Experiment - 6

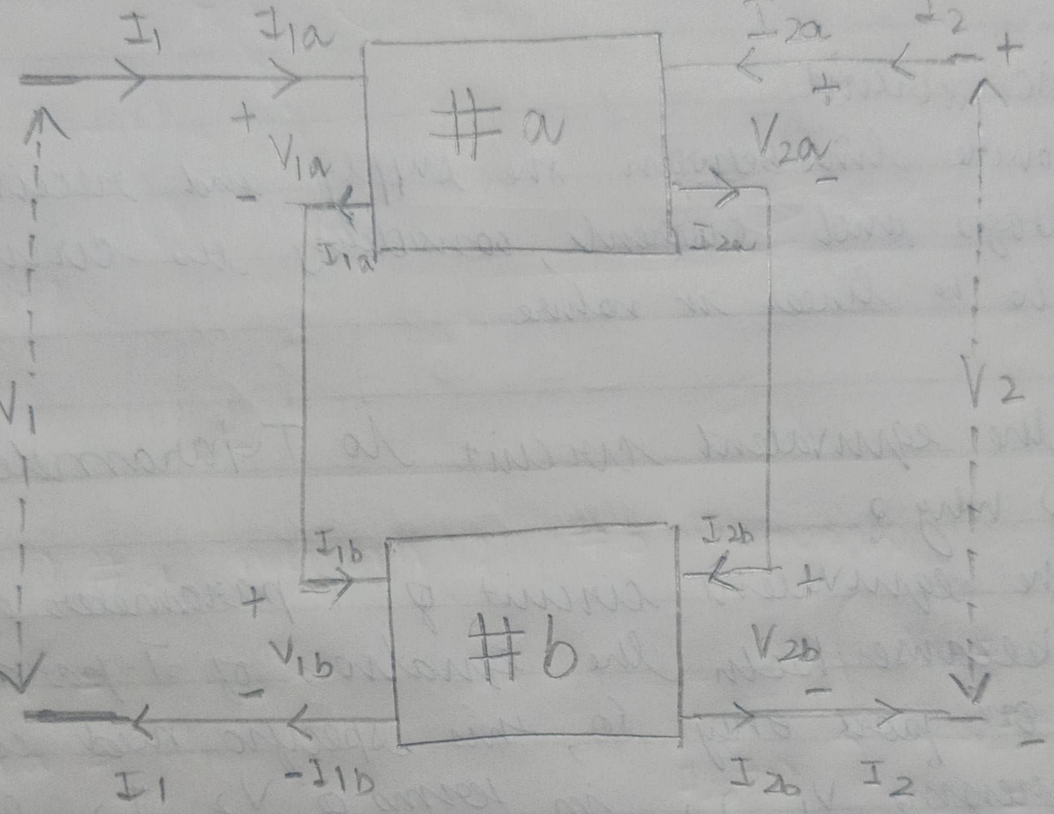
Aim: Interconnection of two 2-port networks in series-series interconnection and determination of overall z parameter. Also verification of the result.

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 or 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 parameter. 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

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

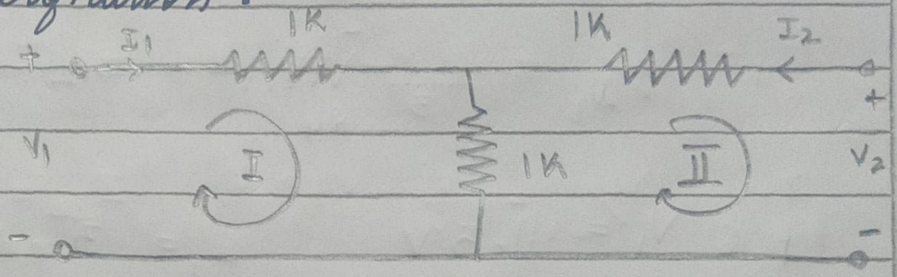
All in kΩ

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

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

Applying KVL in loop II

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

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

Z parameter equations $\Rightarrow$ $V_1 = Z_{11} I_1 + Z_{12} I_2 \quad — (3)$

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

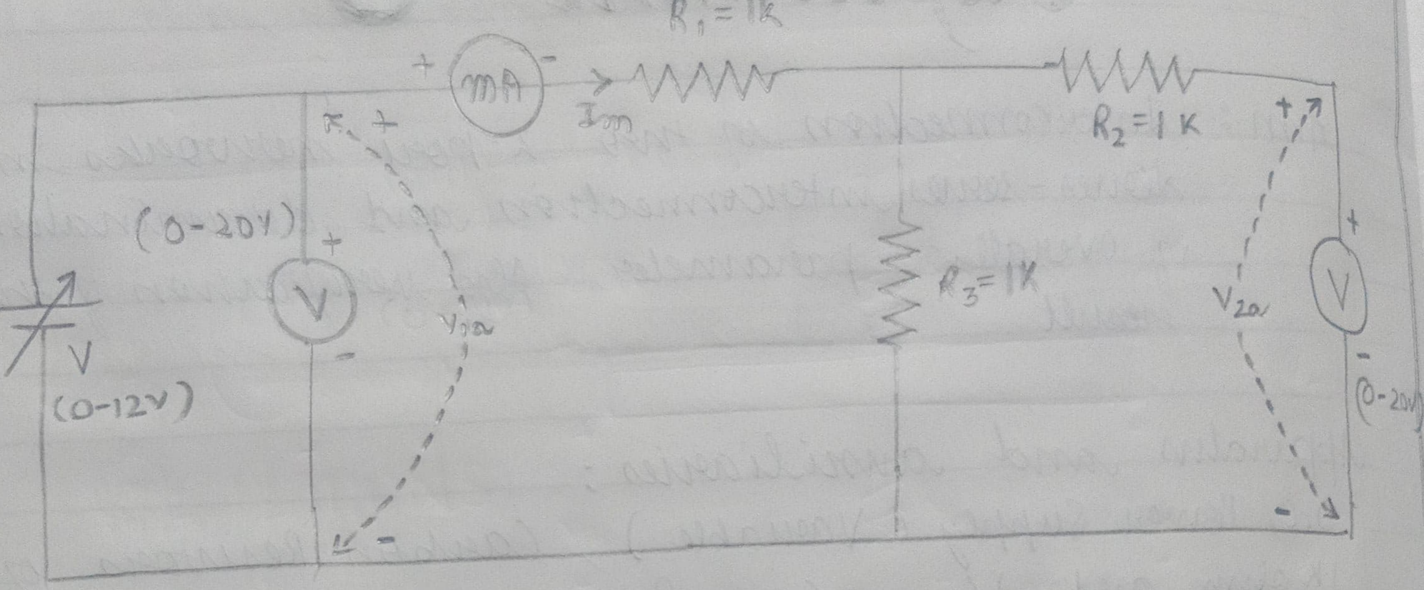
Comparing (1) and (3)

$Z_{11} = 2k$

$Z_{12} = 1k$

Procedure :

Step 1 and 2 :-

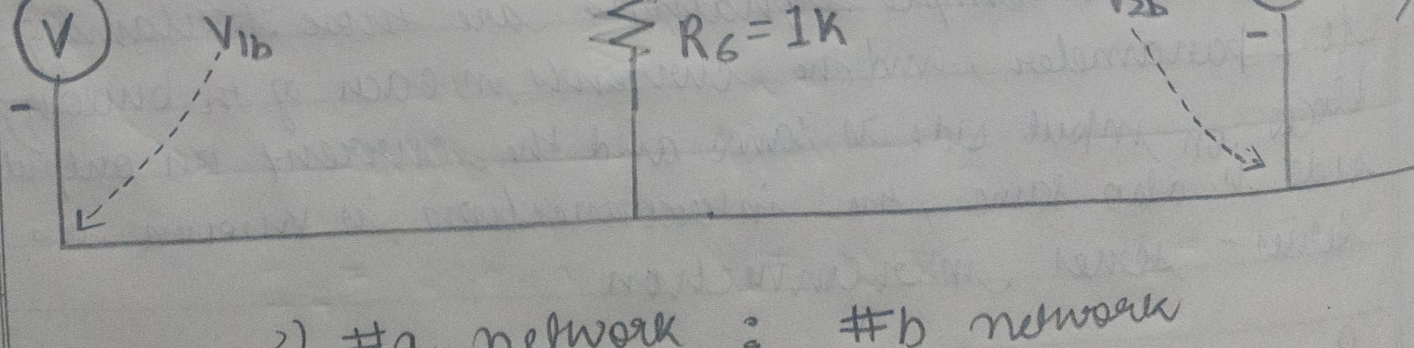


1) #a network ; #b network

$I_{2a} = 0$
$$\begin{cases} V_{1a} = 11.5\ V \\ I_{1a} = 5\ mA \\ V_{2a} = 15\ V \end{cases}$$

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

Step 3 and 4 :



2) #a network ; #b network

Comparing ② and ④

$Z_{21} = 1K$
$Z_{22} = 2k$

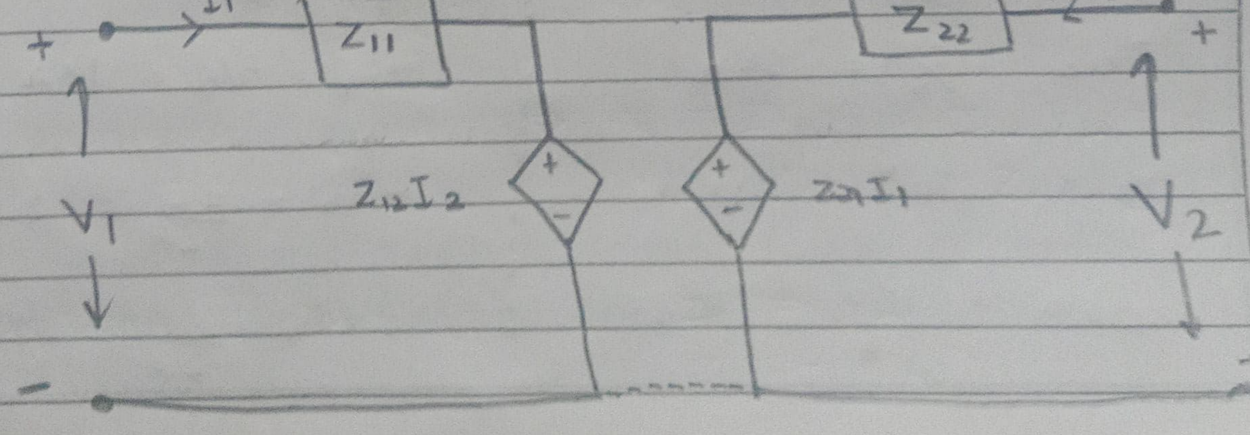
Precautions :
1) Never connect ammeter directly across the supply
2) Keep the pot of the power supply at zero position initially and gradually increase the voltage.
3) Connecting wires must be properly connected.
4) Don't pull the connecting cords as it would get damaged.

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.

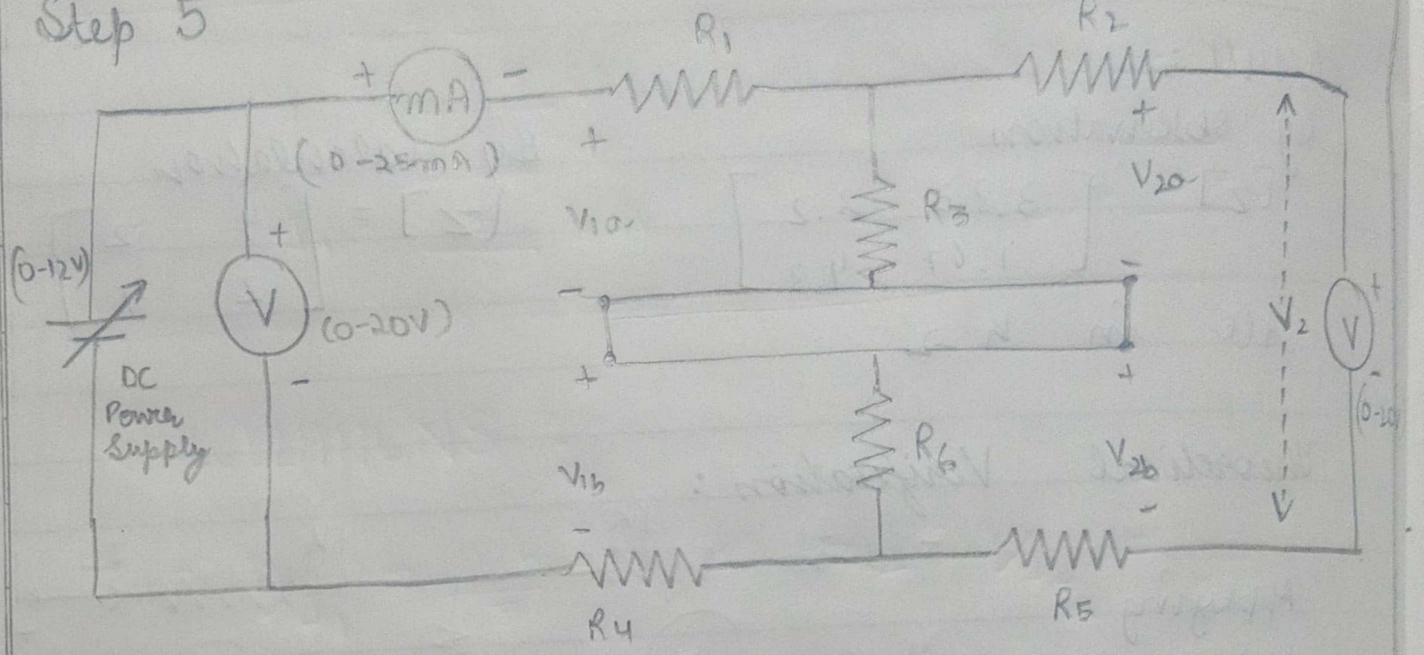
Ans



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

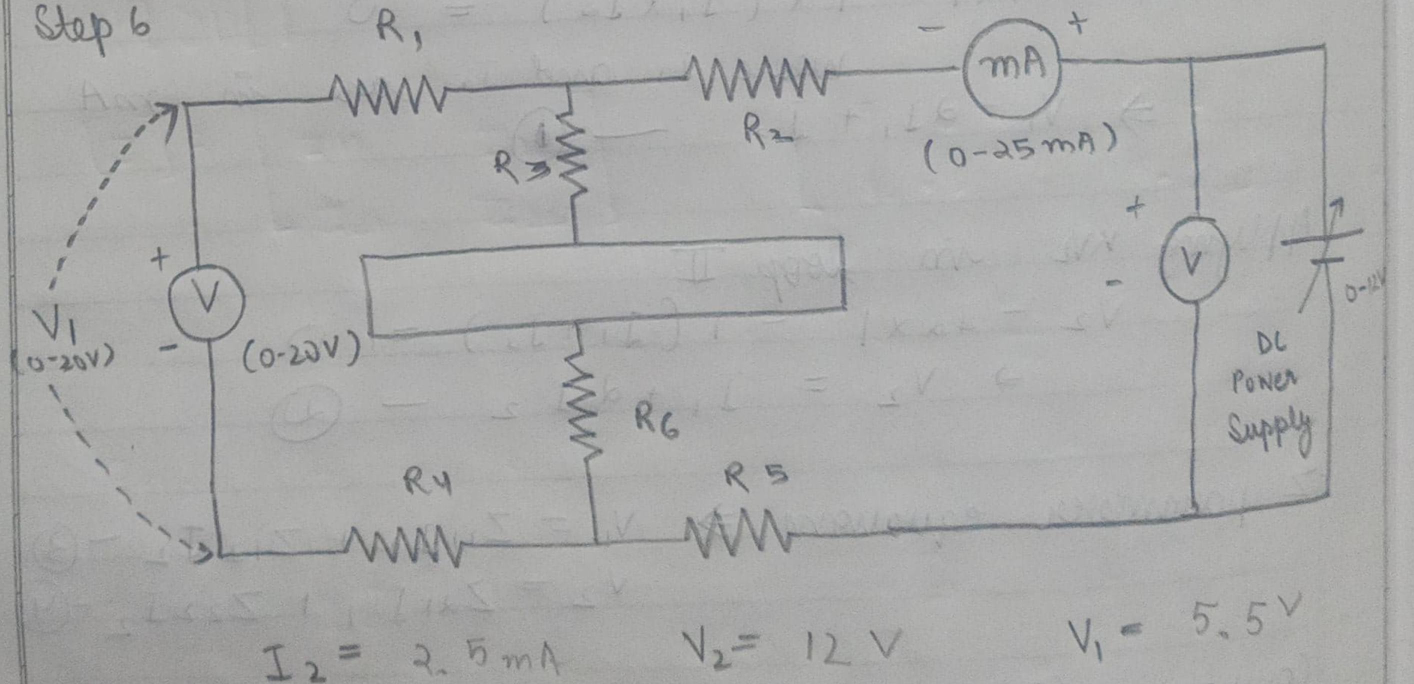
with $I_{1b} = 0$ $\begin{cases} V_{2b} = 11.5V \\ I_{2b} = 5mA \\ V_{1b} = 5.5V \end{cases}$

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 :

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

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

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

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

RESULT :

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

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

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

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

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

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

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

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

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

Experiment :

Date

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~~ interconnections will result in same connection but the values will be changed.

By Observation

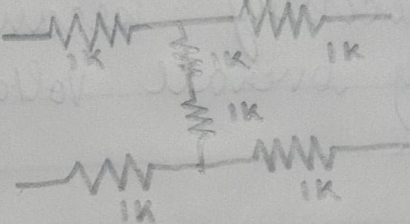
$$[Z] = \begin{bmatrix} 3.83 & 2.2 \\ 1.69 & 4.8 \end{bmatrix}$$

All in $k\Omega$

By Calculations

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

All in $k\Omega$



Hence verified.