NETWORK ANALYSIS AND SYNTHESIS LAB

LABORATORY MANUAL

B.Tech. Semester –4th

Subject Code: BEE 451

Session: 2024-25, Even Semester

Name:	
Roll.No.:	
Group/Branch:	

DRONACHARYA GROUP OF INSTITUTIONS

DEPARTMENT OF EEE

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AFFILATED TO Dr. ABDUL KALAM TECHNICALUNIVERSITY, LUCKNOW

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Vision and Mission of the Institute

Vision:

Instilling core human values and facilitating competence to address global challenges by providing Quality Technical Education.

Mission:

- M1 - Enhancing technical expertise through innovative research and education, fostering creativity and excellence in problem-solving.
- M2 - Cultivating a culture of ethical innovation and user-focused design, ensuring technological progress enhances the well-being of society.
- M3 - Equipping individuals with the technical skills and ethical values to lead and innovate responsibly in an ever-evolving digital landscape.

Vision and Mission of the Department

Vision:

"To be a Centre of Excellence in Globalizing Education and Research in the field of Electrical and Electronics Engineering."

Mission:

M1: To empower technocrats with state-of-art knowledge to excel as eminent electrical engineers with multi-disciplinary skills.

M2: To emphasize social values and leadership qualities to meet the industrial needs, societal problems and global challenges.

M3: To enable the technocrats to accomplish impactful research and innovations.

Programme Educational Objectives (PEOs)

PEO1: To foster strong knowledge in basic sciences and electrical engineering that enable technocrats to have successful careers.

PEO2: Imbibed with the state of art knowledge to adapt ever transforming technical scenario.

PEO3: Inspire engineers to provide innovative solutions to real-world challenging problems by applying electrical and electronics engineering principles.

Programme Outcomes (POs)

- **PO1. Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- **PO2. Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- **PO3. Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
- **PO4. Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
- **PO5. Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
- **PO6. The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
- **PO7. Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- **PO8. Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- **PO9. Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- **PO10. Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

- **PO11. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- **PO12. Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)

PSO1: Graduates will be capable to gain knowledge in diverse areas of electrical and electronics engineering and apply that to a successful career, entrepreneurship and higher education.

PSO2: Enhance the competence of graduates to design and analyze systems used in advanced power applications, renewable energy, electrical drives in allied technical fields.

PSO3. Graduate will use advance tools to analyze, design and develop electrical and electronic systems for feasible operation and meet the industry requirements.

University Syllabus

BEE-451	**NETWORK ANALYSIS AND SYNTHESIS LAB**	**0L:0T:2P**	**1Credit**

SUGGESTIVE LIST OF EXPERIMENTS:

1. Verification of Maximum power transfer theorem.
2. Verification of Tallegen's theorem.
3. Study of phenomenon of resonance in RLC series circuit and obtain resonant frequency.
4. Design and find cut-off frequency of low pass and high pass filters.
5. Design and find the pass band frequencies of band pass filters.
6. Design and find the stop band frequencies of band reject filters.
7. Determination of two port network Z and h parameters.
8. Verification of parameters properties in interconnection of 2, two port networks in series-series interconnection.
9. Verification of parameters properties in interconnection of 2, two port networks in parallel-parallel interconnection.
10. Determination of Z parameters of a T network and Computation of corresponding parameters to equivalent π network.
11. To perform the transient response of RL circuit.
12. Verification of parameters properties in interconnection of 2, two port networks in cascade interconnection.

Note: Any two experiments from above list should also be performed by students on Virtual Lab.

Course Outcomes (COs)

Upon successful completion of the course, the students will be able to:

CO1	Recall basics of electrical circuits with nodal and mesh analysis.
CO2	Illustrate electrical network theorems.
CO3	Develop Laplace Transformed network for steady state and transient analysis.
CO4	Analyse electrical network parameter for different application.
CO5	Determine the elements required to network synthesis methods

CO-PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	-	-	-	1	-	-	-	1	2	-	2
CO2	3	2	-	-	2	-	-	-	1	2	-	2
CO3	2	2	2	2	-	-	-	-	1	1	-	1
CO4	2	-	2	2	2	-	-	-	1	1	-	1
CO5	2	-	2	2	2	-	-	-	1	1	-	1
Course Correlation mapping	**2.2**	**1.2**	**1.4**	**1.2**	**1.4**	**-**	**-**	**-**	**1**	**1.4**	**-**	**1.6**

Correlation Levels: High-3, Medium-2, Low-1

CO-PSO Mapping

	PSO1	PSO2	PSO3
CO1	2	3	1
CO2	2	3	1
CO3	2	3	1
CO4	2	3	1
CO5	2	3	1
	2	3	1

Course Overview

Objective of this course is to familiarize students about detailed analysis of a network (including multi-port networks) for different kinds of inputs utilizing the concept of complex frequency and impedance transform, the in-depth analysis of network is further extended to make students acquitted with design of passive and active filters. Finally, students are made to learn synthesis of passive electrical networks from a given impedance or admittance function. The course has been designed for analysis and synthesis of linear, time invariant networks. Analysis of non-linear, time varying network requires advanced studies.

List of Experiments mapped with COs

S.No.	Name of the Experiment	Course Outcome
1	Verification of Maximum power transfer theorem.	CO1
2	Verification of Tallegen's theorem.	CO1
3	Study of phenomenon of resonance in RLC series circuit and obtain resonant frequency.	CO2
4	Design and find cut-off frequency of low pass and high pass filters.	CO2
5	Design and find the pass band frequencies of band pass filters.	CO3
6	Design and find the stop band frequencies of band reject filters.	CO5
7	Determination of two port network Z and h parameters.	CO4
8	Verification of parameters properties in interconnection of 2, two port networks in series-series interconnection.	CO2
9	Verification of parameters properties in interconnection of 2, two port networks in parallel-parallel interconnection.	CO3
10	Determination of Z parameters of a T network and Computation of corresponding parameters to equivalent π network.	CO5
11	To perform the transient response of RL circuit.	CO5

Do’s and Don’ts in Laboratory (for students):

1. Do not handle any equipment before reading the instructions/Instruction manuals.
2. Apply proper voltage to the circuit as given in the procedure.
3. Check CRO probe before connecting it.
4. Strictly observe the instructions given by the teacher/Lab Instructor.

Guidelines to write your observation book (for students):

1. Experiment Title, Aim, Apparatus, Procedure should be right side.
2. Circuit diagrams, Model graphs, Observations table, Calculations table should be left side.
3. Theoretical and model calculations can be any side as per your convenience.
4. Result and Conclusion should always be at the end.
5. You all are advised to leave sufficient no of pages between experiments for theoretical or model calculations purpose.

General Safety Precautions

Precautions (In case of Injury or Electric Shock)

1. To break the victim with live electric source, use an insulator such as fire wood or plastic to break the contact. Do not touch the victim with bare hands to avoid the risk of electrifying yourself.
2. Unplug the risk of faulty equipment. If the main circuit breaker is accessible, turn the circuit off.
3. If the victim is unconscious, start resuscitation immediately, use your hands to press the chest in and out to continue breathing function. Use mouth-to-mouth resuscitation if necessary.
4. Immediately call medical emergency and security. Remember! Time is critical; be best.

Precautions (In case of Fire)

1. Turn the equipment off. If power switch is not immediately accessible, take plug off.
2. If fire continues, try to curb the fire, if possible, by using the fire extinguisher or by covering it with a heavy cloth if possible isolate the burning equipment from the other surrounding equipment.
3. Sound the fire alarm by activating the nearest alarm switch located in the hallway.
4. Call security and emergency department immediately:

Emergency : 201(Reception)

Security : 231(GateNo.1)

Guide lines to students for report preparation

All students are required to maintain a record of the experiments conducted by them.Guidelines for its preparation are as follows: -

1) All files must contain a title page followed by an index page. ***The files will not be signed by the faculty without an entry in the index page.***

2) Student's Name, Roll number and date of conduction of experiment must be written on all pages.

3) For each experiment, the record must contain the following
   - (i) Aim/Objective of the experiment
   - (ii) Pre-experiment work (as given by the faculty)
   - (iii) Lab assignment questions and their solutions
   - (iv) Test Cases (if applicable to the course)
   - (v) Results/output

Note:

1. Students must bring their lab record along with them whenever they come for the lab.

2. Students must ensure that their lab record is regularly evaluated.

Lab Assessment Criteria

An estimated 10 lab classes are conducted in a semester for each lab course. These lab classes are assessed continuously. Each lab experiment is evaluated based on 5 assessment criteria as shown in following table. Assessed performance in each experiment isused to compute CO attainment as well as internal marks in the lab course.

Grading Criteria	Exemplary(4)	Competent(3)	Needs Improvement(2)	Poor(1)
AC1: Designing experiments	The student chooses the Problems to explore.	The student chooses the Problems but does not set an appropriate goal For how to explore them.	The student fails to Define the problem adequately.	The student does not Identify the problem.
AC2: Collecting data through observation and/or experimentation	Develops a clear Procedure for Investigating the Problem	Observations are Completed with Necessary theoretical Calculations and proper Identification of required components.	Observations are Completed with Necessary theoretical Calculations but without Proper understanding. Obtain the correct Values for only a few Components after Calculations. Followed The given experimental Procedures but obtained Results with some errors.	Observations are In complete. Lacks the Appropriate knowledge Of the lab procedures.
AC3: Interpreting data	Decides what data and Observations are to be collected and verified	Can decide what data and observations are to be collected but lacks the Knowledge to verify	Student decides what Data to gather but not sufficient	Student has no Knowledge of what data and observations are to be collected
AC4: Drawing conclusions	Interprets and analyses The data in order to propose viable Conclusions and solutions	Incomplete analysis of Data hence the quality of conclusions drawn is not upto the mark.	Cannot analyze the data or observations for any kind of conclusions.	Lacks the required knowledge to propose viable conclusions and solutions
AC5: Lab record assessment	Well-organized and Confident presentation of record & ability to correlate the theoretical Concepts with the Concerned lab results With appropriate reasons.	Presentation of record is acceptable	Presentation of record Lacks clarity and organization	No efforts were exhibited

LAB EXPERIMENTS

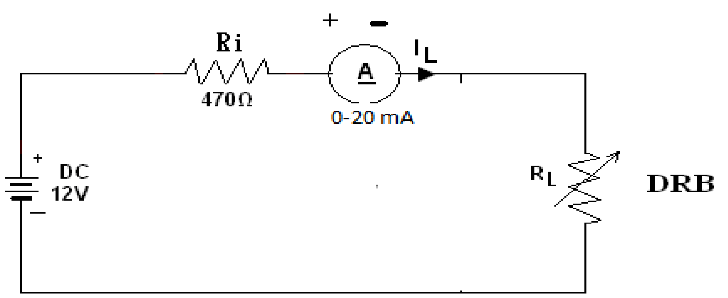
EXPERIMENT -1

AIM: To Verify The Maximum Power Transfer Theorem For The Given Circuit.

APPARTUS REQUIRED:

SI. No	Equipment	Range	Qty
1	Bread board	-	1 NO
2	DC Voltage source.	0-30V	1 NO
3	Resistors	470 Ω	1 NO
4	Decade resistance box	0-10k Ω	1 NO
5	Ammeter	0-20mA	1 NO
6	Connecting wires	1.0.Sq.mm	As required

CIRCUIT DIAGRAM:



THEORY:

STATEMENT:

It states that the maximum power is transferred from the source to load when the load resistance is equal to the internal resistance of the source.

(or)

The maximum transformer states that " A load will receive maximum power from a linear bilateral network when its load resistance is exactly equal to the Thevenin"s resistance of network, measured looking back into the terminals of network.

Consider a voltage source of V of internal resistance R_i delivering power to a load Resistance R_L

Circuit current = $\frac{V}{R_L+R_i}$

Power delivered P = $I^2 R_L$

$$= \left|\frac{V}{R_L+R_i}\right|^2 R_L$$

for maximum poewer $\frac{d(p)}{dt} = 0$

RL+Ri cannot be zero,

Ri – RL = 0

$R_L == Ri$

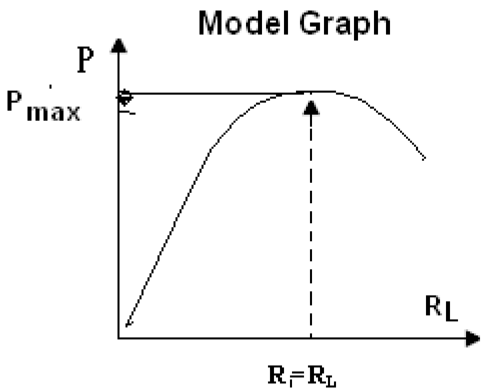
$$P_{max} = \frac{V^2}{4R_L} \text{ watts}$$

PROCEDURE:

1. Connect the circuit as shown in the above figure.
2. Apply the voltage 12V from RPS.
3. Now vary the load resistance (R_L) in steps and note down the corresponding Ammeter Reading (I_L) in milli amps and Load Voltage (V_L) volts
6. Tabulate the readings and find the power for different load resistance values.
7. Draw the graph between Power and Load Resistance.
8. After plotting the graph, the Power will be Maximum, when the Load Resistance will be equal to source Resistance

TABULAR COLUMN:

S.No	**R_L**	**I_L(mA)**	**Power(P max)=I_L^2*R_L(mW)**
1			
2			
3			
4			
5			
6			
7			
8			



Theoretical Calculations:-

R = (R_i + R_L) =...**Ω**

I_L = V / R =…**mA**

Power = $(I_L^2) R_L$ =…**mW**

RESULT:

VIVA QUESTIONS:

1) What is maximum power transfer theorem?
2) What is the condition for maximum power transfer?
3) What is the application of this theorem?
4) What is the limitation of maximum power transfer theorem?

NETWORK ANALYSIS AND SYNTHESIS LAB (BEE 451)

EXPERIMENT -2

Aim: To verify Tellegen's theorem

Apparatus:

Sl. No.	Apparatus	Range	Quantity
1	Voltmeter	(0-10V)MC	1
2	Rheostat	1KΩ, 1KΩ, 3Ω	3
3	Multimeter	--	1
4	DC supply		
5	Wires	--	Required

Theory:

Tellegen's theorem is one of the most powerful theorems in network theory. Most of the energy distribution theorems and principles in network theory can be derived from it. It was published in 1952 by Bernard Tellegen. Fundamentally, Tellegen's theorem gives a simple relation between magnitudes that satisfy the Kirchhoff's laws of electrical circuit theory.

Tellegen's theorem is based on the fundamental law of conservation of energy and is a logical outcome of Kirchoff's laws. It is a general and useful theorem. It states that the algebraic sum of power absorbed by all elements in a circuit is zero at any instant. This theorem is about the power balance in a circuit. Power absorbed by a resistor is always positive, whereas a source may deliver power then in this case the power associated with the source is negative. Tellegen's theorem gives $\sum V_k I_k = 0$, for k=0 to 6. Where V is branch voltage, I is branch current and k is number of branches.

Circuit Diagram:

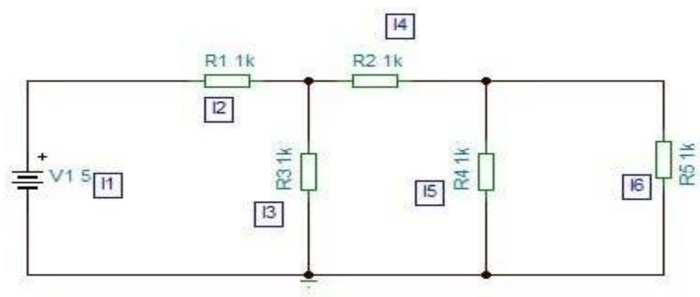


Fig1: Circuit Diagram

Procedure:

1. Rig up the circuit as shown in figure. Adjust power supply voltage 5V at channel1 respectively.
2. Measure all branch voltages by connecting voltmeter parallel to the components.
3. Measure all branch currents by connecting ammeter in series with component.
4. Find algebraic summation of $\sum V_k I_k$ **= …………..** for k = 0 to 6.
5. Compare practical values with theoretical values.

Observations:-

Table1: Branch Currents and voltages

Currents	Voltages
I_1=	V_1=
I_2=	V_2=
I_3=	V_3=
I_4=	V_4=
I_5=	V_5=
I_6=	V_6=

Table2: Theoretical and practical Power comparison

Values	Theoretical	Practical
P_1		
P_2		
P_3		
P_4		
P_5		
P_6		

Result: $\sum V_k I_k = 0$, Hence Tellegen's theorem is proved.

EXPERIMENT -3

Aim:-

1) To design a T-section constant K Low Pass Filter with a cut-off frequency of 2 K Hz and a characteristic load impedance of 600Ω.

2) To obtain the output characteristics of the above filter.

Components:

Name	Quantity
Resistor 600Ω	1
Capacitance box	1
Inductance box	2

Equipment:

Name	Range	Quantity
Bread Board		1
Function Generator	(0-2)MHz	1
Digital Ammeter, Voltmeter	[0-200µA/200mA],[0-20V]	1
CRO	(0-20)MHz	1
CRO probes, Connecting Wires		

Theory:-

Low pass filter is a circuit which passes low frequency signals and attenuates high frequency signals, The frequency at which the gain is 70% of the maximum value is called as cut off frequency.

Design:-

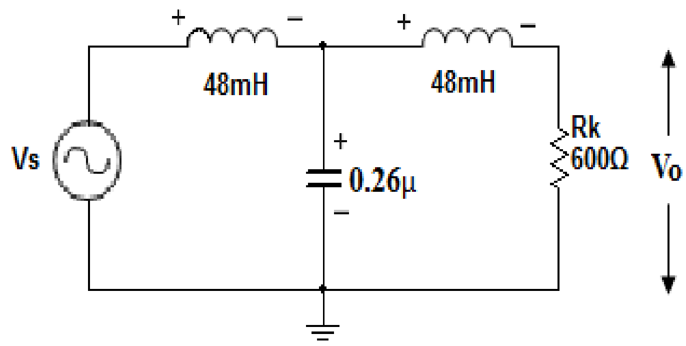
We know that the cutoff frequency is given by,

$$f_C = \frac{1}{\pi\sqrt{LC}}$$

and the characteristic load impedance is, then the design equations for L and C will be

$$C = \frac{1}{\pi R_K f_C} = \frac{1}{\pi\times 600\times 2000} = 0.26\mu F$$

Circuit Diagram:-



Fig(1):Low pass filter

Procedure:-

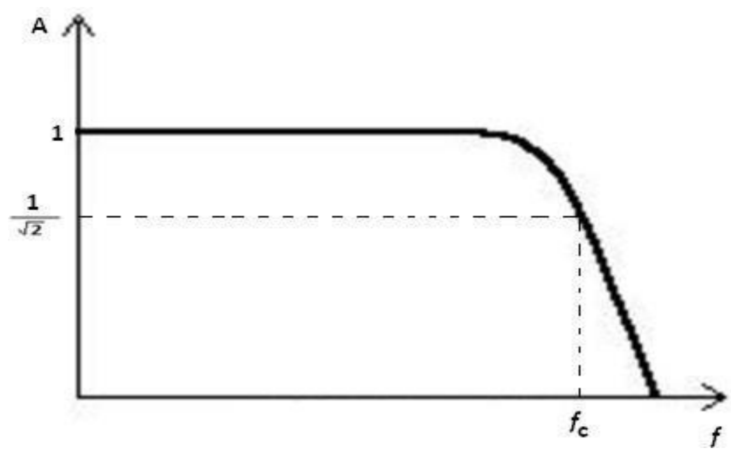
1) Connect the components as shown in the circuit diagram.
2) Adjust V_i= 4V (peak-to-peak) and keep it constant throughout the experiment.
3) Vary the input frequency from 100 Hz to 20Khz in steps of 200Hz and note down the peak-to-peak voltage across R_L i.e., V_O.

Note: Take more readings between 1.8 KHz and 2.2 KHz.

4) Plot the variation of Gain Versus frequency
5) From the graph find out f_C.

-

Observations:-



Sl. No.	**Frequency (Hz)**	**V_i(Volt)**	**V_O (Volt)**	$\alpha = \ln\left(\frac{V_i}{V_O}\right)$

Results: - From the attenuation characteristics curve, $f_C = Hz$

EXPERIMENT -4

Aim:

A
i
m

1) To design an m-derived high pass T-section filter with a cut-off frequency of 1.2 KHz, characteristic load impedance of 600 Ω and $f_\infty = 1.1 KHz$

2) To obtain outpour characteristics of the above filter.

Components:

Name	Quantity
Resistor 600 Ω	1
Capacitance box	3
Inductance box	1

Equipment:

Name	Range	Quantity
Bread Board		1
Function Generator	(0-2)MHz	1
Digital Ammeter, Voltmeter	[0-200µA/200mA],[0-20V]	1
CRO	(0-20)MHz	1
CRO probes, Connecting Wires		

Theory:-

High pass filter is a circuit which passes high frequency signals and attenuates low frequency signals, The frequency at which the gain is 70% of the maximum value is called as cut off frequency. m-derived filters have a very sharp cut off frequency

Design:-

a) Design of prototype High Pass T-section

$$L = \frac{R_O}{4\pi f c} = \frac{600}{4\pi \times 1200} = 39.78 mH$$

$$= \frac{1}{4\pi \times 600 \times 1200} = 0.8 \mu F$$

$$C = \frac{1}{4\pi R_O f_C}$$

Value of m for m-derived section to give infinite attenuation at 800 Hz is given by,

$$m = \sqrt{1 - \left(\frac{f_\infty}{f_C}\right)^2} = \sqrt{1 - \left(\frac{800}{1200}\right)^2} = 0.4$$

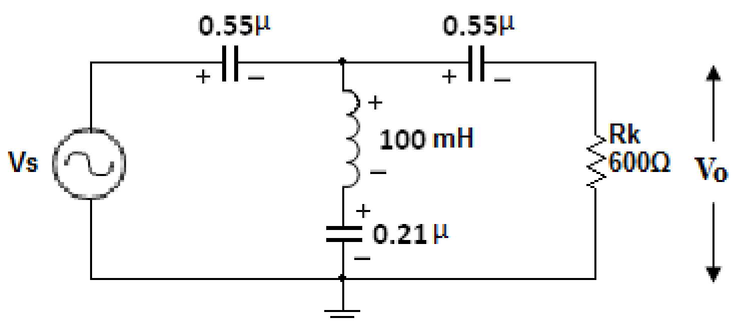
b) For the m-derived T-section

Each series arm $= \frac{2C}{m} = \frac{0.22}{0.4} = 0.55\mu F$

Shunt arm $= \frac{L}{m} = \frac{39.78}{0.4} = 99.45 mH$

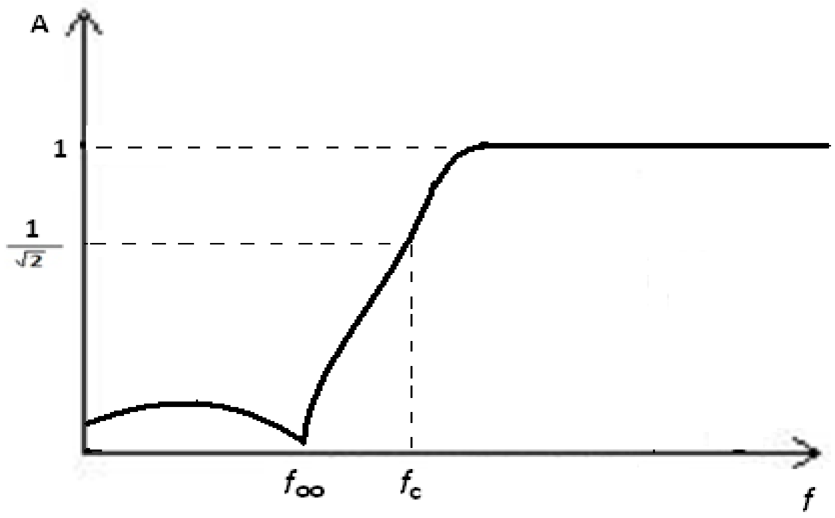
And, $\frac{4mC}{1-m^2} = \frac{4\times0.4\times0.8}{1-(0.4)^2}$

Circuit Diagram:-



Sl. No.	Frequency (Hz)	V_i(Volt)	V_O (Volt)	$\alpha = \ln\left(\frac{V_i}{V_O}\right)$

Expected Graphs:-



Fig(2):Frequency response of high pass filter

Results:-

From the attenuation characteristics curve,

$f_C = \_\_ Hz$ $f_\infty = \_\_ Hz$

EXPERIMENT -5

AIM: To find the resonant frequency, quality factor and band width of a given series and parallel resonant circuits.

APPARATUS REQUIRED:

S.No	Name Of The Equipment	Range	Type	Quantity
1	Bread board	-	-	1 NO
2	Resistor	1k Ω	-	1 NO
3	Inductor	50 mH	-	1 NO
4	Capacitors	0.1 uF	-	1 NO
5	CRO	20MHz.Dual CH	-	1 NO
6	Function generator	100-10MHz	-	1 NO
7	Ammeter	0-20mA	Digital	1 NO
8	Connecting wires			Required number

CIRCUIT

DIAGRAM: SERIES

RESONANCE:

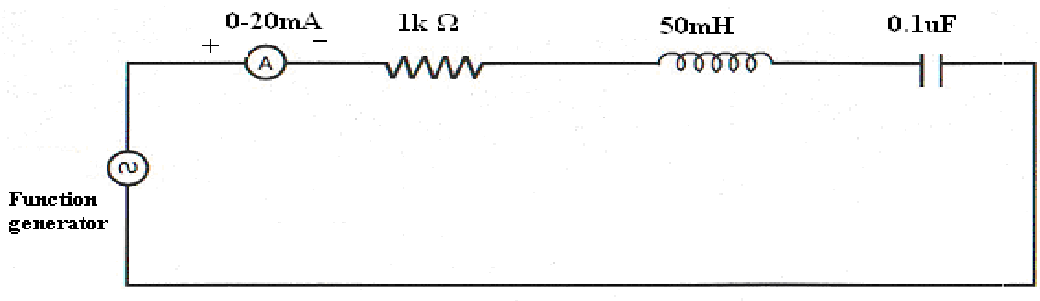


Fig.1

PARALLEL RESONANACE:

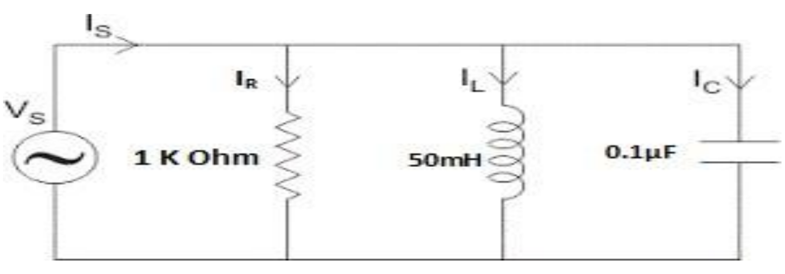


Fig.2

Resonance is a particular type of phenomenon inherently found normally in every kind of system, electrical, mechanical, optical, Acoustical and even atomic. There are several definitions of resonance. But, the most frequently used definition of resonance in electrical system is studied state operation of a circuit or system at that frequency for which the resultant response is in time phase with the forcing function.

SERIES RESONANCE:

A circuit is said to be under resonance, when the applied voltage „V" and current are in phase. Thus a series RLC circuit, under resonance behaves like a pure resistance network and the reactance of the circuit should be zero. Since V & I are in phase, the power factor is unity at resonance.

The frequency at which the resonance will occur is known as resonant frequency.

Resonant frequency,

$$f_r = \frac{1}{2\Pi\sqrt{LC}}$$

Thus at resonance the impedance Z is minimum. Since I = V/Z. The current is maximum So that current amplification takes place. Quality factor is the ratio of reactance power inductor (or) capacitor to its resistance.

PARALLEL RESONANCE:

In the circuit (parallel RLC circuit) shown in figure.2, the condition for resonance occurs when the susceptance part is zero. The frequency at which the resonance will occur is known as resonant frequency. Resonant frequency,

$$f_r = \frac{1}{2\Pi\sqrt{LC}}$$

Thus at resonance the admittance(Y) is Minimum and voltage is Maximum. However the performance of such a circuit is of interest in the general subject of resonance. Lower cut-off frequency is above the resonant frequency at which the current is reduced to $\frac{1}{\sqrt{2}}$ times of its minimum value. Upper cut-off frequency is above. Quality factor is the ratio of resistance to reactance of inductor (or) capacitor. Selectivity is the reciprocal of the quality factors.

THEORITICAL CALCULATIONS:

For Series Resonance circuit:

1. Resonant frequency $f_r = \frac{1}{2\pi\sqrt{LC}}$
2. Lower Cut off Frequency $f_1=f_r-(R/4\pi L)$
3. Upper Cut off Frequency $f_2=f_r+(R/4\pi L)$
4. Band width = f_2-f_1
5. Quality factor $Q = \frac{w_0 L}{R} = \frac{2\pi fr.L}{R}$

6. Current at Resonance $I_o = V_{Ro}/R$

For Parallel Resonance circuit:

1. Resonant frequency $f_r = \frac{1}{2\pi\sqrt{LC}}$
2. Lower Cut off Frequency $f_1 = \{1/2\pi\}\{(-1/2RC)+((1/2RC)^2+(1/LC))^{0.5}\}$
3. Upper Cut off Frequency $f_2 = \{1/2\pi\}\{(1/2RC)+((1/2RC)^2+(1/LC))^{0.5}\}$
4. Band width = f_2-f_1 :
5. Quality factor_Q = $\frac{R}{W_0 L}$
6. Current at resonance $I_o = V_{Ro}/R$

PROCEDURE:

1. Connect the circuit as shown in fig.1 for series resonant circuit & fig.2 for parallel resonant circuit.
2. Set the voltage of the signal from function generator to 5V.
3. Vary the frequency of the signal over a wide range in steps and note down the corresponding ammeter readings.
4. Observe that the current first increases & then decreases in case of series resonant circuit & the value of frequency corresponding to maximum current is equal to resonant frequency.
5. Observe that the current first decreases & then increases in case of parallel resonant circuit & the value of frequency corresponding to minimum current is equal to resonant frequency.
6. Draw a graph between frequency and current & calculate the values of bandwidth & quality factor.

OBSERVATION TABLE:
Series Resonance:

S. No.	**Frequency** (Hz)	**Current** (mA)

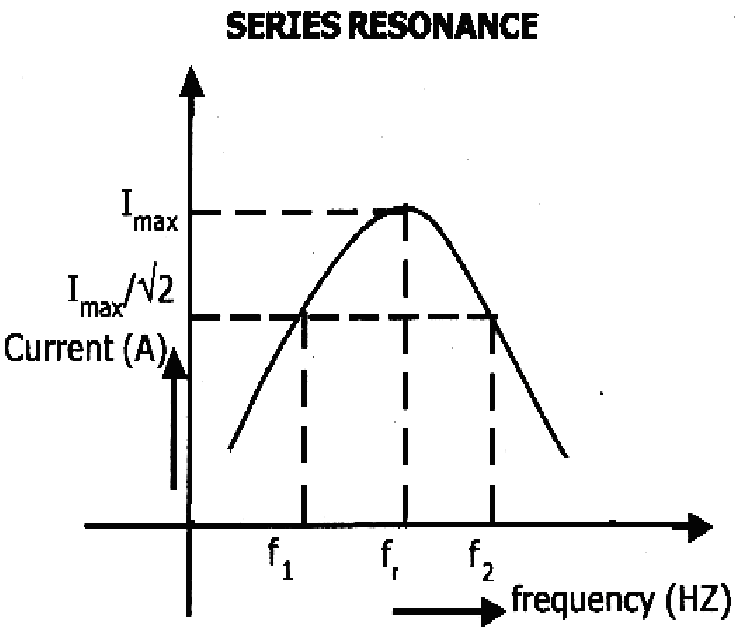
OBSERVATION TABLE:
Parallel Resonance:

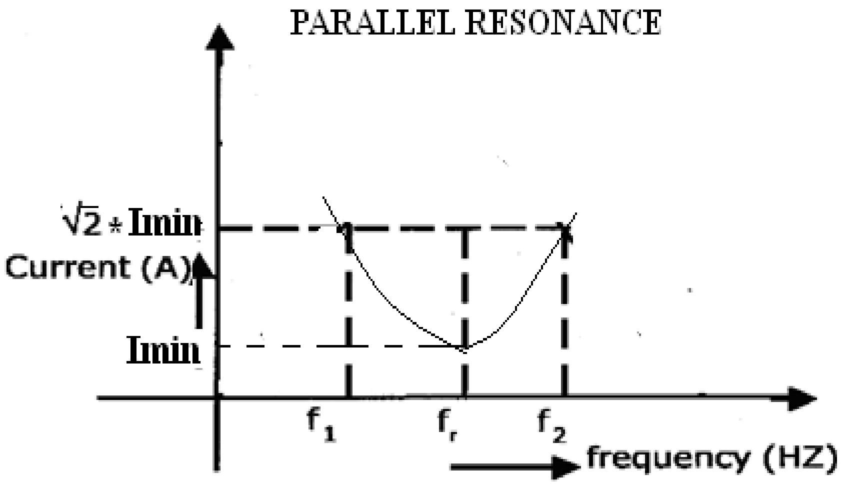
S. No.	Frequency (Hz)	Current (mA)

TABULAR COLUMN:

S.NO	PARAMETER	Series resonant circuit		Parallel resonant circuit	
		Theoretical	Practical	Theoretical	Practical
1	Resonant Frequency(f_r)				
2	Band width				
3	Quality factor				

MODEL GRAPHS:





f_1= lower cutoff frequency
f_2 = upper cutoff frequency
f_r= Resonant Frequency

PRECAUTIONS:
1. Initially keep the RPS output voltage knob in zero volt position.
2. Avoid loose connections.
3. Avoid short circuit of RPS output terminals.

RESULT:

VIVA QUESTIONS:
1) What is resonance of circuit?
2) What is series and parallel resonance?
3) What is cut-off frequency?
4) Define bandwidth and Quality factor?

EXPERIMENT -6

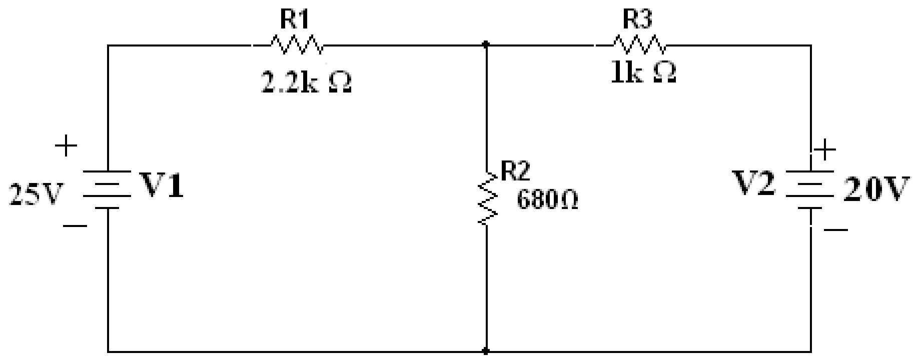
DETERMINATION OF Z AND Y PARAMETERS OF A TWO- PORT NETWORK

AIM: To determine the Impedance (Z) and admittance (Y) parameters of a two port network.

APPARATUS REQUIRED:

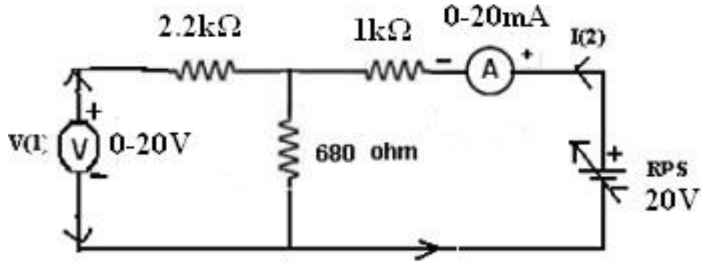
S.No	Name Of The Equipment	Range	Type	Quantity
1	Voltmeter	(0-20)V	Digital	1 NO
2	Ammeter	(0-20)mA	Digital	1 NO
3	RPS	0-30V	Digital	1 NO
4	Resistors	2.2k Ω	-	1 NO
		1k Ω	-	1 NO
		680 Ω	-	1 NO

CIRCUIT DIAGRAMS:
1. GIVEN CIRCUIT:

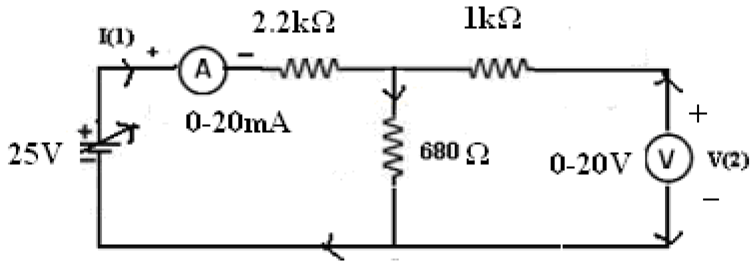


PRACTICAL CIRCUITS:

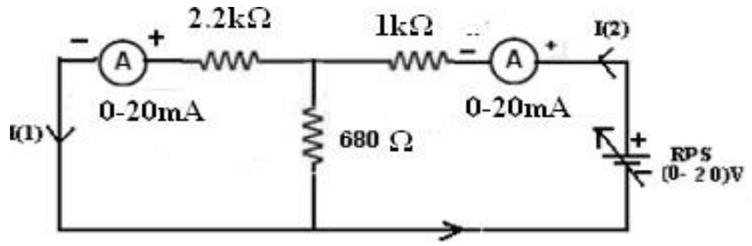
2. When I_1 = 0:



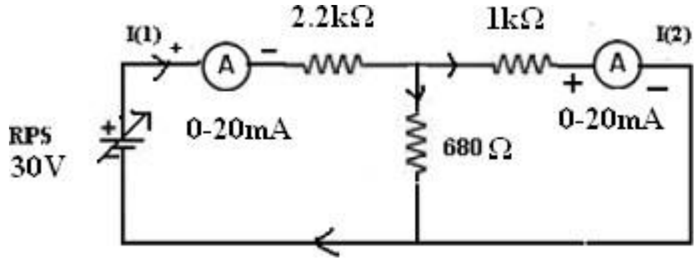
3. When $I_2 = 0$:



4. When $V_1 = 0$:



5. When $V_2 = 0$:



THEORY:

A pair of terminals between which a signal may enter or leave the network is known as port. If a network has one such type pair of terminals it is known as One-Port Network and that have two such type of ports is known as Two-Port Network.

If we relate the voltage of one port to the current of the same port, we get driving point admittance. On the other hand, if we relate the voltage of one port to the current at another port, we get transfer admittance. Admittance is a general term used to represent either the impedance or the admittance of a network. We will consider a general two-port network composed of linear, bilateral elements and no independent sources. The voltage and current at port -1 are V_1 and I_1 and at port -2 are V_2 and I_2. The position of V_1 and V_2 and the directions of I_1 and I_2 are customarily selected. Out of four variables only two are independent. The other two are expressed in terms of the independent variable of network parameters. The relation between the voltages and currents in terms of Z and Y parameters are as follows.

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

$$I_1=Y_{11} (V_1) +Y_{12} (V_2)$$
$$I_2=Y_{21} (V_1) +Y_{22} (V_2)$$

Z-PARAMETERS:

$Z11 = \frac{V1}{I1}$ / I_2 =0

$Z12 = \frac{V1}{I2}$ / I_1 =0

$Z21 = \frac{V2}{I1}$ / I_2 =0

$Z22 = \frac{V2}{I2}$ / I_1 =0

Y-PARAMETERS:

$$Y11 = \frac{I1}{V1} / V2 = 0$$
$$Y12 = \frac{I2}{V1} / V1 = 0$$
$$Y21 = \frac{I2}{V1} / V2 = 0$$
$$Y22 = \frac{I2}{V2} / V1 = 0$$

PROCEDURE:

1. Connections are made as per the circuit diagram.
2. Open circuit the port – 1 i.e., I_1=0, find the values ofV_1, I2 and V_2.
3. Short circuit the port-1 i.e. V_1 =0, find the values of V_2, $I_1$and I_2.
4. Open circuit the port – 2 i.e., I_2=0, find the values of V_1, I1 and V_2.
5. Short circuit the port-2 i.e. V_2 =0, find the values of V_1, $I_1$and $I_{2.}$
5. Find the Z and Y parameters of the given two port network.

THEORITICAL VALUES:

$V_1 = 0$	$V_{2=}$	$I_{1=}$	$I_{2=}$
$V_2 = 0$	$V_{1=}$	$I_{1=}$	$I_{2=}$
$I_1 = 0$	$V_{1=}$	$V_{2=}$	$I_{2=}$
$I_2 = 0$	$V_{1=}$	$V_{2=}$	$I_{1=}$

PRACTICAL VALUES:

$V_1 = 0$	$V_{2=}$	$I_{1=}$	$I_{2=}$
$V_2 = 0$	$V_{1=}$	$I_{1=}$	$I_{2=}$
$I_1 = 0$	$V_{1=}$	$V_{2=}$	$I_{2=}$
$I_2 = 0$	$V_{1=}$	$V_{2=}$	$I_{1=}$

Z-PARAMETERS:

Z-parameters	Theoretical	Practical
$Z11 = \frac{V1}{I1}$ / $I_2 = 0$		
$Z12 = \frac{V1}{I2}$ / $I_1 = 0$		
$Z21 = \frac{V2}{I1}$ / $I_2 = 0$		
$Z22 = \frac{V2}{I2}$ / $I_1 = 0$		

Y-PARAMETERS:

Y-Parameters	Theoretical	Practical
$Y11 = \frac{I1}{V1} / V2 = 0$		
$Y12 = \frac{I2}{V1} / V1 = 0$		
$Y21 = \frac{I2}{V1} / V2 = 0$		
$Y22 = \frac{I2}{V2} / V1 = 0$		

PRECAUTIONS:

1. Initially keep the RPS output voltage knob in zero volt position.
2. Avoid loose connections.
3. Avoid short circuit of RPS output terminals.

RESULT:

VIVA QUESTIONS:

1. Define Port?
2. Define Z & Y parameters?
3. What is the condition for symmetry in case Z & Y parameters?
4. Define characteristic impedance?
5. What is the condition for reciprocity in case Z & Y parameters?

EXPERIMENT -7

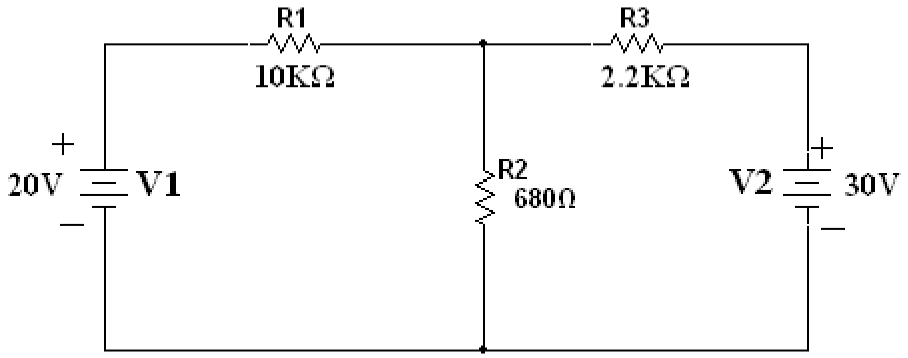
DETERMINATION OF TRANSMISSION AND HYBRID PARAMETERS OF A TWO-PORT NETWORK

AIM: To determine the Transmission and Hybrid parameters of a two port network.

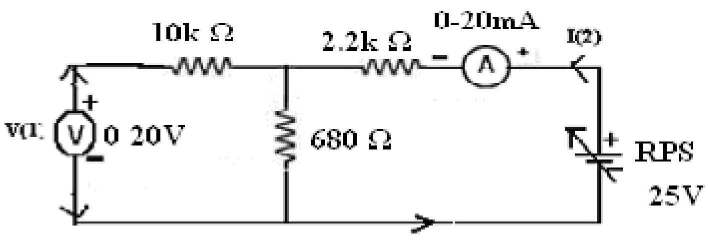
APPARATUS REQUIRED:

S.No	Name Of The Equipment	Range	Type	Quantity
1	Voltmeter	(0-20)V	Digital	1 NO
2	Ammeter	(0-20)mA	Digital	1 NO
3	RPS	0-30V	Digital	1 NO
4	Resistors	10K Ω		1 NO
		2.2Ω		1 NO
		680 Ω		1 NO
5	Breadboard	-	-	1 NO
6	Connecting wires			Required number

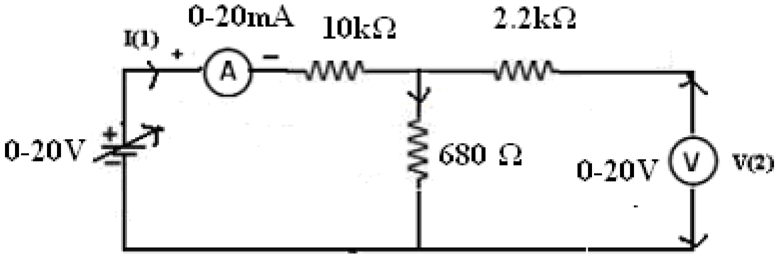
CIRCUIT DIAGRAMS:
GIVEN CIRCUIT:



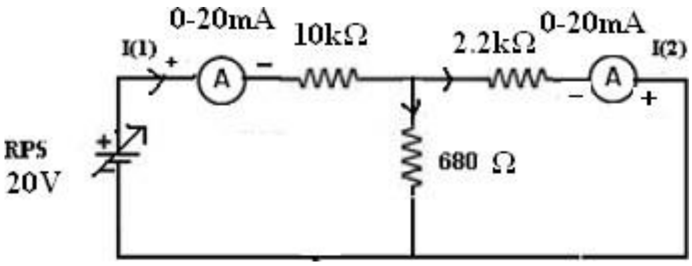
PRACTICAL CIRCUITS:
1. When $I_1 = 0$:



2. When $I_2 = 0$:



3. When $V_2 = 0$:



THEORY:

The relation between the voltages and currents of a two port network in terms of ABCD and h–parameters is given as follows.

ABCD PARAMETERS:

$V_{1=}AV_2\text{-}BI_2$
$I_{1=}CV_2\text{-}DI_2$

H-PARAMETERS

$V_1=h_{11}I_1+h_{12}V_2$
$I_{2=}h_{11}I_1+h_{22}V_2$

ABCD PARAMETERS:

$A = \frac{V1}{V2}$ / I2 =0
$B = \frac{-V1}{I2}$ / $V2$ =0
$C = \frac{I1}{V2}$ / I2 =0
$D = \frac{-I1}{I2}$ / V2 =0

H-PARAMETERS:

$h11 = \frac{V1}{I1}$ / V2 =0

$h12 = \frac{V1}{V2}$ / I1 =0
$h21 = \frac{I2}{I1}$ / V2 =0
$h22 = \frac{I2}{V2}$ / I1 =0

PROCEDURE:
1. Connections are made as per the circuit diagram.
2. Open circuit the port – 1 i.e., I_1=0 find the values ofV_1, I2 and V_2.
3. Short circuit the port-1 V_1 =0 find the values of V_2, $I_1$and I_2.
4. Open circuit the port – 2 i.e., I_2=0 find the values of V_1, I1 and V_2.
5. Short circuit the port-2 i.e. V_2 =0 find the values of V_1, $I_1$and I_2
5. Find the ABCD and h-parameters of the given two port network from the above data.

THEORITICAL VALUES:

$V_2 = 0$	$V_{1=}$	$I_{1=}$	$I_{2=}$
$I_1 = 0$	$V_{1=}$	$V_{2=}$	$I_{2=}$
$I_2 = 0$	$V_{1=}$	$V_{2=}$	$I_{1=}$

PRACTICAL VALUES:

$V_2 = 0$	$V_{1=}$	$I_{1=}$	$I_{2=}$
$I_1 = 0$	$V_{1=}$	$V_{2=}$	$I_{2=}$
$I_2 = 0$	$V_{1=}$	$V_{2=}$	$I_{1=}$

ABCD-PARAMETERS:

T-parameters	Theoretical	Practical
$A = \frac{V1}{V2}$ / I_2 =0		
$B = \frac{-V1}{I2}$ / $V2$ =0		
$C = \frac{I1}{V2}$ / I_2 =0		
$D = \frac{-I1}{I2}$ / V_2 =0		

H- PARAMETERS:

h-Parameters	Theoretical	Practical
$h11 = \frac{V1}{I1}$ / V_2 =0		
$h12 = \frac{V1}{V2}$ / I_1 =0		
$h21 = \frac{I2}{I1}$ / V_2 =0		
$h22 = \frac{I2}{V2}$ / I_1 =0		

PRECAUTIONS:

1. Initially keep the RPS output voltage knob in zero volt position.
2. Avoid loose connections.
3. Avoid short circuit of RPS output terminals.

RESULT:

VIVA QUESTIONS

1. Define Port?
2. What is the condition for symmetry in case h-parameters & ABCD (T) parameters?
3. Define characteristic impedance?
4. What is the condition for reciprocity in case Hybrid (h) & ABCD (T) parameters?

NETWORK ANALYSIS AND SYNTHESIS LAB (BEE 451)

This lab manual has been updated by

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Verified By
Director, DGI Greater Noida

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