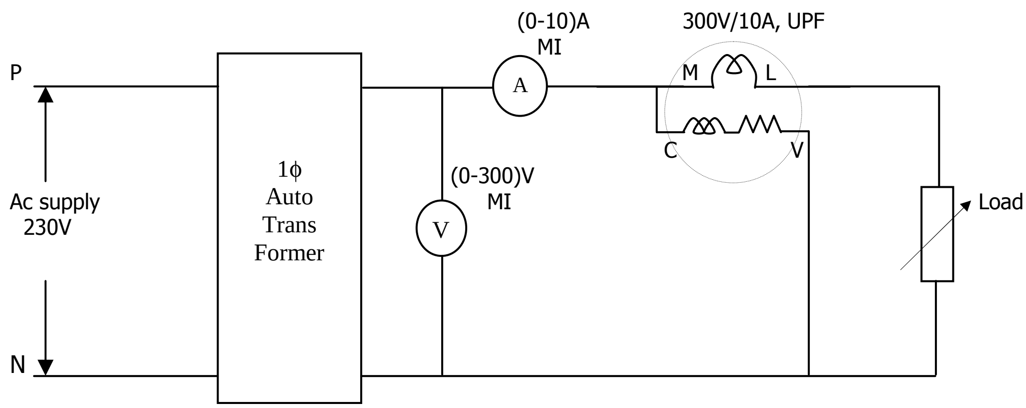
CONTENTS

Circuit Diagram:



Exp. No. : **Date:**

CALIBRATION OF AC WATTMETER BY STANDARD VOLTMETER AND AMMETER

Aim:

To calibrate a given wattmeter by using standard voltmeter & ammeter

Apparatus Required:

1. Voltmeter – 1 No.
2. Ammeter – 1 No.
3. Wattmeter – 1 No.

Theory:

Calibration means verification of marks graduated on instrument by standard instrument. Here a ac wattmeter is calibrated by a standard voltmeter and a standard ammeter. The calibrating reading will be (V X I) watts and the observed reading will be w-watts which will be given by the wattmeter. Then the error can be calculated by using the formula

$$\% \text{ Error} = \frac{W-VI}{VI} \times 100$$

Where W = Wattmeter reading

VI = Calculated reading

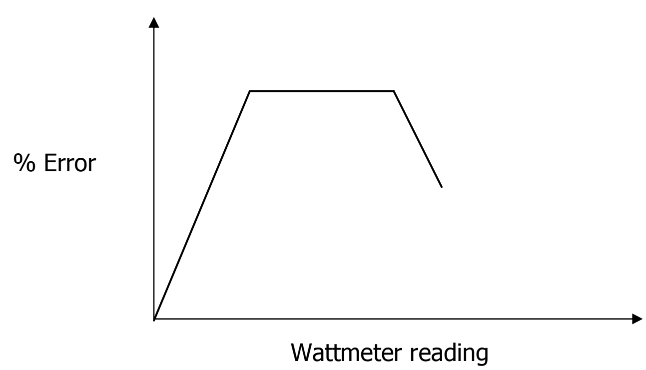
Procedure:

1. Connections are given as per the circuit diagram
2. Current coils of wattmeter was connected in series with the load and the pressure coils was connected across the load
3. Then the load was switched on and the corresponding readings of voltmeter, ammeter and wattmeter were taken.
4. The load was switched off and experimental results were tabulated

Tabulation:

Sl.No	Ammeter reading (A)	Voltmeter reading (V)	Wattmeter reading (w)	VI (w)	% error

Model Graph:



Formulae:

$$\% \text{ Error} = \frac{W - VI}{VI} \times 100$$

Where, W = Wattmeter reading

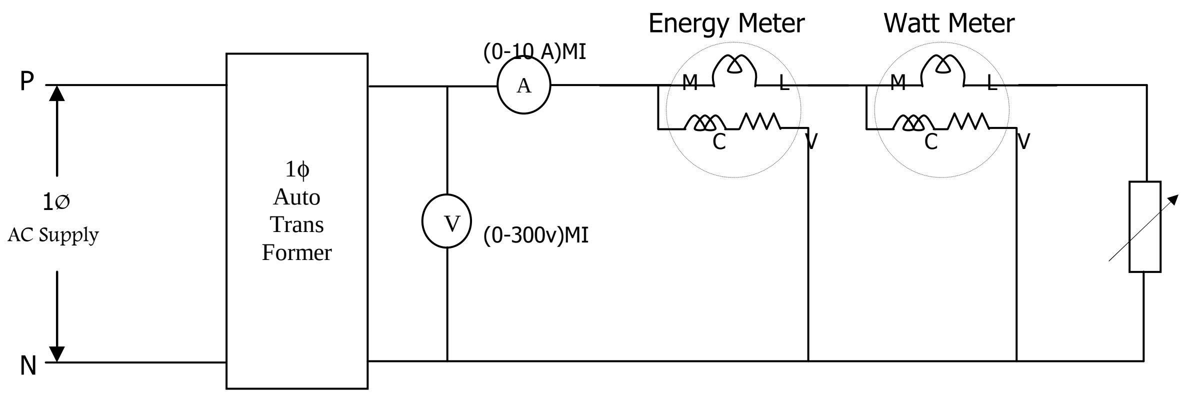
VI = Calculated reading

RESULT:

The calibration of wattmeter is successfully done and corresponding calibration curve was drawn. Also the error was found to be

% Error =

Circuit Diagram:



Exp. No. : **Date:**

CALIBRATION OF SINGLE PHASE ENERGY METER

Aim:

To calibrate the given single phase energy meter at unity and other power factors

Objective:

1. To study the working of energy meter.
2. To accurately calibrate the meter at unity and other power factor.
3. To study the % of error for the given energy meter.

Apparatus Required:

Sl.no	Name of the Apparatus	Range	Type	Qty
1	Energy meter			
2	Wattmeter			
3	Ammeter			
4	Voltmeter			
5	Stop watch			
6	Connecting Wires			

Name Plate Details:

Rated current	
Rated voltage	
Frequency	
Revolutions/kwh	

Formulae Used:

Let x revolution / kwh be the rating.

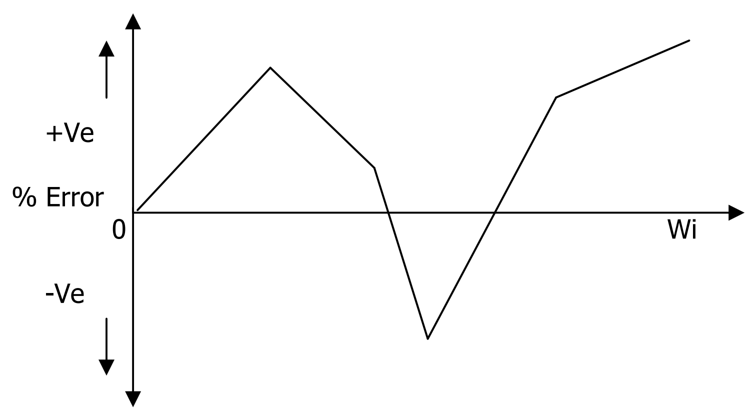
Now x revolution = 1 kwh

= 1* 3600*1000 watt-sec.

Tabular Column:

Sl. No	Load Current I (amps)	Wattmeter Reading (watt)		No.of Revolution	Time Taken (sec)	Observed Reading (E_2) Watt/sec	Calculated Reading (E_1) Watt/sec	% Error
		Obs	Act					

Model Graph:



E_1 = Actual Reading * time taken

E_2 = 15000 w-sec(from calculation) for 5 revaluations

Constant k of energy meter = $3600 * 10^3 / x$ watt-sec

For each load, indicated power Wi is given as Wi = k/t watts

Where

K= energy meter constant (watt-sec)

t = time for 1 revolution(sec)

% error = Wi – Wa / Wi * 100

= $E_2 - E_1 / E_1 * 100$

Where Wi is indicated power in watts

Wa is actual power shown by wattmeter in watts

% error can be zero +ve or –ve.

Procedure:

1. Connections are given as shown in the circuit diagram.
2. Supply is switched ON and load is increased in steps, each time noting the readings of ammeter and wattmeter. Also the actual time taken for 1 revolution of the disc is measured using stop watch.
3. Step 2 is repeated till rated current of the energy meter is reached.
4. % error is calculated and calibration curve is drawn.

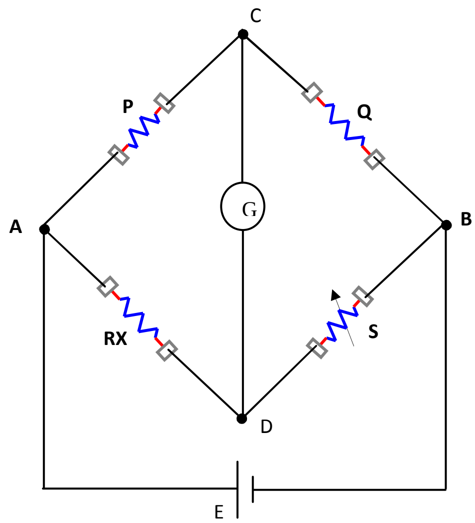
Note:

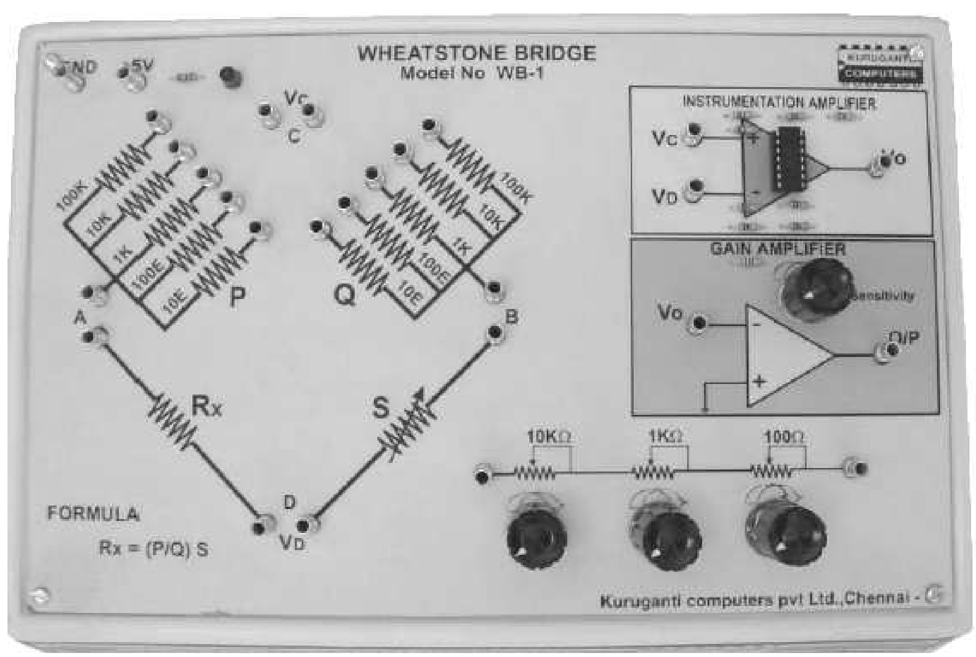
From the calibration curve it is possible to predict the error in recording the energy. So the correction can be applied to the energy meter reading so that correct energy reading can be obtained and used.

RESULT:

The calibration of wattmeter is successfully done and corresponding calibration curve was drawn. Also the error was found to be____________

Circuit Diagram: **Wheatstone bridge**





Exp. No. : **Date:**

MEASUREMENT OF RESISTANCE USING WHEATSTONE BRIDGE

Aim :

To measure the given medium resistance using Wheatstone Bridge.

Objective :

1. To study the working of bridge under balanced and unbalanced condition.
2. To study the sensitivity of bridge.

Equipment :

1. Wheat stone Bridge kit – 1 No
2. Unknown resistance – 1 No
3. Multimeter – 1 No
4. Connecting Wires.

Procedure:

1. The resistance to be measured is connected between XX points in the bridge kit.
2. The P/Q ratio (multiplier) is initially kept at position '1' and the deflection of the galvanometer is observed by pressing both the battery and the galvanometer keys.
3. The S arm (X 1000Ω) is adjusted and two positions are identified for which the deflection of the galvanometer is on either side of the null point and kept at the lowest value of S. Then the x100Ω, x10Ω, x1Ω knobs of S are adjusted to get null deflection. If necessary the sensitivity knob may be controlled to get appreciable deflection. [If not possible P/Q ratio is kept at suitable value ie, any one of ratios provided.]
4. The value of unknown resistance is read. (S value)
5. Steps 3 and 4 are repeated for some other P/Q ratio. The mean value is taken.
6. The experiment is repeated with other samples provided.

Note:-

The above experiment may be used for measuring resistance of the samples less than 1Ω to greater than 10000Ω with lesser sensitivity.

Tabular Column:

S.No	Sample	P/Q Ratio (Multiplier)	S Value (Ω)	Unknown Resistance Rx = P/Q * S (Ω)	% Error

Calculation:

Unknown Resistance, **Rx = P/Q * S (Ω)**

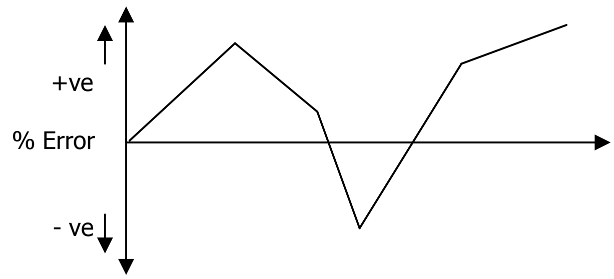
Where P, Q = Ratio Arms

S = Variable resistance

Rx = Unknown resistance

% Error = (Sample value – Measured Value)/ (Sample Value) * 100

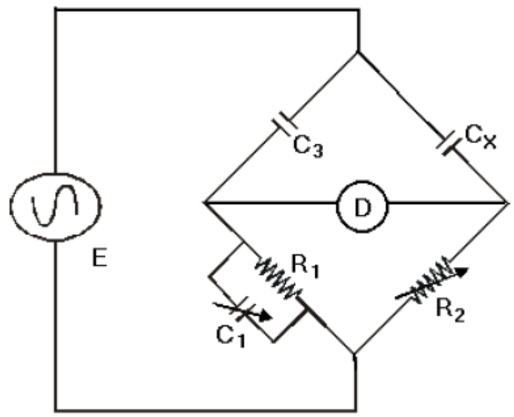
Model graph:

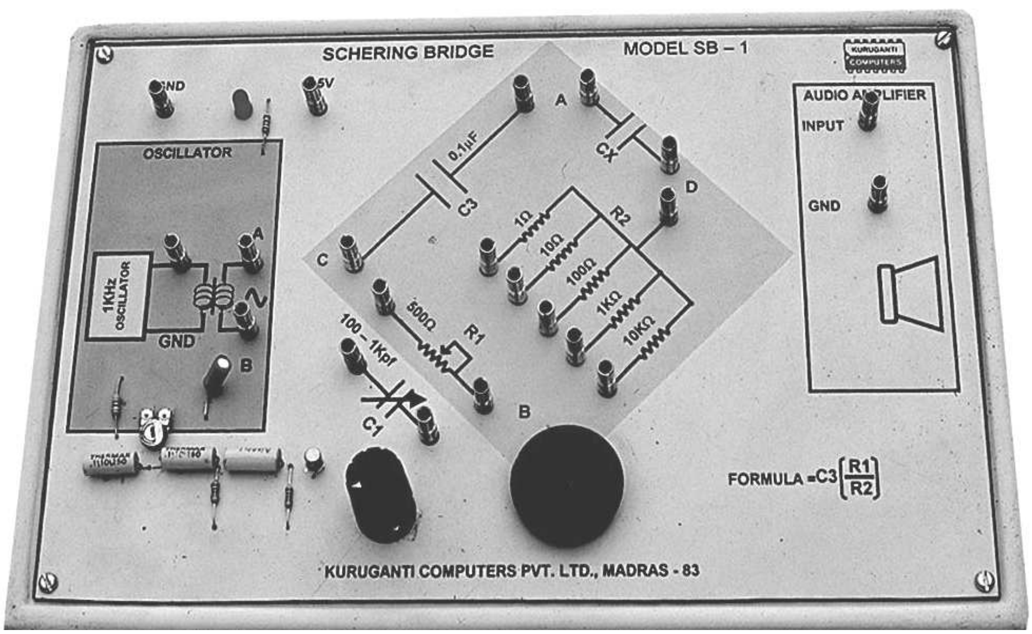


RESULT:

The value of unknown resistances was measured by using Wheatstone Bridge.

Circuit Diagram: **Schering Bridge**





Exp. No. : **Date:**

MEASUREMENT OF CAPACITANCE USING SCHERING BRIDGE

Aim :

To measure the unknown capacitance using Schering bridge.

Objective :

1. To measure the unknown capacitance.
2. To study about dissipation factor.

Equipment:

1. Schering Bridge kit – 1 No
2. Multimeter – 1 No
3. Unknown capacitance – 1 No
4. Connecting wires

Procedure:

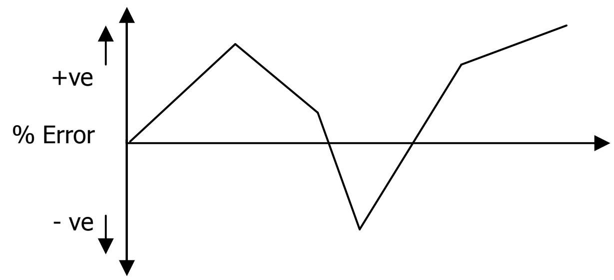
1. Connections are given as shown in the circuit diagram.
2. The value of R2 is selected arbitrarily (say1K) and R1 is varied.
3. If the selection of R2 is correct the balance point (NULL POINT) can be observed on the oscilloscope by varying R1.If not another value of R2 is chosen.[At balance the vertical line in the oscilloscope comes to a point for an particular value of R1 in the same direction.]
4. The capacitor C1 can be varied for fine balance adjustment.
5. When the balance condition is reached, the trainer kit is switched OFF and the value R1 is measured using a multimeter.
6. The value of unknown capacitance is calculated.
7. The experiment is repeated for various samples provided.

Tabular Column:

C3 =

S.No	Sample	R1 (Ω)	R2 (Ω)	Unknown Capacitance $C_x = R1/R2 * C3$	% Error

Model graph:



Calculation:

Unknown capacitance, **Cx = R1/R2 * C3,**

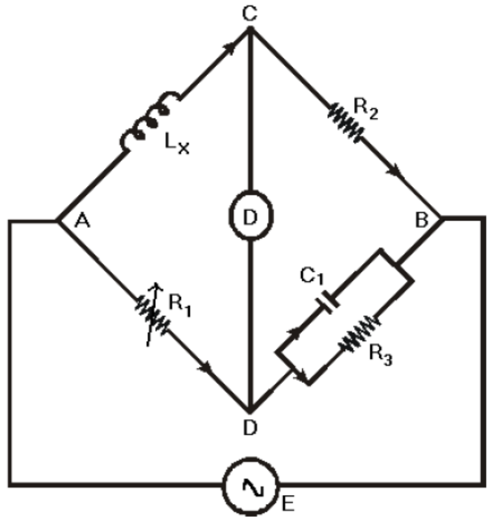
Where, C3 = Known Capacitance, Microfarads

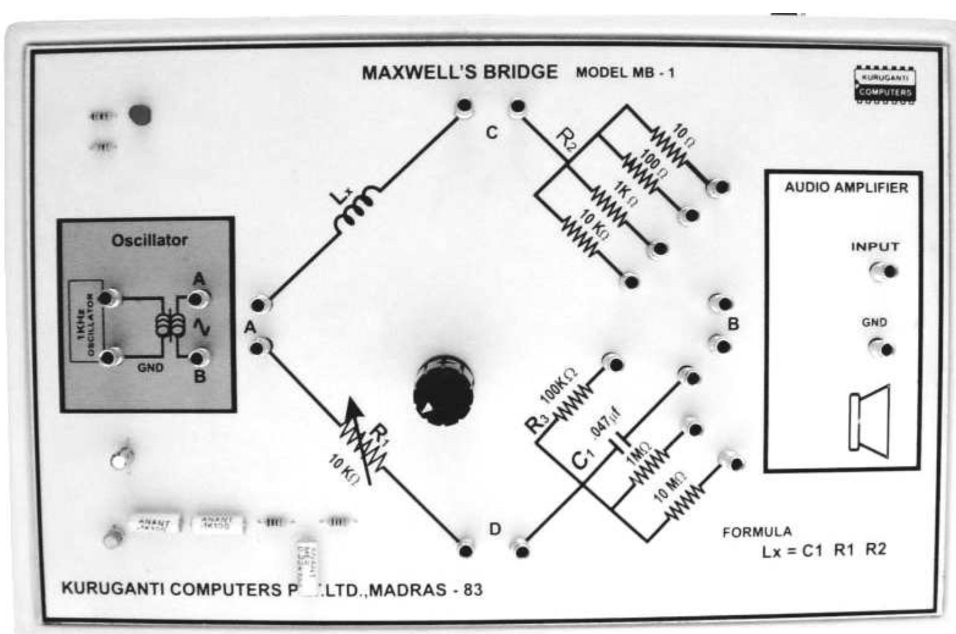
% Error = (Sample value – Measured Value)/ (Sample Value) * 100

RESULT:

The value of unknown capacitance is found experimentally by using the Schering bridge.

Circuit diagram: **Maxwell Bridge**





Exp. No. : **Date:**

MEASUREMENT OF INDUCTANCE USING MAXWELLS BRIDGE

Aim:

To find the unknown inductance and Q factor of a given coil.

Objective:

1. To find the unknown inductance of the given coil using bridge circuit.
2. To study that Maxwell inductance, capacitance bridge is suitable for the measurement of law Q coils.

Equipment:

1. Maxwell's inductance Capacitance Bridge kit – 1 No
2. Multimeter – 1 No
3. Unknown Inductance – 1 No
4. Connecting wires

Exercise:

1. Design a bridge circuit for the given parameters.
2. Find Q factor of the coil.
3. Find unknown Inductance.

Tabular column:

C1 =

S.No	Sample	R1	R2	Unknown Inductance **Lx= (R1.R2) x C1**	% Error

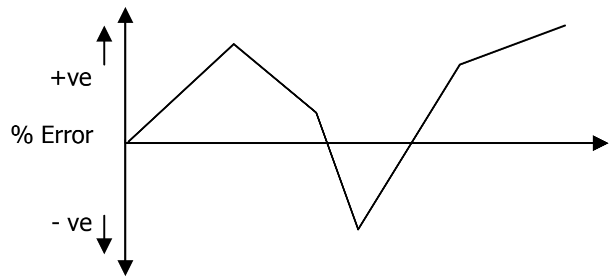
Calculation:

Unknown Inductance Lx= (R1.R2) x C1 Henry

The expression for Q factor

Q=ϖLx/R1

Model graph:

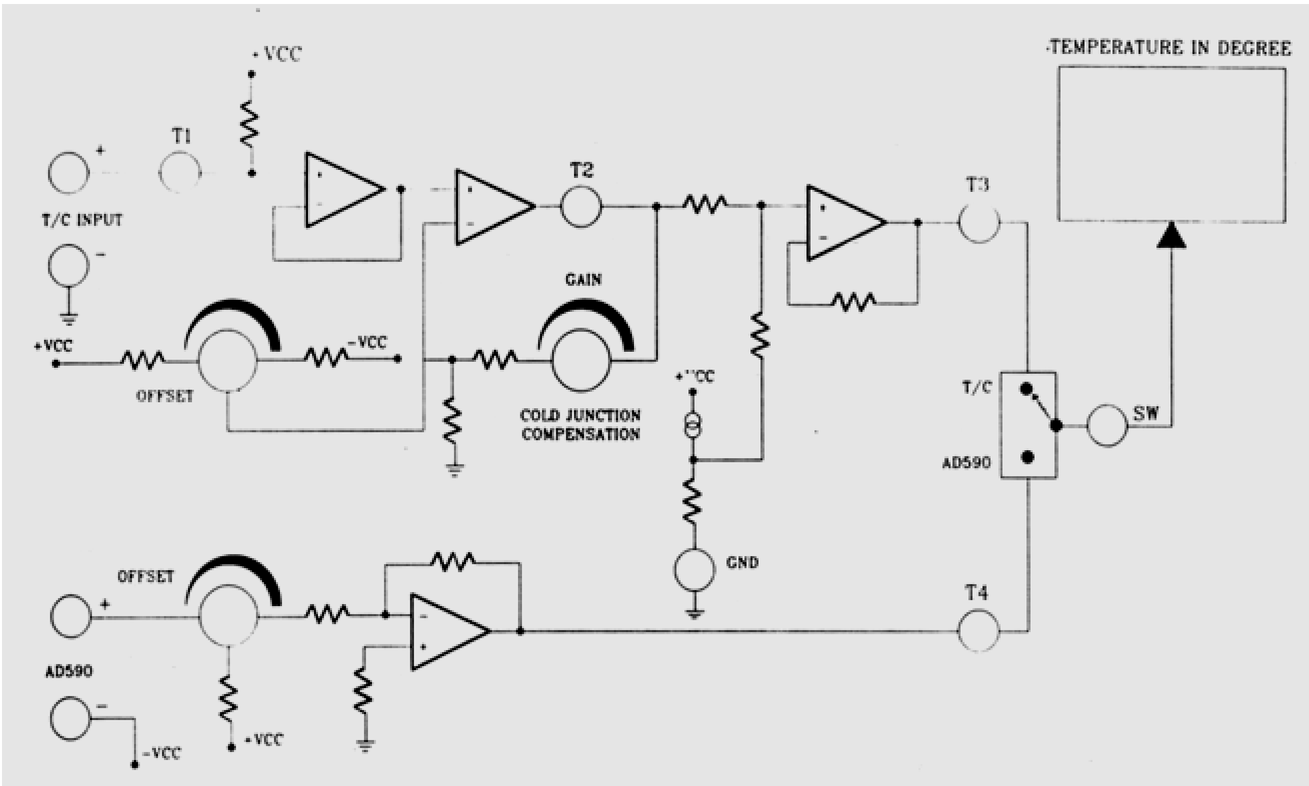


% Error = (Sample value – Measured Value)/ (Sample Value) * 100

RESULT:

The value of unknown inductance is found experimentally by using the Maxwell Bridge.

Circuit Diagram: **THERMOCOUPLE**



Exp. No. : **Date:**

TEMPERATURE MEASUREMENT USING THERMOCOUPLE

Aim:

To measure the change in temperature using a thermo couple and to plot Temperature Vs voltage.

Apparatus required:

1. Thermo couple [Iron-constantan]
2. Milli voltmeter or multimeter.

Theory:

Thermocouples are active transducers which can generate voltage when subjected to a temperature source. They do not need any external excitation for voltage generation. The principle is bare on sea beck effect. When heat is applied to a junction (hot)of two dissimilar metals, an emf is generated which can be measured at the other junction (cold junction). The two dissimilar metals from an electric circuit.

Procedure:

1. Connect the two terminals of the thermocouple to T/C input and points.
2. Connect the multimeter in millivolts range.
3. Measure the displayed voltage in multimeter for room temperature.
4. Using thermometer, measure the temperature and the corresponding thermocouple output voltage.
5. Repeat step5 for different temperature of water batch.

Tabular Column:

Temperature (c)	Thermocouple voltage (mv)

Model Graph:

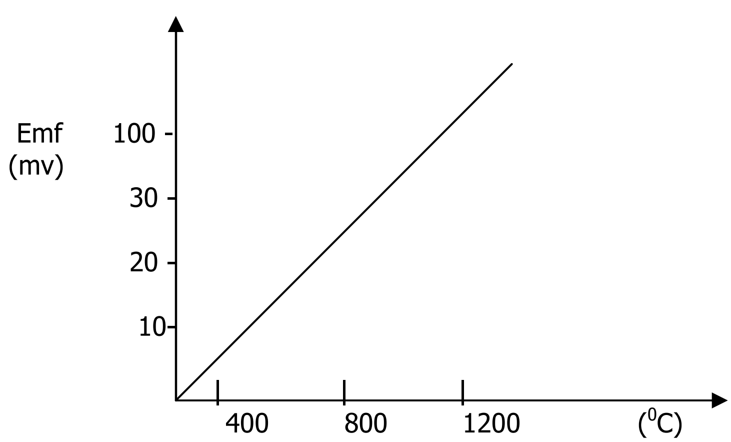
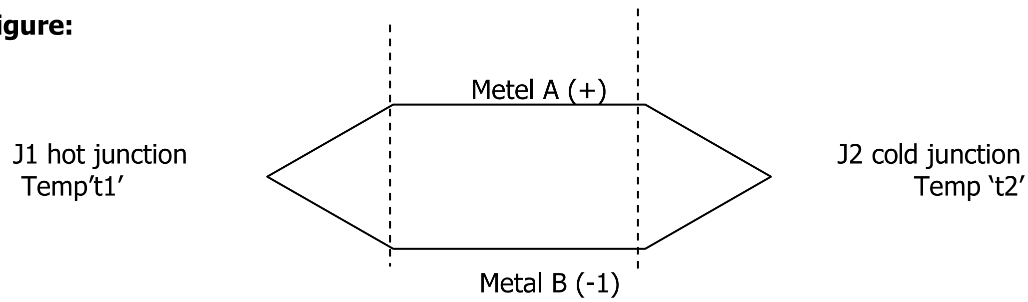


Figure:

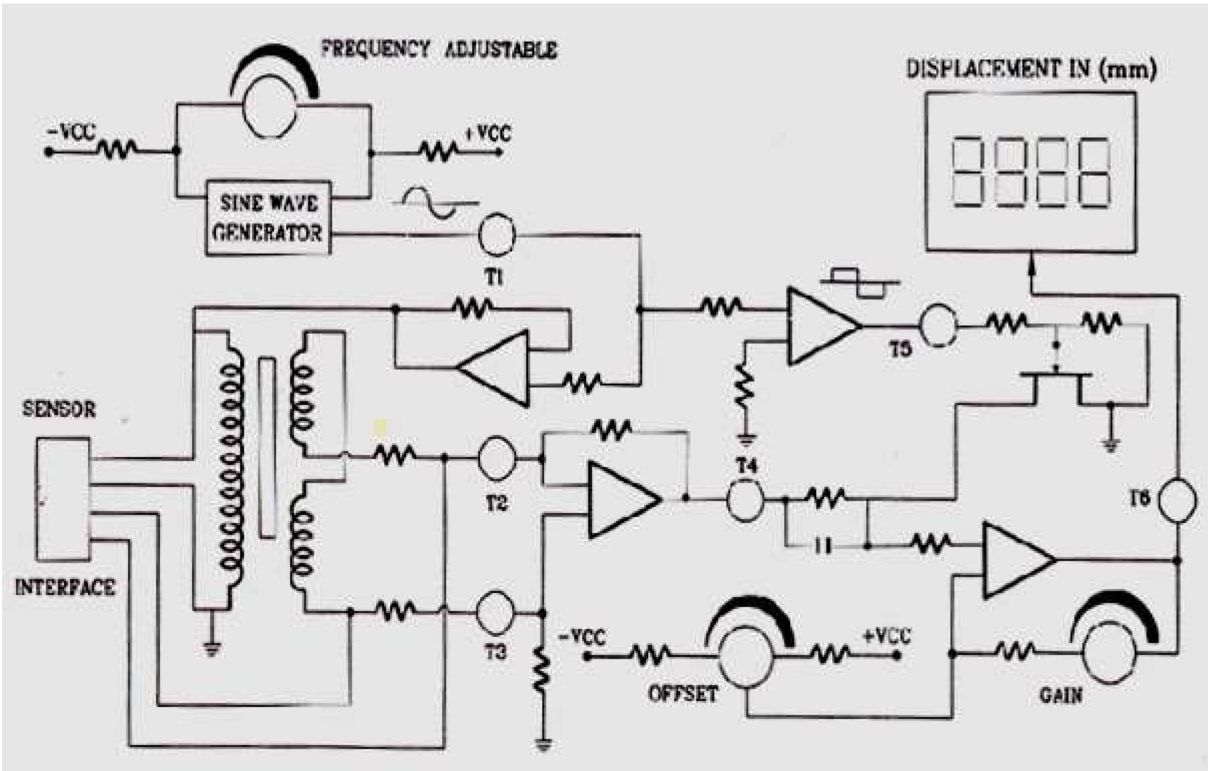


ΔQ = different between temperature of hot and cold junctions.

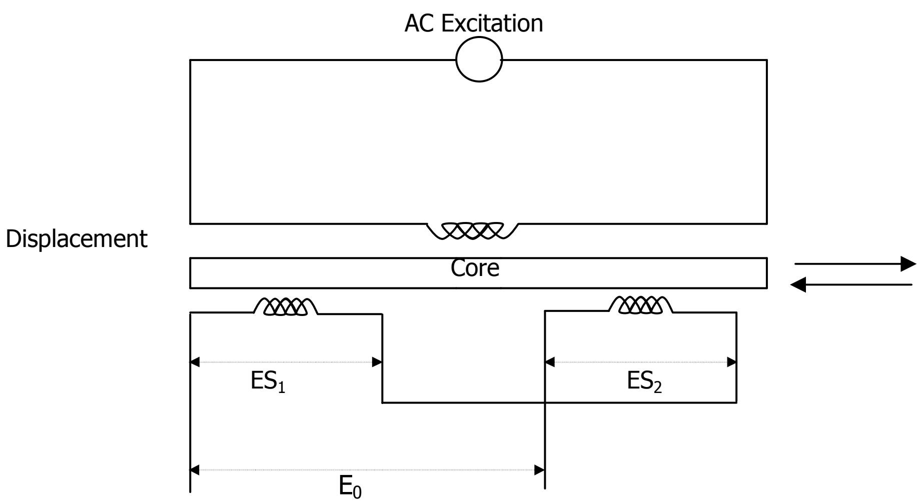
RESULT:

Thus for the using appropriate temperature various voltage output of thermocouple is found.

LVDT MODULE



Circuit Diagram:



Exp. No. : **Date:**

POSITION MEASUREMENT USING LINEAR VARIABLE DIFFERENT TRANSFORMER (LVDT)

Aim:

To measure the position using LVDT and to draw a graph showing induced voltage Vs displacement.

Apparatus Required:

1. Cathode Ray Oscilloscope - 1
2. LVDT

Theory:

LVDT is used to measure the position or displacement. It is used as process control systems. It is a variable reluctance displacement transducers where in a moving core is used to vary the magnetic flux coupling between two coils. It consists of a transformer with two secondary windings, one primary winding and a movable core. With core in centre position, the voltage in the two secondaries will be equal and the output will be zero.

Procedure:

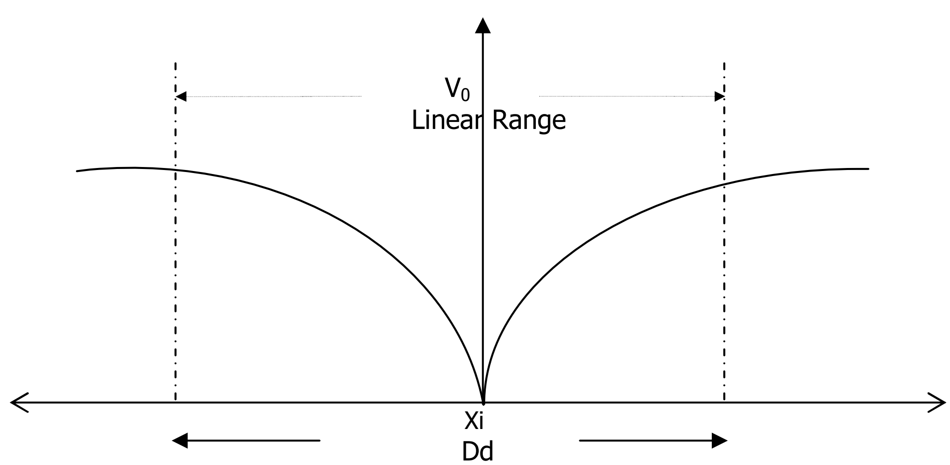
1. Switch on the power supply to the LVDT module.
2. Connect the CRO at T1 to check the input sine wave signal. Adjust the frequency to 4 kHz.
3. Place the LVDT at null position (10mm) and adjust the offset to display zero on the DVM calibrate in displacement (mm) of the core.
4. Gradually move the core of LVDT in the positive direction (20mm) and note the reading on the scale (mm) and display (mm). it should be around 10 mm, if it not ,adjust the gain to display 10mm.
5. Repeat step4 in the opposite direction.
6. The LVDT core may be moved through a distance of 20mm (10mm in each direction).

Tabular Columns:

Da (mm)	V_0(V)	Dd (mm)	% Error

Da (mm)	V_0	Dd (mm)	% Error

Model Graph:



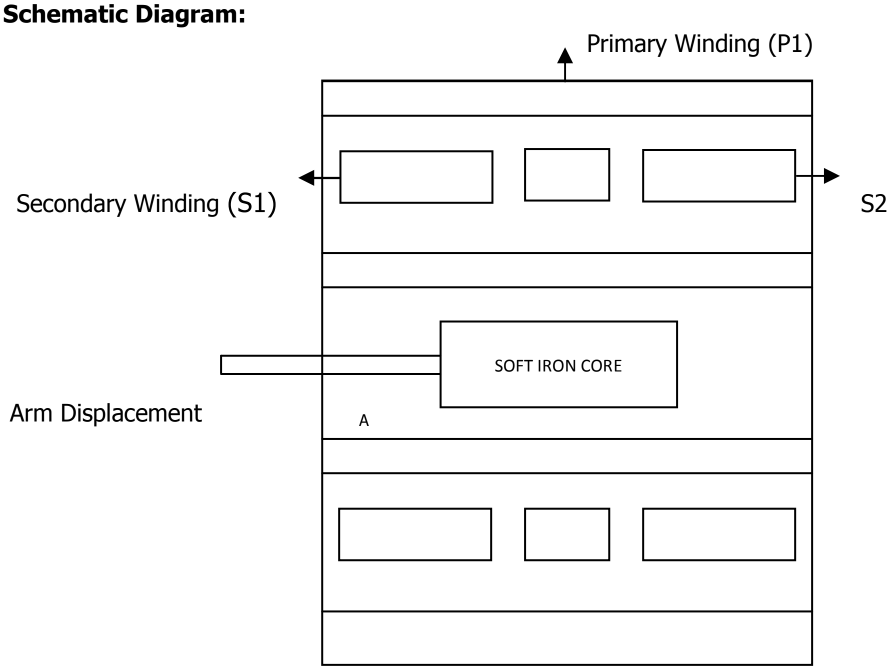
Da (mm) - actual displacement on micro meter (mm)

VO - output voltage to DVM (volts)

Dd - displayed displacement.

% Error = Dd – Da / Da x 100

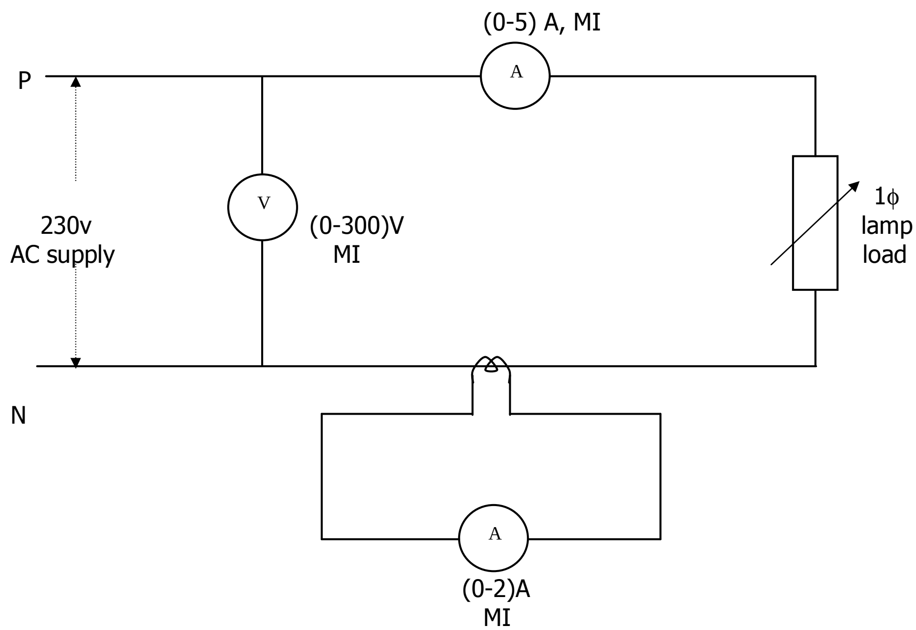
Schematic Diagram:



RESULT:

Thus the LVDT is tested and the response waveform is drawn.

To Measure High Current:



To find K_{CT}:

Voltage (v)	Current $_{actual}$ (A)	Current $_{CT}$ (A)	K_{CT}

Exp. No. : **Date:**

MEASUREMENT OF HIGH CURRENT USING CURRENT TRANSFORMER

Aim:

To measure high current and high voltage by using current transformer(CT)

Name Plate Details:

CT

Precautions:

i) The CT & PT should be loaded

ii) The CT secondary winding should be at least short circuited

THEORY:

Transformer used in conjunction with measuring purpose are called Instrumentation transformer.

Current Transformer: The transformer used for the measurement of current is called current transformer. The current is used with its primary winding connected in series with the line carrying the current to be measured and therefore the primary current is dependent upon the load connected to the system is not determined by the load connected to the secondary winding of CT. The primary consist of a very few turns and therefore no drop in it. The secondary winding of the current transformer has larger number of times the exact number being determined by the turn's ratio

Procedure:

Current Transformer:

i) Connections are given according to the circuit diagram

ii) The load is switched on one buy one and reading of both primary and secondary readings are noted down

iii) The load is decreased gradually and the supply is switched off.

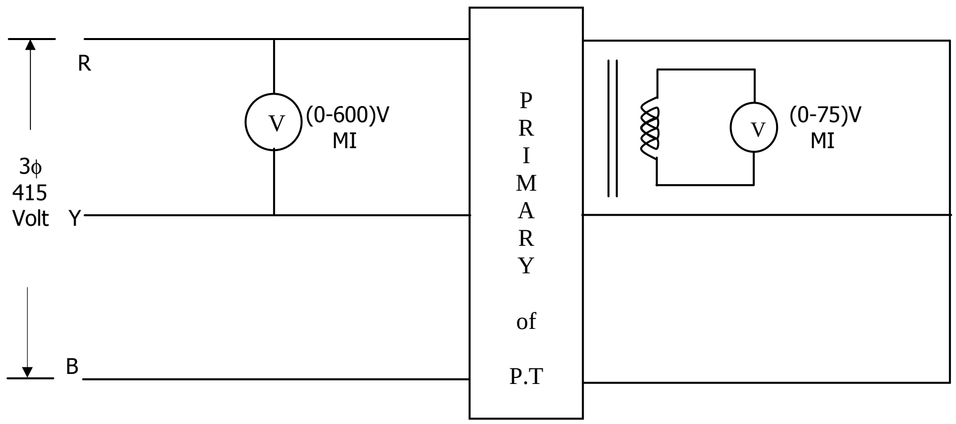
Formulae:

$$K_{CT} = \frac{\text{Primary winging current (rated)}}{\text{Secondary winging current (rated)}}$$

RESULT:

Thus the high current measured using current transformer.

To measure the High Voltage:



Tabulation to find K_{PT} :

Voltage $_{actual}$ (V)	Voltage $_{PT}$ (V)	K_{PT}

Exp. No. : **Date:**

MEASUREMENT OF HIGH VOLTAGE USING POTENTIAL TRANSFORMER

Aim:

To measure high current and high voltage by using current transformer(CT) and potential transformer(PT)

Name Plate Details:

PT

Precautions:

i) The PT should be loaded

THEORY:

Transformer used in conjunction with measuring purpose are called Instrumentation transformer.

Potential Transformer: The transformer is used for measurement of potential voltage is called potential transformer. They are used to operate voltmeter. A potential coil of wattmeter is connected to the relays from high voltage lines. The primary winding of the transformer is connected across the line carrying the voltage to be measured and voltage circuit is connected across the secondary windings. These instruments are very useful in high voltage measurement on power system lines.

Procedure:

Potential transformer:

i) The same procedure is applied for potential transformer also.
ii) The readings are taken for the rated voltage
iii) The readings are tabulated.

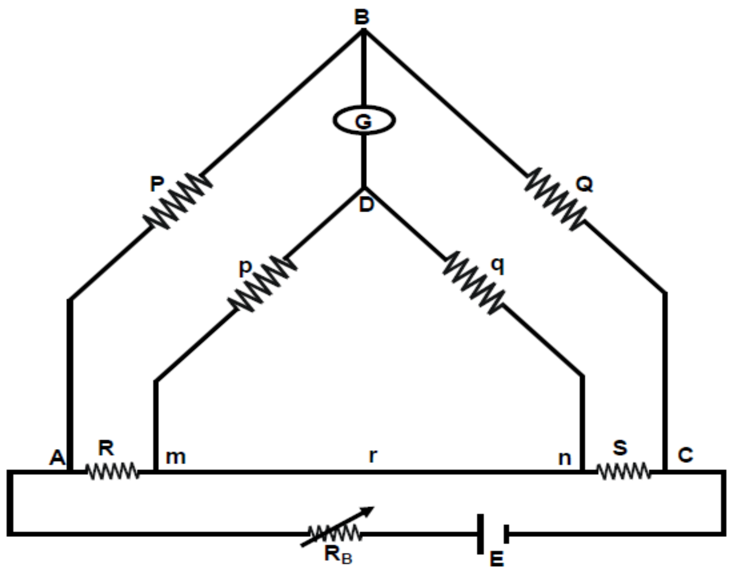
Formulae:

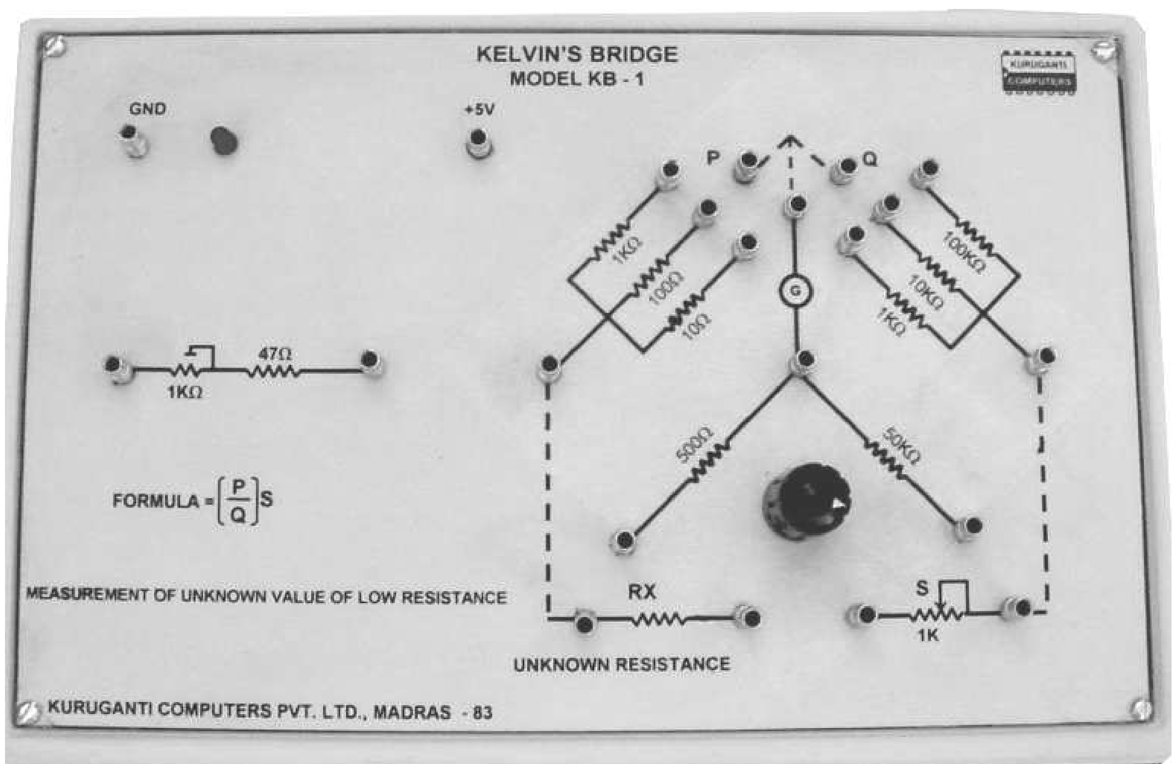
$$K_{PT} = \frac{\text{Primary winging voltage (rated)}}{\text{Secondary winging voltage (rated)}}$$

RESULT:

Thus the high voltage measured using potential transformer.

Circuit Diagram:





Exp. No. : **Date:**

MEASUREMENT OF RESISTANCE USING KELVIN'S DOUBLE BRIDGE

Aim:

To measure the given low resistance using Kelvin's double bridge method.

Objective:

To study the working of bridge under balanced and unbalanced condition and to study the sensitivity of bridge.

Equipment :

1. Kelvin Double Bridge kit – 1 No
2. Unknown resistance – 1 No
3. Multimeter – 1 No
4. Connecting Wires.

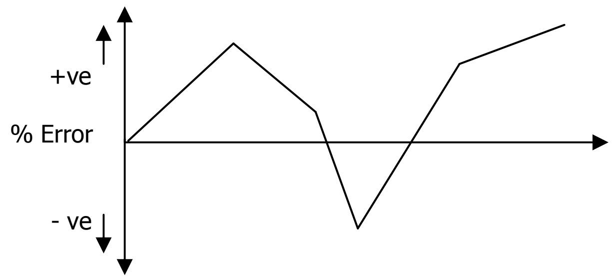
Procedure:

1. The resistance to be measured is connected such that the leads from +C and + P are connected to one end and those from –C and –P are connected to the other end in the kit.
2. The P/Q ratio (multiplier) is initially kept at position '1' and the deflection of the galvanometer is observed by pressing the galvanometer key.
3. The 'S' arm (main dial) is adjusted and two positions are identified for which the deflection of the galvanometer is on either side of the null point. [If not some other P/Q ratio is to be tried].
4. The lowest of the two position indicates the coarse value of the unknown resistance and the null point is obtained by adjusting the Vernier scale, with the galvanometer sensitivity knob at the maximum position.
5. The value of unknown resistance is read. ['S' Value]
6. Steps 3, 4, 5 are repeated for some other P/Q ratio for the unknown resistance. The mean value is taken.
7. The above procedure is repeated with another sample.

Tabular Column:

S.No	Sample	P/Q Ratio (Multiplier)	S Value (Ω)	Unknown Resistance Rx = P/Q * S (Ω)	% Error

Model graph:



Calculation:

Unknown Resistance, Rx = P/Q * S (Ω)

Where P, Q = Ratio Arms

S = Variable resistance

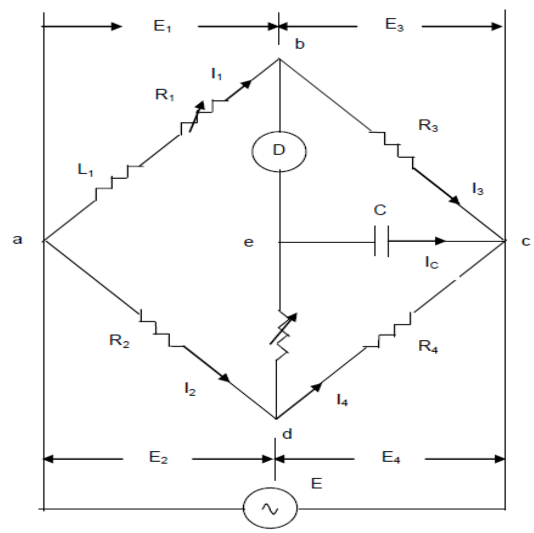
Rx = Unknown resistance

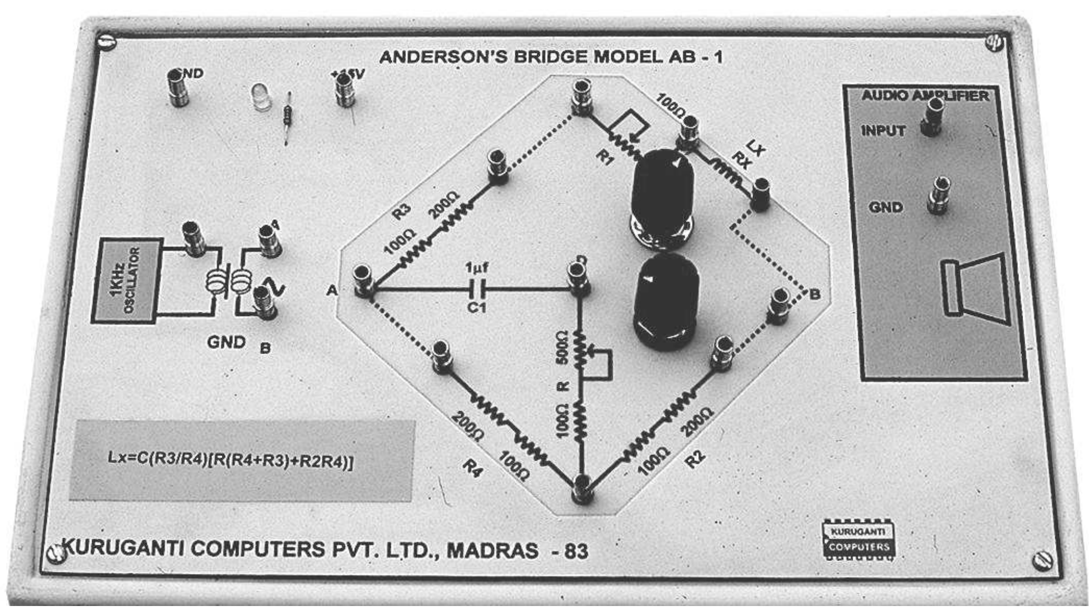
% Error = (Sample value – Measured Value)/ (Sample Value) * 100

RESULT:

The value of unknown resistances was measured by using Kelvin's Double Bridge.

Circuit Diagram:





Ex.No.: **Date :**

ANDERSON'S BRIDGE

Aim : -

To measure the self - inductance of a given coil by Anderson's bridge method.

Apparatus :-

1. Anderson's inductance Capacitance Bridge kit – 1 No
2. Multimeter – 1 No
3. Unknown Inductance – 1 No
4. Connecting wires

Formula :-

Inductance of given coil Lx **= C (R3/ R4) [(R4+ R3) R + R2R4] H**

Where

C = Capacity of the standard capacitor (μ F)

R2,R3,R4 = Known, fixed and non – inductive resistances (K_)

R1, R = Variable resistances (K_)

Description :-

Anderson's bridge is the most accurate bridge used for the measurement of self – inductance over a wide range of values, from a few micro-Henries to several Henries. In this method the unknown self-inductance is measured in terms of known capacitance and resistances, by comparison. It is a modification of Maxwell's L – C bridge. In this bridge, double balance is obtained by the variation of resistances only, the value of capacitance being fixed.

Theory :-

Anderson bridge, in fact, is a modification of Maxwell's Inductance - Capacitance Bridge. In this method, the self inductance is measure in terms of a standard capacitor. This method is applicable for precise measurement of self-inductance over a very wide range of values

Let ,

L_1 = self inductance to be measured
Rx = resistance of the self-inductor
R_1 = resistance connected in series with self inductor

R_2, R_3, R_4 = unknown non inductive resistance
& C = fixed standard capacitance

At balance $I_1 = I_3$ & $I_2 = I_0 + I_4$

Now $I_1R_3 = I_cX_1/j\omega CR_3$

Writing other balance equations

$I_1(r_1+R_1+j\omega L_1) = I_2R_2 + I_c r$
& $I_c(r+1/j\omega C) = (I_2-I_c)R_4$

Substituting the value of Ic in the above equations, we have

$I_1(r_1+R_1+j\omega L_1) = I_2R_2+I_1 j\omega CR_3r$ or $I_1(r_1+ R_1+j\omega L_1- j\omega CR_3r) = I_2R_2$ -------- (1)
& $j\omega CR_3(r+1/j\omega C)(I_2- j\omega CR_3)R_4$ or $I_1(j\omega CR_3r+ j\omega CR_3R_4+R_3) =I_2R_4$ -------- (2)

From equation (1) & (2) , we obtain

$I_1(r_1+R_1+ j\omega L_1- j\omega CR_3r) = I_1((R_2R_3/R_4)+(j\omega CR_2R_3r/R_4)+ + j\omega CR_2R_3)$

Equating the real & imaginary part

$R_1 = (R_2R_3/R_4) - r_1$
& $L_1 = C (R_3/R_4)(r(R_4+R_2)+R_2R_4)$

An experimental of balance equations reveals that to obtain easy convergence of balance, alternate adjustments of R1 & R should be done as they appear in only one of the two balance equations

Precautions : -

1) The product (CR2R4) must always be less than L .
2) $\mathbf{R_1}$ and r or **R** are adjusted until a minimum sound is heard in head – phone or loud speaker

Procedure :-

1. This bridge measures unknown inductance in the range of 350mH to 2H
2. Anderson bridge consists of a built – in +15V power supply, 1Khz oscillator & the detector
3. Patch the circuit as shown in wiring diagram
4. Switch on the training board & check the power supply & output of the oscillator. Connect the oscillator output(sine wave) to AF input of the bridge circuit

5. Now adjust the value of R to obtain the balance condition. For precise balance, connect the output of the bridge to the input of the detector (Audio amplifier input). Alternatively an oscilloscope can also be connected at the output of the bridge circuit to observe the convergence or balance condition
6. Firstly adjust R by moving it in the clockwise direction. You'll find that the sound in the speaker gradually decreases to a particular minimum and then gain increases. Similarly in the oscilloscope you can find that the output of the bridge comes to a minimum & then again increases.
7. For further fine balance vary R1, which will compensate for negative component of the inductor because every inductor has some resistance
8. In the Anderson Bridge Trainer the values of R3, R3 & R4 are approximate 300Ω each. For this value of resistance the range of resistance, the range of inductance that can be measured is to be 350mH to 2H. To measure any other values of inductance R & R1 have to be correspondingly changed either by increasing or decreasing the resistance. The resistance in any of the arms of the bridge can be changed by externally connecting some resistance in series to increase or decreased by connecting in parallel for which the provision has been given in the Trainer.
9. The self – Inductance if the coil measurement in the standard capacitor can be calculated as follows :

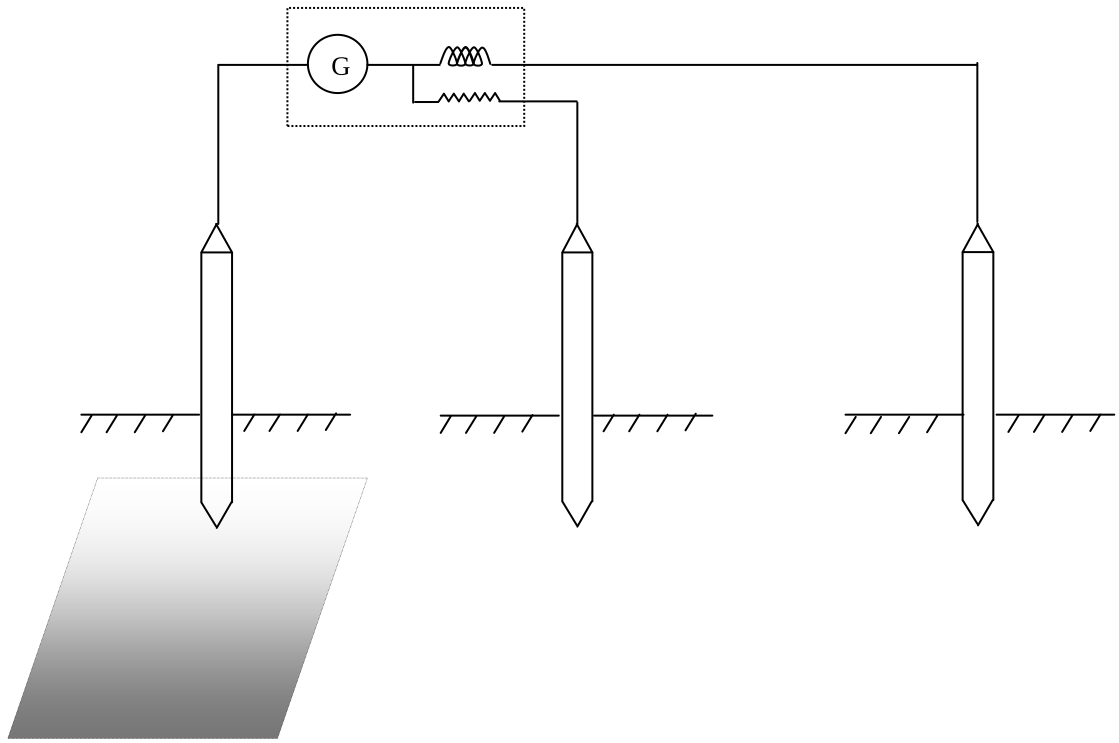
   $$L_x = C(R3/ R4) [(R4+ R3) R + R2R4] H$$

   Where L_x is the self-inductance of the coil in henrys
10. While making the measurement of resistance R disconnect wire number 7 using resistance meter measure value of R. This is used for calculation of unknown inductance value.

RESULT :-

Thus the experiment was conducted & unknown inductance was measured.

Earth Resistance Measurement:



Tabulation:

Distance(M)	Resistance(MΩ)

EX.NO: **DATE:**

EARTH RESISTANCE MEASUREMENT

Aim:

To measure the earth pit electrode resistance

Apparatus Required:

- Earth tester
- Spikes
- Connecting wires.
- Tester.

Theory:

The earth resistance tester has a built in ohmmeter and a hand driven DC Generator. The DC generator supplies current via the earth electrode under the test and the current spikes. The voltage develops between the earthing system under test and the voltage spike. The ohmmeter to the earth resistance tester measure the ratio of V/I several readings of V/I = R are taken for different position of the voltage spike. A graph between distance verses R plotted. The flat position of the curve or R is considered to be the earth resistance of the earth point under the measurement. The resistance value can be between fractions of ohm to three ohms. Depth of electrode, electrode design may be suitably modified in case of hard rock.

Procedure:

- The Earth Resistance meter is taken.
- Three spikes one for earth electrode, one for voltage spike and one for current spike are connected.
- The hand driven generator is rotated.
- The earth resistance value is noted directly from the pre calibrated earth meter.
- Various values of earth resistance cab be taken by varying the spike position.

Result:

Thus the earth resistance was found to be.