LAB MANUAL
EC206PES06
Electronics Measurement and Sensor Lab

Bachelor of Technology

in

Electronics & Communication Engineering

Department of Electronics & Communication Engineering

School of Studies of Engineering & Technology

Guru Ghasidas Vishwavidyalaya

Bilaspur-495009 (C. G.)

Website: www.ggu.ac.in

SCHOOL OF STUDIES OF ENGINEERING & TECHNOLOGY

GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR (C.G.)

(A CENTRAL UNIVERSITY)

CBCS-NEW SYLLABUS

B. TECH. THIRD YEAR (Electronics and Communication Engineering)

Vision and Mission of the Institute

Vision		To be a leading technological institute that imparts transformative education to create globally competent technologists, entrepreneurs, researchers and leaders for a sustainable society
Mission	1	To create an ambience of teaching learning through transformative education for future leaders with professional skills, ethics, and conduct.
	2	To identify and develop sustainable research solutions for the local and global needs.
	3	To build a bridge between the academia, industry and society to promote entrepreneurial skills and spirit

Vision and Mission of the Department

Vision		The Department endeavours for academic excellence in Electronics & Communication Engineering by imparting in depth knowledge to the students, facilitating research activities and cater to the ever-changing industrial demands, global and societal needs with leadership qualities.
Mission	1	To be the epitome of academic rigour, flexible to accommodate every student and faculty for basic, current and future technologies in Electronics and Communication Engineering with professional ethics.
	2	To develop an advanced research centre for local & global needs.
	3	To mitigate the gap between academia, industry & societal needs through entrepreneurial and leadership promotion.

Program Educational Objectives (PEOs)

The graduate of the Electronics and Communication Engineering Program will

PEO1: Have fundamental and progressive knowledge along with research initiatives in the field of Electronics & Communication Engineering.

PEO2: Be capable to contrive solutions for electronic & communication systems for real world applications which are technically achievable and economically feasible leading to academia, industry, government and social benefits.

PEO3: Have performed effectively in a multi-disciplinary environment and have self-learning & self-perceptive skills for higher studies, professional career or entrepreneurial
endeavors to be confronted with a number of difficulties.

PEO4: Attain team spirit, communication skills, ethical and professional attitude for lifelong learning.

Programme Outcomes: Graduates will be able to:

PO1: Fundamentals: Apply knowledge of mathematics, science and engineering.

PO2: Problem analysis: Identify, formulate and solve real time engineering problems using first principles.

PO3: Design: Design engineering systems complying with public health, safety, cultural, societal and environmental considerations

PO4: Investigation: Investigate complex problems by analysis and interpreting the data to synthesize valid solution.

PO5: Tools: Predict and model by using creative techniques, skills and IT tools necessary for modern engineering practice.

PO6: Society: Apply the knowledge to assess societal, health, safety, legal and cultural issues for practicing engineering profession.

PO7: Environment: Understand the importance of the environment for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics, and responsibilities and norms of the engineering practice.

PO9: Teamwork: Function effectively as an individual and as a member or leader in diverse teams and multidisciplinary settings.

PO10: Communication: Communicate effectively by presentations and writing reports.

PO11: Management: Manage projects in multidisciplinary environments as member or a team leader.

PO12: Life-long learning: Engage in independent lifelong learning in the broadest context of technological change.

Programme Specific Outcomes:

PSO1: Identify, formulate and apply concepts acquired through Electronics & Communication Engineering courses to the real-world applications.

PSO2: Design and implement products using the cutting-edge software and hardware tools to attain skills for analyzing and developing subsystem/processes.

PSO3: Ability to adapt and comprehend the technology advancement in research and contemporary industry demands with demonstration of leadership qualities and betterment of organization, environment and society.

ELECTRONIC MEASUREMENT AND SENSORS LAB

Course Objectives:

- To introduce students to monitor, analyze and control any physical system.
- To understand students how different types of meters work and their construction.
- To introduce students a knowledge to use modern tools necessary for electrical projects.

Course Outcomes:

At the end of the course, the students will able to:

CO1 Identify different measuring instruments for the measurement of various electrical and non- electrical parameters.

CO2 Design different bridges to find unknown values of self-inductance. CO3 Design different bridges to find unknown values of capacitance.

CO4 Analyze the sensitivity and characteristics of LVDT CO5 Analyze the characteristics of thermocouple.

Course Outcomes and their mapping with Program Outcomes & Program Specific Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	2					2			2	3	2	1
CO2	3	1	2	2					2			2	3	2	1
CO3	3	1	2	2					2			2	3	2	1
CO4	3	1	2	2					2			2	3	2	1
CO5	3	1	2	2					2			2	3	2	1

Weightage: **1-Sightly; 2-Moderately; 3-Strongly**

LIST OF EXPERIMENT

Subject : Electronics Measurement and sensor Lab

Experiment No. 1

Objective: To determine unknown inductance of a given coil by Maxwell's bridge method.

Apparatus Used:

S. No.	Name of the apparatus	Quantity
1	Lab trainer kit	1
2	Multimeter	1
3	Unknown inductor	1

Theory: This bridge circuit measures an inductance by comparison with a variable standard self inductance.

The connections and the phasor diagrams for balance conditions are shown below.

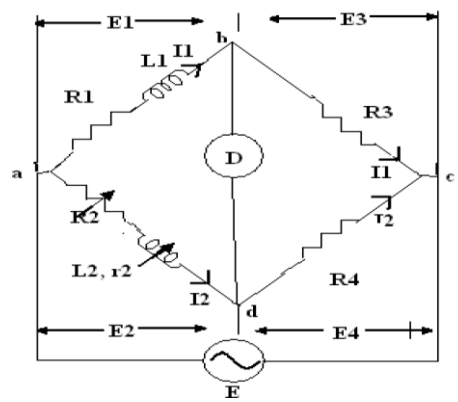
Let, L1 = unknown inductance of resistance R1,

L2 = variable inductance of fixed resistance r2,

R2 = variable resistance connected in series with inductor L2,

R3, R4 = known non-inductive resistances.

Circuit Diagram:



At balance, L1 = R3L2/R4 , R1= R3(R2+r2)/R4.

Procedure:

1. Connect the circuit as shown in the figure.
2. Connect the unknown inductance in L1.
3. Connect the multimeter between ground and output of imbalance amplifier.
4. Vary R2, from minimum position, in clockwise direction.
5. If the selection of R2 is correct the balance point can be obtained at minimum position.
6. Vary R2 for fine balance adjustment.

Observation Table:

S. No.	R2	R3	C1	L1= R3L2 / R4	True value of L1
1					
2					
3					

Result: Actual and practical values of Inductances are found to be nearly equal.

Experiment No. 2

Objective: To determine unknown inductance using Hays bridge. of inductance by Hay's bridge **Apparatus Used:**

S. No.	Name of the apparatus	Quantity
1	Lab trainer kit	1
2	Multimeter	1
3	Unknown inductor	1

Theory: The Hay's Bridge differs from Maxwell's bridge by having resistor R1 in series with standard capacitor C1 instead of in parallel. It is immediately apparent that for large phase angles, R1 should have a very low value. The Hay's circuit is therefore more convenient for measuring high Q coils. The balance equations are again derived by substituting the values of the impedance of the bridge arms into the general equation for bridge balance. On separating real and imaginary terms, the balance equations are:

R1Rx+Lx/C1 = R2R3 -------------- (1)

Rx/ωC1 = ωLxR1 ----------------(2)

Both equations 1 & 2 consist of L & R. By solving the above equations

$$R_x = \frac{\omega^2 C_1^2 R_1 R_2 R_3}{1+\omega^2 C_1^2 R_1^2} \quad \text{(3)}$$

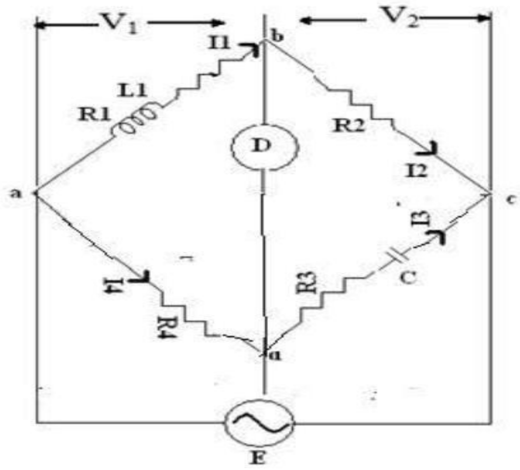
$$L_x = \frac{R_2 R_3 C_1}{1+\omega^2 C_1^2 R_1^2} \quad \text{(4)}$$

The expressions for the unknown inductance & resistance are consists of frequency term under balanced condition when two phase angles are equal, their tangents are also equal. Hence,

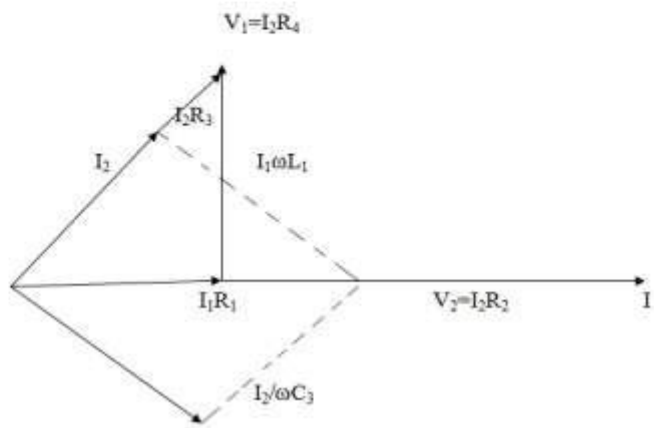
$$\tan\theta L = \tan\theta C \text{ (or) } Q = \frac{1}{\omega C_1 R_1} \quad \text{(5)}$$

Substituting (5) in (4)

Circuit Diagram:



Phasor Diagram:



Procedure:

1. Switch ON the trainer & check the power supply.
2. Connect the unknown value of inductance (high Q) in arm marked Lx.
3. Vary R2 for fine balance adjustment.
4. The balance of bridge can be observed by using head phone. Connect the output of the bridge at the input of the detector.
5. Connect the head phone at output of the detector, alternately adjust R1 and proper selection of R3 for a minimum sound in the head phone.
6. Finally disconnect the circuit and measure the value of R1 at balance point using any multimeter. By substituting R1, R3 and C1 the unknown inductance can be obtained.
7. **Observation Table:**

S.No.	R2 (KΩ)	R3 (Ω)	C1 (μF)	Lx (mH)	L mH
1					
2					
3					

8. **Result:** After balancing the bridge, the values of R1 R3 and C1 are measured and found that the calculated value of Lx is almost equal to the actual value.

Experiment No.3

Objective: To determine unknown inductance by using Anderson's bridge

Apparatus Used:

S. No.	Name of the apparatus	Quantity
1	Lab trainer kit	1
2	Multimeter	1
3	Unknown inductor	1

Theory: In this bridge, the self inductance is measured in terms of a standard capacitor. This method is applicable for precise measurement of self-inductance over a very wide range of values. Figure below show the connections and the phasor diagram of the bridge for balanced conditions.

Let L1 = self inductance to be measured, R1 = resistance of self-inductor, r,R2,R3,R4 = known non-inductive resistance r1 = resistance connected in series with self-inductor,

At, balance, I1 =I3 and I2 = IC +I4.

Now, I1R3 = IC/jωC therefore, IC = I1jωCR3.

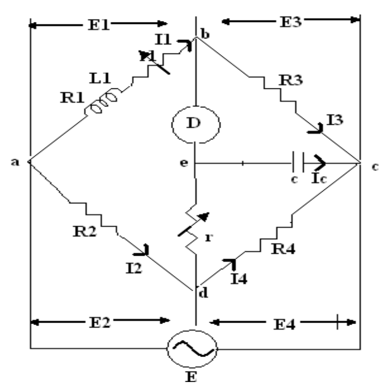
Writing the other balance equations.

I1(r1+R1+jωL1) = I2R2 + ICr and IC(r+1/jωC) = (I2-IC) R4

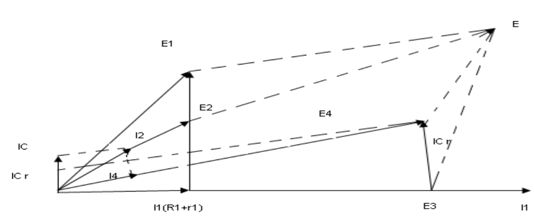
By substituting IC value and equating real and imaginary parts

R1 = R2R3/R4 – r1

L1 = C R3/R4{ r(R4+R2)+R2R4}**Circuit Diagram**



Phasor Diagram:



Procedure:

1. Connect the circuit as shown in the figure.
2. Connect the unknown inductance in L1.
3. Select any value of r.
4. Connect the multimeter between ground and output of imbalance amplifier.
5. Vary r1 and r, from minimum position, in clockwise direction.
6. Calculate the inductance L1 by substituting known values.

Observation Table:

S. No.	Actual value of L in mH	R in ohms	Practical value of L in mH

Results: The unknown inductance is determined using the Anderson's bridge.

Experiment No. 4

Objective: Measurement of inductance by Owen's bridge

Apparatus Used:

S. No.	Name of the apparatus	Quantity
1	Lab trainer kit	1
2	Multimeter	1
3	Unknown inductor	1

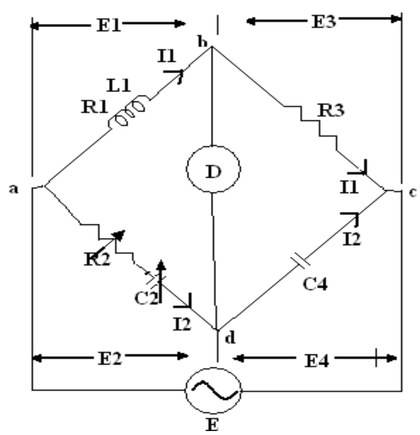
Theory: This bridge is used for measurement of an inductance in terms of capacitance.

Let L1 = unknown self-inductance of resistance R1, R3 = fixed non-inductive resistance, R2 = variable non-inductive resistance, C4 = fixed standard capacitor, C2 = variable standard capacitor.

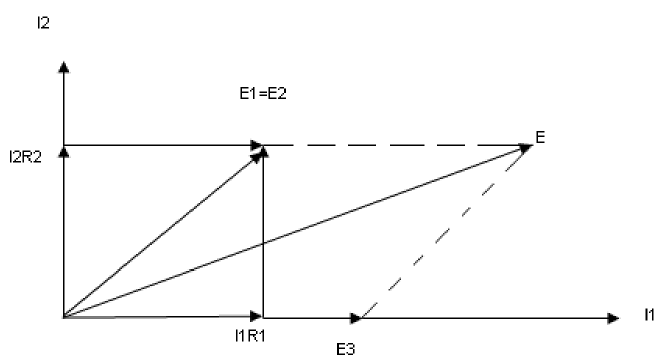
At balance, $(R1+j\omega L1)(1/j\omega C4) = (R2 + 1/j\omega C2) R3$.

Separating the real and imaginary terms, we obtain: $L1 = R2R3C4$ and $R1 = R3C4/C2$.

Circuit Diagram



Phasor Diagram:



Procedure:

1. Connect the circuit as shown in the figure.
2. Connect the unknown inductance in L1.
3. Select any value of R1, R4 and C3..
4. Connect the multimeter between ground and output of imbalance amplifier.
5. Vary R1 and R4, from minimum position, in clockwise direction.
6. If the bridge does not balance change the value of C3.
7. Calculate the inductance L1 by substituting known values.

Observation Table:

S.NO	R2	R4	C3	L1= R2C3R4	True value of L1

Result: Actual and practical values of Inductances are found to be nearly equal.

Experiment No. 5

Objective: Measurement of capacitance by Schering bridge

Apparatus Used:

S. No.	Name of the apparatus	Quantity
1	Lab trainer kit	1
2	Multimeter	1
3	Unknown inductor	1

Theory: Schering bridge is one of the most important of the a.c. bridge. It is extensively used in measurement of capacitance.

At balance, {r1+ 1/(jωC1)} {R4/(1+jωC4R4)} = R3/(jωC2)

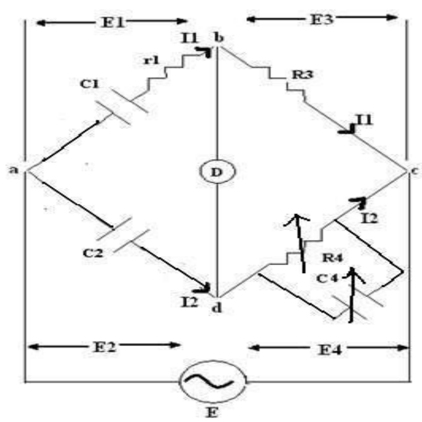
{r1+ 1/(jωC1)} R4 = R3/(jωC2) *{(1+jωC4R4)}

r1R4 – {(jR4)/(ωC1)} ={ (-jR3)/(ωC2)} + {(R3R4C4)/(C2)}

Equating real and imaginary terms,

r1 = R3C4/C2 and C1 = C2R4/R3

Circuit Diagram:



Procedure:

1. Connect the circuit as shown in the figure.
2. Select any value of C1.
3. Connect the Multimeter between ground and output of imbalance amplifier.
4. Vary R4 and C4, from minimum position, in clockwise direction.
5. If the selection of C1 is correct the balance point can be obtained at minimum position.
6. If that is not the case, select another C1.
7. Calculate the Capacitance by substituting known values.

Observation Table:

S.NO	C4	C1	C2	R3	R4

Result: Hence the balanced condition of schering bridge is obtained and unknown value of capacitance is found.

Experiment 6

Experiment Name: To measure capacitance by Desauty's bridge.

Apparatus Required:

1.Desauty`s Bridge Trainer

2.Multi meter

3. 2mm Patch cords

Theory:

Capacitor:

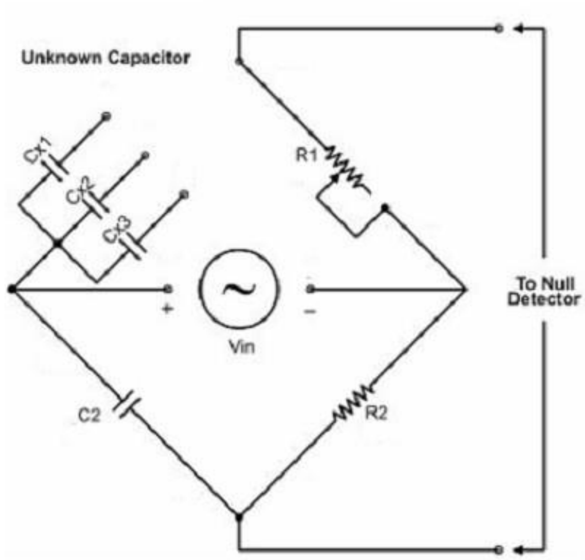
A capacitor is a passive electronic component that stores energy in the form of an electrostatic field.

In its simplest form, a capacitor consists of two conducting plates separated by an insulating material called the dielectric. The capacitance is directly proportional to the surface areas of the plates, and is inversely proportional to the separation between the plates.

Capacitance also depends on the dielectric constant of the substance separating the plates. Desauty's bridge**:**
The Desauty's bridge is a direct carryover of the Wheatstone bridge with the DC Source replaced by an AC source.

The null detector we will be using also has an amplifier where the gain can be adjust ed. This is connected to Null detector which is used for getting the null point.

$$Cx = R_2 \times \frac{C_2}{R_1}$$



Procedure:

1. Connect mains cord to the Trainer.

2. Connect terminal 1 to 4(for evaluating unknown capacitance Cx1).

3. Rotate variable resistance R1 towards anti clockwise direction.

4. Select Frequency Selector f or any desired range of frequency.

· 100 Hz to 1 kHz

· 1 kHz to 10 kHz

· 10 kHz to 60 kHz

7. For example 2 kHz frequency, select frequency select or between the ranges1 kHz-10 kHz.

8. Use Frequency Variable knob to set 2 kHz frequency on display screen.

9. Connect terminal 19 to 6 and 20 to 7.

10. Now switch 'On' the power supply.

11. Set toggle of null detector towards 'on' condition.

12. Vary Amplitude Variable f or enough sound of speaker.

13. Vary resistance R1 towards clockwise direction slowly. (Sound diminishes). Keep varying R1 until you get very low sound or null sound (null condition).

1. Now remove the patch cord between terminal 1 & 4 and record the value of R1 in the observation table using multimeter.

Observation Table:

S.No.	Unknown capacitor	Frequency		Resistance R_1 ohm	Resistance R_2 ohm	Capacitor C_2 µF
1.	Cx1	f_1				
		f_2				
		f_3				
2.	Cx2	f_1				
		f_2				
		f_3				
3.	Cx3	f_1				
		f_2				
		f_3				

Calculations:

1. **For unknown Capacitance Cx1 on frequency f_1:**

$$C_{x1} = R2 \times \frac{C_2}{R_1}$$

=...............μF

Similarly calculate Capacitance Cx1 on frequency *f2 and f3.* and take the mean value.

2. **For unknown Capacitance Cx2 on frequency *f1*:**

$$C_{x2} = R2 \times \frac{C_2}{R_1}$$

=...............μF

Similarly calculate Capacitance Cx2 on frequency *f2 and f3* and take the mean value.

3. **For unknown Capacitance Cx3 on frequency f_1:**

$$C_{x3} = R2 \times \frac{C_2}{R_1}$$

=.................μF

Experiment 7

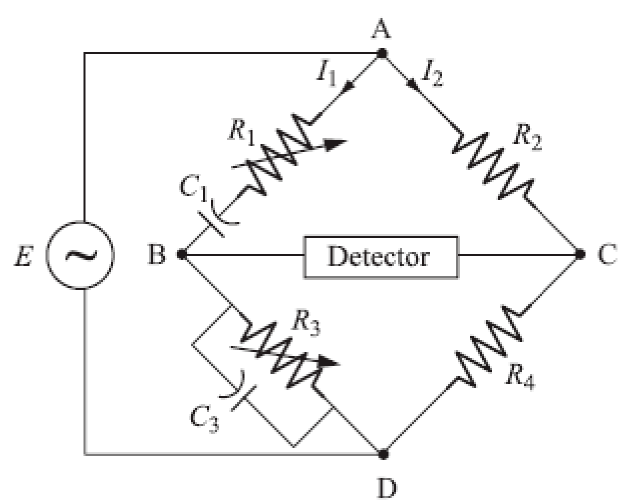
Experiment Name:To measure frequency by Wien's bridge

Apparatus Required:

1. Wien`s Bridge Trainer
2. Multi meter
3. 2mm Patch cords

Theory:

In this bridge circuit, there is a lead-lag network. Balancing of the bridge is easier because satisfying the phase angle equality condition can be achieved. This bridge can also be used to determine the frequency of the AC input in terms of the component values of the bridge circuit. In this AC bridge, there is no inductor. Inductive losses because of stray fields cause problems in balancing of the bridge. Owing to the absence of *L* in the circuit, this can be effectively used for determining the frequency *f* of the AC input..



Procedure:

1. Connect mains cord to the Trainer.

2. Connect terminal 1 to 4(for evaluating unknown capacitance Cx1).

3. Rotate variable resistance R1 towards anti clockwise direction.

4. Select Frequency Selector f or any desired range of frequency.

· 100 Hz to 1 kHz

· 1 kHz to 10 kHz

· 10 kHz to 60 kHz

7. For example 2 kHz frequency, select frequency select or between the ranges1 kHz-10 kHz.

8. Use Frequency Variable knob to set 2 kHz frequency on display screen.

9. Connect terminal 19 to 6 and 20 to 7.

10. Now switch 'On' the power supply.

11. Set toggle of null detector towards 'on' condition.

12. Vary Amplitude Variable f or enough sound of speaker.

13. Vary resistance R1 towards clockwise direction slowly. (Sound diminishes). Keep varying R1 until you get very low sound or null sound (null condition).

16. Now remove the patch cord between terminal 1 & 4 and record the value of R1 in the observation table using multimeter.

Observation Table:

S No.	R1	R2	C1	C2	f
1					
2					
3					
4					
5					

Calculations:

$$f = \frac{1}{2\pi\sqrt{R_1 R_3 C_1 C_3}}$$

Precaution:

1. Handle all the equipments with care

2. Make connections according to circuit diagram

3. Take the readings carefully& the connections should be tight

EXPERIMENT No.8

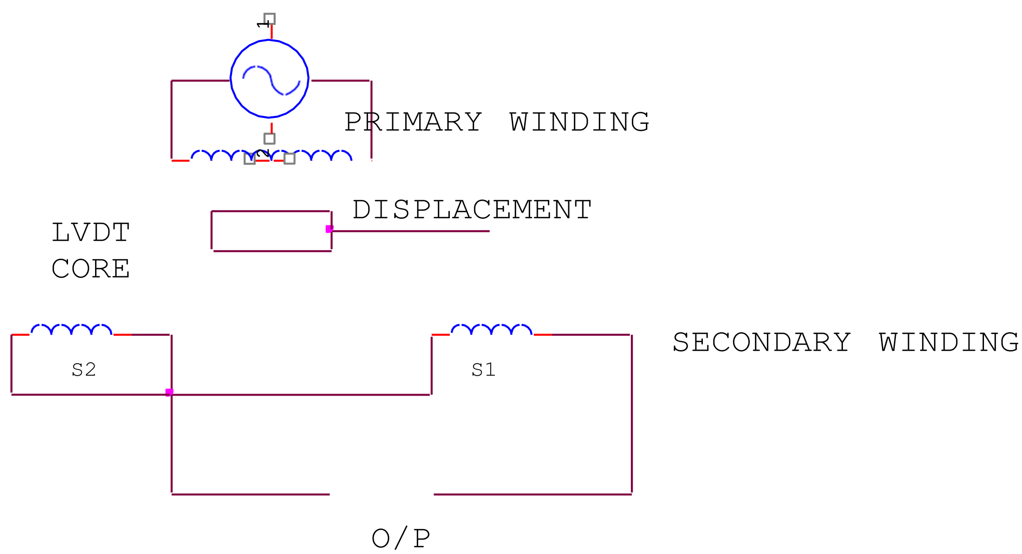
OBJECTIVE:- Measurement of displacement using LVDT.

APPARATUS REQUIRED: - LVDT kit, multimeter, connecting wires.

THEORY: -

The differential transformer is a passive inductive transformer also known as Linear Variable Differential Transformer (LVDT). LVDT has a soft iron core which slides within the hollow transformer & therefore affects magnetic coupling between the primary and two secondaries. The displacement to be measured is applied at its arm attached to soft iron core. When core is in normal position (null), equal voltages are induced in the two secondaries. The frequency of ac applied to the primary winding ranges from 50Hz to 20KHz.

CIRCUIT DIAGRAM



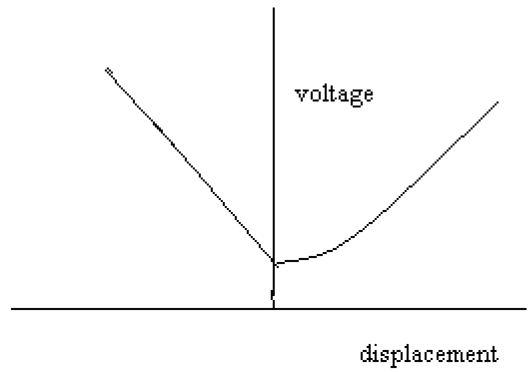
PROCEDURE: -

1. Connect the circuit according to circuit diagram.
2. Switch on the power supply.
3. The core is initially brought to null position.
4. First turn the nut in clockwise direction to move core inwards i.e. left of null position & takerespective voltage readings on the voltmeter.
5. Now turn nut in anticlockwise direction to move the core towards right of null point & again takerespective voltage reading from voltmeter.
6. Plot the graph from the observations taken.

OBSERVATIONS TABLE

S.No.	Displacement Micrometer (mm)	Displacement Reading (mm)	Analog o/p

GRAPH



RESULT: - Graph between voltage and displacement is plotted.

PRECAUTIONS: -

1. Handle all equipments with care.
2. Make connections according to the circuit diagram.
3. Take the readings carefully.
4. The connections should be tight.

EXPERIMENT No.9

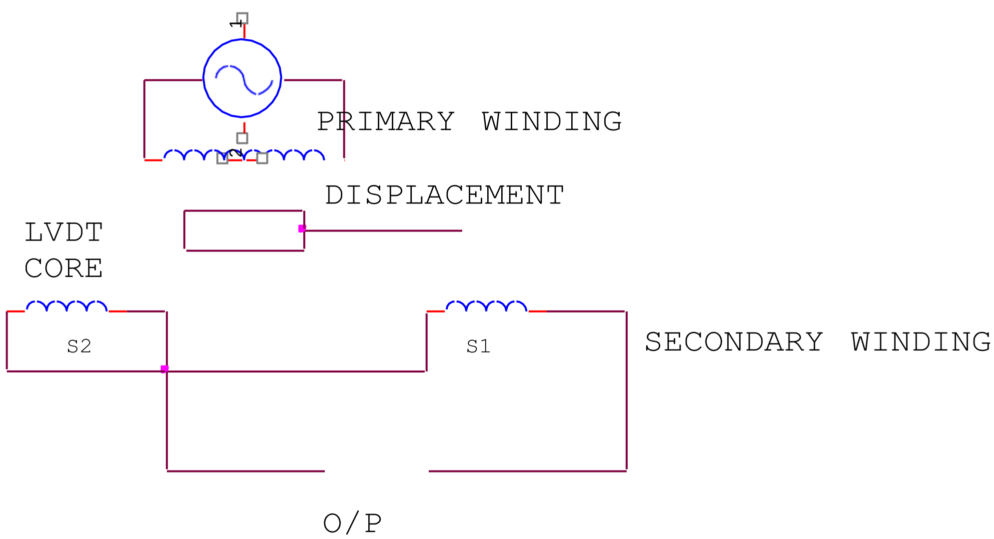
OBJECTIVE:- To study the I/O characteristic of LVDT.

APPARATUS REQUIRED: - LVDT kit, multimeter, connecting wires.

THEORY: -

The differential transformer is a passive inductive transformer also known as Linear Variable Differential Transformer (LVDT). LVDT has a soft iron core which slides within the hollow transformer & therefore affects magnetic coupling between the primary and two secondaries. The displacement to be measured is applied at its arm attached to soft iron core. When core is in normal position (null), equal voltages are induced in the two secondaries. The frequency of ac applied to the primary winding ranges from 50Hz to 20KHz.

CIRCUIT DIAGRAM



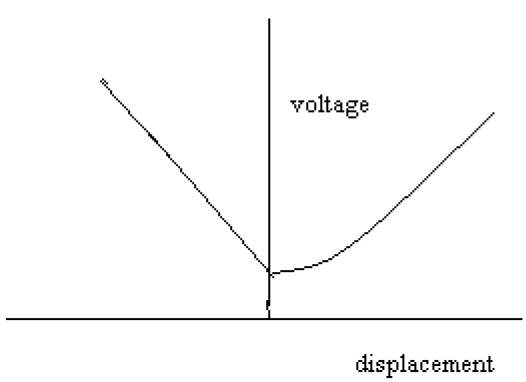
PROCEDURE: -

i. Connect the circuit according to circuit diagram.
ii. Switch on the power supply.
iii. The core is initially brought to null position.
iv. First turn the nut in clockwise direction to move core inwards i.e. left of null position & takerespective voltage readings on the voltmeter.
v. Now turn nut in anticlockwise direction to move the core towards right of null point & again takerespective voltage reading from voltmeter.
vi. Plot the graph from the observations taken.

OBSERVATIONS TABLE

S.No.	Displacement Micrometer (mm)	Displacement Reading (mm)	Analog o/p

GRAPH



RESULT: - Graph between voltage and displacement is plotted.

PRECAUTIONS: -

1. Handle all equipments with care.
2. Make connections according to the circuit diagram.
3. Take the readings carefully.
4. The connections should be tight.

EXPERIMENT No.10

Objective: To measure the phase difference between primary & secondary.

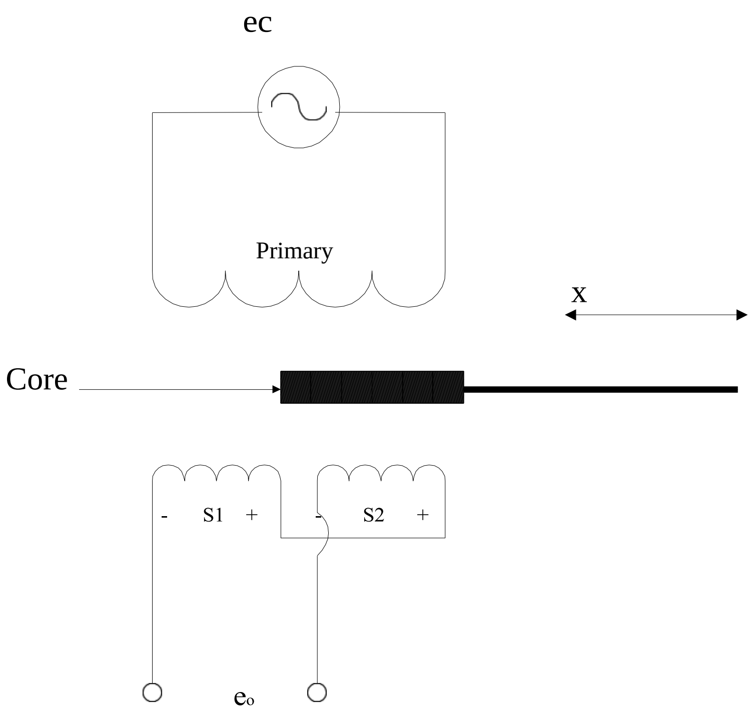
Procedure:-

1. Connect the mains lead to instrument and switch ON the power
2. Rotate the lead screw to get 0.00 in DVM and set the dial of dial gauge to zero position
3. Turn the lead screw clockwise or anticlockwise direction by one full turn and note the reading of DVM.
4. Again turn the lead screw in same direction as earlier by one full turn and note the reading of DVM. The reading of DVM should be twice the earlier reading of DVM as in step 3.
5. Set to zero and the dial gauge and the DVM
6. Put the object between whose thickness is to be measured in between lead screw and dialgauge shaft
7. The reading of the DVM directly gives the thickness of the object in mm.
8. For studying phase shift of LVDT set DVM to zero, connect the CRO to the terminals marked Phase Shift/ CRO Output.
9. Observe the waveshape for null position and then rotate the lead screw first in clockwise direction and observe the waveshape ,then rotate in anticlockwise direction and observe the waveshape.

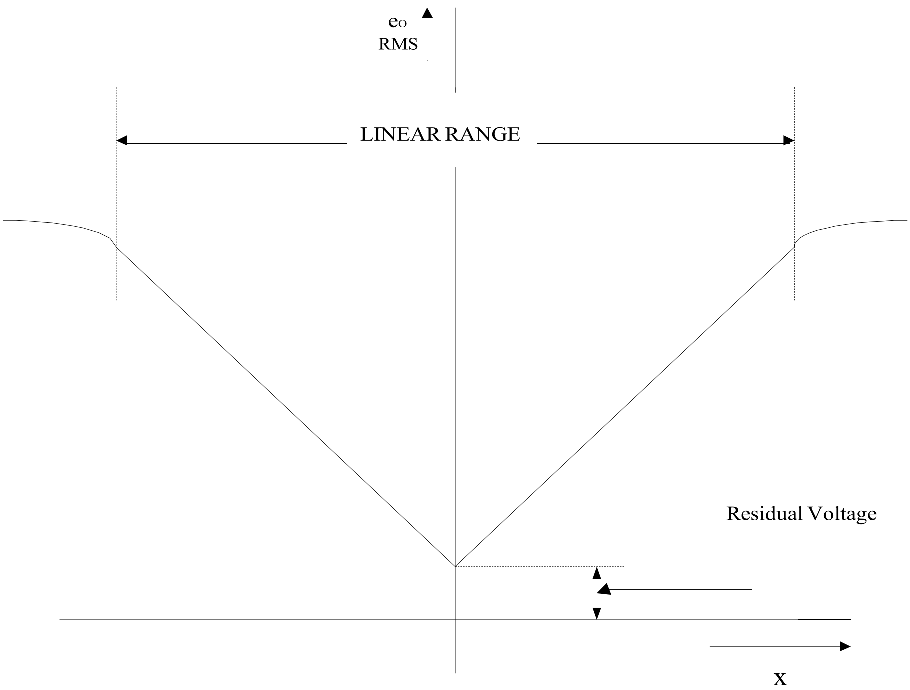
Observations:-

In the case of studying the phase shift the output waveshape on a CRO is a straight line when the reading of DVM shows zero reading indicating NULL position. The waveshape appears as shown in fig. 3 for clockwise motion of lead screw being negative (below the null position) and appears to be positive (above the null position) when the lead screw motion is anticlockwise.

Circuit Diagram: -

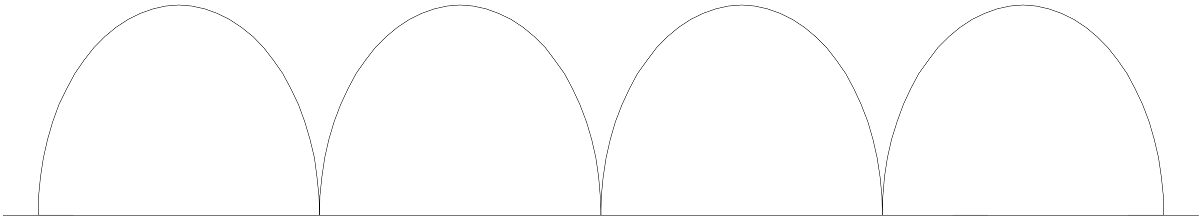


BASIC DIAGRAM
OF LVDT

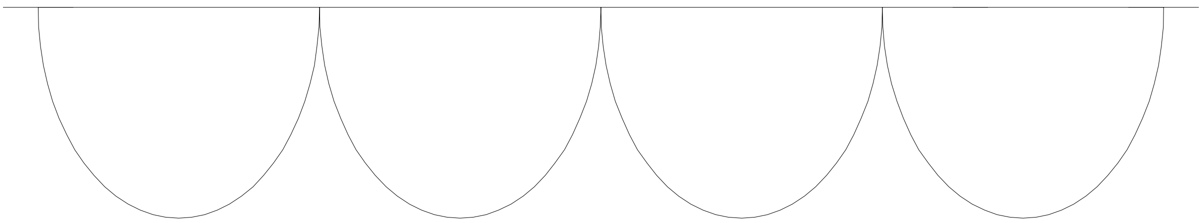


INPUT - OUTPUT CHARACTERISTICS

Observation: - The following waveforms are observed on the CRO



+ VE (ANTI - CLOCKWISE)



- VE (CLOCKWISE)