ASIA PACIFIC UNIVERSITY OF TECHNOLOGY & INNOVATION

EE001-3-1-ANALYSIS OF CIRCUITS

GUIDED LAB REPORT

TITLE	TWO PORT NETWORK ANALYSIS
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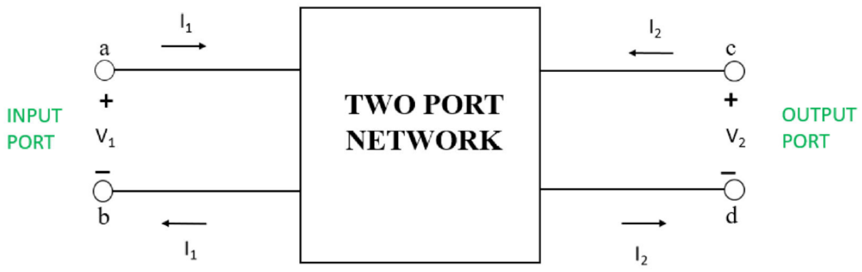
TABLE OF CONTENTS

I. TWO-PORT NETWORKS(INTRODUCTION)

Two-port networks are circuits in which one pair of terminals is defined as the input port and another pair of terminals as the output port.
as the input port and another pair of terminals as the output port.
Examples of two-port networks are amplifiers and filters.
A two-port network can be connected to a generator or a load. Also
can also be connected to another two-port network to form a more complex two-port network.
port network.

EQUATION AND PARAMETERS OF LINEAR TWO-PORT NETWORKS

Two-port network variables are defined as: input voltage **V1**, input current **I1**, output voltage **V2**, and output current **I2**.
input current **I1**, output voltage **V2,** and output current **I2.** From
of these four variables, two are selected as independent variables and two as dependent variables.
as dependent variables



The equations of a linear two-port network express the two dependent variables as a linear combination of the two independent variables.
dependent variables as a linear combination of the two independent variables.
They are used to model the behaviour of the network as seen from its terminals.
The four coefficients of these linear combinations are called network parameters.
are called network parameters. There are different sets of parameters, according to
according to which variables are chosen as independent.

Y-ADMITTANCE PARAMETERS

To model a network with admittance parameters, or Y-parameters, the following are chosen
voltages, V1 and V2, are chosen as independent variables:

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

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

$$\underbrace{\begin{bmatrix} I_1 \\ I_2 \end{bmatrix}}_{[I]} = \underbrace{\begin{bmatrix} y_{11} & y_{12} \\ y_{21} & y_{22} \end{bmatrix}}_{[Y]} \underbrace{\begin{bmatrix} V_1 \\ V_2 \end{bmatrix}}_{[V]}$$

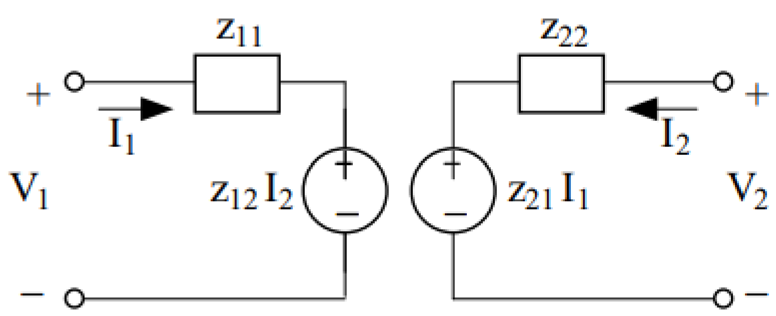
Determination of Y-parameters
From the Y-parameter network equations it is easy to find that:

$$y_{11} = \left.\frac{I_1}{V_1}\right|_{V_2=0} \qquad y_{12} = \left.\frac{I_1}{V_2}\right|_{V_1=0} \qquad y_{21} = \left.\frac{I_2}{V_1}\right|_{V_2=0} \qquad y_{22} = \left.\frac{I_2}{V_2}\right|_{V_1=0}$$

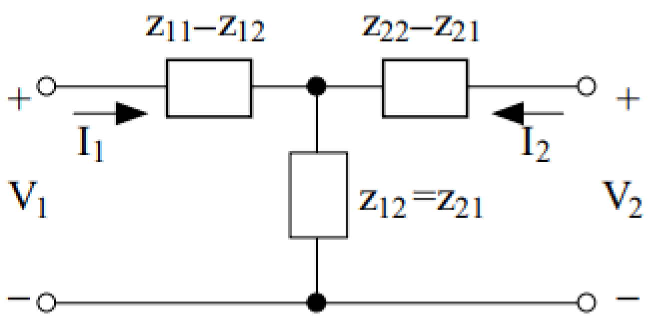
y11 and y21 are determined by shorting the output port and driving the input port.
input port. They are therefore referred to as input admittance with the output
short-circuited output and transfer admittance with the output short-circuited, respectively.
short-circuited output, respectively.
- y22 and y12 are determined by shorting the input port and driving the output port.
the output port. They are therefore called output admittance at the shorted input and transfer admittance at the shorted output, respectively.
short-circuited input and transfer admittance with the short-circuited input, respectively.
short-circuited input, respectively.

Y-parameter network model

General



Passive Networks



2

Z-IMPEDANCE PARAMETERS

If we choose the currents as the independent variables and the voltages as the dependent variables, we are able to express the terminal voltages as a linear
dependent variables we can express the terminal voltages as a linear combination of the incoming and outgoing currents.
inrush currents. Thus, it will be:

$$\begin{aligned} V_1 &= Z_{11} I_1 + Z_{12} I_2 \\ V_2 &= Z_{21} I_1 + Z_{22} I_2 \end{aligned} \qquad (4)$$

Based on the system of equations (4) we can obtain the Zij (i, j = 1, 2):

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

The four Zij coefficients are called open-circuit impedance parameters, or Z-parameters.
Z parameters, and they are all obtained by leaving some pair of terminals in open circuit:
- Z11, Z22 are the input impedances (resistances if we work in D.Sc.) viewed from 1-1' or 2-2', and Z12, Z21 are the transfer impedances.

In a matrix form:

$$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} \qquad (5)$$

II. OBJECTIVE

1. Measure the parameters of a two-port network using experimental result

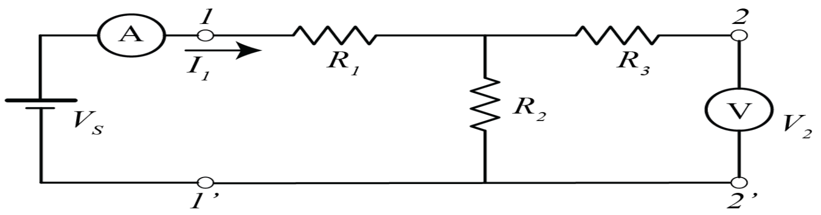
III. APARATUS

1. Power supply
2. Ammeter
3. Voltmeter
4. Resistors (R1=1kohms, R2=2kohms, R3=3kohms

IV. PROCEDURE

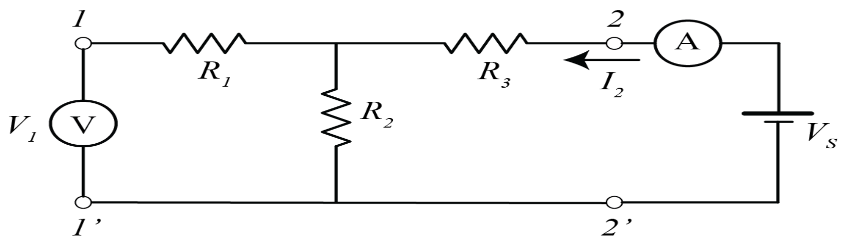
LIST OF FIGURES

FIGURE 1: T-NETWORK VERIFICATION (Z-PARAMETER) CIRCUIT 1



1. Power supply was set to 5V.
2. Value of I1 and V2 were recorded in Table 1.
3. Step 2 and Step 3 were repeated with power supply of 10V and 15V

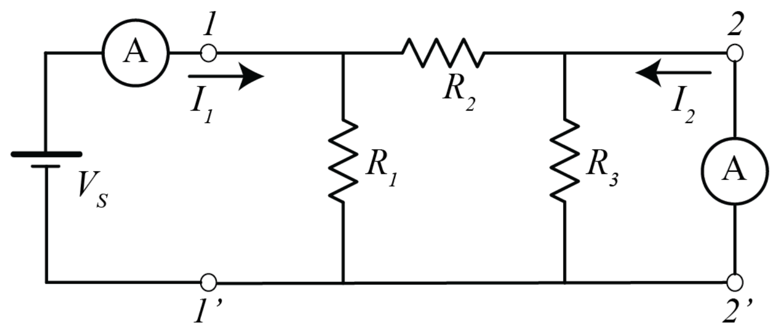
FIGURE 2: T-NETWORK VERIFICATION (Z-PARAMETER) CIRCUIT 2



1. Power supply was set to 5V
2. Values of I2 and V1
3. Steps two and three were repeated with power supply of 10V and 15V

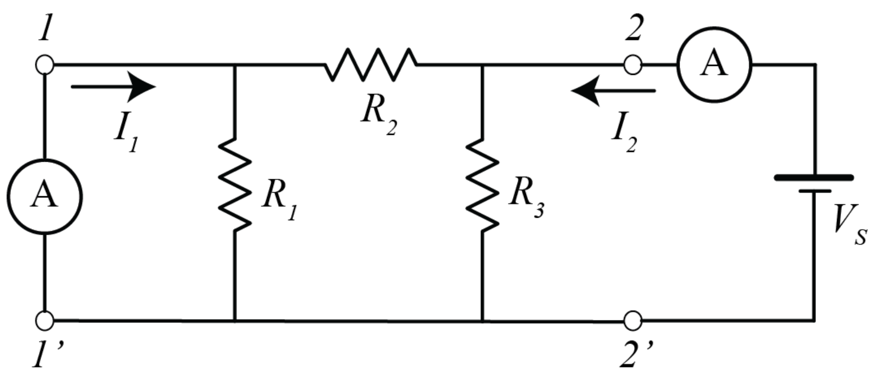
3

FIGURE 3: π- NETWORK VERIFICATION (PARAMETER Y) CIRCUIT 1



1. Power supply was set to 5V.
2. Value of I2 and I2.
3. Steps two and three were repeated with power supply 10V and 15V.

FIGURE 4: π- NETWORK VERIFICATION (PARAMETER Y) CIRCUIT 2



1. Power supply was set to 5V.
2. Value of I1 and I2 were recorded in table 2.
3. Steps two and three were repeated with power supply 10V and 15V.

V. RESULTS

TABLE 1: T-NETWORK VERIFICATION RESULT

$I_2 = 0$	V_1	$5V$	$10V$	$15V$
	I_1	1.667 mA	3.3 mA	5mA
	V_2	3.3 V	6.66 mA	10 V
$I_1 = 0$	V_2	$5V$	$10V$	$15V$
	I_2	1 mA	2 mA	3mA
	V_1	2 V	4 V	6 V

TABLE 2 π- NETWORK VERIFICATION RESULT

V_s = figure 3 Y11 and Y21	V_2	$5V$	$10V$	$15V$
	I_1	7.5mA	15 mA	22.5 mA
	I_2	2.5 mA	5 mA	7.5 mA
Vs = figure 4 Y12 and Y22	V_1	$5V$	$10V$	$15V$
	I_1	2.5 mA	5 mA	7.5 mV
	I_2	4.16 mA	8.33 mA	12.5 mA

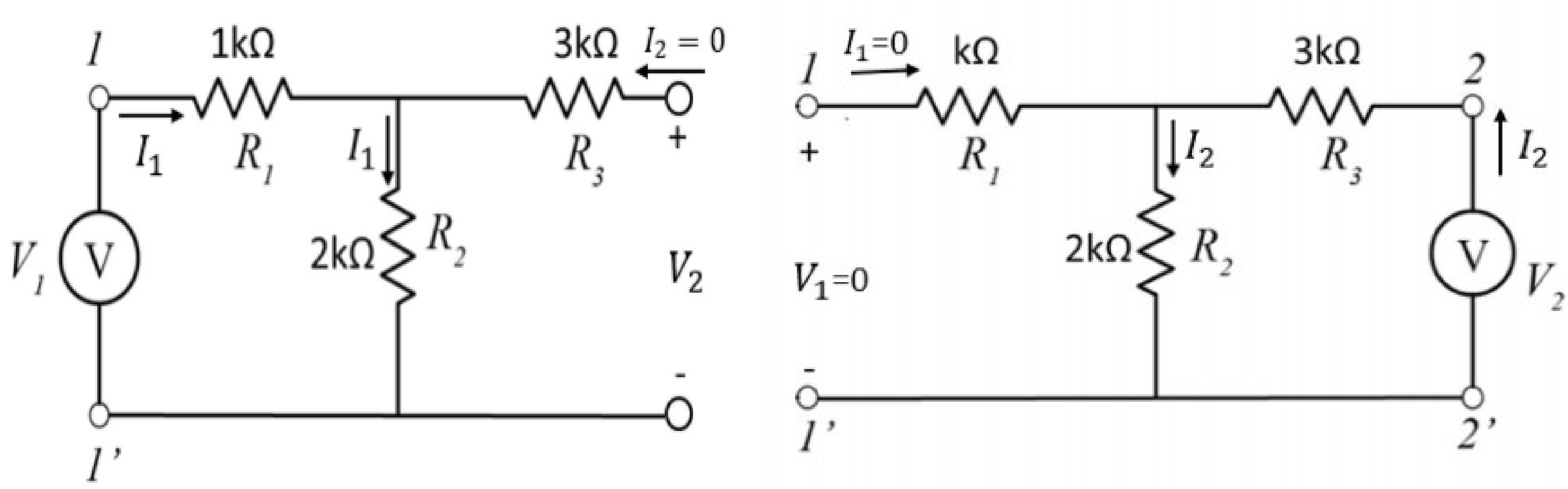
TABLE 3: PARAMETERS CALCULATION

	V_S								
	$5V$			$10V$			$15V$		
	Based on Theoretical Values	Based on Measured Values	% Difference	Based on Theoretical Values	Based on Measured Values	% Difference	Based on Theoretical Values	Based on Measured Values	% Difference
z_{11}	3k ohms	5V/1.667mA=2.9994k	0.02%	3k	10V/3.333mA=3.0003k	0.01%	3kohms	15V/5mA=3k	0%
z_{12}	2k ohms	2V/1mA=2k	0%	2k	4V/2mA=2k	0%	2kohms	6V/3mA=2k	0%
z_{21}	2k ohms	3.333V/1.667mA=1.9994k	0.03%	2k	6.66V/3.333mA=2.0003k	0.01%	2kohms	10V/5mA=2k	0%
z_{22}	5kohms	5V/1mA=5k	0%	5k	10V/2mA=5k	0%	5kohms	15V/3mA=5k	0%
y_{11}	1.5mS	7.5mA/5v=1.5mS	0%	1.5mS	15mA/10v=1.5mS	0%	1.5mS	22.5mA/15v=1.5v	0%
y_{12}	0.5 mS	2.5mA/5v=0.5mS	0%	0.5mS	5mA/10v=0.5mS	0%	0.5mS	7.5mA/15v=0.5mS	0%
y_{21}	0.5mS	2.5mA/5v=0.5mS	0%	0.5mS	5mA/10v=0.5mS	0%	0.5mS	7.5mA/15v=0.5mS	0%
y_{22}	0.8 mS	4.16mA/5v=0.8mS	0%	0.8 mS	8.33mA/10v=0.8mS	0%	0.8mS	12.5mA/15v=0.8mS	0%

VI. DISCUSSION

Basically, in the discussion I will demonstrate certain results that I obtained in the experiment tested from the LtSpice software.

Z PARAMETERS



TWO DIAGRAMS FOR Z11, Z22, Z12, and Z21

THEORICAL VALUES (Z PARAMETERS): Discussion by handwriting:

* THEORICAL VALUES

$$Z_{11} = \frac{(1+2)\cancel{I_1}}{\cancel{I_1}} = 3K\Omega \quad // \quad Z_{22} = \frac{(3+2)\cancel{I_2}}{\cancel{I_2}} = 5\Omega$$

$$Z_{12} = \frac{2\cancel{I_2}}{\cancel{I_2}} = 2K\Omega \quad // \quad Z_{21} = \frac{2\cancel{I_1}}{\cancel{I_1}} = 2K\Omega$$

Screenshot theorical value z parameters

MEASURED VALUES (Z PARAMETERS):

* Measure values ($V_s = 5V$)

$$Z_{11} = \frac{V_1}{I_1} = \frac{5V}{1.667mA} = 2.9994K\Omega$$

$$Z_{12} = \frac{V_1}{I_2} = \frac{2V}{1mA} = 2K\Omega$$

$$Z_{21} = \frac{V_2}{I_1} = \frac{3.333}{1.667} = 1.9994K\Omega$$

$$Z_{22} = \frac{V_2}{I_2} = \frac{5V}{1mA} = 5K\Omega$$

Screenshot 1 measured value (z parameters) voltage= 5V

* Measure Values ($V_s = 10V$)

$$Z_{11} = \frac{V_1}{I_1} = \frac{10V}{3.333mA} = 3.0003K\Omega$$

$$Z_{12} = \frac{V_1}{I_2} = \frac{4V}{2mA} = 2K\Omega$$

$$Z_{21} = \frac{V_2}{I_1} = \frac{6.66V}{3.333mA} = 2.0003K\Omega$$

$$Z_{22} = \frac{V_2}{I_2} = \frac{10V}{2mA} = 5K\Omega$$

Screenshot 2 measured value (z parameters) voltage= 15V

6

* Measured values ($V_s = 15V$)

$$y_{11} = \frac{I_1}{V_1} = \frac{22.5mA}{15V} = 1.5V$$

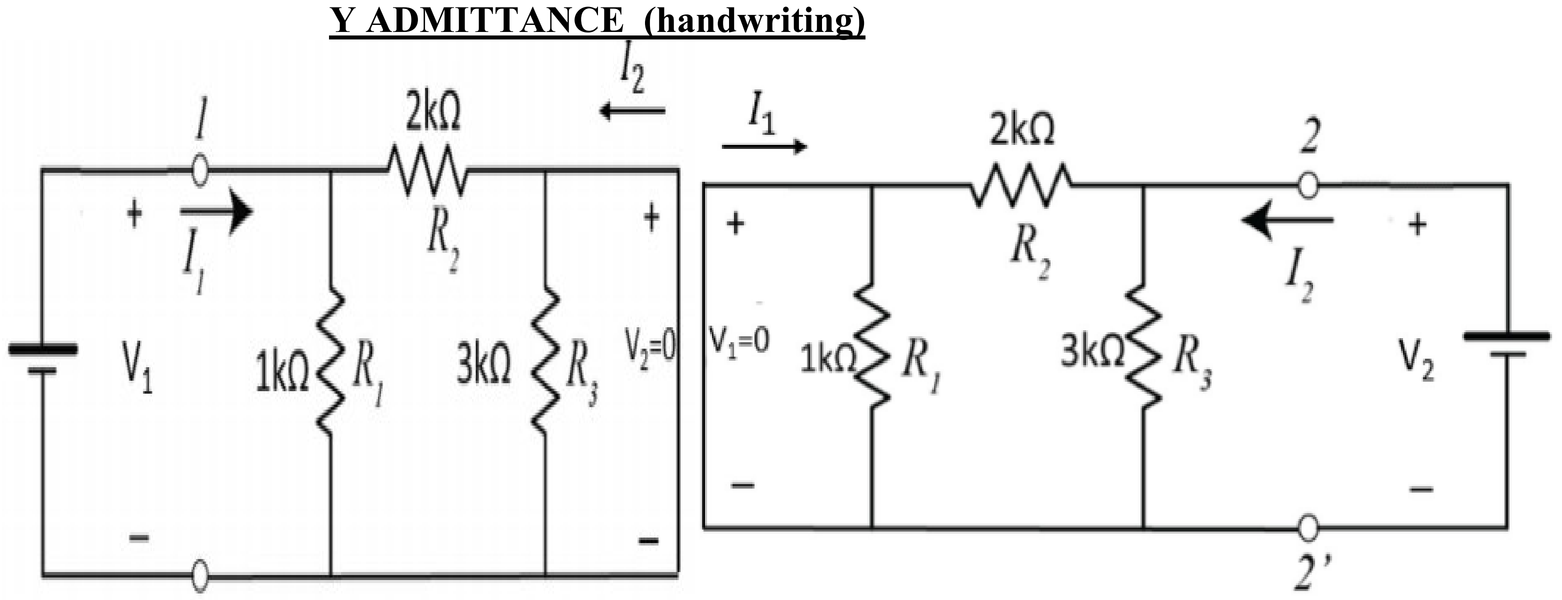
$$y_{12} = \frac{I_1}{V_2} = \frac{7.5mA}{15V} = 0.5mS$$

$$y_{21} = \frac{I_2}{V_1} = \frac{7.5mA}{15V} = 0.5mS$$

$$y_{22} = \frac{I_2}{V_2} = \frac{12.5mA}{15V} = 0.8mS$$

Screenshot 3 measured value (z parameters) voltage= 15V

<u>Y ADMITTANCE (handwriting)</u>



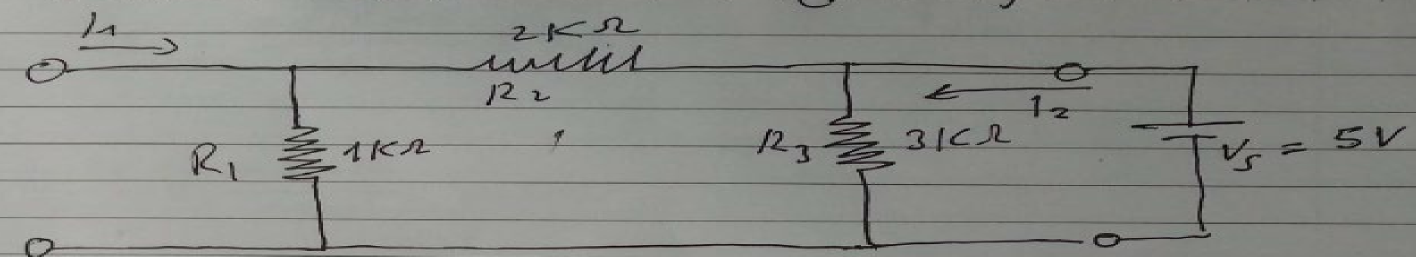
TWO DIAGRAMS FOR Y11, Y22, Y12, and Y21

THEORICAL VALUES (Y ADMITTANCE):

No.:

Date:

* Theorical values. ($V_s = 5V$)



(1) $V_1 = I_1(1//2) = \frac{2}{3} I_1 \rightsquigarrow y_{11} = \frac{I_1}{V_1} = \frac{I_1}{\frac{2}{3} I_1} = 1.5mS$

(2) $-I_2 = \frac{1}{1+2} I_1 = \frac{1}{3} I_1 \rightsquigarrow y_{21} = \frac{I_2}{V_1} = \frac{\frac{1}{3} I_1}{\frac{2}{3} I_1} = 0.5mS$

(4) $-I_1 = \frac{3}{3+2} I_2 = \frac{3}{5} = \frac{3}{5} I_2 \quad y_{12} = \frac{I_1}{V_2} = \frac{\frac{3}{5} I_2}{\frac{6}{5} I_2} = 0.5mS$

(3) $V_2 = I_2(3//2) = \frac{6}{5} I_2 \quad y_{22} = \frac{I_2}{V_2} = \frac{I_2}{\frac{6}{5} I_2} = 0.8mS$

Screenshot theorical value (Y admittance)

MEASURED VALUE (Y ADMITTANCE):

* Measured Values ($V_s = 5V$)

$$y_{11} = \frac{I_1}{V_1} = \frac{7.5mA}{5V} = 1.5mS$$

$$y_{12} = \frac{I_1}{V_2} = \frac{2.5mA}{5V} = 0.5mS$$

$$y_{21} = \frac{I_2}{V_1} = \frac{2.5mA}{5V} = 0.5mS$$

$$y_{22} = \frac{4.16mA}{5V} = 0.8mS$$

$$y_{22} = \frac{I_2}{V_2}$$

Screenshot 1 measured value y admittance voltage 5v

* Measured values ($V_s = 10V$)

$$y_{11} = \frac{I_1}{V_1} = \frac{15mA}{10V} = 1.5mS$$

$$y_{12} = \frac{I_1}{V_2} = \frac{5mA}{10V} = 0.5mS$$

$$y_{21} = \frac{I_2}{V_1} = \frac{5mA}{10V} = 0.5mS$$

$$y_{22} = \frac{I_2}{V_2} = \frac{8.33mA}{10V} = 0.8mS$$

Screenshot 2 measured value y admittance voltage 10v

* Measured values ($V_s = 15V$)

$$y_{11} = \frac{I_1}{V_1} = \frac{22.5mA}{15V} = 1.5V$$

$$y_{12} = \frac{I_1}{V_2} = \frac{7.5mA}{15V} = 0.5mS$$

$$y_{21} = \frac{I_2}{V_1} = \frac{7.5mA}{15V} = 0.5mS$$

$$y_{22} = \frac{I_2}{V_2} = \frac{12.5mA}{15V} = 0.8mS$$

Screenshot 3 measured value y admittance voltage 15v

VII. CONCLUSION

As a conclusion of this experiment, it is necessary to highlight and emphasise once again that it has been carried out thanks to the LtSpice software that I have used to obtain the values and results of the experiment. It should be noted that in the calculations I have been able to observe certain differences that are not very relevant as they are approximate differences in decimals, which confirms the veracity and transparency of the values obtained in table number three and the effectiveness of the work and of the experiment in general.

VIII. REFERENCES

REFERENCES

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APPENDIX