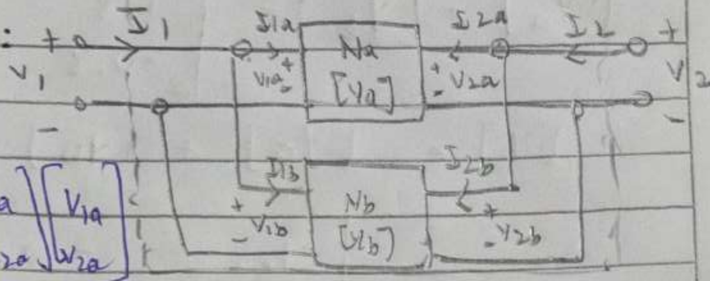
$y_{11} = 1.8 \, m\mho$

$y_{12} = -0.952 \, m\mho$

$y_{21} = -0.8 \, m\mho$

$y_{22} = 1.905 \, m\mho$

Theoritical verification :



for Network N_a,

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

lly for network N_b,

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

$V_1 = V_{1a} = V_{1b}$, $\quad V_2 = V_{2a} = V_{2b}$

$I_1 = I_{1a} + I_{1b}$, $\quad I_2 = I_{2a} + I_{2b}$

Now, $I_1 = I_{1a} + I_{1b} = (Y_{11a} V_{1a} + Y_{12a} V_{2a}) + (Y_{11b} V_{1b} + Y_{12b} V_{2b})$

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

(since $V_1 = V_{1a} = V_{1b}$ and $V_2 = V_{2a} = V_{2b}$)

lly. $I_2 = I_{2a} + I_{2b} = (Y_{21a} + Y_{21b}) V_1 + (Y_{22a} + Y_{22b}) V_2$

$\Rightarrow$

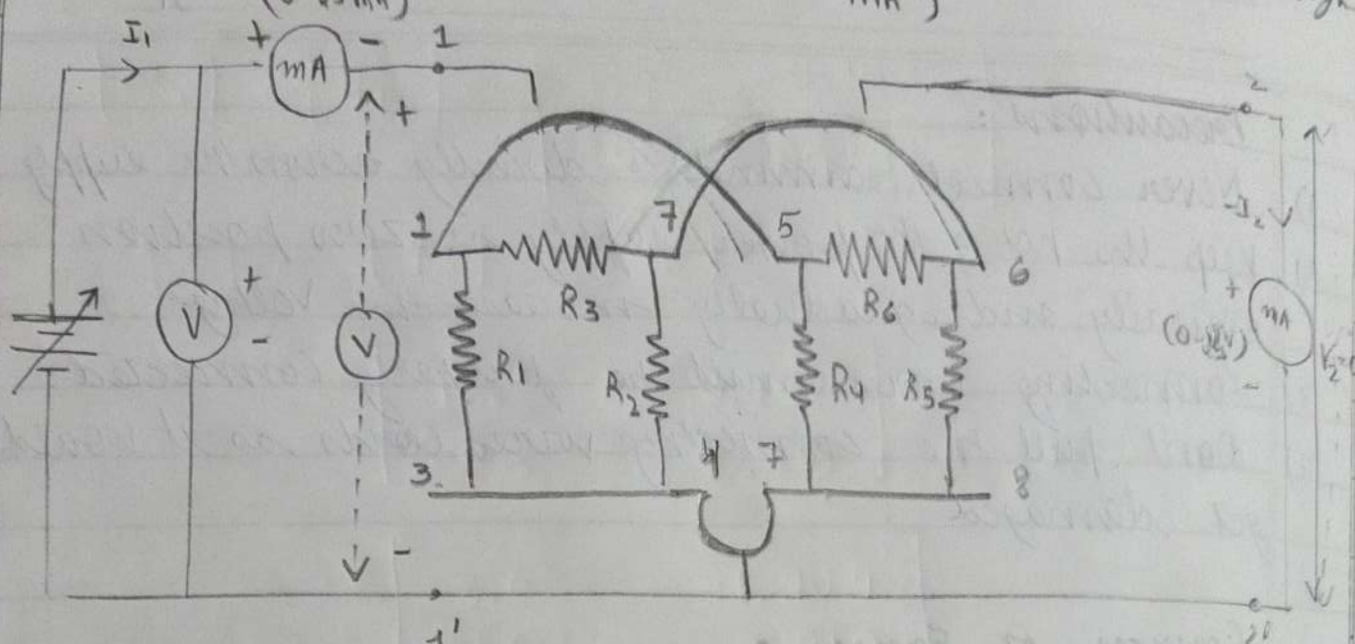
$$\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} Y_{11} & Y_{12} \\ Y_{21} & Y_{22} \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix}$$

Where
$y_{11} = Y_{11a} + Y_{11b}$
$y_{12} = Y_{12a} + Y_{12b}$
$y_{21} = Y_{21a} + Y_{21b}$
$y_{22} = Y_{22a} + Y_{22b}$

Hence, $[Y] = [Y_a] + [Y_b]$

VIVA VOCE

Connection diagram on kit (with 2-2' shorted through mA)



$V_1 =$ 5V $I_1 =$ 18.5 mA

$-I_2 =$ 9 mA

OBSERVATION FOR DIRECT CALCULATION

For $V_1 = 0$ $V_2 =$ 5.5 V

$I_2 =$ 20 mA

$-I_1 =$ 9.5 mA

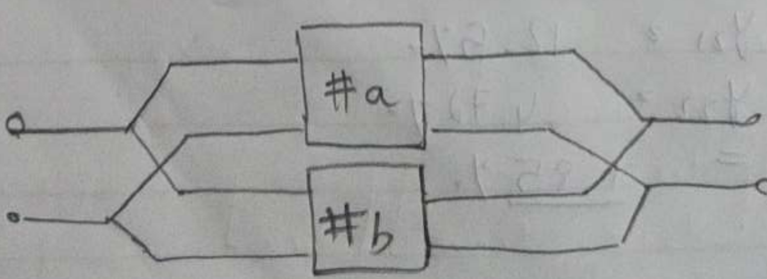
For $V_2 = 0$ $V_1 =$ 5V

$I_1 =$ 18.5 mA

$-I_2 =$ 9 mA

$$[Y] = \begin{bmatrix} 3.7 & -1.72 \\ -1.8 & 3.63 \end{bmatrix}$$ all in (m℧)

observed $\begin{bmatrix} 4 & -2 \\ -2 & 4 \end{bmatrix}$



Experiment :

Date

Ans 1. Is it preferable to connect bulbs in series ?
Ans No, its preffered to connect them in parrallel so that if one bulb blow out others continue to get a current supply.

Ans 2. What is the short circuit admittance of composite network and how is it evaluated ?
Ans Short circuit admittance of a composite network is sum of short circuit admittance of each individual networks

$$[Y_{total}] = [Y_1] + [Y_2] + [Y_3] + \cdots + [Y_n]$$

Ans 3. What are the applications of parallel network ?
Ans They are used in dc supply from automobile industry, computer hardware, etc.

Ans 4. Why study of 2-port network is important ?
Ans Two port network model is used in circuit analysis techniques to isolate portions from a larger circuit. This allows response of network to signal applied to ports to be calculated easily without solving for all internal voltages and currents in the network.

Result Obtained Using Property of Interconnection

$$[Y_a] = [Y_b] = \begin{bmatrix} 1.8 & -0.952 \\ -0.8 & 1.905 \end{bmatrix}$$

$$[Y] = [Y_a] + [Y_b]$$

$$= \begin{bmatrix} 1.8 & -0.952 \\ -0.8 & 1.905 \end{bmatrix} + \begin{bmatrix} 1.8 & -0.952 \\ -0.8 & 1.905 \end{bmatrix}$$

$$= \begin{bmatrix} 3.6 & -1.904 \\ -1.6 & 3.810 \end{bmatrix}$$

COMPARISON OF EXPERIMENTAL RESULTS :

Direct calculation $[Y] = \begin{bmatrix} 3.7 & -1.72 \\ -1.8 & 3.63 \end{bmatrix}$ (m℧)

Using property $[Y] = \begin{bmatrix} 3.6 & -1.904 \\ -1.6 & 3.810 \end{bmatrix}$ (m℧)

% error in each case $y_{11} = 2.78\%$

$y_{12} = 9.67\%$

$y_{21} = 12.5\%$

$y_{22} = 4.72\%$

avg error = 1.85 %