

**TITLE: LIST OF EXPERIMENTS**

1. Verification of Thevenin's and Norton's theorem. (i) Experiment (ii) Simulation.
2. Verification of Superposition theorem and Reciprocity Theorem. (i) Experiment (ii) Simulation.
3. Verification of Maximum Power Transfer Theorem (i) Experiment (ii) Simulation.
4. Study the characteristics of RLC Series & Parallel Resonance Circuit.
5. Determination of Self & Mutual Inductance.
6. To calculate and verify 'Z' and 'Y' parameters of two-port network.
7. To calculate and verify ABCD parameters of two-port network.
8. To determine and verify the equivalent parameters of series connection of two port network..
9. To determine and verify the equivalent parameters of parallel connection of two port network.
10. To determine the equivalent parameters of the cascade connection of two port Network
11. Design the characteristics of Constant-K Low Pass and High Pass filters.
12. Design the characteristics of m-derived Low Pass and High Pass filters
13. Design the characteristics of Constant k Band Pass filters and Band stop filters
14. To determine & verify characteristic impedance and propagation constant of symmetrical networks.
15. To determine and verify the image impedance and iterative impedance of asymmetrical networks

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<b>TITLE:</b> VERIFICATION OF	GPREC/EEE/EXPT.No. NTLP-01	
THEVENIN’S THEOREM	DATE: 28-02-2022	

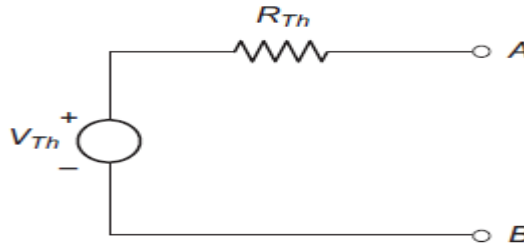
**OBJECTIVE:** To verify Thevenin’s theorem by (a) Simulation in PSpice software  
 (b) Experiment.

**APPARATUS:**

Sl.No.	Unit	Range	Type	No.
1	Regulated power supply	(0-30)V/(0-2)A		1
2	Ammeter	(0-2)A	MC	1
3	Rheostat			4
4	Digital Multimeter			1
5	Connecting Wires			Reqd.

**STATEMENT:**

*Thevenin’s theorem states that any two terminal linear network having a number of sources and resistances can be replaced by a simple equivalent circuit consisting of a single voltage source in series with a resistance, where the value of the voltage source is equal to the open circuit voltage across the two terminals of the network, and resistance is equal to the equivalent resistance measured between the terminals with all the energy sources are replaced by their internal resistances.*



**Fig.1 Thevenin’s Equivalent Circuit**

**THEORY:**

In electrical circuit theory, Thevenin’s theorem for linear electrical networks states that any combination of voltage sources, current sources and resistors with two terminals is electrically equivalent to a single voltage source  $V$  and a single series resistor  $R$ . For

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single frequency AC systems, the theorem can also be applied to general impedances, not just resistors. Any complex network can be reduced to a Thevenin's equivalent circuit consist of a single voltage source and series resistance connected to a load.

**Procedure to obtain Thevenin's equivalent circuit**

- i. Temporally remove the load resistance whose current is required.
- ii. Find the open circuit voltage  $V_{OC}$  which appear across the two terminals from where the load resistance has been removed. It is also called Thevenin's voltage  $V_{th}$ .
- iii. Calculate the resistance of the whole network as looked into from these two terminals, after all voltage sources are replaced by short circuit and current sources are replaced by open circuit leaving internal resistance (if any). It is also called Thevenin's resistance  $R_{th}$ .
- iv. Replace the entire network by a single Thevenin's voltage source whose voltage is  $V_{th}$  and whose resistance is  $R_{th}$ .
- v. Connect the load resistance ( $R_L$ ) back to its terminals from where it was previously removed.
- vi. Finally calculate the current flowing though  $R_L$  by using equation.

$$I_L = \frac{V_{th}}{R_{th} + R_L}$$

**Applications of Thevenin's Theorem:**

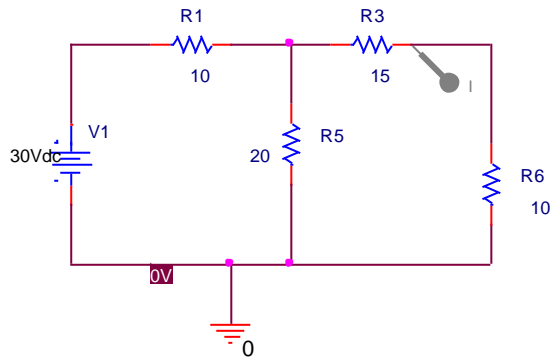
- Thevenin's Theorem is especially useful in analyzing power systems and other circuits where one particular resistor in the circuit (called the “load” resistor) is subject to change, and re-calculation of the circuit is necessary with each trial value of load resistance, to determine voltage across it and current through it.
- Source modeling and resistance measurement using the Wheatstone bridge provide applications for Thevenin's theorem.

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 THEVENIN'S THEOREM

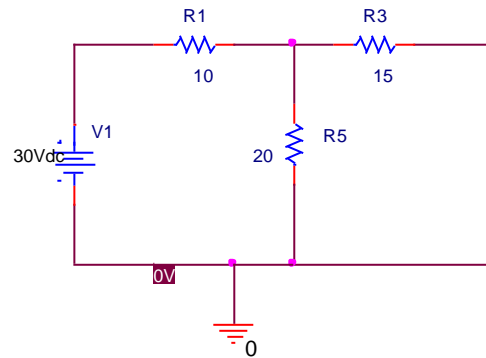
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**CIRCUIT DIAGRAM:**

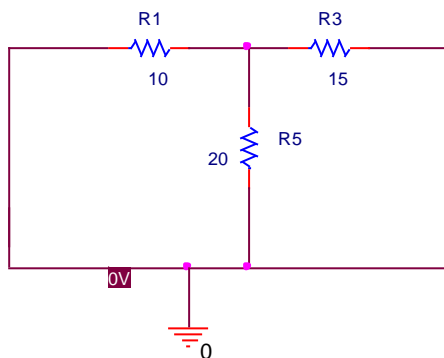
**a. Simulation Model in PSpice**



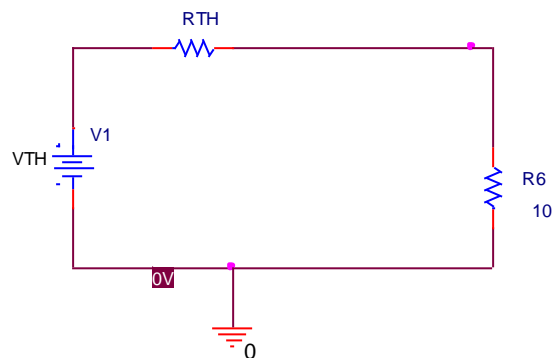
**Fig.2**



**Fig.3**

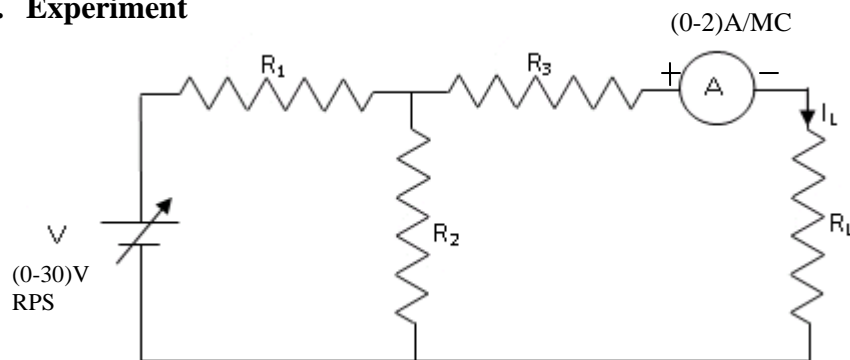


**Fig.4**



**Fig.5**

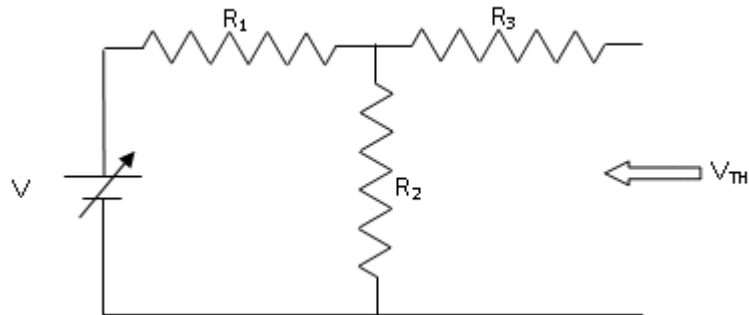
**b. Experiment**



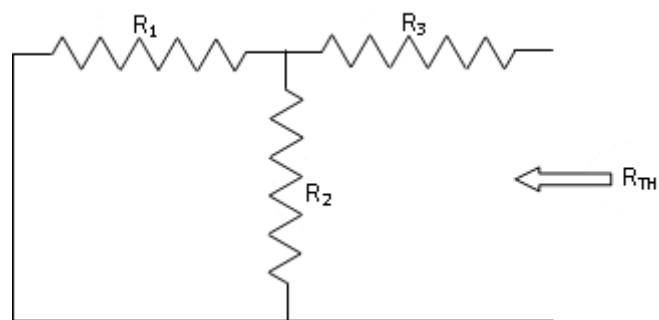
**Fig.6**

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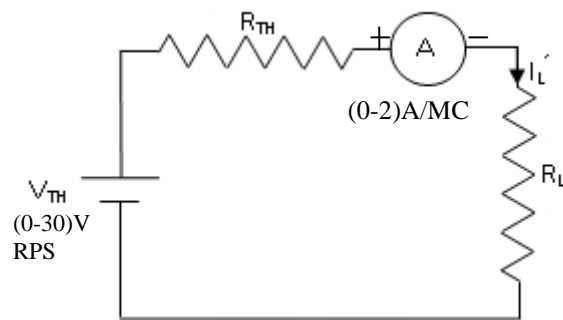
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**Fig.7**



**Fig.8**



**Fig.9**

TABULAR COLUMN:  
**Table.1 for Fig.6**

S.No.	V (V)	I <sub>L</sub> (A)	
		Th.	Pr.

**Table.2 for Fig.7**

S.No.	V(V)	V <sub>TH</sub> (V)	
		Th.	Pr.

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**Table.3 for Fig.8**

$R_{TH}(\Omega)$

**Table.4 for Fig.9**

Sl.no.	$V_{TH}(V)$	$I_L'(A)$	
		Th.	Pr.

**PROCEDURE:**

1. a. Connections are made as per the circuit shown in Fig.6.  
 b. By varying the voltage in steps note down the readings.
2. a. Connections are made as per the circuit shown in Fig.7.  
 b. By varying the voltage in steps note down the readings.
3. Connections are made as per the circuit shown in Fig. 8 to find  $R_{TH}$ .
4. a. Connections are made as per the circuit shown in Fig. 9.  
 b. Vary the voltage in steps of  $V_{TH}$  and note down the readings of  $I_L'$ .

**The above procedure is followed for experiment also.**

**RESULT:** Thevenin's theorem is verified.

**QUESTIONS:**

1. Define Thevenins theorem
2. What are the applications of Thevenins theorem?
3. Explain the procedure of solving the circuits using Thevenins theorem.
4. Draw the equivalent circuit of Thevenin's theorem.
5. State the difference between Thevenin's and Norton's theorem?

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<b>TITLE:</b> VERIFICATION OF	GPRED/EEE/EXPT.No.NTLP-01	
NORTON'S THEOREM	DATE: 28-02-2022	

**OBJECTIVE:** To verify Norton's theorem by (a) Experiment (b) Simulation in PSpice software.

**APPARATUS:**

Sl.No.	Unit	Range	Type	No.
1	Regulated power supply	(0-30)V/(0-2)A		2
2	Rheostat			4
3	Digital multimeter			1
4	Ammeter	(0-2)A	MC	1
5	Connecting Wires			Reqd.

**NORTON'S THEOREM:**

**STATEMENT:** *Norton's Theorem states that any two terminal linear network with current sources, voltage sources and resistances can be replaced by an equivalent circuit consisting of a current source in parallel with a resistance. The value of the current source is that short circuit current between the two terminals of the network and the resistance is the equivalent resistance measured between the terminals of the network with all the energy sources replaced by their internal resistance.*

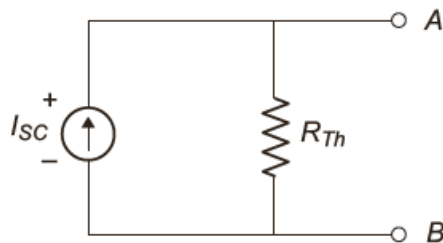


Fig. Norton's Equivalent Circuit

**THEORY:** This theorem is just alternative of Thevenin theorem.

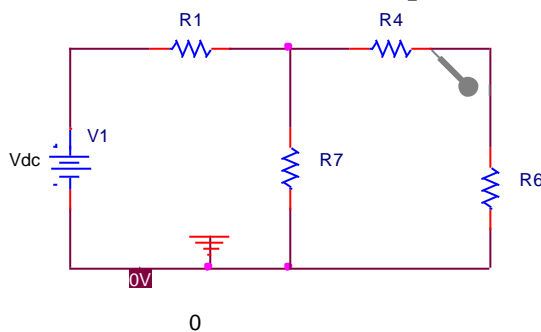
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**Procedure to obtain Norton's equivalent circuit**

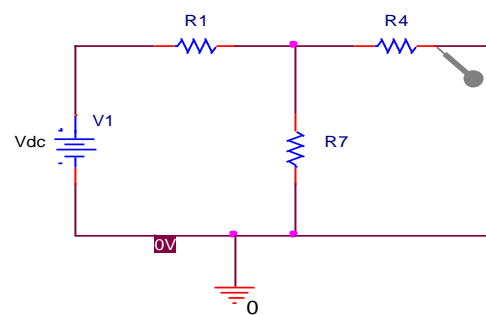
- i. Temporarily remove the load resistance (if any) across the two given terminals and put a short circuit across them.
- ii. Calculate the short circuit current  $I_{sc}$  or  $I_N$
- iii. Calculate the resistance of the whole network as looked into these two terminals, after all voltage sources are replaced by short circuit and current sources are replaced by open circuit leaving internal resistance (if any). It is called Thevenin's resistance  $R_{th}$  or Norton resistance  $R_N$ .
- iv. Replace the entire network by a single Thevenin's current source whose short circuit current is  $I_{sc}$  or  $I_N$  and parallel with Thevenin's resistance  $R_{th}$  or  $R_N$
- v. Connect the load resistance ( $R_L$ ) back to its terminals from where it was previously removed.
- vi. Finally calculate the current flowing through  $R_L$  by using current division formula.

**CIRCUIT DIAGRAM:**

**a. Simulation Model in PSpice**



**Fig.1**

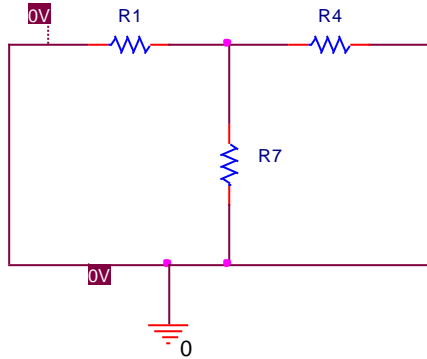


**Fig.2**

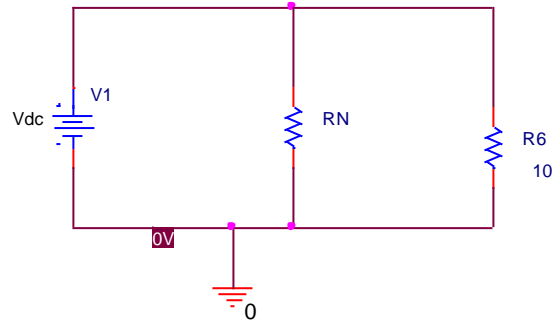


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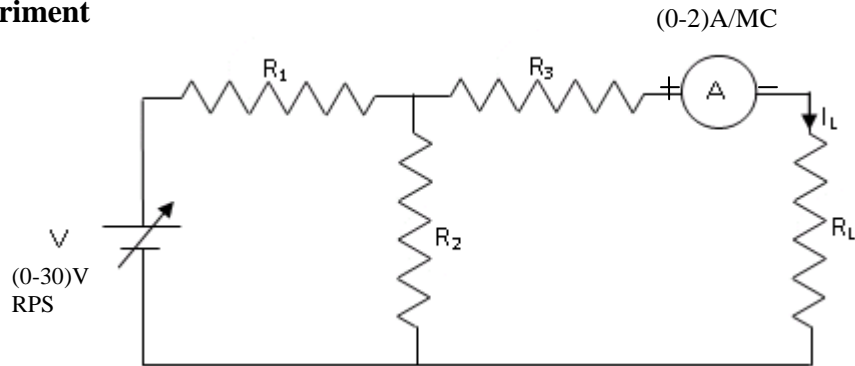


**Fig.3**

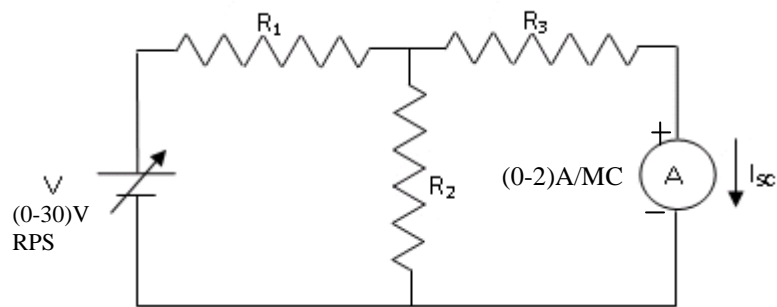


**Fig.4**

**b. Experiment**



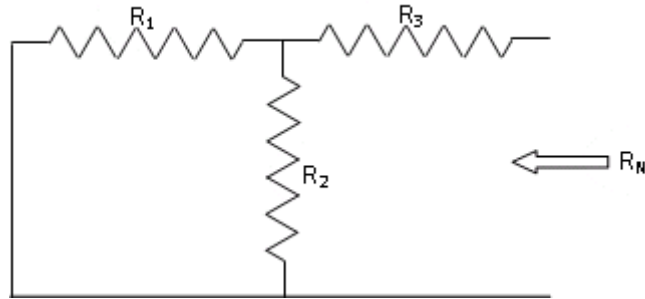
**Fig.5**



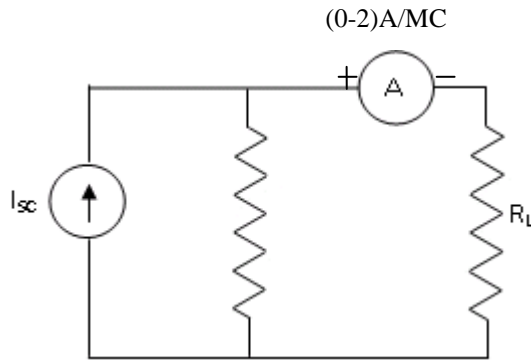
**Fig.6**

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**Fig.7**



**Fig.8**

**TABULAR COLUMNS:**

**Table.1 for Fig.5**

S.No.	V (V)	I <sub>L</sub> (A)	
		Th.	Pr.

**Table.2 for Fig.6**

S.No.	V(V)	I <sub>sc</sub> (A)	
		Th.	Pr.

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**Table 1 for Fig.7**

$R_N$

**Table.4 for Fig.8**

S.No.	$I_{sc}(A)$	$I_L'(A)$	
		Th.	Pr.

**PROCEDURE:**

1. a. Connections are made as per the circuit shown in Fig.5.  
 b. By varying the voltage in steps note down the readings.
2. a. Connections are made as per the circuit shown in Fig.6.  
 b. By varying the voltage in steps note down the readings of  $I_{sc}$ .
3. a. Connections are made as per Fig.7 to find  $R_N$ .
4. a. Connections are made as per the circuit shown in Fig.8.  
 b. By varying the current  $I_{sc}$  in steps note down the readings of  $I_L'$ .

**RESULT:** Norton's theorem is verified.

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**Questions:**

1. State Norton's theorem
2. State the applications of Norton's theorem.
3. To Linear and bilateral network, Norton's theorem can be applied.
4. Differentiate unilateral and bilateral, linear and non-linear.
5. Differentiate single port and two port networks.

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<b>TITLE:</b> VERIFICATION OF SUPERPOSITION THEOREM	GPREC/EEE/EXPT.No. NTLP-02 DATE: 28-02-2022
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**OBJECTIVE:** To Verify Superposition theorem by (a) Experiment (b) Simulation in PSpice software.

**APPARATUS:**

Sl.No.	Unit	Range	Type	No.
1	Regulated power supply	(0-30)V/(0-2)A		2
2	Ammeter	(0-2)A	MC	1
3	Rheostat			3
4	Connecting Wires		-	Reqd.

**STATEMENT:** *In any linear network with several independent sources and dependent sources, the overall response in any part of the network is equal to the sum of the individual responses due to each independent source with all other independent sources reduced to zero.*

**(or)**

*“According to superposition theorem, in any linear network containing two or more sources, the response in any element is equal to the algebraic sum of the responses caused by the individual sources acting alone while the other sources are non-operative.”*

*This means all independent voltages are shorted and all independent current sources are open circuited. If the sources contain internal impedances, the sources are replaced by the impedances.*

**THEORY:** Superposition theorem is valid only for linear systems. Superposition theorem is not applicable to power. This theorem can be applicable to voltages and currents. The above statement can be proved by the following explanation.

In linear systems, currents are propositional to the voltages  $I \propto V$

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In this theorem, we add individual currents of a branch due to each source taking at a time to get the resultant current. This is similar to voltages.

∴ We can have  $I = I_1 + I_2 + \dots$

$$V = V_1 + V_2 + \dots$$

But  $P \neq P_1 + P_2$ .

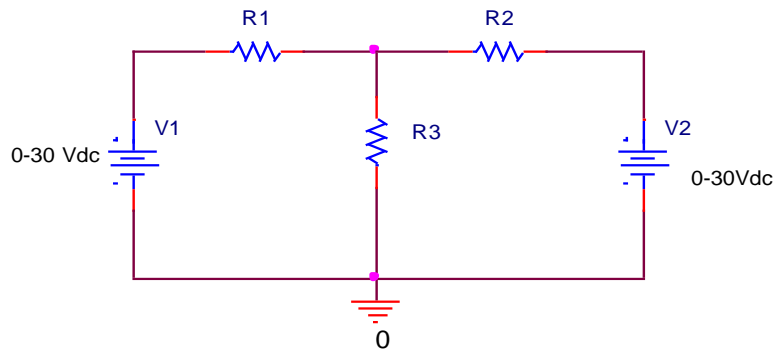
### Procedure to verify Superposition Theorem

- i. While evaluating the superposition theorem only one source (voltage source or current source) is kept in the network while making the other sources equal to zero. This implies to each source present in the network
- ii. If there are 2 voltage sources,  $V_1, V_2$  and one current source  $I$  in a network, first  $V_1$  is considered to be present in the network while making the other voltage source and current source equal to zero
- iii. The corresponding parameter (current or voltage) is found in the particular element when  $V_1$  is present.
- iv. In the next step  $V_2$  is considered while making the other sources constant and the corresponding parameter in the particular element is found out
- v. The same procedure is followed when the current source is considered
- vi. The values of parameter across the particular element obtained during various sources is added and verified with the value of parameter obtained when all the three sources are present in the network
- vii. The theorem is said to be satisfied if both the values are equal

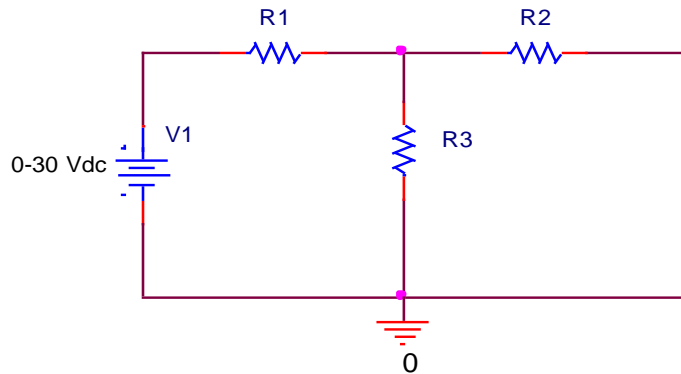
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**CIRCUIT DIAGRAM:**

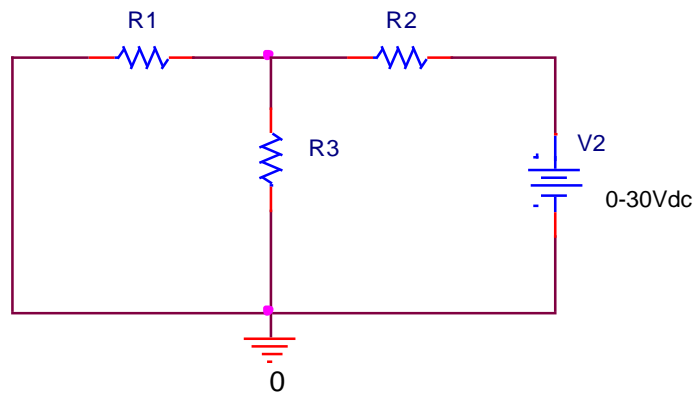
**a. PSpice Simulation**



**Fig.1**



**Fig.2**

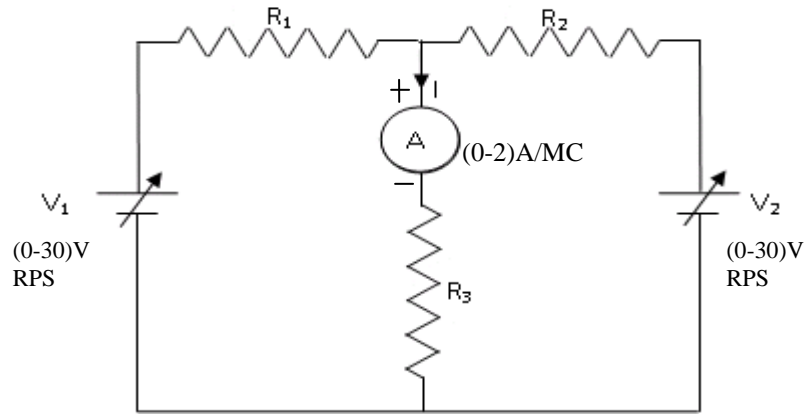


**Fig.3**

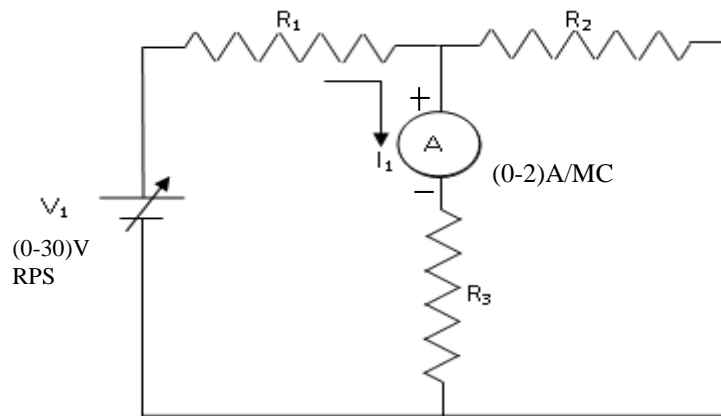
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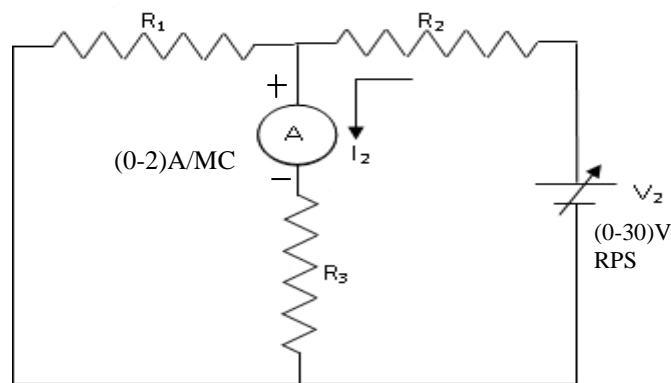
**b.Experiment**



**Fig.4**



**Fig.5**





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**Fig.6**

**PROCEDURE:**

1. a. Connections are made as per the circuit diagram shown in Fig.4.  
 b. By varying  $V_1$  &  $V_2$  in steps note down the ammeter reading (I).
2. a. Connections are made as per the circuit diagram shown in Fig.5.  
 b. By varying  $V_1$  in steps note down the ammeter reading ( $I_1$ ).
3. a. Connections are made as per the circuit diagram shown in Fig.6.  
 b. By varying  $V_2$  in steps note down the ammeter reading ( $I_2$ ).
4. Verify the superposition theorem ( $I=I_1+I_2$ ).

**TABULAR COLUMNS:**

**Table.1 for Fig.4**

Sl.no.	$V_1(V)$	$V_2(V)$	I(A)	
			Th.	Pr.

**Table.2 for Fig.5**

Sl.no.	$V_1(V)$	$I_1(A)$	
		Th.	Pr.

**Table.3 for Fi.6**

Sl.no.	$V_2(V)$	$I_2(A)$	
		Th.	Pr.

**Table.4 To verify Superposition theorem**

Sl.no.	$V_1(V)$	$V_2(V)$	I(A)		$I=(I_1+I_2)$ (A)	
			Th.	Pr.	Th.	Pr.

**RESULT: Superposition theorem is verified.**

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**Questions:**

1. Define superposition theorem
2. Super position theorem is applicable for the circuits which consists of \_\_\_\_\_ of sources.
3. Why superposition theorem is not applicable for powers.
4. What are the applications of superposition theorem?

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<b>TITLE:</b> VERIFICATION OF	GPREC/EEE/EXPT.No. NTLP-02
RECIPROCITY THEOREM	DATE: 28-02-2022

**OBJECTIVE:** To Verify Reciprocity theorem by (a) Experiment (b) Simulation in PSpice software.

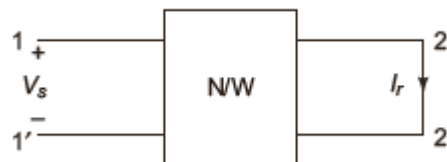
**APPARATUS:**

Sl.No.	Unit	Range	Type	No.
1	Regulated Power Supply	(0-30)V/(0-2)A		1
2	Ammeter	(0-2)A	MC	1
3	Rheostat			3
4	Digital Multimeter			1
	Connecting Wires			Reqd.

**STATEMENT:** *In a linear bilateral network, the ratio of excitation to response is equal in the case even though the positions of excitation and response are interchanged. However, if the excitation is a voltage source, the response must be a current and vice-versa.*

**THEORY:**

Considering two port networks as shown in Fig.1.



**Fig. 1**

The reciprocity theorem can be illustrated using this network. Considering the network has  $k$  loops and the network is excited by  $V_s$  (voltage source) at  $s_{th}$  loop and current should be determined at  $r_{th}$  loop then

$$I_r = \frac{A_{sr}}{D_z} V_s \text{ which implies } \frac{V_s}{I_r} = \frac{D_z}{A_{sr}} \quad (a)$$

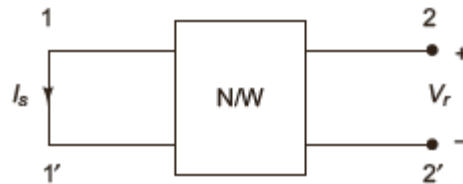
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where  $A_{sr}$  is a cofactor

$D_z$  is the impedance of the network

$\frac{A_{sr}}{D_z}$  is the admittance

As we interchange the positions of response and excitation, the circuit is



**Fig. 2**

$$I_s = \frac{A_{rs}}{D_z} V_r \text{ which implies}$$

$$\frac{V_r}{I_s} = \frac{D_z}{A_{rs}} \tag{b}$$

From equations a and b

$$\frac{V_s}{I_r} = \frac{D_z}{A_{sr}} \text{ and } \frac{V_r}{I_s} = \frac{D_z}{A_{rs}}$$

If  $A_{sr}$  and  $A_{rs}$  are equal we can have a symmetric network with RLC elements and no controlled sources

$$\frac{V_s}{I_r} = \frac{V_r}{I_s}$$

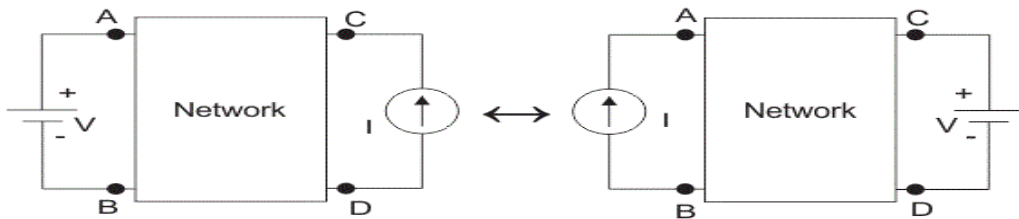
Hence the theorem can be proved

**Procedure to verify Reciprocity theorem**

- i. In order to verify reciprocity theorem consider a network in which excitation is placed at terminals 11' and response is to be found out at 22'.

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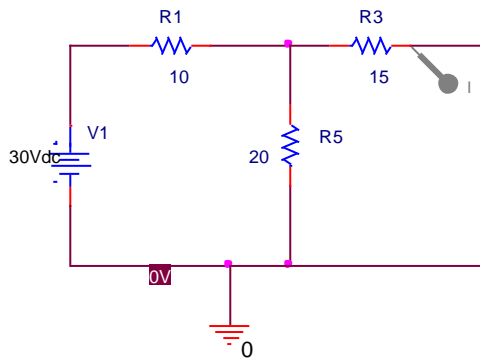
- ii. The response is found at the terminals of  $22'$  using various techniques discussed earlier and noted
- iii. The excitation is now shifted to across the terminals  $22'$  and the response is found out across the terminals  $11'$ .
- iv. If the ratio of excitation to response in both the cases is considered and is found to be the same, then reciprocity theorem is said to be satisfied.



**Fig. 3**

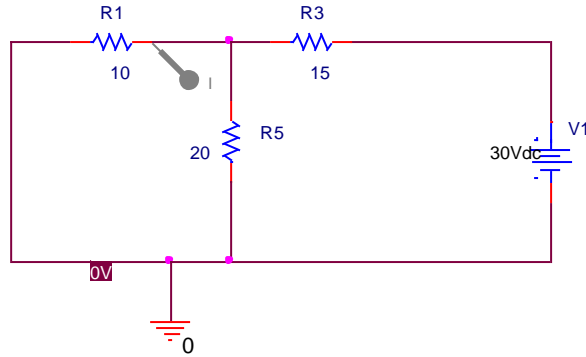
**CIRCUIT DIAGRAM:**

**a. Simulation Model**



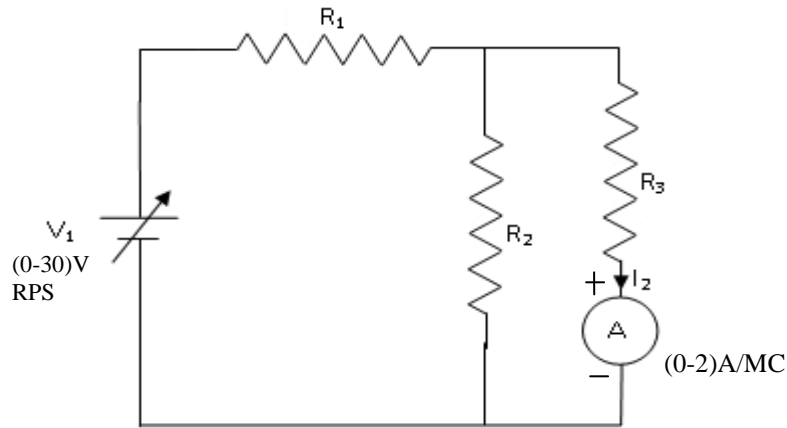
**Fig.4. Pspice Model**

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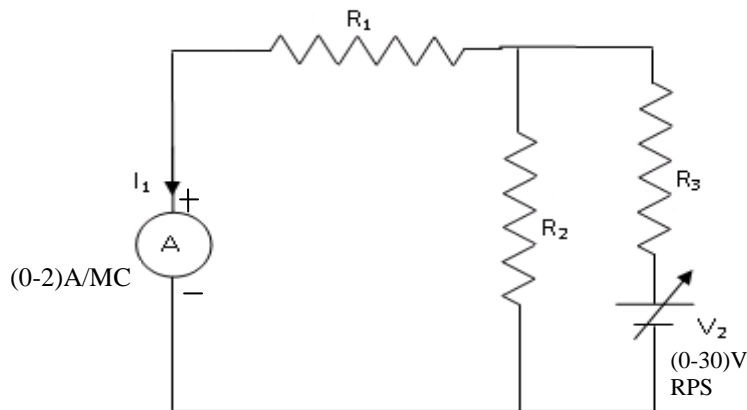


**Fig.5. Pspice Model**

**b. Experiment**



**Fig.6**



**Fig.7**

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**PROCEDURE:**

1. Connections are made as per the circuit diagram shown in Fig.6.
2. Apply voltage in steps.
3. Note down meter readings and calculate the ratio of voltage to current.
4. Repeat the procedure for the circuit shown in Fig.7 and calculate the ratio.
5. Verify that the ratio remains same in both the procedures.

**TABULAR COLUMNS:**

Table.1 for Fig.6

S.No.	V	I		V / I	
		Th.	Pr.	Th.	Pr.

Table.1 for Fig.7

S.No.	V	I		V / I	
		Th.	Pr.	Th.	Pr.

**RESULT:** Reciprocity theorem is verified.

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<b>TITLE:</b> VERIFICATION OF RECIPROCITY THEOREM	GPREC/EEE/EXPT.No. ECP-03 DATE: 16-08-2021
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**Questions:**

1. Define reciprocity theorem.
2. What are the applications of reciprocity theorem?
3. What are the limitations of reciprocity theorem?



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<b>TITLE:</b> VERIFICATION OF MAXIMUM POWER TRANSFER THEOREM	GPREC/EEE/EXPT.No. NTLP-03 DATE: 28-02-2022
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**OBJECTIVE:** To verify Maximum Power Transfer theorem by (a) Simulation in PSpice software (b) Experiment.

**APPARATUS:**

Sl.No.	Unit	Range	Type	No. Required
1	Voltmeter	(0-100V)	MC	1
2	Ammeter	(0-5)A	MC	1
3	Rheostat		-	2
4	Connecting Wires			Reqd.

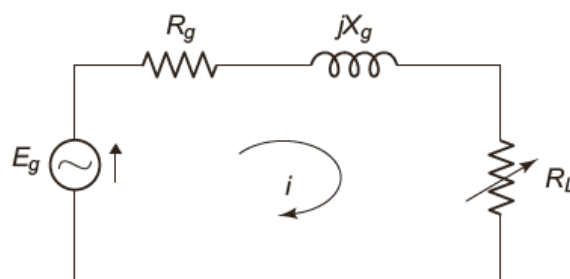
**STATEMENT:** *Maximum power transfer theorem states that the power delivered by an active network to a load connected across its terminals is maximum, when the impedance of the load is the complex conjugate of the active network impedance.*

**THEORY:**

In this theorem we shall consider different cases

**Case (i):** When the load is purely resistive

Consider a network delivering power to the load as shown in figure given below



**Fig. 1**

Current delivered to the load is 
$$i = \frac{E_g}{(R_g + R_L) + jX_g}$$

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Power delivered to the load is  $i^2 R_L$

$$P = \frac{E_g^2 R_L}{(R_g + R_L)^2 + X_g^2} \text{ watts}$$

The condition when the power delivered to the load is maximum, can be formed if

$$\frac{dP}{dR_L} = 0$$

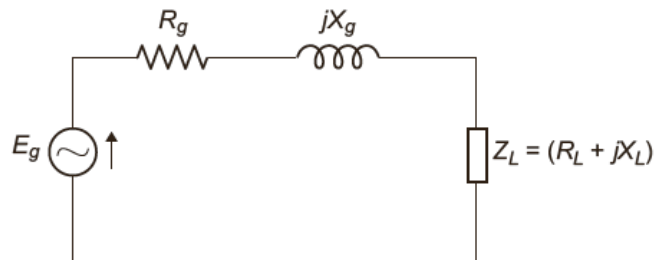
$$\frac{d}{dR_L} \left[ \frac{E_g^2 R_L}{(R_g + R_L)^2 + X_g^2} \right] = 0$$

$$\text{Simplifying we get } R_L^2 = R_g^2 + X_g^2 \text{ or } R_L = \sqrt{R_g^2 + X_g^2}$$

Therefore load resistance  $R_L = Z_g$

If  $X_g = 0$  then  $R_L = R_g$

**Case (ii)** Let the load be an impedance with fixed resistance and variable reactance



**Fig. 2**

The current  $i$  is given as  $i = \frac{E_g}{(R_g + R_L) + j(X_g + X_L)}$

The power delivered to the load is given as  $P = \frac{E_g^2 R_L}{(R_g + R_L)^2 + (X_g + X_L)^2}$

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The condition can be found by using  $\frac{dP}{dX_L} = 0$

$$\text{i.e. } \frac{d}{dX_L} \left[ \frac{E_g^2 R_L}{(R_g + R_L)^2 + (X_g + X_L)^2} \right] = 0$$

Solving this we get

$$X_L = -X_g$$

The reactance of the load is of the same magnitude as the reactance of the network but is of opposite sign.

**Case (iii)** Let the load be an impedance with fixed reactance and variable resistance

$$\text{The power } P = \frac{E_g^2 R_L}{(R_g + R_L)^2 + (X_g + X_L)^2}$$

The condition can be found by  $\frac{dP}{dR_L} = 0$

$$\frac{d}{dR_L} \left[ \frac{E_g^2 R_L}{(R_g + R_L)^2 + (X_g + X_L)^2} \right] = 0$$

Solving this we get

$$R_L = (R_g + jX_g) + jX_L \quad \text{or} \quad R_L = Z_g + jX_L$$

**General case:** If the load is an impedance with variable reactance and resistance, then the maximum power would be delivered when  $Z_L = Z_g$  i.e  $R_L = R_g$  and  $X_L = -X_g$

**Procedure to verify Maximum Power Transfer Theorem**

- i. In order to verify maximum power transfer theorem the network is reduced in such a way that the network consists of a single source, active network impedance and the load impedance.

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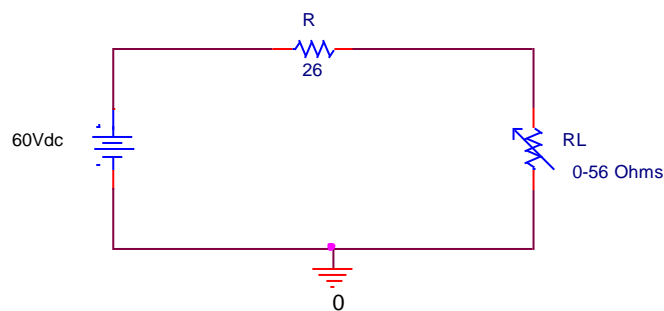
- ii. The condition for maximum power transfer is then verified by checking at the condition when the impedance of the load is the complex conjugate of the active network impedance.

**Application:**

1. In communication system, maximum power transfer is always sought. For example in public address system, the circuit is adjusted for maximum power transfer by making load resistance (speaker) equal to the source resistance (amplifier). When source and load have the same resistance, they are said to be matched.
2. In car engines, the power delivered to the starter motor of the car will depend upon the effective resistance of the motor and the internal resistance of the battery. If the two resistances are equal, maximum power will be transferred to the motor to turn to the engine.

**CIRCUIT DIAGRAM:**

**a. Simulation in PSpice**



**Fig. 3**

**PROCEDURE:**

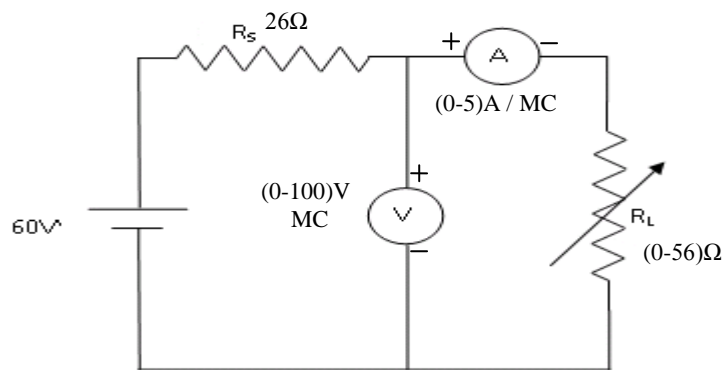
1. Simulation model is prepared according to the circuit.
2. Load resistance is varied in steps and voltage, current and power values are tabulated.
3. Graph is drawn between load resistance and power, to find the load resistance value where maximum power transfer takes place from source to load.

<b>TITLE:</b> VERIFICATION OF MAXIMUM POWER TRANSFER THEOREM	GPREC/EEE/EXPT.No. NTLP-03 DATE: 28-02-2022
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**TABULAR COLUMN:**

R	V	I	P	R <sub>L</sub>

**b. Experiment**



**Fig. 4**

**PROCEDURE:**

1. Connections are made as per the circuit diagram.
2. Keep the load resistance (R<sub>L</sub>) at maximum position.
3. Apply a DC voltage of 60V.
4. Vary R<sub>L</sub> in steps and note all the meter readings.
5. Calculate the power (P) drawn by the load for different values of R<sub>L</sub> and tabulate.
6. Plot a graph, Power Vs load resistor R<sub>L</sub>. Where  $P = I^2 R_L$ ;  $I = \frac{V_s}{R_s + R_L}$
7. Observe that the maximum power is drawn when the load resistance is equal to the source resistance.

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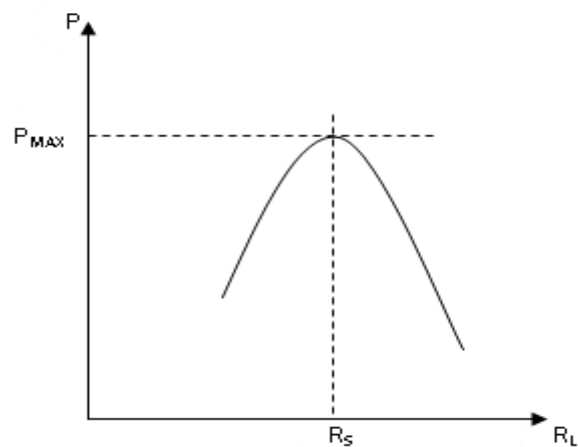
**TITLE:** VERIFICATION OF  
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**TABULAR COLUMN:**

S.No.	V	I	P	$R_L$

**EXPECTED GRAPH:**



**Fig. 5**

**RESULT:** Maximum power transfer theorem is verified.

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**TITLE:** VERIFICATION OF  
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**QUESTIONS**

1. Define maximum power transfer theorem.
2. What is the condition, at which the power transferred from source to load is maximum, when the load is pure resistive.
3. What is the condition, at which the power transferred from source to load is maximum, when the load is impedance with fixed resistance and variable reactance.
4. What is the condition, at which the power transferred from source to load is maximum, when the load is impedance with fixed reactance and variable resistance.
5. What is the condition, at which the power transferred from source to load is maximum, when the load is impedance with resistance and reactance are variable.
6. What are the applications of Maximum power transfer theorem?

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<b>TITLE:</b> Study the characteristics of RLC Series & Parallel Resonance	GPREC/EEE/EXPT.No. NTLP-04 DATE: 28-02-2022
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**OBJECTIVE:** To verify RLC Series resonance & Parallel resonance.

**APPARATUS:**

Sl.No.	Unit	Range	Type	No. Required
1	Function Generator			1
2	Digital Multimeter			1
3	Resistor	1K $\Omega$		1
4	Capacitor	0.1 $\mu$ F		1
5	Inductance box	25mH		1
6	Connecting Wires			Reqd.

**THEORY:**

In an electrical circuit consisting of various active sources and passive sources, the state at which the current is maximum is called as resonance. In a series RLC circuit the condition of current lagging or leading the applied voltage depends upon the values of  $X_L$  and  $X_C$ . If one of the parameters of the series RLC circuit is varied in such a way that the current in the circuit is in phase with the applied voltage, then the circuit is said to be in resonance. In other words resonance can also be defined as when the net or total current in an electrical circuit is in phase with the applied voltage, then the circuit is said to undergo resonance

Fig.1 shows a series RLC circuit where the parameters R, L, C are laid in series with each other. The voltage of the circuit is given by

$$V = I(R + j(X_L - X_C))$$

Total impedance of the series RLC circuit is given by

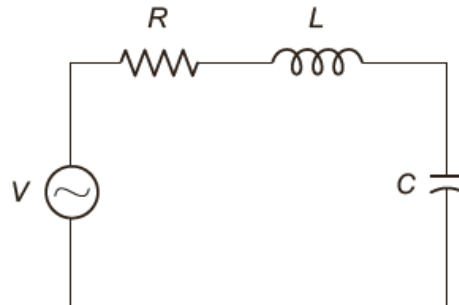
$$Z = R + j(X_L - X_C)$$



**TITLE:** Study the characteristics of  
 RLC Series & Parallel Resonance

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$$Z = R + j\left(\omega L - \frac{1}{\omega C}\right)$$



**Fig.1. RLC series circuit**

The circuit is said to be in resonance if the current is in phase with the applied voltage. In a series RLC circuit resonance occurs when  $X_L = X_C$ . The frequency at which the resonance occurs is called resonant frequency.

**Resonant frequency**

When the condition of series resonance is considered i.e.  $X_L = X_C$ , the impedance in a series RLC circuit becomes purely resistive. At resonant frequency ( $f_o$ ), the voltages across capacitance and inductance are equal in magnitude i.e.  $V_L = V_C$ .

At resonance,  $X_L = X_C$

$$\omega L = \frac{1}{\omega C}$$

$$2\pi f_o L = \frac{1}{2\pi f_o C} \quad \text{where } f_o \text{ is frequency at resonance}$$

$$f_o = \frac{1}{2\pi\sqrt{LC}}$$

Since  $2\pi f_o = \omega_o$  it can be written as  $\omega_o = \frac{1}{\sqrt{LC}}$

**TITLE:** Study the characteristics of  
 RLC Series & Parallel Resonance

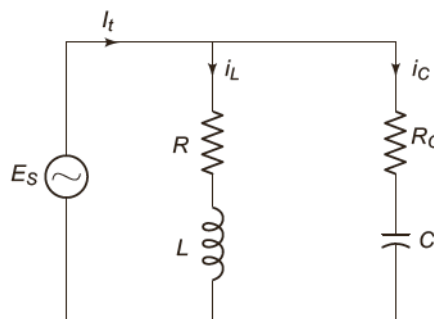
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The relation of resonant frequency changes when the R-L-C parameters are placed in parallel with each other. Two cases are majorly considered in the concept of parallel resonance.

- i. Considering the internal resistance of both L and C
- ii. Considering the internal resistance of only L

**Parallel Resonance Considering Internal Resistance of L and C**

Normally parallel resonance occurs at  $X_C = X_L$ . Consider the parallel circuit as shown in Fig 2. The internal resistances of both L and C have been incorporated along with the parameters.



**Fig.2. Parallel Circuit**

According to KCL

$$I_t = i_L + i_C$$

$$I_t = V_s(Y_L + Y_C)$$

Where  $i_L = V_s \cdot Y_L$

$$i_C = V_s \cdot Y_C$$

$Y_L$  &  $Y_C$  are branch admittances

$$\therefore Y_L = \frac{1}{Z_L} = \frac{1}{R_L + j\omega L}$$

Rationalizing this we get

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$$Y_L = \frac{R_L}{R_L^2 + \omega^2 L^2} - j \frac{\omega L}{R_L^2 + \omega^2 L^2}$$

Similarly

$$Y_C = \frac{1}{Z_C} = \frac{1}{R_C - j\left(\frac{1}{\omega C}\right)}$$

Rationalizing this we get,  $Y_C = \frac{R_C + j\left(\frac{1}{\omega C}\right)}{R_C^2 + \left(\frac{1}{\omega^2 C^2}\right)}$

$$= \frac{R_C}{R_C^2 + \left(\frac{1}{\omega^2 C^2}\right)} + \frac{j\left(\frac{1}{\omega C}\right)}{R_C^2 + \frac{1}{\omega^2 C^2}}$$

∴ Substituting the values of  $Y_L$  and  $Y_C$  we get

$$I_t = V_s \left( \frac{R_L}{R_L^2 + \omega^2 L^2} + \frac{R_C}{R_C^2 + \left(\frac{1}{\omega^2 C^2}\right)} \right) - j \left( \frac{\omega L}{R_L^2 + \omega^2 L^2} - \frac{1/\omega C}{R_C^2 + \left(\frac{1}{\omega^2 C^2}\right)} \right)$$

The circuit is to resonance if the net susceptance is zero.

∴ From the above equation equating the imaginary part equal to zero we get

$$\frac{\omega_o L}{R_L^2 + \omega_o^2 L^2} - \frac{Y \omega_o C}{R_C^2 + \frac{1}{\omega_o^2 C^2}} = 0$$

Where  $\omega_o$  is the resonant frequency

Solving the above equation we get  $\omega_o = \sqrt{\frac{1}{LC} \left( \frac{L - CR_L^2}{L - CR_C^2} \right)}$

∴ Substituting  $\omega_o = 2\pi f_o$  is above equation

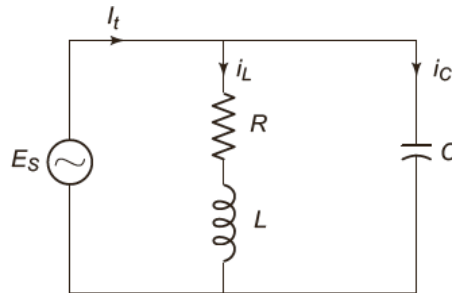
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$$f_o = \frac{1}{2\pi} \sqrt{\frac{1}{LC} \left( \frac{L - CR_L^2}{L - CR_C^2} \right)}$$

If  $R_L = R_C$  then,  $f_o = \frac{1}{2\pi\sqrt{LC}}$

**Parallel Resonance Considering Internal Resistance of only L**



**Fig.3. Parallel Circuit with  $R_C = 0$**

Figure shows the parallel L-C circuit where the internal resistance of C is considered to be zero and only the internal resistance of L is considered. The above figure can also be referred to as a tank circuit because the circuit stores energy in the magnetic field of the coil and in the electric field of the capacitor. Normally the circuit is asid to be in resonant condition when the susceptance part of the admittance is zero

The total admittance of the above circuit is

$$Y = \frac{1}{R_L + jX_L} + \frac{j}{X_C}$$

Simplifying further

$$Y = \frac{R_L - jX_L}{R_L^2 + X_L^2} + \frac{j}{X_C}$$

$$= \frac{R_L}{R_L^2 + X_L^2} + j \left[ \frac{1}{X_C} - \frac{X_L}{R_L^2 + X_L^2} \right] = G + jB$$

In order to satisfy the condition of resonance, the suseptance part,  $B$  should be zero

**TITLE:** Study the characteristics of  
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$$\therefore \frac{1}{X_C} - \frac{X_L}{R_L^2 + X_L^2} = 0$$

which implies  $\frac{1}{X_C} = \frac{X_L}{R_L^2 + X_L^2}$

$$\omega C = \frac{\omega L}{R_L^2 + \omega^2 L^2}$$

From the above expression

$$R_L^2 + \omega^2 L^2 = \frac{L}{C}$$

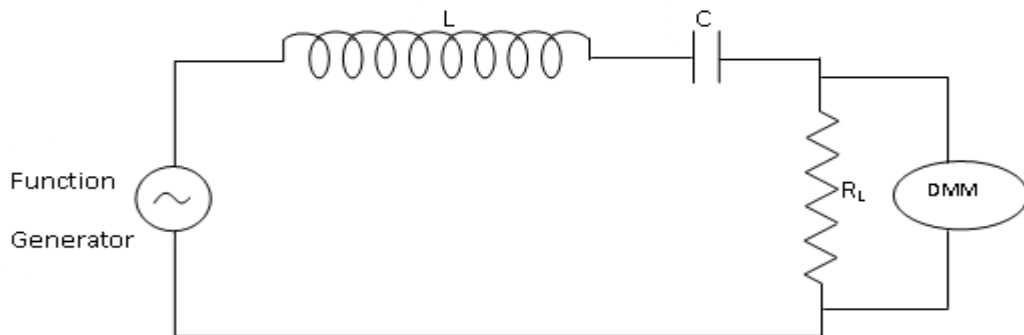
$$\omega^2 L^2 = \frac{L}{C} - R_L^2$$

$$\omega = \sqrt{\frac{1}{LC} - \frac{R_L^2}{L^2}}$$

The resonant frequency for the tank circuit is given by  $f_o = \frac{1}{2\pi} \sqrt{\frac{1}{LC} - \frac{R_L^2}{L^2}}$

**CIRCUIT DIAGRAM & EXPECTED GRAPH:**

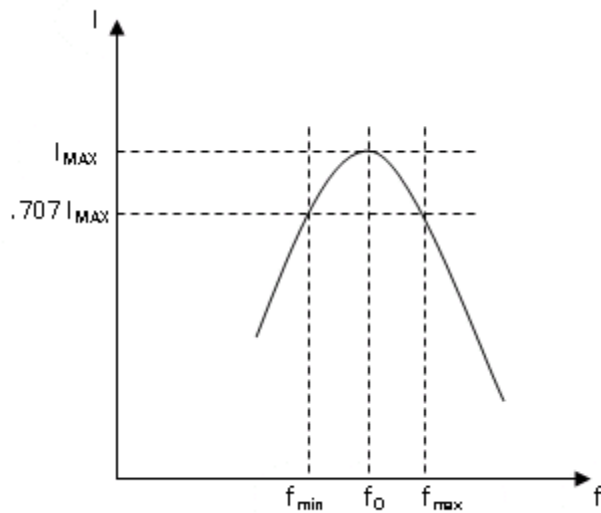
**RLC Series Resonance:**



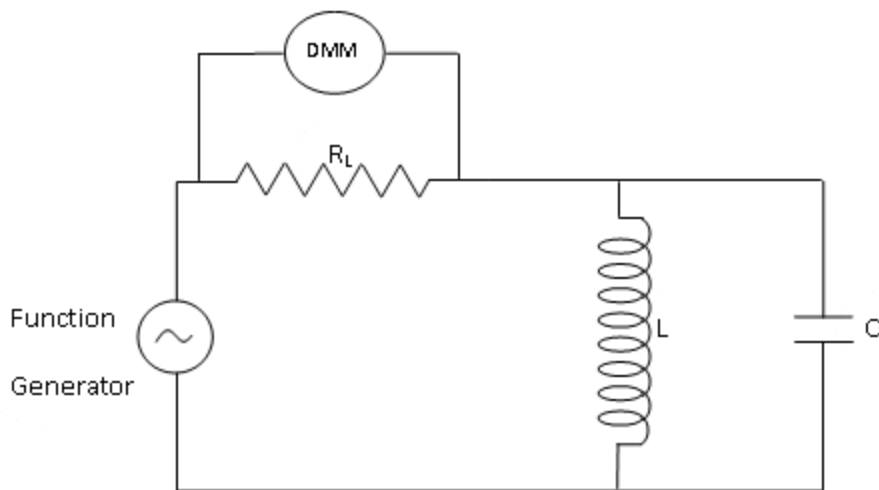
**Fig.4 RLC series circuit**

**TITLE:** Study the characteristics of  
RLC Series & Parallel Resonance

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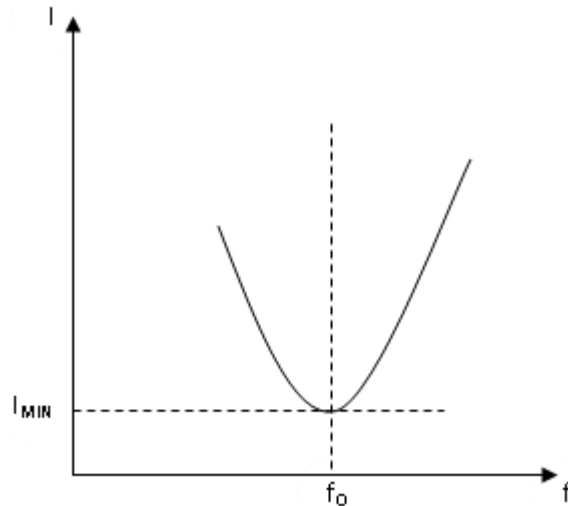


**RLC Parallel Resonance:**



**Fig.5 RLC Parallel Circuit**

<b>TITLE:</b> Study the characteristics of RLC Series & Parallel Resonance	GPREC/EEE/EXPT.No. NTLP-04 DATE: 28-02-2022
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**PROCEDURE:**

**RLC Series & Parallel Resonance:**

1. Connections are made as per the circuit diagram shown in Fig.4 & Fig.5, for series and parallel resonance respectively.
2. By varying the frequency of the function generator, note down the voltmeter reading.
3. Find the current I by using R value
4. Plot f Vs I for series resonance and parallel resonance.
5. Observe that the resonance occur at resonant frequency.

**TABULAR COLUMN:**

**RLC Series & Parallel Resonance:**

Sl.no.	f(Hz)	V(V)	I(A)

**RESULT:** RLC Series Resonance & Parallel Resonance graphs are plotted and resonant frequency is found.

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**TITLE:** Study the characteristics of  
RLC Series & Parallel Resonance

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**Questions:**

1. Define resonance.
2. What is the condition for resonance in RLC series and parallel circuits.
3. Define bandwidth
4. Define Selectivity
5. Define Q factor.



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**TITLE:** DETERMINATION OF  
SELF & MUTUAL INDUCTANCE

GPREC/EEE/EXPT.No. NTLP-05

DATE: 28-02-2022

**OBJECTIVE:** To Determine of Self Inductance, Mutual Inductance and coefficient of coupling of an air core transformer.

**APPARATUS:**

Sl.No.	Unit	Range	Type	No.
1	Air core transformer	1KVA		1
2	Ammeter	0-5A	MI	1
3	Voltmeter	0-300V	MI	1
4	Wattmeter	5A, 300V	LPF UPF	1 1
5	Connecting Wires			Reqd.

**THEORY:**

**Self Inductance:**

The property of self-inductance is a particular form of electromagnetic induction. Self inductance is defined as the induction of a voltage in a current-carrying wire when the current in the wire itself is changing. In the case of self-inductance, the magnetic field created by a changing current in the circuit itself induces a voltage in the same circuit. Therefore, the voltage is self-induced.

$$V = L \frac{di}{dt}$$

From the concepts of basic electrical engineering, we know that inductance may also be expressed as

$$L = \frac{N\phi}{I}$$

Therefore self inductance is represented as

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**TITLE:** DETERMINATION OF  
 SELF & MUTUAL INDUCTANCE

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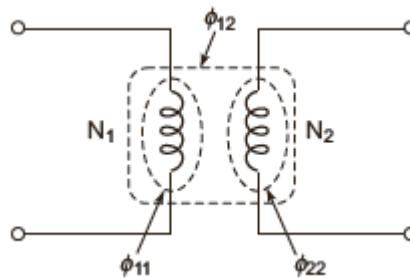
$$L = N \frac{d\phi}{dt}$$

The unit for self inductance is Henry.

**Mutual Inductance:**

Mutual inductance is defined as the constant of proportionality between the rate of change in current in one circuit and the resulting e.m.f induced in another circuit. A varying current in coil 1 produces a magnetic field. This magnetic field links with coil 2 and inducing an e.m.f between its ends. Such an action in which a varying quantity in one circuit causes the development of a quantity in a different circuit is called mutual action or transfer action. Figure shows two coils which carry current  $I_1$  and  $I_2$ . The coils will have leakage flux  $\Phi_{11}$  and  $\Phi_{22}$  for coils 1 and coil 2, respectively, and a mutual flux  $\Phi_{21}$  where the flux of coil 2 links coil 1 or flux of coil 1 links coil 2. The induced voltage of coil 2 may be written as

$$V_{L2} = N_2 \frac{d\phi_{12}}{dt}$$



**Fig. 1**

As  $\Phi_{12}$  is related to current of coil 1, the induced voltage is proportional to the rate of change of  $I_1$ . This implies

$$V_{L2} = M \frac{di_1}{dt}$$

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where  $M$  is constant of proportionality between the two coils, also known as mutual inductance.

When the coils are linked with air as medium, the flux and current are linearly proportional to each other and the expressions of mutual inductance are written as

$$M = N_2 \frac{\phi_{12}}{I_1}$$

$$M = N_1 \frac{\phi_{21}}{I_2}$$

### Coefficient of Coupling

Coefficient of coupling is defined as the ratio of mutual inductance actually present between the two coils to the maximum possible value.

$$K = \frac{M}{\sqrt{L_1 L_2}}$$

Where

$K$  is the coupling coefficient and  $0 \leq k \leq 1$

$L_1$  is the inductance of the first coil, and

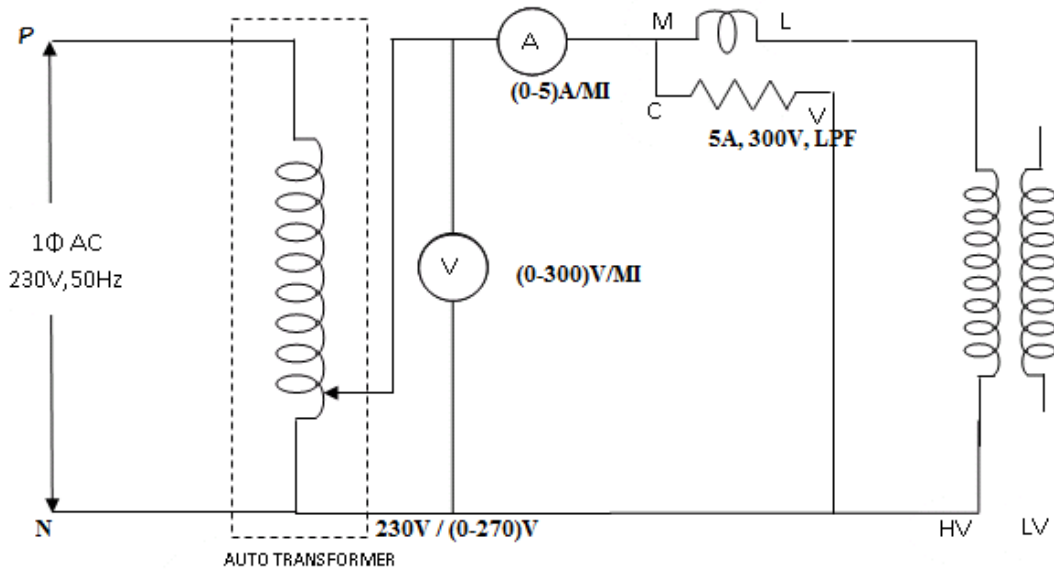
$L_2$  is the inductance of the second coil.

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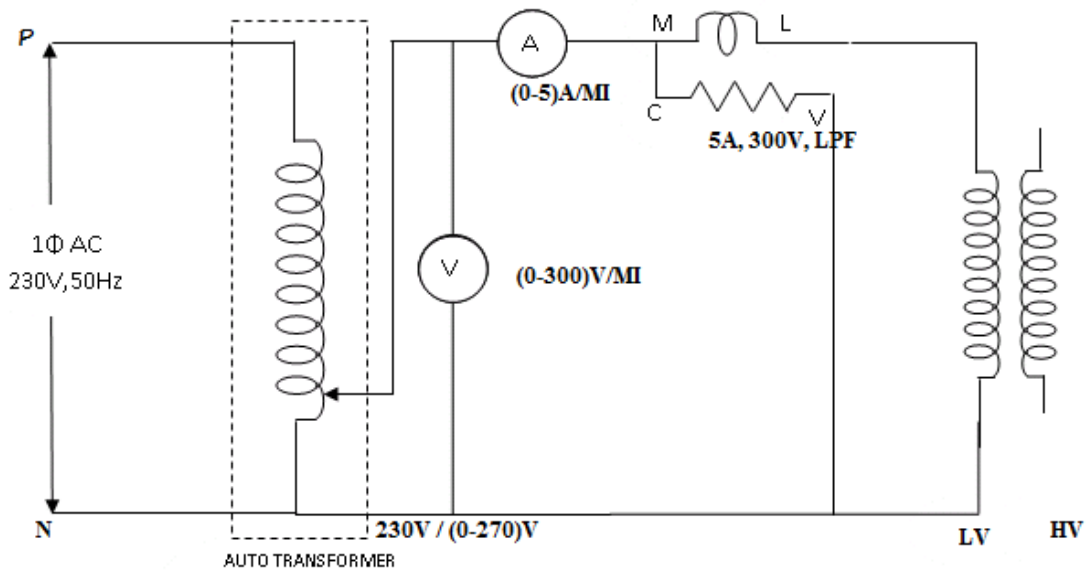
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**CIRCUIT DIAGRAM:**

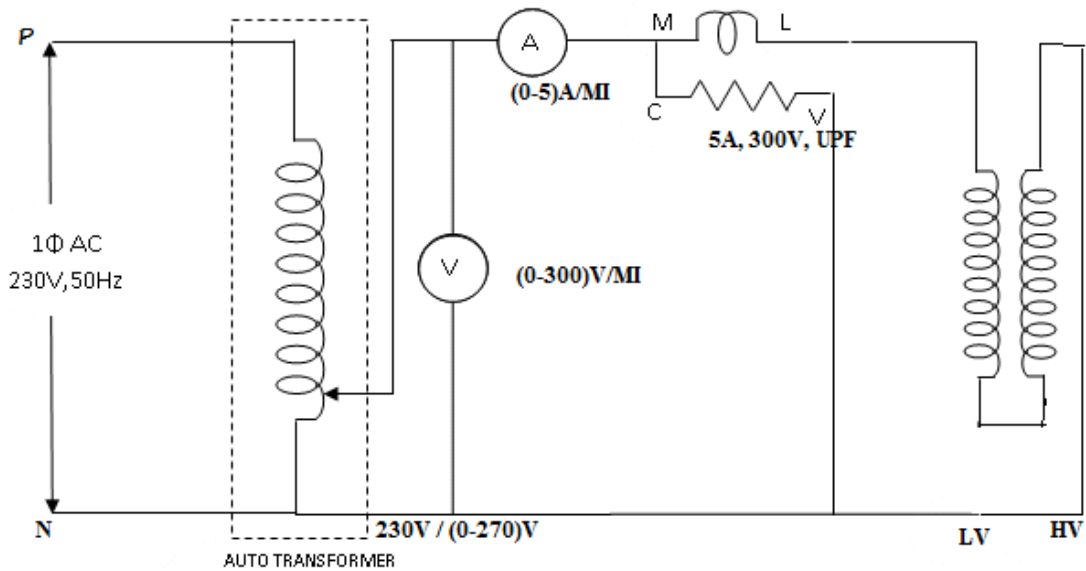


**Fig. 2 To find  $L_{HV}$**



**Fig. 3 To find  $L_{LV}$**

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**PROCEDURE:**

1. Connections are made as per the circuit shown in Fig.2.
2. Using auto transformer, apply voltage in steps.
3. Note down all meter readings.
4. Calculate self inductance  $L_1$  of high voltage (HV) winding.
5. Above procedure is repeated for circuit diagram shown in Fig.3 & Fig.4 to find self inductance  $L_2$  of low voltage (LV) winding and mutual inductance of both windings.

**TABULAR COLUMN:**

S.No	V(V)	$I_1$ (A)	$W_1$ (W)	$\Phi_1$	$Z_1$ ( $\Omega$ )	$L_1$ (H)

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Sl.No	V(V)	I <sub>2</sub> (A)	W <sub>2</sub> (W)	Φ <sub>2</sub>	Z <sub>2</sub> (Ω)	L <sub>2</sub> (H)

Sl.No	V(V)	I(A)	W(W)	Φ	Z(Ω)	L(H)	M=(L·(L <sub>1</sub> +L <sub>2</sub> ))/2

**RESULT:** Self inductance, mutual inductance and coefficient of coupling are determined.

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**Questions:**

1. Define self inductance.
2. Define mutual inductance.
3. Define coefficient of coupling.
4. Differentiate air core and iron core transformer.
5. If the transformer core is made of wood, what will be the coupling coefficient.

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**TITLE:** To calculate and verify Z  
& Y Parameters

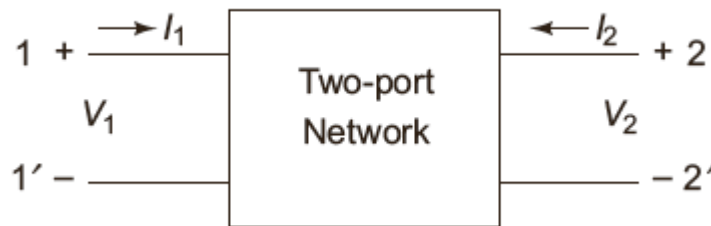
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**OBJECTIVE:** To determine Impedance (Z) & Admittance (Y) parameters.

**APPARATUS:**

Sl.No.	Unit	Range	Type	No.
1	Regulated power supply	(0-30) V/(0-2)A		1
2	Rheostats		-	
3	Voltmeter	(0-30) V	MC	2
4	Ammeter	(0-2)A	MC	2
5	Connecting Wires			Reqd.

**THEORY:** Consider the two-port network shown in Fig.1. In the figure, 1–1' represents input port where the voltage is  $V_1$  and the conventional current is ' $I_1$ ' as shown and 2–2' represents out port where the voltage is  $V_2$  and the conventional current is ' $I_2$ '. The defining equations can be expressed by considering any two variables as independent variables and expressing the other two variables in terms of these two variables and network parameters.



**Fig.1 Two port network**

∴ The defining equations of Z parameters are

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

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

These two equations can be expressed in the matrix form as



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

Where  $Z_{11}$ ,  $Z_{12}$ ,  $Z_{21}$ ,  $Z_{22}$  are network parameters called Z parameters,  $I_1$  and  $I_2$  are independent variables,  $V_1$  and  $V_2$  are dependent variables. If the output port 2–2' is open circuited then  $I_2 = 0$

$$\therefore V_1 = Z_{11} I_1 + 0$$

$$\Rightarrow Z_{11} = \left. \frac{V_1}{I_1} \right|_{I_2=0}$$

$Z_{11}$  is called as **driving point impedance** because current  $I_1$  develops voltage  $V_1$  at the input port. Also we have

$$V_2 = Z_{21} I_1 + 0$$

$$\Rightarrow Z_{21} = \left. \frac{V_2}{I_1} \right|_{I_2=0}$$

$Z_{21}$  is called as **“Forward transfer impedance”** because current  $I_1$  develops voltage  $V_2$  at the open circuited port. Similarly  $Z_{12}$  and  $Z_{22}$  can be found by considering  $I_1 = 0$  i.e., by open circuiting the input port terminals.

By substituting  $I_1 = 0$ , we get

$$V_1 = 0 + Z_{12} I_2$$

$$\Rightarrow Z_{12} = \left. \frac{V_1}{I_2} \right|_{I_1=0}$$

$Z_{12}$  is called as **“Reverse Transfer impedance”** because current  $I_2$  develops voltage  $V_1$  at the open circuited port. Also we have

$$V_2 = 0 + Z_{22} I_2$$

$$\Rightarrow Z_{22} = \left. \frac{V_2}{I_2} \right|_{I_1=0}$$

$Z_{22}$  is called as **driving point impedance**.

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**Note:** The unit for Z parameters is Ohms( $\Omega$ )

**Methods of finding the Z – PARAMETERS:**

The defining equations for Z Parameters are

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

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

There are two methods for finding Z – parameters (i) Direct method and (ii) Indirect method

**(i)Direct Method**

**Step (i) :**By open circuiting of the output port,  $I_2$  will tends to zero and so express  $V_1$  and  $V_2$  in terms of  $I_1$  and calculated as

$$Z_{11} = \frac{V_1}{I_1} \quad \text{and} \quad Z_{21} = \frac{V_2}{I_1}$$

**Step (ii) :** By open circuiting of the input port,  $I_1$  will tends to zero and so express  $V_1$  and  $V_2$  in terms of  $I_2$  and calculate as

$$Z_{12} = \frac{V_1}{I_2} \quad \text{and} \quad Z_{22} = \frac{V_2}{I_2}$$

**(ii)Indirect Method**

Using node analysis or loop analysis, expresses  $V_1$  and  $V_2$  in terms of  $I_1$  and  $I_2$  then calculate Z parameters.

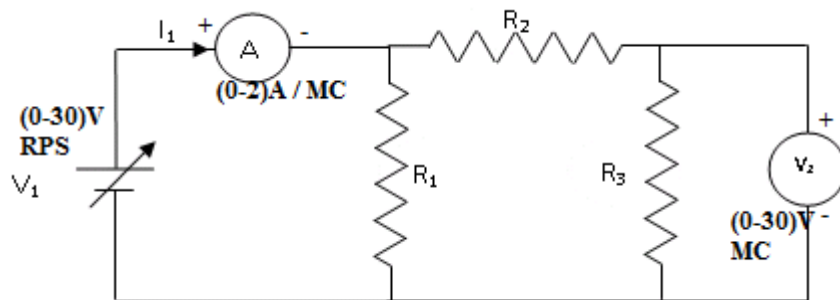
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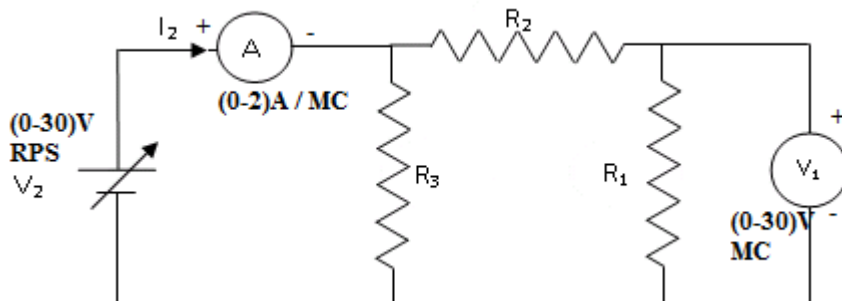
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**Z PARAMETERS (Open Circuit Impedance Parameters):**

**CIRCUIT DIAGRAM:**



**Fig. 2 To find  $Z_{11}$  &  $Z_{21}$**



**Fig. 3 To find  $Z_{12}$  &  $Z_{22}$**

**PROCEDURE:**

1. Connections are made as per the circuit shown in Fig. 2 and Fig.3.
2. By varying the RPS, corresponding readings are noted down.
3. The impedance parameters  $Z_{11}$ ,  $Z_{21}$ ,  $Z_{22}$  &  $Z_{12}$  are calculated.

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**TABULAR COLUMN:**

S.No.	V <sub>1</sub>	I <sub>1</sub>	I <sub>2</sub>	Z <sub>11</sub> =V <sub>1</sub> / I <sub>1</sub>		Z <sub>21</sub> =V <sub>2</sub> / I <sub>1</sub>	
				Th.	Pr.	Th.	Pr.

S.No.	V <sub>2</sub>	I <sub>1</sub>	I <sub>2</sub>	Z <sub>12</sub> =V <sub>1</sub> / I <sub>2</sub>		Z <sub>22</sub> =V <sub>2</sub> / I <sub>2</sub>	
				Th.	Pr.	Th.	Pr.

**Y PARAMETERS (Short Circuit Admittance Parameters):**

**THEORY:**

The Y-Parameters of a two port network are generally defined by expressing the port Currents  $I_1$  and  $I_2$  in terms of their voltages  $V_1$  and  $V_2$ . The defining equations are expressed by considering any two variables as independent variables and expressing the other two variables in terms of these two variables and network parameters. The defining equations for hybrid parameters are

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

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

By short circuiting the output port  $V_2 = 0$

$$\therefore I_1 = Y_{11} V_1 + 0$$

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$$\Rightarrow Y_{11} = \frac{I_1}{V_1} \Big|_{V_2=0}$$

$Y_{11}$  is called as **Input admittance**.

And also when  $V_2 = 0$

$$I_2 = Y_{21} V_1 + 0$$

$$\Rightarrow Y_{21} = \frac{I_2}{V_1} \Big|_{V_2=0}$$

$Y_{21}$  is called as **reverse transfer admittance**.

**Similarly by short circuiting the input port  $V_1 = 0$**

$$\therefore I_1 = Y_{12} V_2$$

$$Y_{12} = \frac{I_1}{V_2} \Big|_{V_1=0}$$

$Y_{12}$  is called as **Forward Transfer admittance**

And also when  $V_1 = 0$

$$I_2 = Y_{22} V_2$$

$$\Rightarrow Y_{22} = \frac{I_2}{V_2} \Big|_{V_1=0}$$

$Y_{22}$  is called as **Output admittance**

**Methods of finding the Y PARAMETERS:**

The defining equations for Y parameters are

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

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

There are two methods for finding Y parameters (i) Direct method (ii) Indirect method

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**(i) Direct Method:-**

**Step (i) :** By short circuiting the output port,  $V_2$  will tends to zero and so express  $I_1$  and  $I_2$  in terms of  $V_1$  and calculate

$$Y_{11} = \frac{I_1}{V_1} \text{ and } Y_{22} = \frac{I_2}{V_2}$$

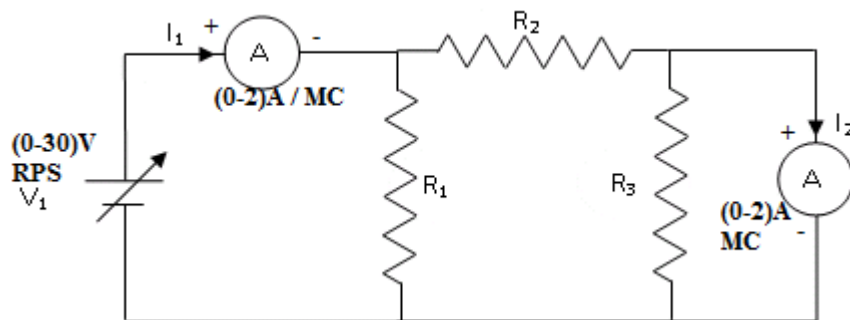
**Step (ii) :** By short circuiting the input port,  $V_1$  will tends to zero and so express  $I_1$  and  $I_2$  in terms of  $V_2$  and calculate

$$Y_{12} = \frac{I_1}{V_2} \text{ and } Y_{21} = \frac{I_2}{V_1}$$

**(ii) Indirect Method:-**

Using node analysis or loop analysis express  $I_1$  and  $I_2$  in terms of  $V_1$  and  $V_2$  and then calculate Y parameters and these are expressed in mho.

**CIRCUIT DIAGRAM:**



**Fig. 4 To find  $Y_{11}$  &  $Y_{21}$**

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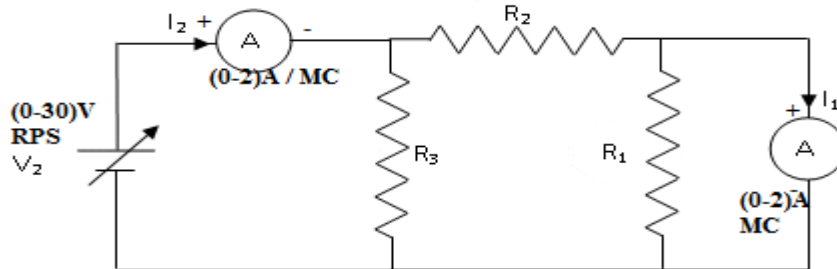


Fig. 5 To find  $Y_{22}$  &  $Y_{12}$

**PROCEDURE:**

1. Connections are to be made as per the circuit diagram shown in Fig.4.
2. Output port is short circuited and by varying  $V_1$ , readings are noted down.
3.  $Y_{11}$  &  $Y_{21}$  are calculated.
4. Input port is short circuited and by varying  $V_2$  as per the circuit diagram shown in Fig.5, readings are noted down to calculate  $Y_{22}$  &  $Y_{12}$ .

**TABULAR COLUMN:**

S.No.	$V_1$	$I_1$	$I_2$	$Y_{11}=I_1/V_1$		$Y_{21}=I_2/V_1$	
				Th.	Pr.	Th.	Pr.

Sl.no.	$V_2$	$I_1$	$I_2$	$Y_{12}=I_1/V_2$		$Y_{22}=I_2/V_2$	
				Th.	Pr.	Th.	Pr.

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**RESULT:** Impedance and admittance parameters are determined.

**Questions**

1. What are the defining equations of Z and Y parameters
2. What are the conditions for symmetry
3. What are the conditions for reciprocity
4. What is the condition to be used to find Z parameters
5. What is the condition to be used to find Y parameters



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**TITLE:** To calculate and verify  
ABCD Parameters

GPREC/EEE/EXPT.No. NTLP-07  
DATE: 28-02-2022

**OBJECTIVE:** To Determine Transmission line parameters (ABCD)

**APPARATUS:**

Sl.No.	Unit	Range	Type	No.
1	Regulated Power supply	(0-30) V/(0-2)A		1
2	Voltmeter	(0-30) V	MC	1
3	Ammeter	(0-2)A	MC	2
4	Rheostat			3
5	Connecting Wires			Reqd.

**THEORY:**

**ABCD-PARAMETERS**

In transmission parameters the voltage and current at the sending end will be expressed with the voltage and current at the receiving end. These parameters will be used to study the performance of the transmission lines.

The defining equations for ABCD parameters are

$$V_1 = AV_2 - BI_2$$

And  $I_1 = CV_2 - DI_2$

Here  $-I_2$  is considered because the direction of  $I_2$  is opposite to that of  $I_1$ .

By open circuiting the output port,  $I_2 = 0$

$$\therefore V_1 = AV_2$$

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

A is called as **open circuit voltage gain**.

Also when  $I_2 = 0$

$$I_1 = CV_2$$

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

C is called as **open circuit transfer impedance**.

Similarly by short circuiting the out put port  $V_2 = 0$

$$\begin{aligned} V_1 &= -BI_2 \\ \Rightarrow -B &= \left. \frac{V_1}{I_2} \right|_{V_2=0} \\ \Rightarrow -\frac{1}{B} &= \left. \frac{I_2}{V_1} \right|_{V_2=0} \end{aligned}$$

It is also called as **short circuit transfer admittance**.

Also when  $V_2 = 0$ .

$$\begin{aligned} I_1 &= -DI_2 \\ \Rightarrow -D &= \left. \frac{I_1}{I_2} \right|_{V_2=0} \\ \Rightarrow -\frac{1}{D} &= \left. \frac{I_2}{I_1} \right|_{V_2=0} \end{aligned}$$

It is also called as **short circuit current gain**.

### Method of Finding ABCD Parameters

Transmission parameters are also known as ABCD parameters. The defining equations for ABCD parameters are

$$V_1 = AV_2 - BI_2$$

$$I_1 = CV_2 - DI_2$$

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

**TITLE:** To calculate and verify  
 ABCD Parameters

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**(i) Direct Method**

**Step (i):** By open circuiting the out put port,  $I_2$  tends to zero and so A and C can be calculated

$$A = \frac{V_1}{V_2}, \quad \text{Called reverse voltage ratio}$$

$$C = \frac{I_1}{V_2}, \quad \text{Called reverse transfer admittance.}$$

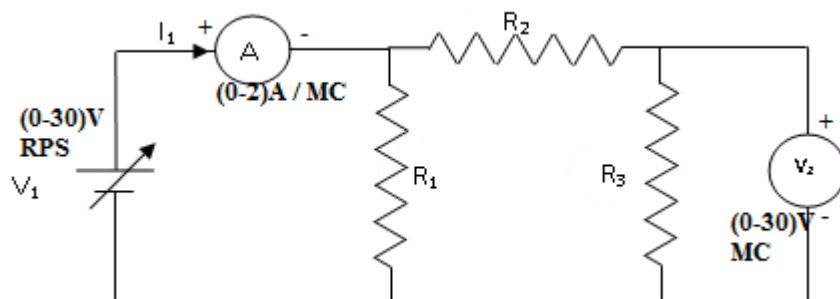
**Step (ii):** By short circuiting the out put port,  $V_2$  tends to zero and so B and D can be calculated.

$$- B = \frac{V_1}{I_2} \quad \text{Called reverse transfer impedance}$$

$$- D = \frac{I_1}{I_2} \quad \text{Called reverse current ratio}$$

A and D parameter has no units, parameter C in mho and parameter B is ohm.

**CIRCUIT DIAGRAM:**



**Fig.1 To find Parameter 'A' & 'C'**

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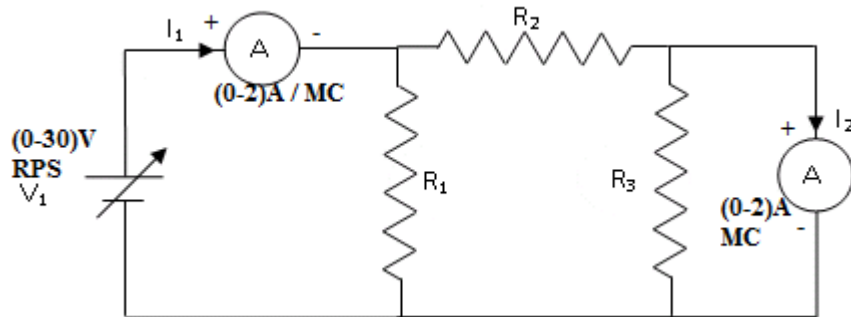


Fig.2 To find Parameter 'B' & 'D'

**PROCEDURE:**

**TO FIND A, C PARAMETERS:**

1. Connections are made as per the circuit diagram shown in Fig.1.
2. By varying  $V_1$ , the corresponding readings of  $V_2$  and  $I_1$  are noted down.
3. A and C parameters are calculated.

**TO FIND B, D PARAMETERS:**

1. Connections are made as per the circuit diagram shown in Fig.2.
2. By varying  $V_1$ , the corresponding readings of  $I_1$  and  $I_2$  are noted down.
3. B and D parameters are calculated.

**TABULAR COLUMN:**

S.No	$V_1$	$V_2$	$I_1$	A		C	
				Th.	Pr.	Th.	Pr.

S.No	$V_1$	$I_1$	$I_2$	B		D	
				Th.	Pr.	Th.	Pr.

-----

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NETWORKS AND TRANSMISSIONLINES LABORATORY – NTL(P)

**TITLE:** To calculate and verify  
ABCD Parameters

GPREC/EEE/EXPT.No. NTLP-07  
DATE: 28-02-2022

**RESULT:** ABCD parameters are determined.

**Questions:**

1. What are the defining equations of ABCD parameters
2. What is the significance of the two port parameters?
3. What is the applications of ABCD parameters?
4. What is the condition for symmetrical network?

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NETWORKS AND TRANSMISSION LINES LABORATORY -NTL (P)

**Title:** Equivalent parameters of series connection of two port network.

GPREC/EEE/EXPT.No.NTLP-08

DATE: 28-02-2022

**OBJECTIVE:** To Determine Equivalent Parameters of series Connection of two Port network

**APPARATUS:**

Sl.No.	Unit	Range	Type	No.
1	Regulated power supply	(0-30)V/(0-2)A		1
2	Ammeter	(0-2)A	MC	1
3	Voltmeter	(0-30)V	MC	1
4	Rheostat			6
5	Digital Multimeter			1
6	Connecting Wires			Reqd.

**THEORY:** Fig.1 shows the series connection of two-port networks. Z- parameters of the network T are  $Z'_{11}, Z'_{12}, Z'_{21}$  and  $Z'_{22}$  and that of network TT are  $Z''_{11}, Z''_{12}, Z''_{21}$  and  $Z''_{22}$ .

The equivalent Z-parameters of series connection are

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

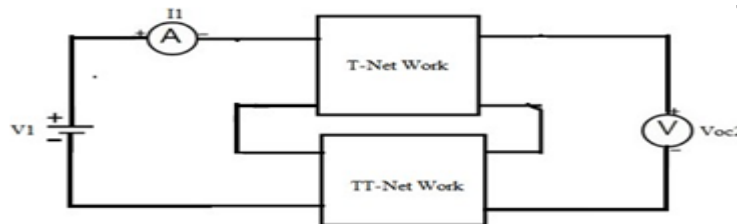
$$V_2 = Z_{21}I_1 + Z_{22}I_2$$

$$\text{Where } Z_{11} = Z'_{11} + Z''_{11} \quad Z_{12} = Z'_{12} + Z''_{12}$$

$$Z_{21} = Z'_{21} + Z''_{21} \quad Z_{22} = Z'_{22} + Z''_{22}$$

Where  $V_1$  and  $V_2$  are independent variables and  $I_1$  and  $I_2$  are independent variables.  $Z_{11}$  and  $Z_{22}$  is Input and Output driving point impedance,  $Z_{12}$  and  $Z_{21}$  is reverse and Forward Transfer impedance.

**CIRCUIT DIAGRAM:**



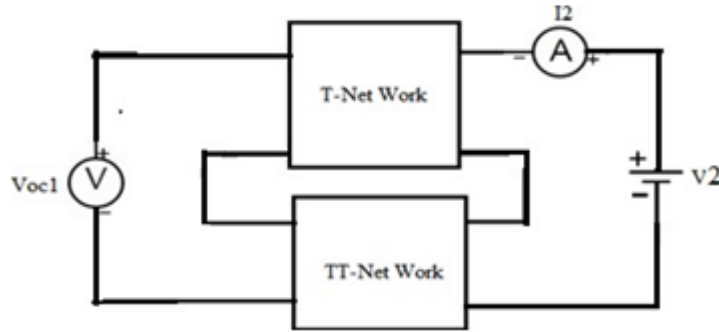
**Fig.1**

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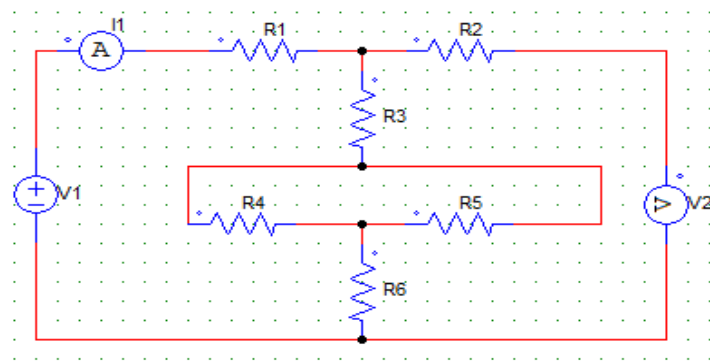
**Title:** Equivalent parameters of series connection of two port network.

GPREC/EEE/EXPT.No.NTLP-08

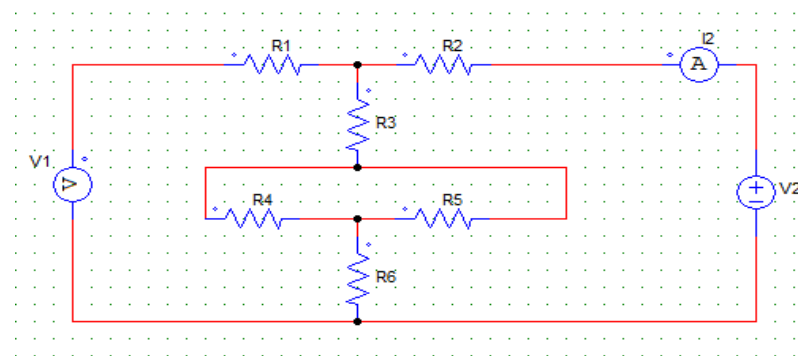
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**Fig. 2**



**Fig.3**



**Fig.4**

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**Title:** Equivalent parameters of series connection of two port network

GPRED/EEE/EXPT.No.NTLP-8

DATE: 28-02-2022

**PROCEDURE:**

1. Connect the circuit as per circuit diagram Fig.3
2. Apply sufficient input voltage
3. Note down the readings meters and input voltage.
4. Repeat above steps for the Fig.4
5. The impedance parameters  $Z_{11}$  ,  $Z_{21}$  ,  $Z_{22}$  &  $Z_{12}$  are calculated using given formula and verify with theoretical values.
5. Switch off the supply after taking the readings.

**OBSERVATION TABLE:**

Table :open circuit parameters

OUTPUT IS OPEN CIRCUITED			$Z_{11} = \frac{V_1}{I_1}$		$Z_{21} = \frac{V_2}{I_1}$	
$V_1$	$I_1$	$V_2$	Theoretical	Practical	Theoretical	Practical

INPUT IS OPEN CIRCUITED			$Z_{12} = \frac{V_1}{I_2}$		$Z_{22} = \frac{V_2}{I_2}$	
$V_2$	$I_2$	$V_1$	Theoretical	Practical	Theoretical	Practical

**SAMPLE CACULATION:**

1. when o/p is open circuited

$$Z_{11} = V_1/I_1 \quad Z_{21} = V_2/I_1 \quad \text{i.e } I_2 = 0$$

2. when i/p is open circuited

$$Z_{12} = V_1/I_2 \quad Z_{22} = V_2/I_2 \quad \text{i.e } I_1 = 0$$



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NETWORKS AND TRANSMISSION LINES LABORATORY - NTL (P)

**Title:** Equivalent parameters of series connection of two port network

GPRED/EEE/EXPT.No.NTLP-8

DATE: 28-02-2022

**RESULT:**

**QUESTIONS:**

1. Which parameters are calculated if two port networks are connected in series?
2. For a Two port network, What is the condition of symmetry in terms of Z-parameters.
3. For a Two port network, What is the condition of reciprocal in terms of Z-parameters.
4. what is the series connection of two port network.
5. What is the difference between series connection and cascade connection of Two port networks

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NETWORKS AND TRANSMISSION LINES LABORATORY –NTL(P)

<b>TITLE:</b> The equivalent parameters of parallel connection of two port network	GPREC/EEE/EXPT.No.NTLP-09 DATE:28-02-2022
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**OBJECTIVE: To Determine Equivalent Parameters of Parallel Connection Of Two Port Network.**

**APPARATUS:**

Sl.No.	Unit	Range	Type	No.
1	Regulated power supply	(0-30)V/(0-2)A		1
2	Ammeter	(0-2)A	MC	1
3	Rheostat			6
4	Digital Multimeter			1
5	Connecting Wires			Reqd.

**THEORY:** Fig.1 shows the parallel connection of two-port networks. Y- parameters of the network T are  $Y'_{11}, Y'_{12}, Y'_{21}$  and  $Y'_{22}$  and that of network TT are  $Y''_{11}, Y''_{12}, Y''_{21}$  and  $Y''_{22}$ .

. The describing equations are

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

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

where  $V_1$  and  $V_2$  are independent variables and  $I_1$  and  $I_2$  are dependent variables.

The equivalent Y-parameters of parallel connection are

$$\text{Where } Y_{11} = Y'_{11} + Y''_{11} \quad Y_{12} = Y'_{12} + Y''_{12}$$

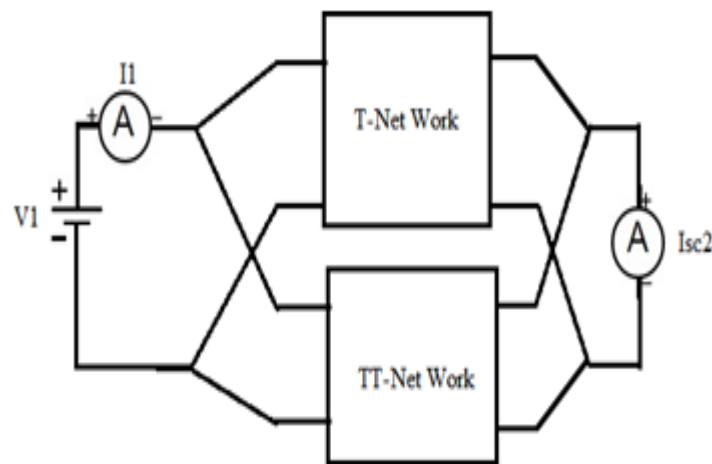
$$Y_{21} = Y'_{21} + Y''_{21} \quad Y_{22} = Y'_{22} + Y''_{22}$$

**TITLE:** The equivalent parameters of  
parallel connection of two port network

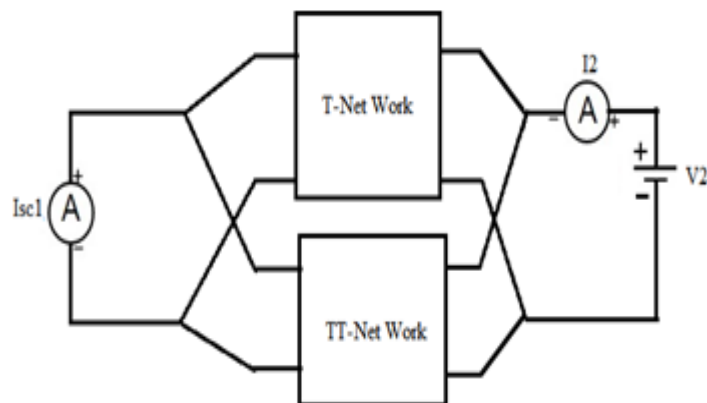
GPREC/EEE/EXPT.No.NTLP-09

DATE:28-02-2022

**CIRCUIT DIAGRAM:**



**Fig.1**



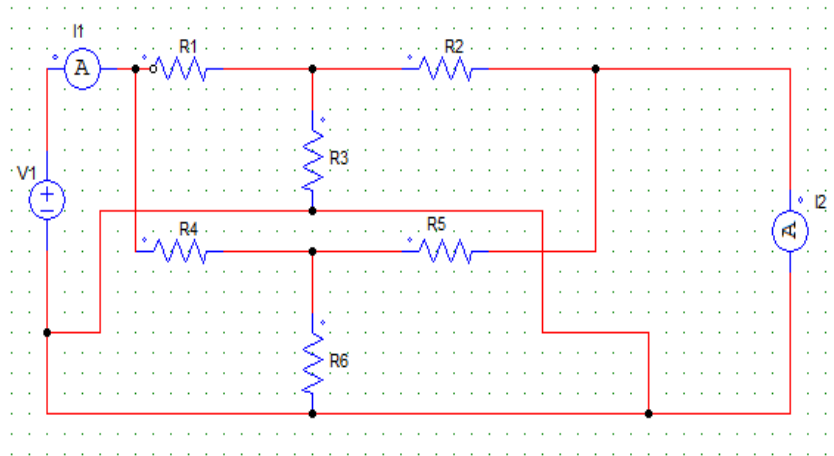
**Fig.2**

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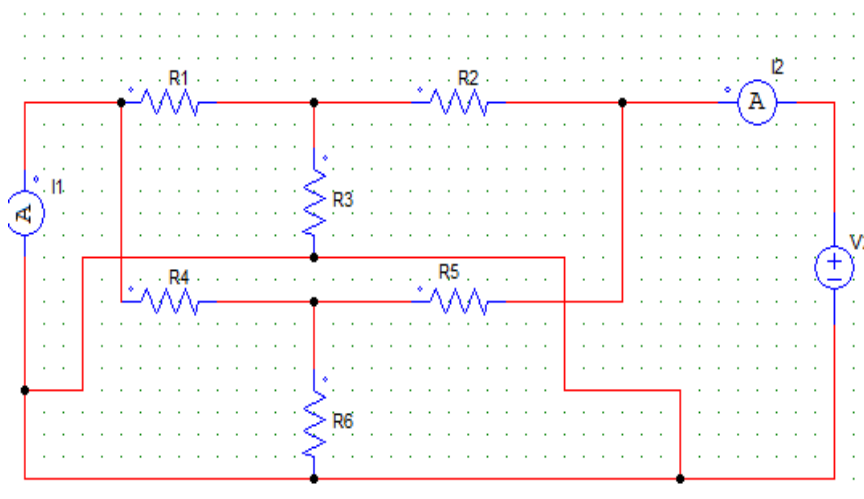
**TITLE:** The equivalent parameters  
of parallel connection of two port

GPREC/EEE/EXPT.No.NTLP-09

DATE:28-02-2022



**Fig.3**



**Fig.4**

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<b>TITLE:</b> The equivalent parameters of parallel connection of two port	GPREC/EEE/EXPT.No.NTLP-09 DATE:28-02-2022
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**PROCEDURE:**

1. Connect the circuit as per circuit diagram Fig.3
2. Apply sufficient input voltage
3. Note down the readings meters and input voltage in table.
4. Repeat above steps for the Fig.4
5. Calculate y-parameters by using given formula and verify with theoretical values.
6. Switch off the supply after taking the readings.

**OBSERVATION TABLE:**

**Tables :** Short-circuit parameters

OUTPUT IS OPEN CIRCUITED			$Y_{11} = \frac{I_1}{V_1}$		$Y_{21} = \frac{I_2}{V_1}$	
V <sub>1</sub>	I <sub>1</sub>	I <sub>2</sub>	Theoretical	Practical	Theoretical	Practical

INPUT IS SHORT CIRCUITED			$Y_{12} = \frac{I_1}{V_2}$		$Y_{22} = \frac{I_2}{V_2}$	
V <sub>2</sub>	I <sub>2</sub>	I <sub>1</sub>	Theoretical	Practical	Theoretical	Practical

**SAMPLE CACULATION:**

1. when o/p is short circuited

$$Y_{11} = I_1/V_1 \quad Y_{21} = I_2/V_1 \text{ i.e } V_2=0$$

2. when i/p is short circuited

$$Y_{12} = I_1/V_2 \quad Y_{22} = I_2/V_2 \text{ i.e } V_1=0$$

-----

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ELECTRICAL CIRCUITS LABORATORY - (EC (P))

**TITLE:** The equivalent parameters  
of parallel connection of two port

GPREC/EEE/EXPT.No.NTLP-09  
DATE:28-02-2022

**RESULT:**

**QUESTIONS:**

1. What will be the total admittance if the two networks are connected in parallel?
2. Which parameter is used for the representation of parallel connection of two port network?.
3. For a Two port network, what is the condition of reciprocal in terms of Y-parameters.
4. For a Two port network, what is the condition of symmetry in terms of Y-parameters.
5. What is the difference between series connection and cascade connection of two port networks

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<b>TITLE:</b> CASCADE CONNECTION OF TWO PORT NETWORK	GPREC/EEE/EXPT.No.NTLP-10 DATE: 28-02-2022
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**OBJECTIVE:** to Determine A,B,C,D Parameters of CASCADE connection of two Port network

**APPARATUS:**

Sl.No.	Unit	Range	Type	No.
1	Regulated power supply	(0-30)V/(0-2)A		1
2	Ammeter	(0-2)A	MC	1
3	Rheostat			6
4	Digital Multimeter			1
5	Connecting Wires			Reqd.

**THEORY:** A two-port network can also be represented using ABCD-parameters. The describing equations are

$$V_1 = AV_2 + B(-I_2)$$

$$I_1 = CV_2 + D(-I_2)$$

Where

1.  $V_1$  and  $I_1$  are dependent variables and  $V_2$  and  $I_2$  are independent variables.
2. A and D is reverse voltage ratio and reverse current ratio.
3. B and C are reverse transfer impedance and Forward Transfer admittance.

Let us consider a cascade connection of two port network T and TT as shown in Fig.1 and Fig.2. Here the output terminals of network T are connected directly to the input terminals of Network TT. Let Transmission line parameters of T network are  $A_1, B_1, C_1, D_1$  and that of TT network are  $A_2, B_2, C_2, D_2$ . Then the transmission line parameters of cascade connection of Two port network are A, B, C and D.

Then

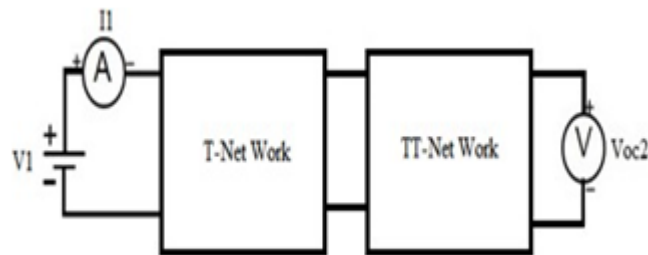
$$\begin{bmatrix} A & B \\ C & D \end{bmatrix} = \begin{bmatrix} A_1 & B_1 \\ C_1 & D_1 \end{bmatrix} \begin{bmatrix} A_2 & B_2 \\ C_2 & D_2 \end{bmatrix}$$

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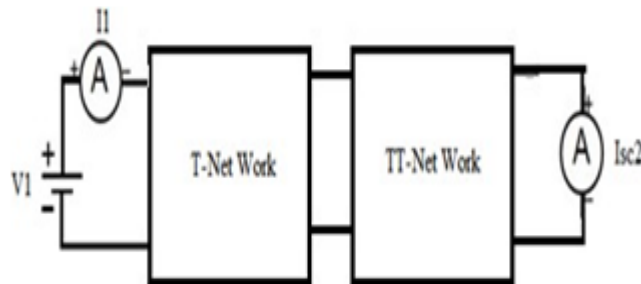
**TITLE:** CASCADE CONNECTION OF  
TWO PORT NETWORK

GP/REC/EEE/EXPT.No.NTLP-10  
DATE: 28-02-2022

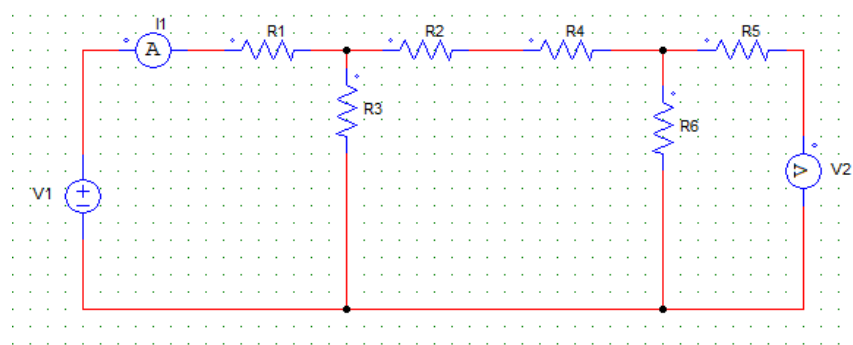
**CIRCUIT DIAGRAM:**



**Fig:1**



**Fig:2**

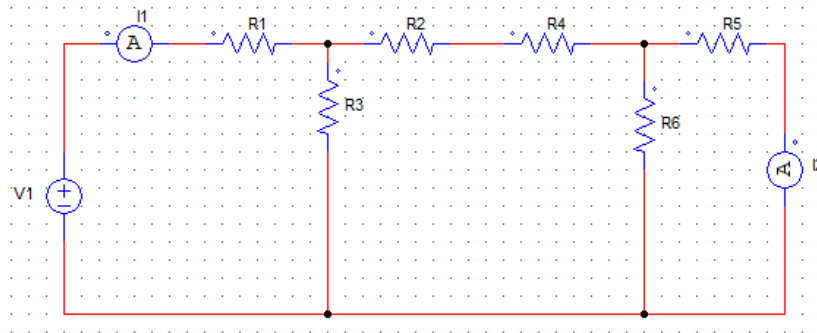


**Fig:3**



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<b>TITLE:</b> CASCADE CONNECTION OF TWO PORT NETWORK	GPREC/EEE/EXPT.No.NTLP-10 DATE: 28-02-2022
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**Fig:4**

**PROCEDURE:**

1. Connect the circuit as per circuit diagram Fig.3
2. Apply sufficient input voltage.
3. Note down the readings of meters and input voltage'
4. Repeat above steps for the Fig.4
5. Calculate A,B,C and D-parameters by using given formula and verify with theoretical values.
6. Switch off the supply after taking the readings.

**OBSERVATION TABLE:**

**Tables : Transmission line parameters**

<b>OUTPUT IS OPEN CIRCUITED</b>			$A = \frac{V_1}{V_2}$		$C = \frac{I_1}{V_2}$	
<b>V<sub>1</sub></b>	<b>I<sub>1</sub></b>	<b>V<sub>2</sub></b>	Theoretical	Practical	Theoretical	Practical

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<b>TITLE:</b> CASCADE CONNECTION OF TWO PORT NETWORK	GPRECD/EEE/EXPT.No.NTLP-10 DATE: 28-02-2022
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<b>OUTPUT IS SHORT CIRCUITED</b>			$B = \frac{V_1}{I_2}$		$D = \frac{I_1}{I_2}$	
$V_1$	$I_1$	$I_2$	Theoretical	Practical	Theoretical	Practical

**SAMPLE CACULATION:**

**1. when o/p is open circuited**

$$A = V_1/V_2 \quad C = I_2/V_1 \quad \text{i.e } I_2 = 0$$

**2. when i/p is open circuited**

$$B = V_1/-I_2 \quad D = I_1/-I_2 \quad \text{i.e } V_2 = 0$$

**RESULT:**

**QUESTIONS:**

1. Which parameters are calculated if two port networks are in cascade connection?
2. What is the difference between series connection and cascade connection of two port networks
3. What are the condition between A,B,C and D parameters.
- 4, What are the units for A,B,C and D parameters?
5. If two ports are connected in cascade configuration then which arithmetic operation should be performed between individual transmission parameters in order to determine overall transmission line parameters.

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NETWORKS AND TRANSMISSION LINES LABORATORY – NTL(P)

<b>TITLE: CONSTANT KLOW PASS FILTER</b>	<b>GPREC/EEE/EXPT.No-NTLP-11</b>
<b>HIGHPASS FILTERS</b>	<b>Date: 28-02-2022</b>

$$C = \frac{1}{4\pi R_k f_c}$$

This filter attenuates all frequencies below the cut-off frequency and allows to pass all other frequencies above the cut-off frequency.

**Procedure:**

1. Connect the circuit for Low pass filter as shown in the figure.
2. Give supply of 20mV at input from the function generator.
3. Note down the output voltage for various frequencies of the input signal.
4. Draw the graph between frequency and gain in dB and calculate the cutoff frequency.
5. Repeat the above procedure for High pass filter circuit also.

**Design:**

For low pass filter

L=                   , C=                   ,  $f_c = 1 / \pi \sqrt{LC} =$

For high pass filter

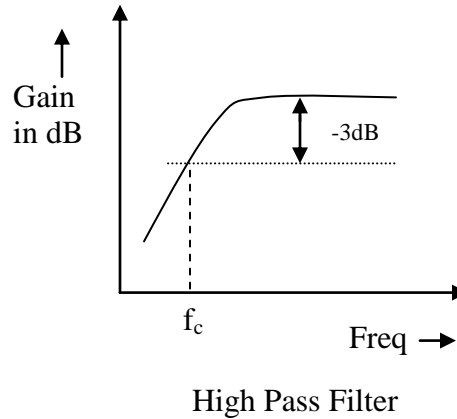
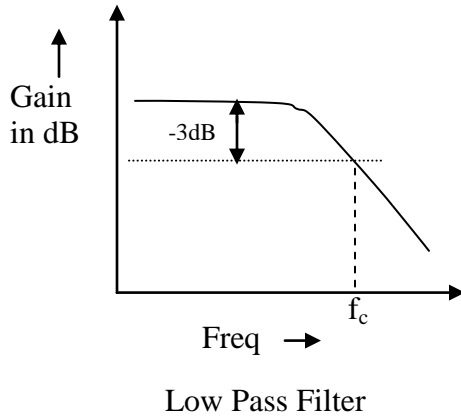
L=                   , C=                   ,  $f_c = 1 / 4\pi \sqrt{LC} =$

**Tabular columns:**

Frequency	Output(V <sub>o</sub> )	Gain = V <sub>o</sub> /V <sub>i</sub>	Gain in dB

<b>TITLE: CONSTANT K LOW PASS FILTER</b>	<b>GPREC/EEE/EXPT.No-NTLP-11</b>
<b>HIGHPASS FILTERS</b>	<b>Date: 28-02-2022</b>

**Expected graphs:**



**Result:**

**Questions:**

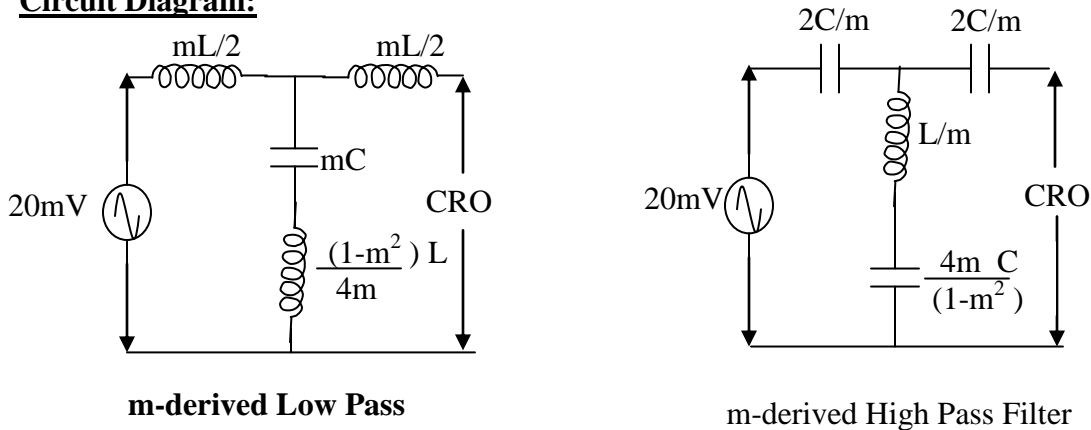
1. What is the cutoff frequency of constant K-type low pass filter.
2. What is a constant K high pass filter
3. What are the limitations of a constant K filter.
4. What is constant K filter why it is called prototype filter section.
5. What are the advantages and disadvantages of constant K filters.

<b>Title: M-DERIVED LOWPASS AND HIGHPASS FILTERS</b>	<b>GPREC/EEE/EXPT.No-NTLP-12</b> <b>Date: 28-02-2022</b>
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**Aim:** To observe the frequency response for m-derived high pass and low pass filters practically and to compare the cut off frequency with the theoretical values.

**Apparatus:** Inductors, Capacitors, Function Generator, CRO and Probes

**Circuit Diagram:**



**THEORY:**

There are two disadvantages of the constant-K filters. These are (1)The attenuation does not increase rapidly beyond cut off frequencies.(2) characteristic impedance varies widely in the transmission or pass band, from the desired value viz,the design impedance  $R_K$ .

Thus a high degree of attenuation just beyond the cut off or a constant impedance in the pass band, demands a better type of filter. To overcome above disadvantages we go for m-derived filter.

**m-derived low pass filter**

m-derived T filter as shown in the above Fig. In general form it must be noted that to divide the impedance of a capacitor by m, its capacitance must be multiplied by m .An inspection of the m-derived T filter shows that if the shunt arm is series resonant its

impedance will be minimum, the output then will be zero and this will correspond to infinite attenuation at this particular frequency.

And so the frequency of infinite attenuation  $f_{\infty}$  is given by

$$f_{\infty} = 1/(\pi\sqrt{LC}\sqrt{1-m^2})$$

and cut off frequency  $f_c = 1/(\pi\sqrt{LC})$

$$\text{therefore } m = \sqrt{1 - \left(\frac{f_c}{f_{\infty}}\right)^2} = \sqrt{1 - \frac{f_c^2}{f_{\infty}^2}}$$

### **m-derived high pass filter**

m-derived high pass T filter as shown in the above Fig. These filter have a frequency of infinite attenuation given by the series resonant of the shunt arm in T-section. so the frequency of infinite attenuation  $f_{\infty}$  is given by

$$f_{\infty} = (\sqrt{1-m^2}) / (4\pi\sqrt{LC})$$

and cut off frequency  $f_c = 1/(4\pi\sqrt{LC})$

$$\text{therefore } m = \sqrt{1 - \left(\frac{f_{\infty}}{f_c}\right)^2}$$

The main advantage of m-derived filters makes it possible to construct “composite filters” to have any desired attenuation/ frequency characteristics.



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<b>Title: M-DERIVED LOWPASS AND HIGHPASS FILTERS</b>	<b>GPREC/EEE/EXPT.No-NTLP-12</b> <b>Date: 28-02-2022</b>
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**Procedure:**

1. Connect the circuit for m-derived low pass filter as shown in figure.
2. Give supply of 20 mV at input from the function generator.
3. Note down the output voltage for various frequencies of the input signal.
4. Draw the graph between frequency and gain in DB and calculate the cutoff frequency .
5. Repeat the above procedure for high pass filter also.

**Design: For m-derived low pass filter**

$$L = \quad , \quad C =$$

$$f_c = 1/(\pi\sqrt{LC}) \quad f_\infty = 1/(\pi\sqrt{LC}\sqrt{1-m^2})$$

**For m-derived high pass filter.**

$$L = \quad , \quad C =$$

$$f_c = 1/(4\pi\sqrt{LC}) \quad f_\infty = (\sqrt{1-m^2}) / (4\pi\sqrt{LC})$$

**Tabular Columns:**

For m-derived low pass filter:

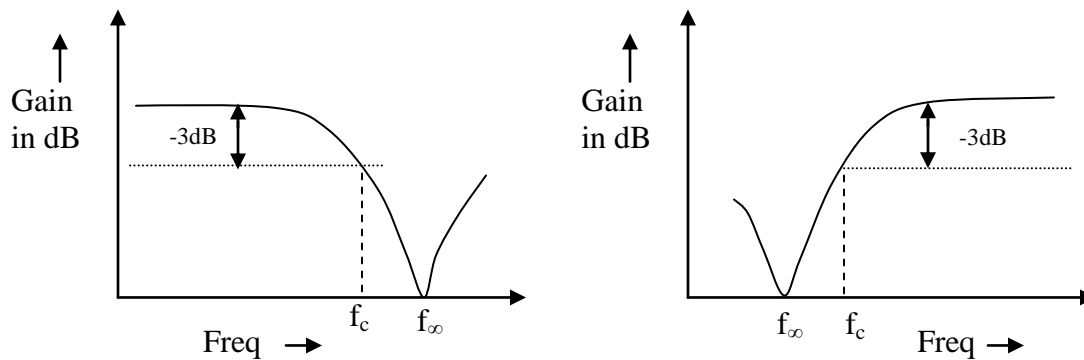
Frequency	Output(V <sub>o</sub> )	Gain = V <sub>o</sub> /V <sub>i</sub>	Gain in dB

<b>Title: M-DERIVED LOWPASS AND HIGHPASS FILTERS</b>	<b>GPREC/EEE/EXPT.No-NTLP-12</b> <b>Date: 28-02-2022</b>
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For m-derived high pass filter:

Frequency	Output( $V_o$ )	Gain = $V_o/V_i$	Gain in dB

**Expected Graphs:**



**Result:**

**Questions:**

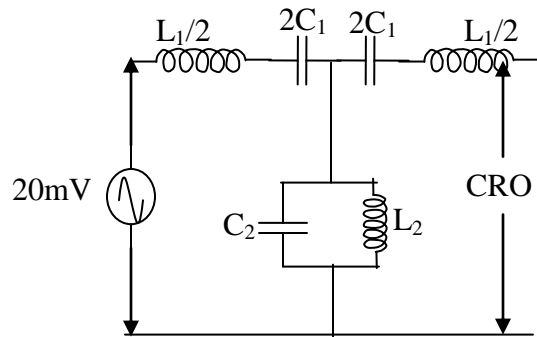
- (1).What is m-derived high pass filter.
- (2).What will be the range of M for m-derived filter.
- (3).What is the need of m-derived filters in filter designing.
- (4).What is m-derived filter explain general configuration and parameters of m-derived low pass filter
- (5).What are the advantages of m-derived filters.

<b>Title: CONSTANT K-BAND PASS FILTER</b>	<b>GPREC/EEE/EXPT-NTLP-13</b>
<b>Date: 28-02-2022</b>	

**Aim:** To observe the frequency response for band pass constant-K filter practically and to compare the cut off frequency with the theoretical values.

**Apparatus:** Inductors, Capacitors, Function Generator, CRO and Probes

**Circuit Diagram:**



**Band Pass Filter**

**THEORY:**

This can be T-section if the series arm contains a series resonant circuit while the shunt arms contains parallel resonant circuit as shown in the above circuit diagram. If resonance in the series arms occurs at the frequency at which the shunt parallel circuit is resonant the section will have bandpass characteristic. For this condition equal resonant frequencies.

$$\omega_0 = \frac{1}{\sqrt{L_1 C_1}} = \frac{1}{\sqrt{L_2 C_2}}$$

$$L_1 C_1 = L_2 C_2$$

$$\text{Hence } \frac{L_2}{C_2} = \frac{L_1}{C_1}$$

**Title: CONSTANT K-BAND PASS FILTER**

**GPREC/EEE/EXPT-NTLP-13**

**Date: 28-02-2022**

$$\text{Here } \frac{L_2}{C_2} = \frac{L_1}{C_1} = R_k^2$$

$$C_1 = (f_2 - f_1) / (4\pi R_k f_1 f_2), \quad C_2 = 1 / (\pi R_k (f_2 - f_1)),$$

$$L_1 = R_k / (\pi (f_2 - f_1)), \quad L_2 = R_k (f_2 - f_1) / (4\pi f_1 f_2)$$

$f_1$  = Lower cutoff frequency,  $f_2$  = Upper cutoff frequency

$R_k$  = nominal impedance

A bandpass filter allows transmission of a limited band of frequencies ( $f_2 \rightarrow f_1$ ) and rejects all other frequencies below or above the frequency band. A bandpass filter has a series tuned circuit in the series arm and parallels the tuned circuit in the shunt arm.

**Procedure:**

1. Connect the circuit for Band pass filter as shown in figure.
2. Give supply of 20 mV at input from the function generator.
3. Note down the output voltage for various frequencies of the input signal.
4. Draw the graph between frequency and gain in DB and calculate the cutoff frequency.

<b>Title: CONSTANT K-BAND PASS FILTER</b>	<b>GPREC/EEE/EXPT-NTLP-13</b>
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**Design:**

**Band Pass filter**

$$L_1 C_1 = L_2 C_2 = R_k^2$$

$f_1$  = Lower cutoff frequency,                       $f_2$  = Upper cutoff frequency

$R_k$  = nominal impedance

$$C_1 = (f_2 - f_1) / (4\pi R_k f_1 f_2), \quad C_2 = 1 / (\pi R_k (f_2 - f_1)),$$

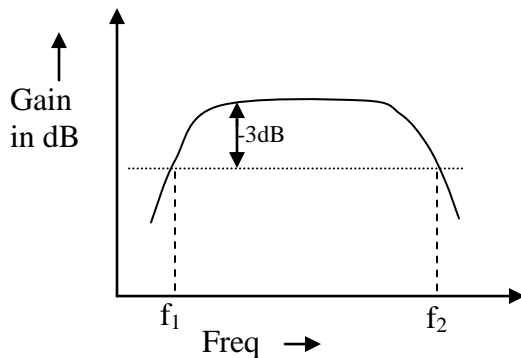
$$L_1 = R_k / (\pi (f_2 - f_1)), \quad L_2 = R_k (f_2 - f_1) / (4\pi f_1 f_2)$$

**Tabular Columns:**

For Band pass filter:

Frequency	Output ( $V_o$ )	Gain = $V_o/V_i$	Gain in dB

**Expected Graphs:**



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**Title: CONSTANT K-BAND PASS FILTER**

**GPREC/EEE/EXPT-NTLP-13**

**Date: 28-02-2022**

**Result:**

**Questions:**

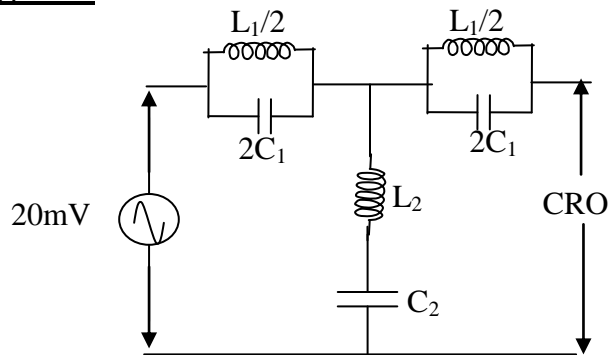
1. Which condition is correct for constant-K Band pass filter.
2. What are the limitations of constant K-type filters.
3. List disadvantages of constant K- filters.
4. Define cut off frequency.
5. Differentiate low pass, high pass and band pass filters..

**Title: BAND STOP CONSTANT- K FILTER** **GPREC/EEE/EXPT-NTLP-13**  
**Date: 28-02-2022**

**Aim:** To observe the frequency response for band stop filters practically and to compare the cut off frequency with the theoretical values.

**Apparatus:** Inductors, Capacitors, Function Generator, CRO and Probes

**Circuit Diagram:**



Band Stop Filter

**THEORY:**

The series and shunt arms of band pass filter are interchanged the resulting structure behaves as a band stop-filter. Hence the two cut-off frequencies together with other properties may be deduced similar to the band pass.

For the equal resonant frequencies and constant K-condition,

$$\frac{L_1}{C_2} = \frac{L_2}{C_1} = R_K^2$$

and  $f_0 = \sqrt{f_1 f_2}$

The band stop filter, also known as a *band reject filter*, passes all frequencies with the exception of those within a specified stop band which are greatly attenuated. Also, just like the band pass filter, the band stop (band reject) filter is a second-order filter having

**Title: BAND STOP CONSTANT- K FILTER**

**GPREC/EEE/EXPT-NTLP-13**

**Date: 28-02-2022**

two cut-off frequencies, commonly known as the -3dB or half-power points producing a wide stop band bandwidth between these two -3dB points.

Then the function of a band stop filter is to pass all those frequencies from zero (DC) up to its first (lower) cut-off frequency point  $f_L$ , and pass all those frequencies above its second (upper) cut-off frequency  $f_H$ , but block or reject all those frequencies in-between. Then the filter's bandwidth, BW is defined as:  $(f_H - f_L)$ .

### **Procedure:**

1. Connect the circuit for Band stop filter as shown in figure.
2. Give supply of 20 mV at input from the function generator.
3. Note down the output voltage for various frequencies of the input signal.
4. Draw the graph between frequency and gain in DB and calculate the cutoff frequency.
5. Repeat the above procedure for Band Stop filter also.

### **Band Stop filter:**

$$L_1 C_1 = L_2 C_2 = R_k^2$$

$f_1$  = Lower cutoff frequency,                       $f_2$  = Upper cutoff frequency

$R_k$  = nominal impedance

$$C_1 = 1/(4\pi R_k(f_2 - f_1)), \quad C_2 = (f_2 - f_1)/(\pi R_k f_1 f_2), \quad L_1 = R_k(f_2 - f_1)/(\pi f_1 f_2), \quad L_2 = R_k/(4\pi(f_2 - f_1))$$



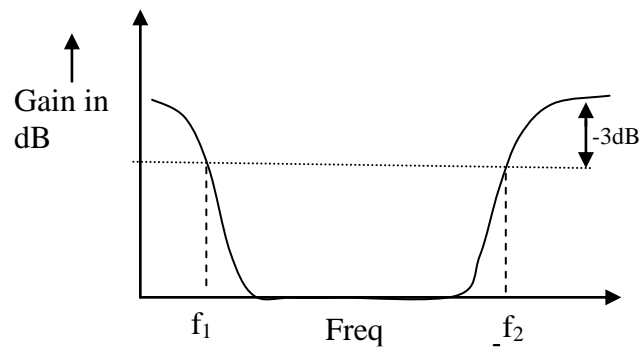
<b>Title: BAND STOP CONSTANT- K FILTER</b>	<b>GPREC/EEE/EXPT-NTLP-13</b>
	<b>Date: 28-02-2022</b>

**Tabular Columns:**

**For Band Stop filter:**

Frequency	Output ( $V_o$ )	Gain = $V_o/V_i$	Gain in dB

**Expected Graphs:**



**Band stop filter**

**Result:**

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**Title: BAND STOP CONSTANT- K FILTER**

**GPREC/EEE/EXPT-NTLP-13**

**Date: 28-02-2022**

**Questions:**

1. What are the limitations of constant K filters.
2. Define cutoff frequencies.
3. Define bandwidth.
4. What are the advantages and disadvantages of constant –K filters.
5. What are the difference between BPF and BRF.

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**TITLE:** CHARACTERISTIC  
IMPEDANCE AND  
PROPAGATION CONSTANT

GPREC/EEE/EXPT.No. NTLP-14

DATE: 28-02-2022

**OBJECTIVE:** To determine the characteristic impedance and propagation constant of a given Symmetrical T-network.

**APPARATUS:**

Sl.No.	Unit	Range	Type	No.
1	Regulated Power Supply	(0-30)V/(0-2)A		1
2	Ammeter	(0-2)A	MC	2
3	Rheostat			4
4	Digital Multimeter			1
5	Connecting Wires			Reqd.

**THEORY:**

**Characteristic impedance:**

Characteristic impedance of a uniform transmission line may be defined as the steady state vector ratio of the voltage to the current at the input of the infinite line. Alternatively, it can simply be defined as the impedance looking into an infinite length of the line. It is also known as surge impedance denoted by  $Z_o$ .

$$Z_o = \frac{V_{si}}{I_{si}} = \sqrt{\frac{R + j\omega L}{G + j\omega C}}$$

If an infinite number of identical symmetrical networks are connected one after the other, then the impedance measured at the input terminals of the first network will have definite value which will depend on the structure of the network called as characteristic impedance of the network. In Practice, characteristic impedance is computed from the knowledge of open circuit and short circuit impedances.

$$Z_o = \sqrt{Z_{OC} * Z_{SC}}$$

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When a symmetrical network is terminated in its characteristic impedance is said to be properly terminated. It is also referred as terminated in a matched load.

**Propagation Constant:**

The propagation constant per unit length of a uniform line may be defined as the natural logarithm of the steady state vector ratio of the current or voltage at any point, to that at point unit distance further from the source when the line is infinitely long.

$$P = \log_e \frac{I_S}{I_R} = \log_e \frac{V_S}{V_R}$$

Propagation constant P is usually a complex quantity and can be expressed as

$$P = \alpha + j\beta.$$

The real part  $\alpha$  is called attenuation constant. It determines the reduction in voltage or current along the line and higher its value the quicker the reduction. Its unit is neper per km. (1neper= 8.686dB)

The imaginary part  $\beta$  is called the phasor constant or wave constant. It determines the variation in phase position of voltage or current along the line. Its unit is radian per km.

$$P = \alpha + j\beta = \sqrt{(R + j\omega L)(G + j\omega C)}$$
$$\tanh P = \sqrt{\frac{Z_{SC}}{Z_{OC}}}$$

**TITLE:** CHARACTERISTIC  
 IMPEDANCE AND  
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**CIRCUIT DIAGRAM:**  
Characteristic Impedance:

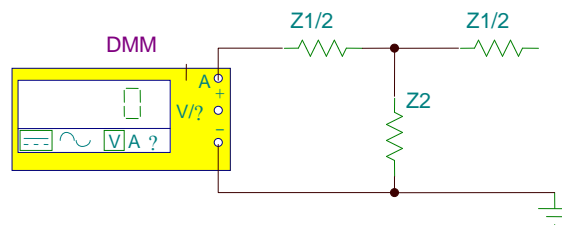


Fig.1

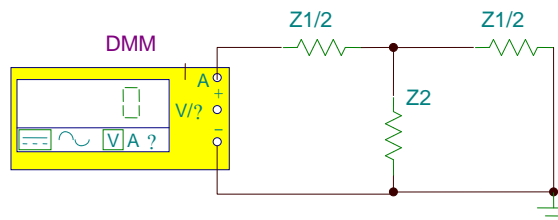


Fig.2

Propagation constant:

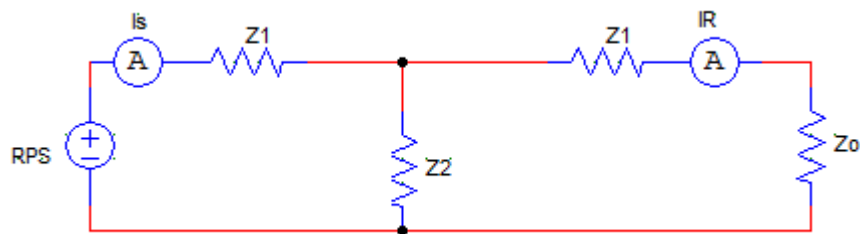


Fig.3

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**TITLE:** CHARACTERISTIC  
IMPEDANCE AND  
PROPAGATION CONSTANT

GPREC/EEE/EXPT.No. NTLP-14

DATE: 01-03-2022

**PROCEDURE:**

**Characteristic Impedance:**

1. Connect the circuit as shown in figure 1, measure the value of input impedance  $Z_{oc}$  when output port is open circuited.
2. Connect the circuit as shown in figure 1, measure the value of input impedance  $Z_{sc}$  when output port is short circuited.
3. Calculate characteristic impedance of symmetrical T-network is  
 $Z_o = (Z_{oc} * Z_{sc})^{1/2}$ .

**Propagation constant:**

1. Connect the circuit as per the circuit diagram shown in Fig.3
2. Apply the input voltage using Regulated Power Supply.
3. Measure source current  $I_s$  and receiving end current  $I_R$  using ammeters.
4. Calculate the propagation constant of symmetrical T-network is  
 $P = \log_e(I_s/ I_R)$

**TABULAR COLUMNS:**

**Characteristic Impedance:**

$Z_{oc}$ (Theoretical)	$Z_{oc}$ (Practical)	$Z_{sc}$ (Theoretical)	$Z_{sc}$ (Practical)	$Z_o$ (Theoretical)	$Z_o$ (Practical)

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**Propagation Constant:**

$\frac{I_S}{I_R}$ (Theoretical)	$\frac{I_S}{I_R}$ (Practical)	$P = \log_e \frac{I_S}{I_R}$ (Theoretical)	$P = \log_e \frac{I_S}{I_R}$ (Practical)

**RESULT:**

**QUESTIONS:**

1. Define characteristic impedance of a symmetrical two port network.
2. Define propagation constant of a symmetrical two port network.
3. Write the expression for characteristic impedance of lossless transmission line.
4. Write the expression for propagation constant of a transmission line in terms of primary constants.
5. What is the relation for characteristic impedance in terms of open circuit impedance and short circuit impedance? Explain.
6. Explain the electrical characteristics of a symmetrical network.

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**TITLE:** IMAGE IMPEDANCES  
AND ITERATIVE IMPEDANCES

GPREC/EEE/EXPT.No. NTLP-15  
DATE: 28-02-2022

**OBJECTIVE:** To determine the image impedances and iterative impedances of a given asymmetrical L-network.

**APPARATUS:**

Sl.No.	Unit	Range	Type	No.
1	Rheostat/Resistors			3
2	Digital Multimeter			1
3	Connecting Wires			Reqd.

**THEORY:**

**Image impedances:**

Image impedances of a network are defined as the impedances which simultaneously terminate each pair of terminals of a network in such a way that at each pair of terminals the impedance in both directions is equal.

Image impedances of an asymmetrical network in terms of open circuit and short circuit impedances with respect to the corresponding ports are

$$Z_{i1} = \sqrt{Z_{OC1} * Z_{SC1}}$$
$$Z_{i2} = \sqrt{Z_{OC2} * Z_{SC2}}$$

Image impedances of an asymmetrical L-network in terms of series impedance  $Z_A$  and shunt impedance  $Z_C$  are

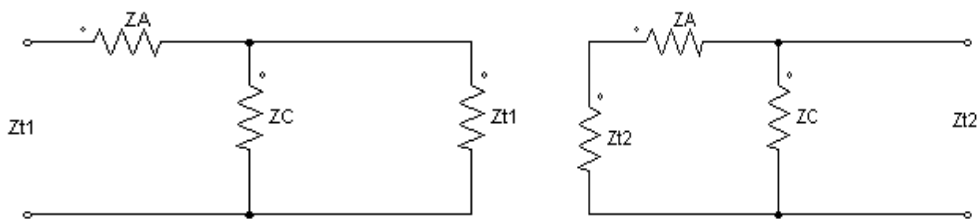
$$Z_{i1} = \sqrt{Z_A^2 + Z_A Z_C} \qquad Z_{i2} = \frac{Z_A Z_C}{\sqrt{Z_A^2 + Z_A Z_C}}$$



<b>TITLE:</b> IMAGE IMPEDANCES AND ITERATIVE IMPEDANCES	GPREC/EEE/EXPT.No. NTLP-15 DATE: 28-02-2022
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**Iterative impedances:**

Iterative impedance is defined as the impedance which will terminate the other pair of terminals in such a way that the impedance measured at the first pair of terminals is equal to the terminating impedance.



Any two-port asymmetrical network will have two iterative impedances ( $Z_{t1}$  and  $Z_{t2}$ ). Iterative impedances of an asymmetrical L-network in terms of series impedance  $Z_A$  and shunt impedance  $Z_C$  are

$$Z_{t1} = \frac{Z_A}{2} + \sqrt{\left(\frac{Z_A^2}{4} + Z_A Z_C\right)}$$

$$Z_{t2} = \frac{-Z_A}{2} + \sqrt{\left(\frac{Z_A^2}{4} + Z_A Z_C\right)}$$

**CIRCUIT DIAGRAM:**

**Image Impedances:**

For  $Z_{i1}$ :

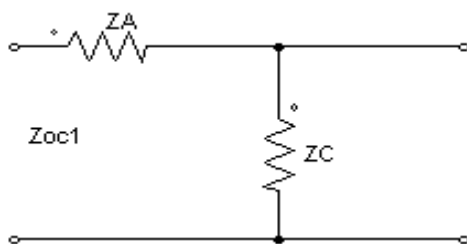


Fig.1

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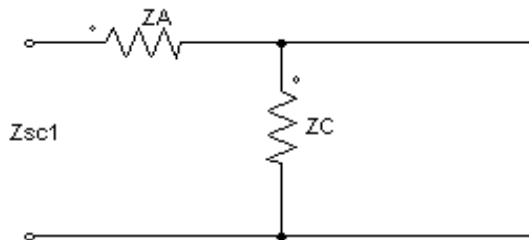


Fig.2

$$Z_{i1} = (Z_{oc1} * Z_{sc1})^{1/2}$$

**For Zi2:**

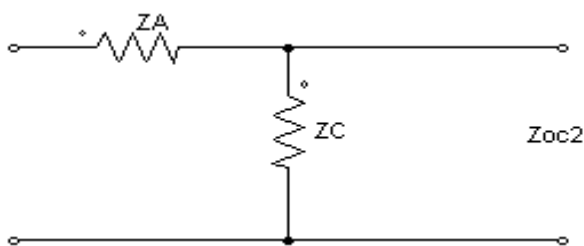


Fig.3

$$Z_{i2} = (Z_{oc2} * Z_{sc2})^{1/2}$$

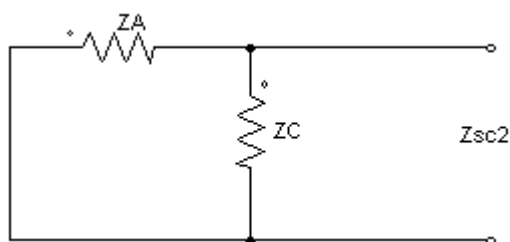


Fig.4

**Iterative Impedances:**

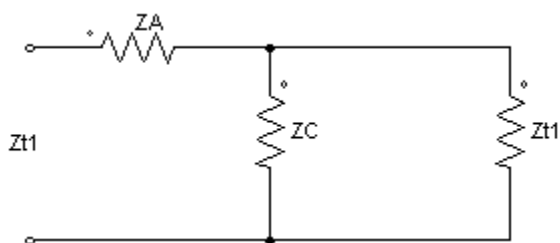


Fig.5

**TITLE:** IMAGE IMPEDANCES  
 AND ITERATIVE IMPEDANCES

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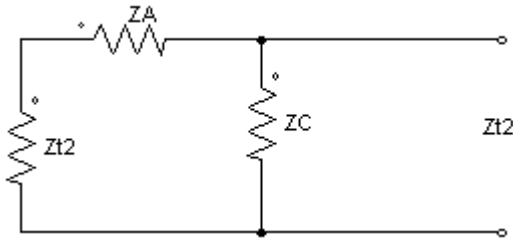


Fig.6

**PROCEDURE:**

**Image Impedances:**

1. Connect the circuit as shown in figure 1, measure the value  $Z_{oc1}$
2. Connect the circuit as shown in figure 2, Measure the value  $Z_{sc1}$ .
3. Calculate  $Z_{i1} = (Z_{oc1} * Z_{sc1})^{1/2}$ .
4. Repeat the same for the networks shown in figure 3 & 4.  
 Calculate  $Z_{i2} = (Z_{oc2} * Z_{sc2})^{1/2}$ .
5. Comment on the values of  $Z_{i1}$  and  $Z_{i2}$ .

**Iterative Impedances:**

1. Connect the circuit as per the circuit diagram shown in Fig.5
2. Connect digital Multimeter at port-1 to measure input impedance at port-1.
3. Adjust the  $Z_{t1}$  value using the variable rheostat at port-2 such that input impedance at port-1 is same value as  $Z_{t1}$ .
4. Compare the values of input impedance at port-1 with  $Z_{t1}$
5. Repeat the same procedure for the network shown in figure.6.
6. Comment on the values of  $Z_{t1}$  and  $Z_{t2}$

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<b>TITLE:</b> IMAGE IMPEDANCES AND ITERATIVE IMPEDANCES	GPREC/EEE/EXPT.No. NTLP-15 DATE: 28-02-2022
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**TABULAR COLUMNS:**

$Z_A = \underline{\hspace{2cm}}$ ,  $Z_C = \underline{\hspace{2cm}}$

**For Image Impedances:**

$Z_{oc1}$ (Theoretical)	$Z_{oc1}$ (Practical)	$Z_{sc1}$ (Theoretical)	$Z_{sc1}$ (Practical)	$Z_{i1}$ (Theoretical)	$Z_{i1}$ (Practical)

$Z_{oc2}$ (Theoretical)	$Z_{oc2}$ (Practical)	$Z_{sc2}$ (Theoretical)	$Z_{sc2}$ (Practical)	$Z_{i2}$ (Theoretical)	$Z_{i2}$ (Practical)

**For Iterative Impedances:**

$Z_{t1}$ (Theoretical)	$Z_{t1}$ (Practical)	$Z_{t2}$ (Theoretical)	$Z_{t2}$ (Practical)

**RESULT:**

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**TITLE: IMAGE IMPEDANCES  
AND ITERATIVE IMPEDANCES**

**GPREC/EEE/EXPT.No. NTLP-15  
DATE: 28-02-2022**

**QUESTIONS:**

1. Define image impedances and iterative impedance of a asymmetrical two port network.
2. Explain the electrical characteristics of an asymmetrical network.
3. Obtain the expression for image impedances of an asymmetrical network. Explain.
4. What is the relation for image impedances in terms of open circuit impedance and short circuit impedance? Explain.
5. Why we need to study the electrical characteristics of a network? Explain.