LABORATORY MANUAL

NETWORK DEVICE LAB

B.Tech. (Electrical Engineering), 3rd Semester

Department of Electrical Engineering
Veer Surendra Sai University of Technology,
BURLA

Vision

To be recognized as a center of excellence in education and research in the field of Electrical Engineering by producing innovative, creative and ethical Electrical Engineering professionals for socio-economic development of society in order to meet the global challenges.

Mission

Electrical Engineering Department of VSSUT Burla strives to impart quality education to the students with enhancement of their skills to make them globally competitive through:

M1. Maintaining state of the art research facilities to provide enabling environment to create, analyze, apply and disseminate knowledge.

M2. Fortifying collaboration with world class R& D organizations, educational institutions, industry and alumni for excellence in teaching, research and consultancy practices to fulfil ‘Make in India’ policy of the Government.

M3. Providing the students with academic environment of excellence, leadership, ethical guidelines and lifelong learning needed for a long productive career.

Program Educational Objectives

The program educational objectives of B.Tech. in Electrical Engineering program of VSSUT Burla are to prepare its graduates:

1. To have basic and advanced knowledge in Electrical Engineering with specialized knowledge in design and commissioning of electrical systems/renewable energy systems comprising of generation, transmission and distribution to become eminent, excellent and skilful engineers.
2. To succeed in getting engineering position with electrical design, manufacturing industries or in software and hardware industries, in private or government sectors, at Indian and in Multinational organizations.
3. To have a well-rounded education that includes excellent communication skills, working effectively on team-based projects, ethical and social responsibility.
4. To have the ability to pursue study in specific area of interest and be able to become successful entrepreneur.
5. To have broad knowledge serving as foundation for lifelong learning in multidisciplinary areas to enable career and professional growth in top academic, industrial and government/corporate organizations.

List of Experiments

1. Verification of Superposition and Thevenin’s Theorem.
2. Verification of Maximum Power Transfer Theorem.
3. Find out the band width, Q-factor and resonance frequency of a R-L-C series circuit.
4. Transient response of a D.C. R-L, R-C and R-L-C circuit.
5. Determination of A, B, C, D, Z, Y and h parameters of a two port network.
6. Spectral Analysis of a non-sinusoidal waveform.

COURSE OUTCOMES:

Upon completion of this course, students will demonstrate the ability to:

CO1. Implement the linear circuits by using network theorems.

CO2. Describe the resonant circuit by understanding its basic properties and find the bandwidth, Q-factor and resonance frequency of a R-L-C series circuit.

CO3. Describe and evaluate the Transient response of R-L, R-C and R-L-C circuits using DC excitation.

CO4. Define ABCD, Z, Y and h parameters of a two port network and know the property of symmetry and reciprocity of network.

CO5. Define and analyze the importance and reason that lead to a non-sinusoidal waveform.

Experiment 1

AIM OF THE EXPERIMENT:

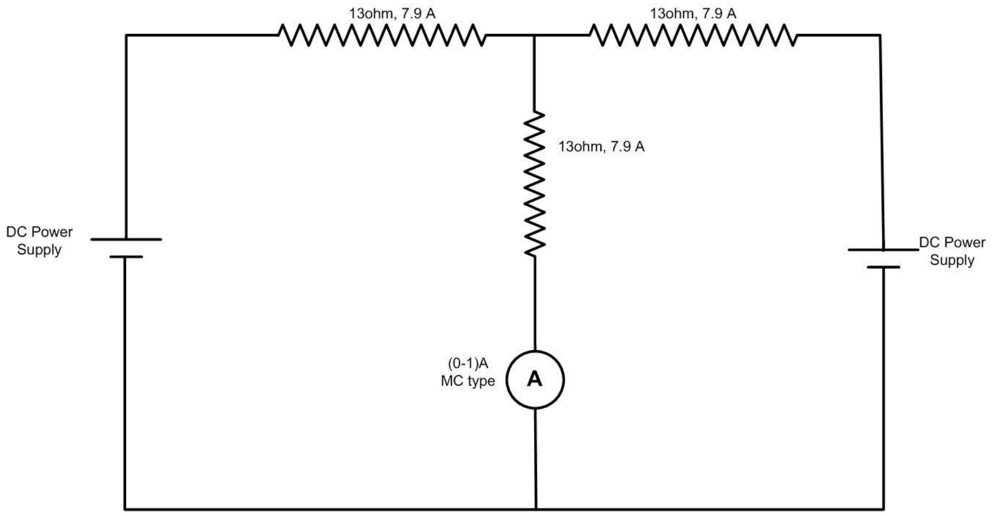
To verify Superposition Theorem and Thevenin's Theorem.

A. Superposition Theorem

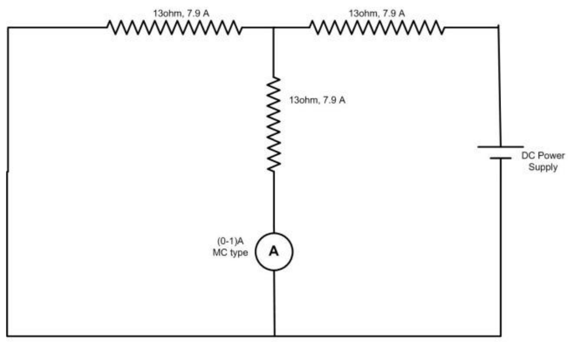
APPARATUS REQUIRED:

Sl. No.	Item	Range/Rating	Maker's Name	Maker's No.

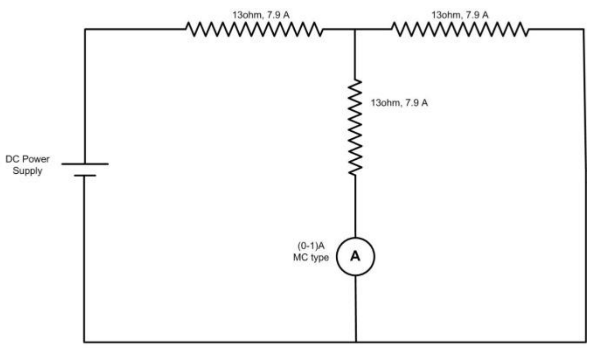
CIRCUIT DIAGRAM



Superposition Theorem
Ckt. Diagram - 1



Superposition Theorem
Ckt. Diagram - 2



Superposition Theorem
Ckt. Diagram - 3

THEORY:

The superposition theorem states that in a linear bilateral network containing more than one source of emf, the resultant current in any branch is the algebraic sum of currents in that would be produced by each energy source acting alone. All the other sources being replaced by their internal resistances.

In order to verify this theorem, we required to know the internal resistance of each emf source. The other method is to connect the series with large value resistors with each emf sources in order to be able to neglect the comparatively small resistance of the sources.

PROCEDURE:

1. The circuit was assembled as per the circuit diagram.
2. First energize source-1. Short circuit the other voltage source-2 & take the ammeter reading (l_1).
3. Next energize source-2 with short circuiting the voltage source-1 & take the ammeter reading (l_2).
4. Then take the ammeter reading (l) with both sources energized at a time.
5. Verify $l_1 + l_2 = l$.

OBSERVATION TABLE:

Sl. No.	Condition		Ammeter reading	% Error
	Source -1	Source -2		
1.	Dc power supply	Dc power supply	I =	
2.	Dc power supply	Short ckt	$I_1 =$	
3.	Short ckt	Dc power supply	$I_2 =$	

CALCULATION:

$I = I_1 + I_2$

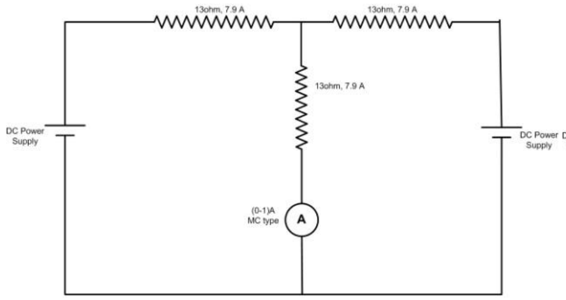
CONCLUSION:

B. Thevenin's Theorem

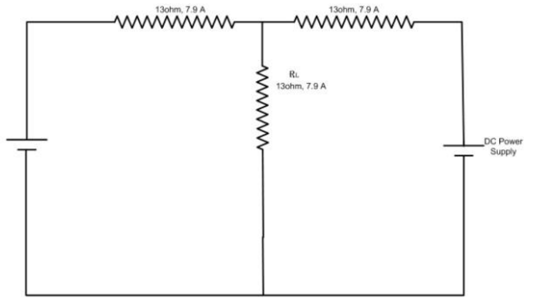
APPARATUS REQUIRED:

Sl. No.	Item	Range/Rating	Maker's Name	Maker's No.

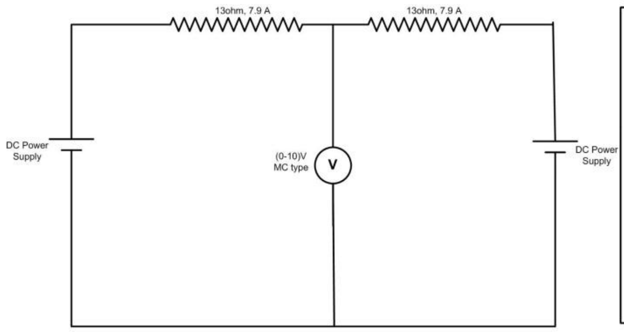
CIRCUIT DIAGRAM



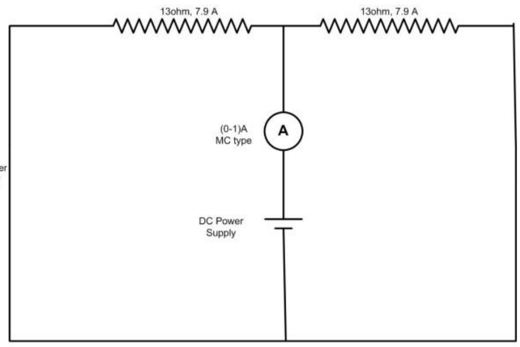
Thevenin Theorem Ckt. Diagram



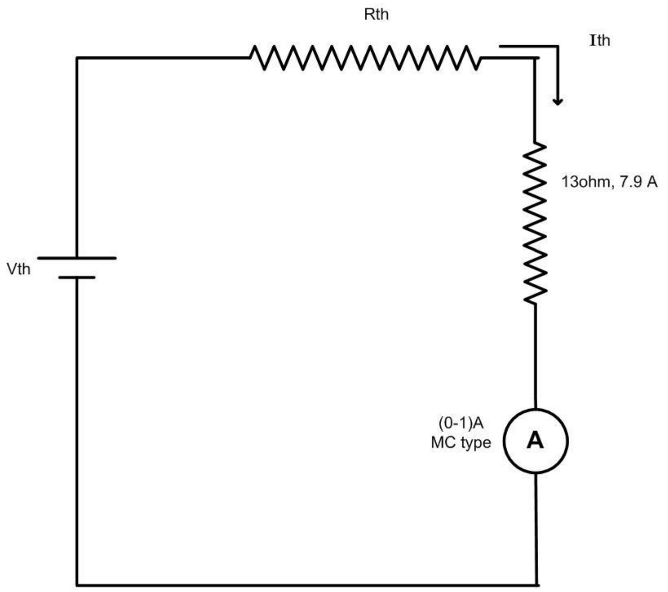
thevinin Ckt. Diagram - 1



Thevenin Theorem Ckt. Diagram - 1



Thevenin Theorem Ckt. Diagram for finding Rth



Thevenin Theorem Ckt. Diagram

THEORY:

The Thevenin's theorem states that the current through resister R_L connected across two points A & B of the active network (i.e. a network containing more than one source) is obtained by dividing open circuit voltage V_{OC} (with R_L disconnected) by (R_L+R_{th}), R_{th} is the equivalent resistance of the network measured at two points A & B with R_L disconnected and the source of emf replaced by the internal resistance.

PROCEDURE:

1. Connect the circuit as per circuit diagram.
2. The load terminal has to kept open circuit.
3. Measure the thevenin voltage V_{th} across the open circuit load terminal
4. Measure the thevenin resistance at the open circuited load terminal by replacing all the energy sources by their internal resistances.
5. Find the current through R_L in the thevenin equivalent circuit.
6. Verify the theoretical result with the practical circuit with all circuit element connected together.

OBSERVATION TABLE:

Sl. No.	V_{th} (volt)	I_{th}(A)	R_{th}(Ω)	Source-1	Source-2	% Error
1.						

CALCULATION:

$$I = \frac{V_{th}}{R_{th}+R_l}(\text{Theoretical})$$

I (Observed) =

I (Theoretical) = I (Observed)

CONCLUSION:

Experiment 2

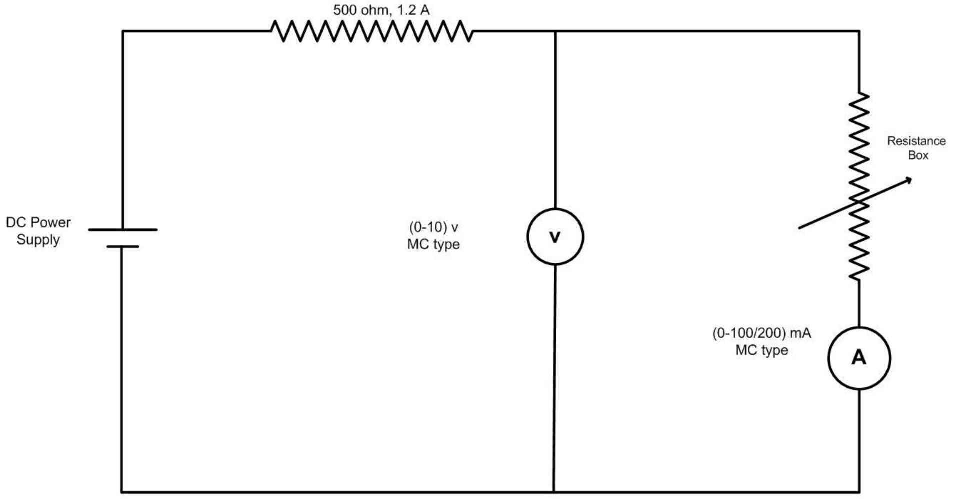
AIM OF THE EXPERIMENT:

To verify Maximum Power Transfer Theorem.

APPARATUS REQUIRED:

Sl. No.	Item	Range/Rating	Maker's Name	Maker's No.

CIRCUIT DIAGRAM



Maximum Power Transfer Theorem Ckt. Diagram

THEORY:

The maximum power transfer theorem states that load will receive maximum power from a linear bilateral DC network when its total resistance value is exactly equal to its Thevenin resistance of the network as seen by the load.

Hence maximum power will be delivered to the load when $R_L = R_{th}$.

PROCEDURE:

1. Connect the circuit as per the circuit diagram.
2. Connect the resistance box as load in the circuit by varying the resistance of the resistance box, find the power consumed at different value of resistances.
3. Take the reading of I_L and V_L
4. Plot the graph between P_LVs. R_L to find out R_L corresponding to maximum power transfer.

OBSERVATION TABLE:

Sl. No.	R_L (Ω)	I_L(Ω)	V_L(V)	P_L(Watt)
1.	100 // 50			
2.	50			
3.	100 // 250			
4.	100			
5.	250			
6.	500			
7.	1000			

CALCULATION:

Power = $I^2 R_L$

CONCLUSION:

Experiment 3

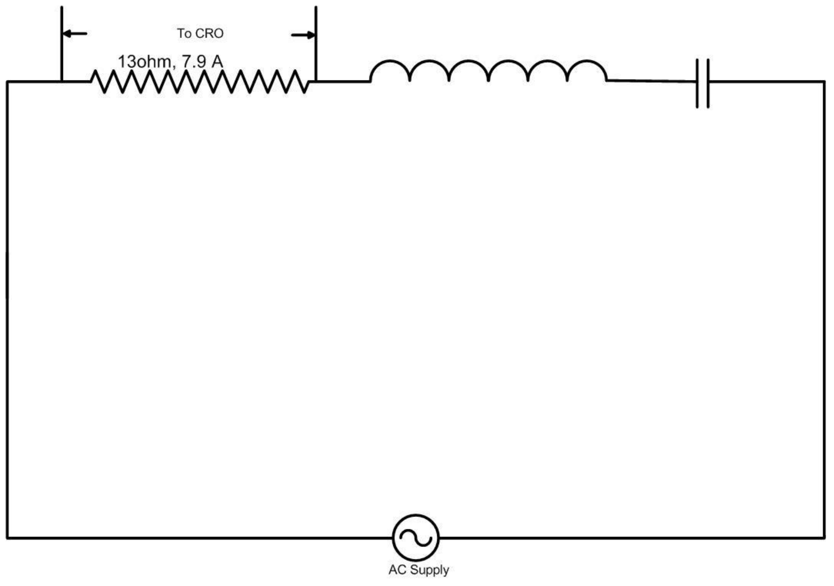
AIM OF THE EXPERIMENT:

Find out the band width, Q factor & resonance frequency of a series R-L-C circuit.

APPARATUS REQUIRED:

Sl. No.	Item	Range/Rating	Maker's Name	Maker's No.

CIRCUIT DIAGRAM



Transient Response for R-L circuit

THEORY:

Resonant frequency

$$f_0 = \frac{1}{2\pi\sqrt{LC}} = \sqrt{f_1 f_2}$$

Where

f_1 = Lower half power frequency

f_2 = Upper half power frequency

C = Capacitance

L = Inductance

$f_1 - f_2 = \Delta f$ = Bandwidth

Q- factor = Resonant frequency / Bandwidth

Resonance is the condition at which the current will be minimum in the R-L-C series circuit whose corresponding frequency is called resonant frequency.

PROCEDURE:

1. Connect the circuit as per the circuit diagram.
2. Apply sinusoidal wave of different frequency to the circuit from function generator.
3. Connect the CRO chord across the standard resistance 1Ω.
4. Take peak to peak reading of current waveform from CRO.

OBSERVATION:

Sl. No.	Resistor(Ω)	Frequency(Hz)	Volt/Div	Time/Div	Peak to Peak Voltage	V_m (Volt)	I_m (A)
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							
11.							
12.							
13.							
14.							

CALCULATION:

Plot the graph I_m Vs freq in semi log paper.
Resonant frequency = Hz
Bandwidth = Hz
Q-factor =

CONCLUSION:

Experiment 4

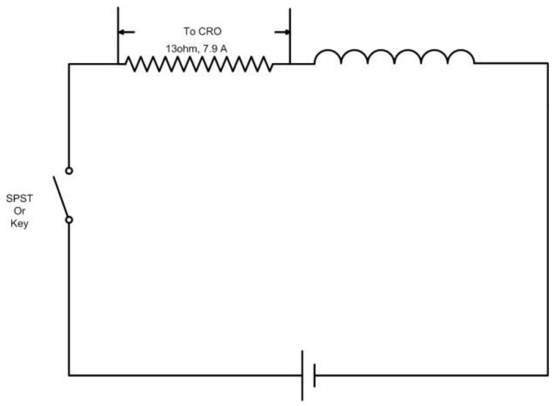
AIM OF THE EXPERIMENT:

Determination of Transient response of the D.C. series RL, RC circuit.

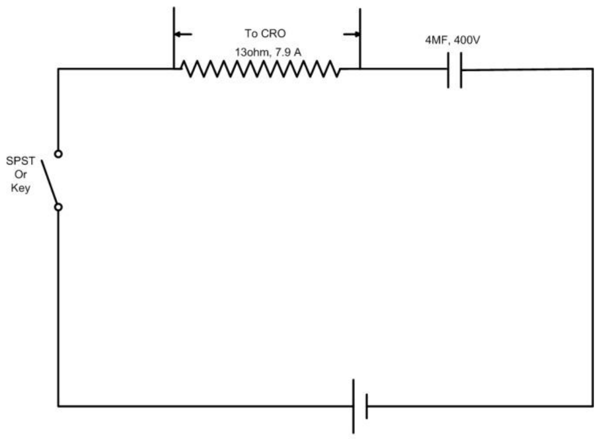
APPARATUS REQUIRED:

Sl. No.	Item	Range/Rating	Maker's Name	Maker's No.

CIRCUIT DIAGRAM



Transient Response for R-L circuit



Transient Response for R-C circuit

THEORY:

Whenever a circuit is switched from one condition to the another either by change in the applied source or a change in the circuit elements there is a transient period during which the branch current and element voltage change from their former values to new one. This period is called transient period. After the transient period is over the circuit is said to have reached the steady state. The linear differential equation that describes the circuits' behaviours will have two parts to its solution. The complimentary function corresponds to the transient & the particular solution corresponds to steady state.

The differential Equation for R-L circuit is:

$$R_i(t) + L\frac{di(t)}{dt} = V_S$$

For RC circuit $R_i(t) + \frac{1}{C}\int i(t)dt = V_S$

PROCEDURE:

1. Connect circuit as per the circuit diagram
2. Apply potential DC of 15V.
3. Trace the current wave-from from CRO
4. Plot the current wave-form from CRO
5. Find out the time constant at 36.8% of the initial value of current of RC ckt and 63.2% of final value of current in the ckt from CRO

OBSERVATION TABLE:

Sl. No.	Type of circuit	V_m(Volt)	V_{rms}(Volt)	Time Constant(sec)
1.	R-C			
2.	R-L			

CALCULATION:

Trace the R-C & R-L Response.

CONCLUSION:

Experiment 5

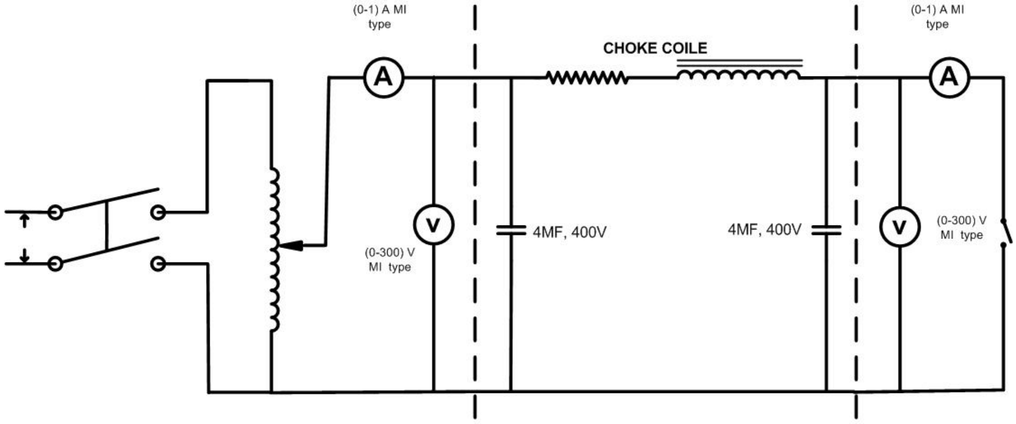
AIM OF THE EXPERIMENT:

To determine the A, B, C, D, Z, Y and h parameters of a two port network.

APPARATUS REQUIRED:

Sl. No.	Item	Range/Rating	Maker's Name	Maker's No.

CIRCUIT DIAGRAM



Circuit Diagram for Two Port Network

THEORY:

A. Z-Parameter

$V_1 = I_1Z_{11} + I_2Z_{12}$

$V_2 = I_1Z_{21} + I_2Z_{22}$

Where

$$Z_{11} = \frac{V_1}{I_1}\Big| I_2 = 0 \qquad Z_{12} = \frac{V_1}{I_2}\Big| I_1 = 0$$

$$Z_{21} = \frac{V_2}{I_1}\Big| I_2 = 0 \qquad Z_{22} = \frac{V_2}{I_2}\Big| I_1 = 0$$

B. Y-Parameter

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

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

Where

$$Y_{11} = \frac{I_1}{V_1}\bigg| V_2 = 0 \qquad Y_{12} = \frac{I_1}{V_2}\bigg| V_1 = 0$$

$$Y_{21} = \frac{I_2}{V_1}\bigg| V_2 = 0 \qquad Y_{22} = \frac{I_2}{V_2}\bigg| V_1 = 0$$

C. ABCD-Parameter

$V_1 = AV_2 - BI_2$

$V_2 = CV_2 - DI_2$

Where

$$A = \frac{Z_{11}}{Z_{21}} \qquad B = \frac{Z_{11} \times Z_{22} - Z_{12} \times Z_{21}}{Z_{21}}$$

$$C = \frac{1}{Z_{21}} \qquad D = \frac{Z_{22}}{Z_{21}}$$

D. Hybrid – Parameter

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

$V_2 = h_{21}I_1 + h_{22}V_2$

Where

$$h_{11} = \frac{V_1}{I_1}\bigg| V_2 = 0$$

$$h_{21} = \frac{I_2}{I_1}\bigg| V_2 = 0$$

$$h_{12} = \frac{V_1}{V_2}\bigg| I_1 = 0$$

$$h_{22} = \frac{I_2}{V_2}\bigg| I_1 = 0$$

PROCEDURE:

a. Connect the circuit as per the circuit diagram.
b. Apply voltage through variac in the primary side for V_2 = 200 V keeping the key open at secondary.
c. Take the ammeter & voltmeter readings.
d. Then reduce the voltage to zero, close the key and apply reduced voltage till I_2 = 1A.
e. Reverse the position 1 & 2 and then repeat the same procedure (a) to (d).
f. Take the ammeter & voltmeter readings.

OBSEVATION TABLE:

Sl. No.	Condition	V_1	I_1	V_2	I_2
1.	Open switch				
2.	Close switch				
Polarity of choke coil interchanged					
Sl. No.	Condition	V_1	I_1	V_2	I_2
1.	Open switch				
2.	Close switch				

CALCULATION:

VERIFICATION:

CONCLUSION:

Experiment 6

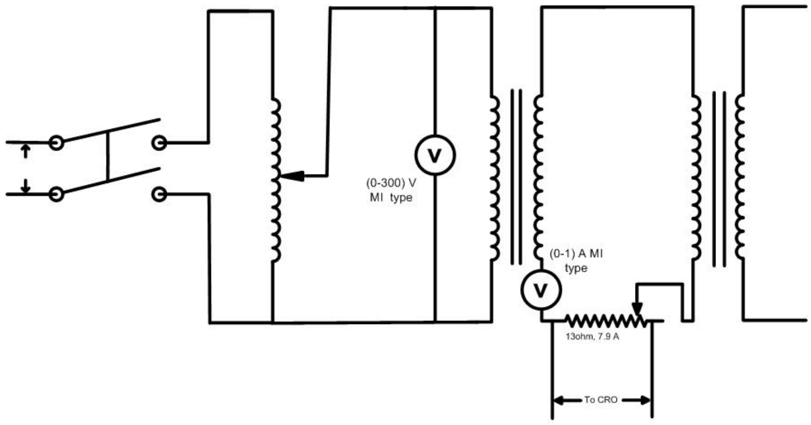
AIM OF THE EXPERIMENT:

Spectral analysis of a non-sinusoidal waveform.

APPARATUS REQUIRED:

Sl. No.	Item	Range/Rating	Maker's Name	Maker's No.

CIRCUIT DIAGRAM



Circuit diagram for spectral analysis of a non – sinusoidal wave

THEORY:

The flux density in transformer core is usually maintained at a fairly high value in order to keep the required volume of iron to be minimum. Due to non linearity of magnetisation curve some third harmonics distortion is always produced. Also there is always some percentage of 5^{th} harmonics. The magnetisation current drawn by the primary contains significance third harmonics components. The Fourier series for the function f(x) in the interval is given by

$\alpha < x < \alpha < 2p$

$$f(x) = \frac{a6}{2} + \sum_{\pi=1}^{\infty} a_n \cos nx + \sum_{\pi=1}^{\infty} b_n \sin nx$$

The Fourier series upto third harmonics can be represented as

$Y = \frac{a_0}{2} + a_1 \cos x + a_2 \cos 2x + a_3 \cos 3x + b_1 \sin x + b_2 \sin 2x + b_3 \sin 3x.$

$a_0 = 2\sum y$ / total observations

$a_1 = 2\sum y \cos x$ / total observations

$a_2 = 2\sum y \cos 2x /$ total observations

$b_1 = 2\sum y \sin x /$ total observations

$b_2 = 2\sum y \sin 2x /$ total observations

PROCEDURE:

1. Connect the circuit as the circuit diagram
2. Apply a supply voltage of 170V AC through variac to the circuit.
3. Trace the current wave from CRO.
4. Take the peak to peak readings at different time interval.
5. Analysis the waveform at different points using Fourier analysis.

OBSERVATION TABLE:

Sl. No.	From The Graph		Time/Div	Volt/Div	Peak to Peak Voltage
	X	Y			
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					

CALCULATION:

$$a_0 = \frac{2\sum y}{(Total\ Observations)}$$

$$a_1 = \frac{2\sum y\ Cos\ x}{(Total\ Observations)}$$

$$a_2 = \frac{2\sum y\ Cos\ 2x}{(Total\ Observations)}$$

$$b_1 = \frac{2\sum y\ sin\ x}{(Total\ Observations)}$$

$$b_2 = \frac{2\sum y\ Sin\ 2x}{(Total\ Observations)}$$

$$y = \frac{a_0}{2} + a_1 cos\ x + a_2 cos\ 2x + b_1 sin\ x + b_2 sin\ 2x$$

Plot the graph.

CONCLUSION: