MUFFAKHAM JAH COLLEGE OF ENGINEERING & TECHNOLOGY
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DEPARTMENT OF ELECTRICAL ENGINEERING

LABORATORY MANUAL

ELECTRICAL MEASUREMENTS AND INSTRUMENTATION LAB

(PC267EE)

For

B.E. VI EEE & EIE

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MUFFAKHAM JAH COLLEGE OF ENGINEERING & TECHNOLOGY

ELECTRICAL ENGG. DEPARTMENT

LIST OF EXPERIMENTS

Electrical Measurements and Instrumentation Lab.

1. Measurement of low resistance by Kelvin's double bridge

2. Measurement of Inductance by Maxwell's and Anderson's Bridge

3. Measurement of capacitance by DeSauty's bridge and Schering's bridge.

4. Calibration of voltmeter using DC Potentiometer.

5. Calibration of Single-phase energy meter by Phantom loading.

6. Measurement of phase and amplitude using CRO.

7. Measurement of frequency of unknown sinusoidal signal with CRO.

8. Calculation of iron losses using B-H curve with oscilloscope.

9. Measurement of resistance and calibration of Ammeter using DC Potentiometer.

EXPERIMENT 1

MEASUREMENT OF LOW RESISTANCE BY KELVIN'S DOUBLE BRIDGE

AIM: To determine the unknown resistance using Kelvin's double bridge.

APPARATUS:

1. Kelvin's double bridge.
2. Galvanometer.
3. Connecting wires.

THEORY:

Kelvin's double bridge is best suited for the measurement of low resistance (less than 1ohm) .The Bridge is shown schematically in fig.1

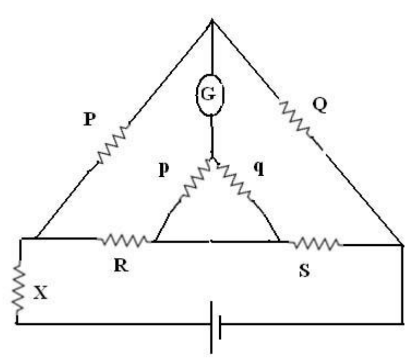


Fig-1

R is the unknown resistance. Resistor R another variable resistor S is connected with a short link along with rheostat X and a battery. The rheostat is used to limit the current in the circuit P,Q,R,S are four non-inductive resistors with P and Q as variables. A suitable galvanometer is connected as shown in fig. (1).

The ratio P/Q is kept same as p/q. By varying S, balance is obtained such that the galvanometer reads zero.

At balance R/S=P/Q

Or unknown resistance R=P/Q*S.

CONNECTION DIAGRAM:

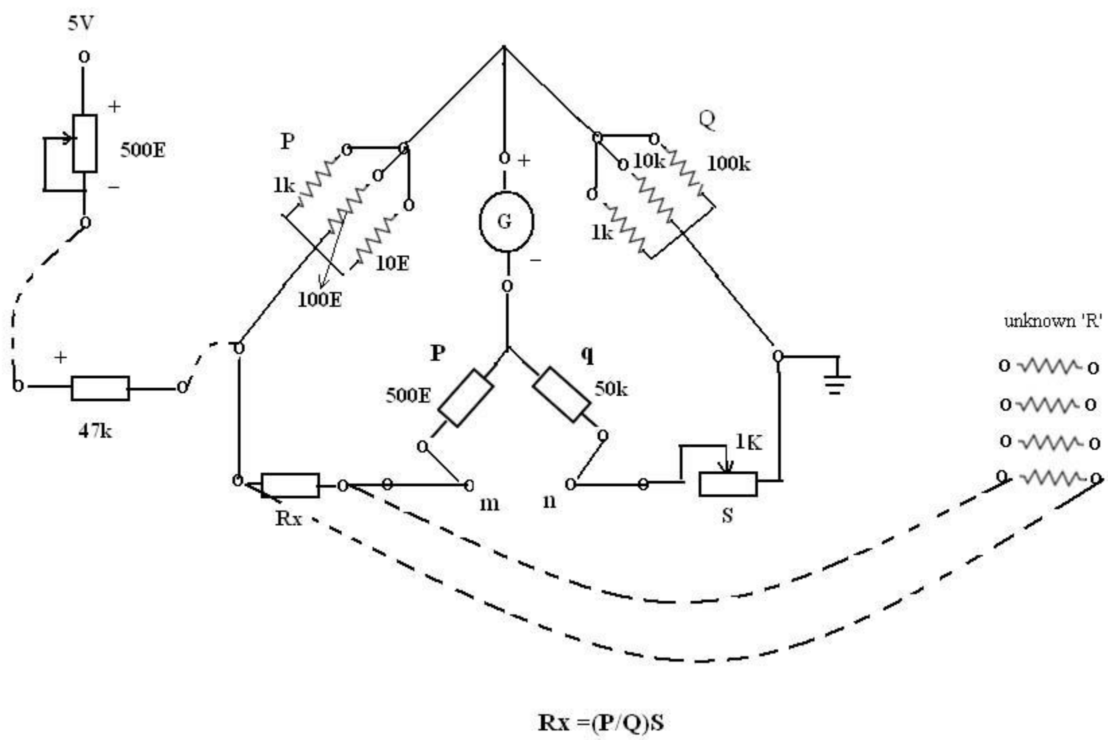


Fig-2

PROCEDURE:

1. Short the 500Ω terminal to 47Ω terminal and short other terminal of 47Ω to terminal.

2. Select any particular resistance for P and Q, such that P/Q = p/q.

3. Connect galvanometer across G terminals.

4. Connect any one resistor provided on the trainer to the R_X terminals.

5. Short p and m; q and n; and m and n terminals.

6. Switch on PHYSITECH'S Kelvin's double bridge trainer.

7. Adjust S for proper balance and at the balancing condition remove all the connections and measure the S value using multimeter.

8. Calculate the value of unknown resistance using the formula,

$R_X = (P/Q)*S$.

9.Repeat the experiment for various values of R_X.

OBSERVATION:

S.No	P (Ω)	Q(KΩ)	S (Ω)	R_X(Ω) measured	R_X(Ω) calculated
1	100	10	408	4.1	4.08

MODEL CALCULATIONS:

For unknown resistance R_X= 4.1Ω

P = 100Ω Q = 10KΩ S = 408Ω

$$R_X = (P / Q) *S$$
$$= (100 / 10) *408$$
$$= 4.08\Omega$$

RESULT:

Kelvin's Double bridge is used to find the value of unknown resistance.

DISCUSSION OF RESULTS:

Comment on how we balance the bridge to find the value of unknown resistance.

EXPERIMENT 2

MEASUREMENT OF INDUCTANCE BY MAXWELL'S AND ANDERSONS BRIDGE

(a) MAXWELL'S BRIDGE

AIM: To determine unknown inductance value in terms of known capacitance.

APPARATUS:

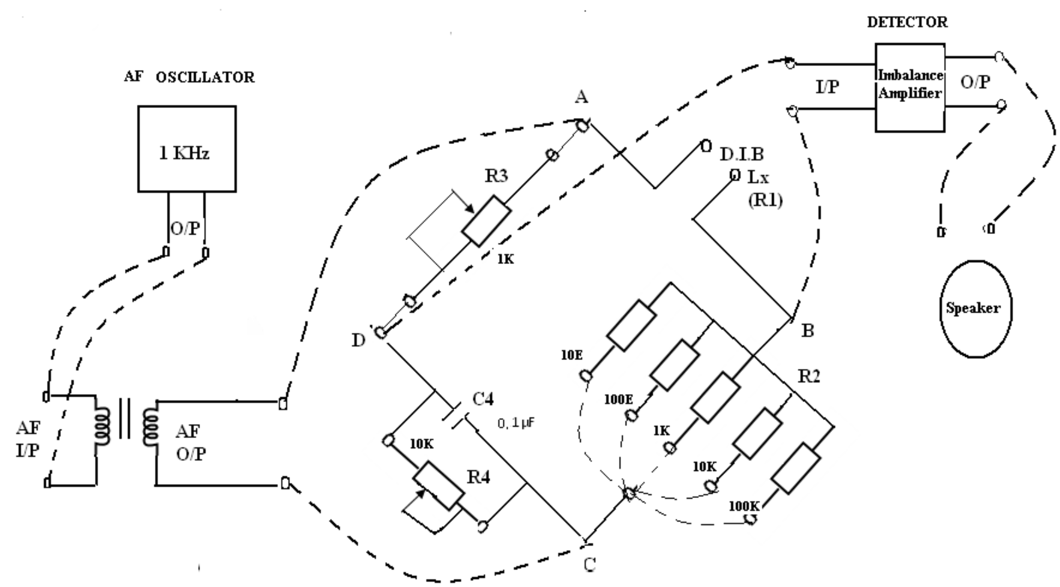
1. Physitech's Maxwell's Bridge trainer.
2. Inductors.
3. CRO.
4. Multimeter.
5. BNC probes and connecting wires.

THEORY:

It is a modification to a Wheatstone bridge used to measure an unknown inductance (usually of low Q value) in terms of calibrated resistance and capacitance. It is a *real product* bridge. It uses the principle that the positive phase angle of an inductive impedance can be compensated by the negative phase angle of a capacitive impedance when put in the opposite arm and the circuit is at resonance; i.e., no potential difference across the detector and hence no current flowing through it. The unknown inductance then becomes known in terms of this capacitance.

$$Lx=R_2C_4\ R_3$$

CONNECTION DIAGRAM:



Lx = R2R3C4

PROCEDURE:

1. Connect AF oscillator O/P(output) to the AF I/P(input) of the Isolation Transformer.
2. Connect AF O/P to the AB terminals of the bridge and connect CD terminals of the bridge to the I/P terminals of an imbalance amplifier.
3. Connect the amplifier output to the speaker terminals.
4. Connect the unknown inductor to the arm marked Lx of the bridge.
5. Switch ON Maxwell's Bridge trainer.
6. Select a particular value for R_2 and by varying R_1 and R_3 observe the balance position, i.e., minimum sound in the loud speaker.
7. At the balance condition, by disconnecting the circuit, measure R_1 and R_3 values.
8. Calculate the inductance value, by substituting R_2, R_3 and C_4 values in the formula $L_x=R_2C_4 R_3$.

OBSERVATION:

S.NO	R_2(KΩ)	C_4(μF)	R_3(Ω)	L_X(mH) measured	L_X(mH) Calculated
1	1	0.1	132	12.3	13.2

MODEL CALCULATIONS:

For unknown Inductance $L_X = 12.3$mH

$R_2 = 1$KΩ C = 0.1μF $R_3 = 0.392$Ω

$L_x=R_2C_4 R_3 = (1*10^3*0.1*10^{-6}*132)$

$= 13.2$mH

(b) ANDERSONS BRIDGE

AIM: To determine the inductance value in terms of a standard capacitor.

APPARATUS:

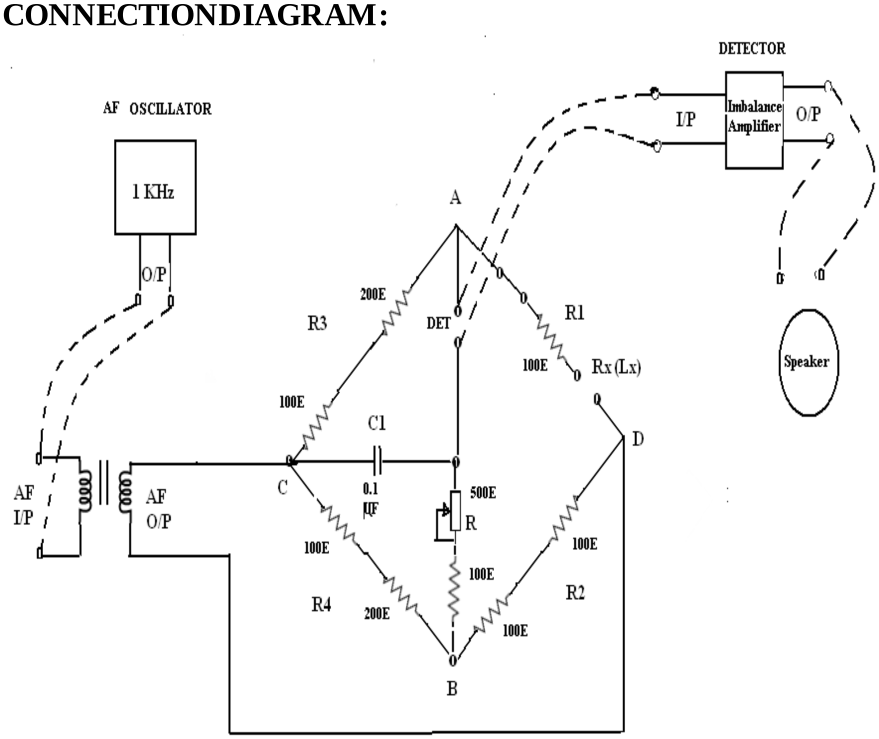
1. PHYSITECH's Anderson's bridge trainer.
2. Inductances.
3. CRO.
4. Multimeter.
5. BNC probes and connecting wires.

THEORY:

AC bridges are often used to measure the value of unknown impedance (self/mutual inductance of inductors or capacitance of capacitors accurately). A large number of AC bridges are available and Anderson's Bridge is an AC bridge used to measure self inductance of the coil. It is a modification of Wheatstones Bridge. It enables us to measure the inductance of a coil using capacitor and resistors and does not require repeated balancing of the bridge.

The bridge is balanced by a steady current by replacing the headphone H by moving coil galvanometer and A.C source by a battery. This is done by adjusting the variable resistance, r. After a steady balance has been obtained, inductive balance is obtained by using the A.C source and headphone.

CONNECTIONDIAGRAM:



$$L_x = C(R_3/R_4)[R(R_4+R_2)+R_2R_4]$$

PROCEDURE:

1. Connect AF oscillator O/P to the I/P terminals of isolation transformer.
2. Connect an inductance across Lx terminals.
3. Switch on PHYSITECH'S Anderson's Bridge trainer.
4. Connect the DET terminals of the bridge to the I/P terminals of the Imbalance Amplifier.
5. Connect the output of detector to the speaker terminals. By varying R_1 and R observe the minimum sound in the loudspeaker.
6. At the balancing condition, by disconnecting all connections, measure R and R_1 values.
7. Calculate the inductance value by substituting the measured values in the equation.

$$L_X = C_1 (R_3/R_2) [R (R_2+R_4) + R_2R_4]$$

OBSERVATION:

S.NO	C_1(µF)	R(Ω)	R_2(Ω)	R_3(Ω)	R_4(Ω)	L_X(mH) measured	L_X(mH) Calculated
1	0.1	118	147.5	258	145	10	10.7

MODEL CALCULATIONS:

For unknown inductance L_X = 10mH

C1 = 0.1µF R = 118Ω R2 = 147.5Ω R3 = 258Ω R4 = 145Ω

$L_X = C_1 (R_3/R_2) [R (R_2+R_4) + R_2R_4]$

$= 0.1(258 / 147.5) [118(147.5 + 145) + (147.5*145)]$

= 10.7mH

RESULT:

Maxwell's and Anderson's bridges are used to find the value of unknown Inductance.

DISCUSSION OF RESULTS:

Comment on how we balance the bridge to find the value of unknown inductance by using Maxwell's and anderson's bridge.

EXPERIMENT 3

MEASUREMENT OF CAPACITANCE BY DESAUTY'S BRIDGE

AIM: To study about Desauty's Bridge and to determine the unknown value capacitance.

APPARATUS:

1. Desauty's bridge trainer.
2. Capacitors.
3. BNC probes and connecting wires.

THEORY:

A basic capacitance comparison bridge also known as Desauty's Bridge is shown in fig.1.This bridge is the simple method of comparing two capacitances. The ratio arms are both resistive and are represented by R_2 and R_3.The standard arm consists of capacitor C_1 in series with resistor R_1, where C_1 is a high quality standard capacitor and R_1 is a variable resistor. Cx represents the unknown capacitances. To write the balance equation, we first express the impedances of the four bridge arms in complex notation and we find that

$$Z_1=R_1-j/\omega C_1;\ Z_2=R_2;\ Z_3=-j/\omega Cx;\ Z_4=R_3.$$

By substituting these impedances in the general equation for a bridge, that is

$$Z_1Z_4=Z_2Z_3$$

$$(R_1-j/\omega C_1)(R_3)=R_2(-j/\omega Cx)$$

$$R_1R_3-R_3j/(\omega C_1)=-R_2j/\omega Cx$$

By equating the imaginary part;

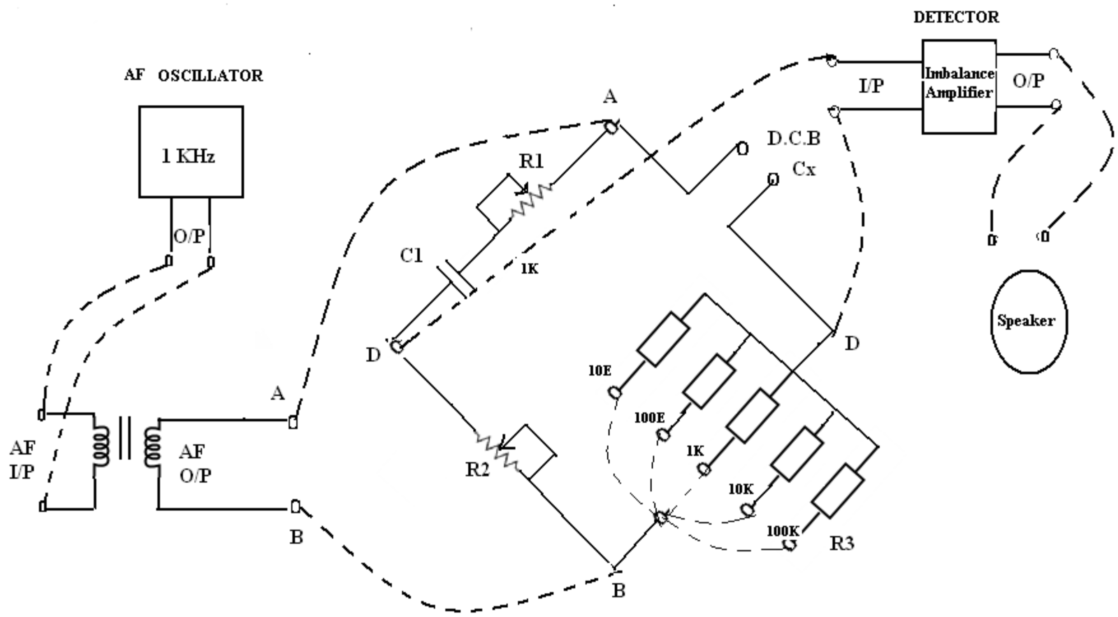
$$R_3j/\omega C_1=R_2j/\omega Cx$$

$$Cx=R_2C_1/R_3.$$

This equation describes the balance condition and also shows that the unknown Cx is expressed in terms of the known bridge components. To satisfy the balance condition, the bridge must contain two variable elements in its configuration. Any two of the available four elements could be choosen, although in practice capacitor C_1 is a high-precision standard capacitor of fixed value and is not available for adjustment. Inspection of the balance equation shows that R_1 does not appear in the expression for Cx. The balance can be obtained by varying either R_2 or R_3.

The advantage of this bridge is its simplicity. But this advantage is nullified by the fact that it is impossible to obtain balance if both the capacitors are not free from dielectric loss. Thus with this method only loss-less capacitors like air capacitors can be compared.

CONNECTION DIAGRAM:



$$C_x = \frac{R_2\ C_1}{R_3}$$

Fig-1

PROCEDURE:

1. Connect the AF oscillator O/P (output) to the AF I/P (input) of oscillation transformer.
2. Connect AB terminals of transformer output to the AB terminals of bridge circuits.
3. Connect the unknown capacitor in the arm marked C_x and select any particular value of R_3.
4. Connect the output of the bridge (CD terminals) to the input of the imbalance amplifier.
5. Connect the amplifier output to the speaker terminals.
6. Switch ON Physitech'sDesauty's Bridge trainer.
7. Alternately adjust R_2 and R_3 for a minimum sound in the loudspeaker.(The process of manipulation of R_2 is typical of the general balancing procedure for AC bridge and is said to cause convergence of the balance point. It should also be noted that the frequency of the voltage source does not enter in the balance equation and the bridge is therefore, said to be independent of the frequency of the applied voltage).
8. Calculate the value of the unknown capacitance using the equation $C_x = R_2C_1/R_3$ by substituting the values of R_2 and R_3 obtained at the balance point.

OBSERVATION:

S.No	R_2(KΩ)	C_1(μF)	R_3(KΩ)	C_X(KPF) Measured	C_X(KPF) Calculated
1	4.91	0.1	10	49.5	49.1

MODEL CALCULATIONS:

For unknown capacitance C_X = 49.5KPF

R_2 = 4.91KΩ C_1 = 0.1μF R_3 = 10KΩ

$$Cx = R_2C_1/R_3 = (4.91*10^3*0.1*10^{-6}) / 10*10^3$$

$$= 49.1 \text{ KPF}$$

RESULT:

Desauty's bridge is used to find the value of unknown Capacitance.

DISCUSSION OF RESULTS:

Comment on how we balance the bridge to find the value of unknown Capacitance.

EXPERIMENT 4

CALIBRATION OF VOLTMETER USING DC POTENTIOMETER

AIM: To calibrate the given D.C Voltmeter using D.C. Potentiometer.

APPARATUS: R.P.S, A sensitive galvanometer, D.C. Crompton's Potentiometer, Voltmeter, Ammeter, Rheostat, Standard cell and Standard resistance.

THEORY:

A potentiometer is an instrument used for the measurement of unknown EMF by a known potential difference by the flow of current in a network. This is used where precision required is higher than that of ordinary deflection instruments. By using in addition, a standard resistance, current can also be measured.

The potentiometer works on the principle of opposing the unknown EMF by a known EMF. A simple arrangement is shown in the Fig.1.

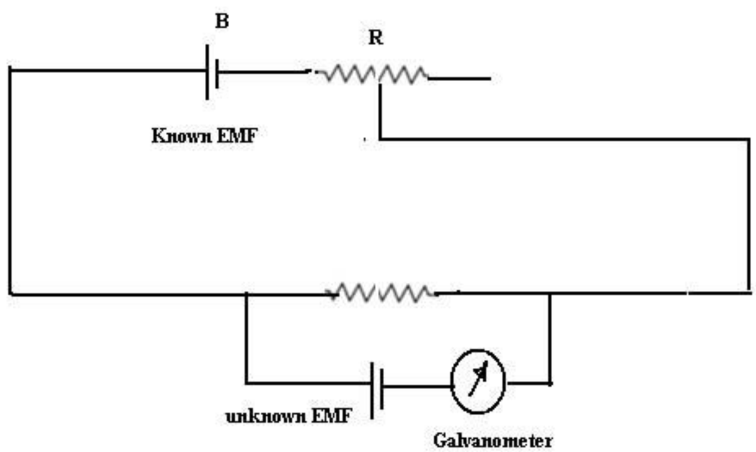
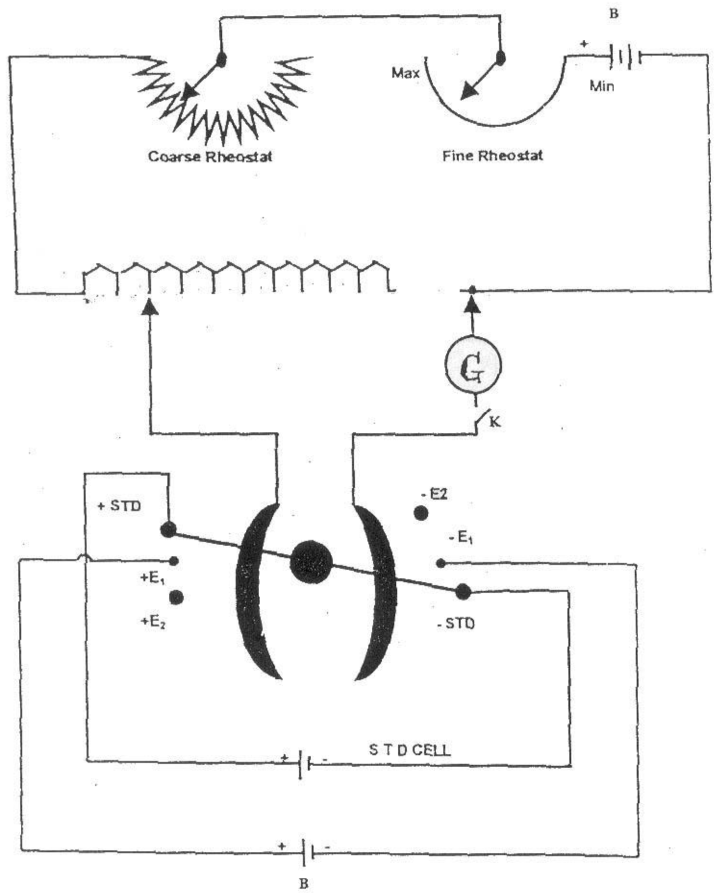


Figure - 1

The unknown EMF is connected in parallel with and in opposition to a voltage drop in a resistor as shown in the Fig. By varying the current in the resistor with fine adjustment, any desired voltage can be obtained. This voltage drop is measured accurately after calibration with a known EMF (standard cell).



CALIBRATION OF A VOLTMETER:

PROCEDURE:

1. Make the connections as shown in the Fig.2.
2. Switch the D.C. Supply and adjust it to 2V keeping all the potentiometer dials to zero position.
3. Standardize the potentiometer as follows:
   Connect the standard cell whose EMF is 1.0186v to the terminal Std. cell. Set the main knob at 1.0v and the circular dial at 18.6 divisions (since each division corresponds to 0.25/250=0.001v).
   The switch is to be kept at STD position. Now the coarse and fine rheostats are so adjusted that there is no deflection in the galvanometer when Galv. Key is pressed. Now the system is pressed. Now the system is ready to measure any unknown voltage.
4. Connect the voltmeter to be calibrated, which is across the voltage source (RPS) to the terminals E1 or E2 (Fig.3).Set a particular value, say, 0.5 by varying the rheostat. Note the voltmeter reading.

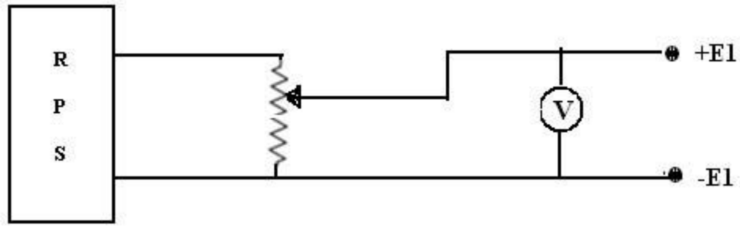


Figure-3

5. Change the switch from Std. to E1 or E2 depending upon the terminals to which the voltmeter is connected.
6. Balance the voltage by adjusting the voltage dial without disturbing course and fine rheostats.
7. Repeat 4 and 6 for different values of voltmeter readings.
8. Tabulate the readings of voltmeter, potentiometer values and find the %Error.

Note: If the calibrated voltage is more than 1.75v, voltage ratio box is to be used.

OBSERVATIONS:

S.No.	Voltmeter reading(E_1)	Potentiometer reading(E_2)	%Error= $(E_1-E_2)/E_2*100$
1	0.452	0.250+0.157 = 0.407	11.05

MODEL CALCULATIONS:

$E_1 = 0.452$ $E_2 = 0.407$

%Error= $(E_1-E_2)/E_2*100$

$=[(0.452 – 0.407) / 0.407]*100$

$= 11.05$

RESULT:

Calibration of D.C voltmeter is performed by using D.C potentiometer**.**

DISCUSSION OF RESULTS:

Comment on the calibration of voltmeter and explain the need of calibration.

EXPERIMENT 5

CALIBRATION OF SINGLE PHASE ENERGY METER

AIM: To calibrate the single-phase energy meter using wattmeter and also to find meter constant by using Phantom Loading.

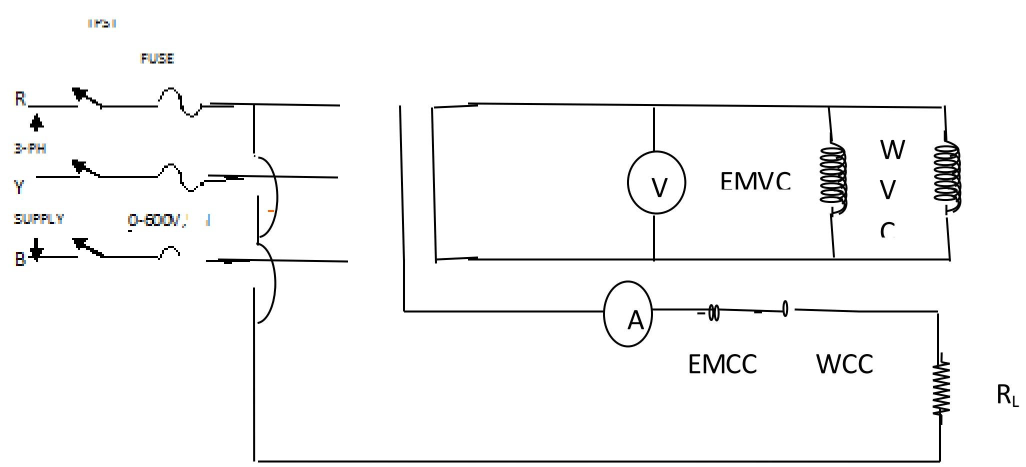
APPARATUS REQUIRED:

1. Single phase energy meter 5A, 220V.
2. Wattmeter (A.C) 300V, 10A.
3. Ammeter (A.C) 0-10A.
4. Voltmeter (A.C) 0-300V.
5. Variac (220/0-270).
6. Rheostat 20Ω, 6A.
7. Stop watch.

THEORY:

nergy meter is an instrument which measures electrical energy. It is also known as watt hour (Wh) meter. It is an integrating meter. There are several types of energy meters. Single phase induction type energy meters is very commonly used to measure electrical energy consumed in domestic and commercial installations. Electrical energy is measured in kilo watt hours (kWh) by these energy meters. In this experiment the purpose is to calibrate the energy meter. This means we have to find out the error/ correction in the energy meter readings. This calibration is possible only if some other standard instrument is available to know the correct reading.

CIRCUIT DIAGRAM:



PROCEDURE:

1. Make the connections as shown in the circuit diagram. Note the Meter Constant of the energy meter.
2. Switch ON the supply, keeping maximum resistance and zero position in the variac.
3. Adjust the variac such that the current of 4A flows in the circuit. Note down the wattmeter reading.
4. Find the time taken for 10 revolutions of the disc using stopwatch. Also note down the reading of the wattmeter and the ammeter.
5. With the same current note down the time taken for increasing number of revolutions.(say,20,30,40).
6. Repeat the above procedure for different currents by varying the variac position and obtain another set of readings.
7. Tabulate the readings and calculate %Error and Meter Constant.

OBSERVATIONS:

Power factor = 1

S.No.	I_L	Power (P)	No. of revolutions	Time t	A	E	%Error	Meter constant
1	2.6A	660W	12	60sec	36	39.6	-9	1090.9

CALCULATIONS:

Actual Energy (A) =Nx3600/1200KW-sec

Calculated Energy (E) = (Pxt/1000) KW-sec

W is in Watts and t is in seconds.

%Error= {(A-E)/E} x100

Meter Constant (k) =Revolutions per KWH. = (Nx3600x1000)/ (wxt).

MODEL CALCULATIONS:

Actual Energy (A) =Nx3600/1200KW-sec

= (12*3600) /1200

= 36

Calculated Energy (E) = (Pxt/1000) KW-sec

= (660*60) / 1000

= 39.6

%Error= {(A-E)/E} x100

Meter Constant (k) =Revolutions per KWH.

= (Nx3600x1000)/ (Pxt).

= (12*3600*1000) / (660*60)

= 1090.9

GRAPH:

Draw graphs between Actual energy versus %Error for different currents.

RESULT:

Calibration of single-phase energy meter using wattmeter and meter constant by using Phantom Loading is done.

DISCUSSION OF RESULTS:

Discuss about Phantom loading.

EXPERIMENT –6

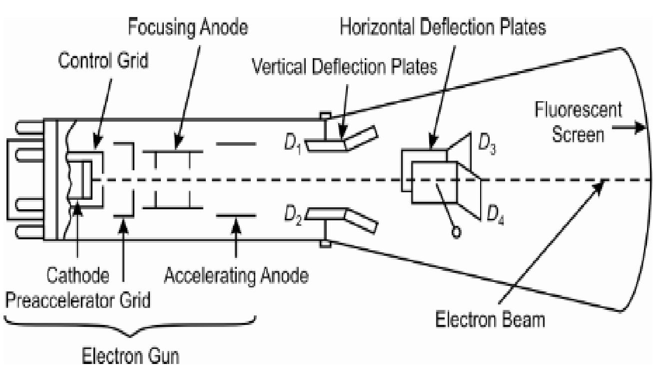
AIM: Measurement of phase and amplitude using CRO.

APPARATUS: CRO, Function generator, Digital Voltmeter, Connecting Wires.

THEORY:

A Cathode Ray Oscilloscope, abbreviated as CRO and referred to as oscilloscope, in short, is now a basic, important and versatile instrument in every electronics and electrical engineering laboratory. In the previous experiment, you got opportunities to measure voltages of a dc-source and an ac-source using a voltmeter and a multimeter. If you study time variation of these voltages, you will observe that the dc voltage remains constant with time (the curve is a straight line parallel to the x-axis in a voltage versus time graph), whereas ac voltage varies sinusoidally with time. While an ac-voltmeter or multimeter can give us information about the magnitudes of the voltages, details on the nature of waveform (of an ac or dc signal) remain hidden. To display a signal or a waveform of any type, we have to use an oscilloscope. This characteristic of CRO makes it a vital tool in medical diagnostics and care.

On a CRO, you can measure important characteristic parameters of a signal like voltage amplitude, frequency, period and shape of the waveform. On a CRO screen, a luminous spot enables us to study the instantaneous value of input voltage. For this reason, an oscilloscope can also be viewed as a plotter or a recorder.



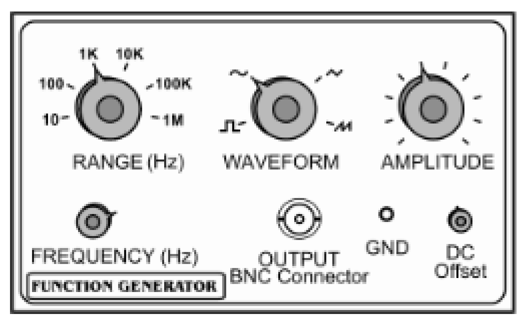


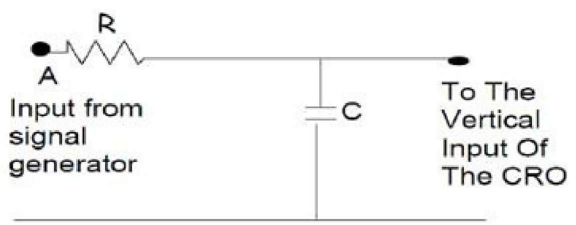
Fig.9: Front panel of a typical function generator

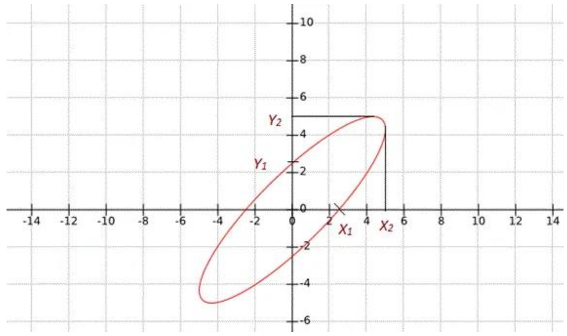
To provide a more stable trace, an additional feature in the form of a trigger is provided in present day oscilloscopes. While using a trigger, the CRO pauses in each cycle when the sweep reaches extreme right side of the screen and retraces back to the left hand side of the screen. Then it waits for a specified event before starting the next trace. The trigger event is usually the input waveform reaching some user-specified threshold voltage in a specified direction (going positive or negative).

Procedure :

PHASE MEASUREMENT USING LISSAJOUS PATTERNS (X-Y MODE):

1. To Measure the phase difference of two sine waves their frequencies must be equal.
2. Connect a 1Volt peak-peak, 1KHz sine wave signal from the function generator to the horizontal input of the CRO.
3. Connect the output of phase shift network to the vertical input as shown in figure.
4. Adjust the vertical and horizontal gains properly for good display.
5. Observe Lissajous Patterns for different combinations of R and C values.





In this condition the phase difference will be,

$$\emptyset = sin^{-1}\left(\frac{x_1}{x_2}\right) = sin^{-1}\left(\frac{y_1}{y_2}\right)$$

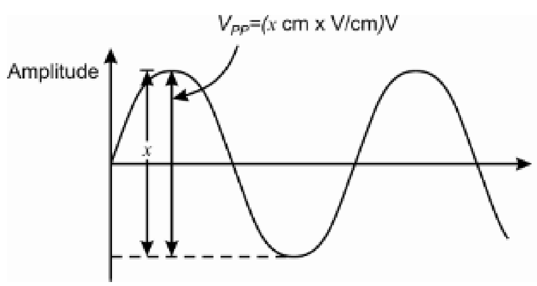
OBSERVATIONS:

Sl.No.	Frequency	R	C	X1	X2	Θ = Sin^{-1} (x1/x2)
1						
2						
3						
4						
5						

AMPLITUDE MEASUREMENT

1. Connect The Probes From CRO To Function Generator
2. connect it to the channel-I input, keeping the DC/AC/GND switch in the AC mode.
3. On the screen you will observe the waveform corresponding to the input signal.
4. Now you measure the vertical distance between the maximum and minimum levels of the signal using the graduated scale on the screen, as shown in Fig.8.
5. If you multiply this distance (in cm) by the sensitivity you have selected (V/cm), you will get the magnitude of peak-to-peak voltage of the applied ac-voltage (Vp-p). You can calculate the root mean square (rms) value of the voltage by dividing Vp-p by .2

GRAPH :



.8: Peak-to-peak voltage measurement for ac-signal using CRO

Result

Discussion of Result

EXPERIMENT -7

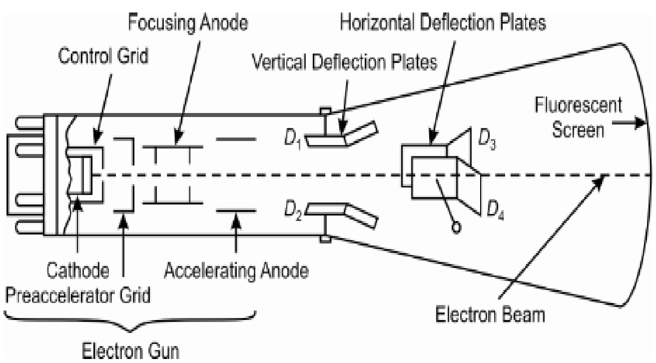
AIM: Measurement of frequency of unknown sinusoidal signal with CRO.

APPARATUS: CRO, Function generator, Digital Voltmeter, Connecting Wires.

THEORY:

A Cathode Ray Oscilloscope, abbreviated as CRO and referred to as oscilloscope, in short, is now a basic, important and versatile instrument in every electronics and electrical engineering laboratory. In the previous experiment, you got opportunities to measure voltages of a dc-source and an ac-source using a voltmeter and a multimeter. If you study time variation of these voltages, you will observe that the dc voltage remains constant with time (the curve is a straight line parallel to the x-axis in a voltage versus time graph), whereas ac voltage varies sinusoidally with time. While an ac-voltmeter or multimeter can give us information about the magnitudes of the voltages, details on the nature of waveform (of an ac or dc signal) remain hidden. To display a signal or a waveform of any type, we have to use an oscilloscope. This characteristic of CRO makes it a vital tool in medical diagnostics and care.

On a CRO, you can measure important characteristic parameters of a signal like voltage amplitude, frequency, period and shape of the waveform. On a CRO screen, a luminous spot enables us to study the instantaneous value of input voltage. For this reason, an oscilloscope can also be viewed as a plotter or a recorder.



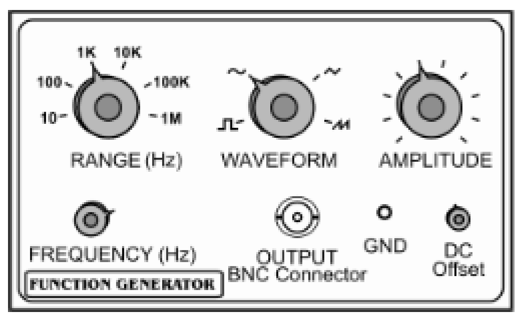


Fig.9: Front panel of a typical function generator

To provide a more stable trace, an additional feature in the form of a trigger is provided in present day oscilloscopes. While using a trigger, the CRO pauses in each cycle when the sweep reaches extreme right side of the screen and retraces back to the left hand side of the screen. Then it waits for a specified event before starting the next trace. The trigger event is usually the input waveform reaching some user-specified threshold voltage in a specified direction (going positive or negative).

PROCEDURE :

1. Connect the OUTPUT terminal of the function generator to the ***Y***-input of the CRO.
2. Select the time base on CRO at 0.5 ms/cm. Select the frequency of input signal to be 1 kHz and limit its amplitude to about 4V.
3. Since the time period of the applied signal is 1/1000 = 1ms, one complete wave of the signal should appear in exactly two horizontal divisions.
4. If it does not, you may fine tune by adjusting the frequency controls of the generator till the desired result is achieved.
5. At this point, you have set the output frequency of the function generator to 1000 Hz.
6. To measure an unknown frequency, you have to essentially measure the period of the signal on the CRO screen.
7. The period of the signal is the length of one cycle of signal on time (horizontal) axis in cm multiplied by the (time/div) setting.
8. The frequency is given by the inverse of period.
9. If the vertical gain control of the CRO is set at a deflection sensitivity of 2 V/cm, the ac-signal will be confined within a vertical length of 2 cm.
10. Then we can write height of the trace (cm) = ***V***/vertical sensitivity. This is shown in Fig. 10.
11. You may make necessary adjustments to get the waveform of say 2 V peak-to-peak from the function generator at different frequencies.
12. We may denote these by ***f***. For each of these sinusoidal waveforms, change the horizontal sensitivity (time/div) and obtain the number of divisions in centimetre horizontally occupied by the wave.
13. Using the method described above, calculate the frequency of the signal.
14. Repeat the procedure using different horizontal sensitivities and compare the results obtained with known frequency.
15. Record your observations in the Observation Table

Observation Table : Measurement of frequency

$V_{p\text{-}p}$ of the input signal = ...V

S.No.	Selected frequency f (Hz)	Horizontal sensitivity S (s cm^{-1})	Extent of single cycle x (cm)	Period of signal $T = x \times S$ (s)	Measured frequency (Hz)
1.					
2.					
3.					
4.					
5.					

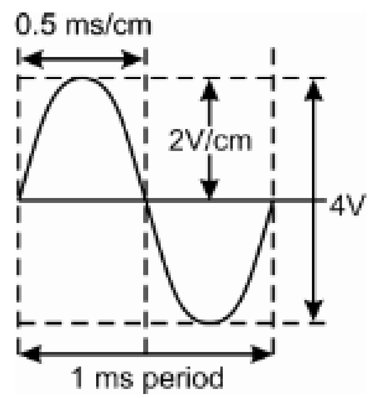


Fig.10: 1 kHz 4V ac signal on CRO

Result

Discussion of Result

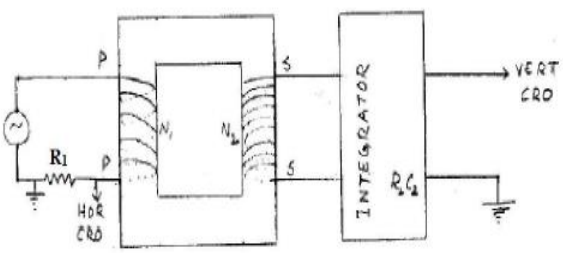
EXPERIMENT 8

CALCULATION OF IRON LOSSES USING B-H CURVE USING OSCILLOSCPE

AIM: To trace the B-H loop (hysteresis loop) of a ferromagnetic specimen using a cathode ray oscilloscope(CRO) and to evaluate the energy loss in the specimen.

APPARATUS:CRO, capacitors, resistors, multi meter and core of the transformer.

CIRCUIT DIAGRAM:



FORMULA

$$E_L = \frac{N_1}{N_2} \times \frac{R_2}{R_1} \times \frac{C_2}{AL} \times S_V \times S_H \times Area\ of\ the\ loop\ in\ m^2 \quad joules/m^3/Cycle$$

Where

No. of turns in the primary coil N_1 = 200

No. of turns in the secondary coil N_2 = 400

R_1 and R_2 are the resistances in the circuit given by

R_1 = 5Ω, 22Ω and 47 Ω $\qquad$ R_2 = 4.5 k Ω=4.5 x10^3Ω

Horizontal sensitivity S_H = ...volt / m

Vertical sensitivity Sv = ... volt / m

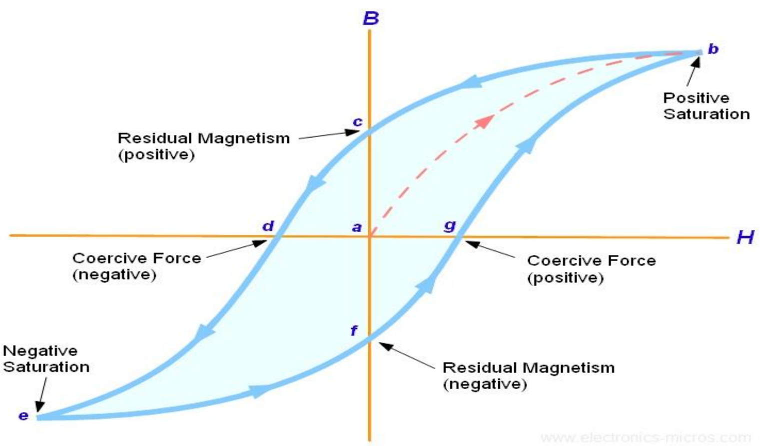
Length of the specimen L = 23 cm=0.23 m

Area of cross-section A = 2 x 1.4 sq. cm =2.8x 10^{-4} sq. m

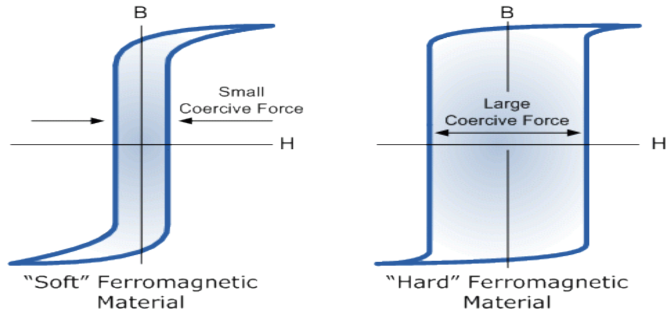
Capacitance C_2 = 4.7 $micro$F = 4.7 x 10^{-6} F

Area of the loop = ... sq.cm = ... x 10^{-6}sq.m

THEORY : The hysteresis of ferromagnetic materials refers to the lag of magnetization (B) behind the magnetising field (H). When a ferromagnetic specimen is subjected to a changing magnetizing force its intensity of magnetization also changes. As the magnetizing field is changed from Hs to -Hs and back again we get the hysteresis loop 'abcdefgb' A hysteresis loop is a curve showing the change in magnetization of a ferromagnetic material to which an external field is applied. When the magnetizing field is reduced to zero, the magnetization of the material does become zero, and this value of intensity of magnetization is called residual magnetism or retentivity. Thus retentivity of a specimen is defined as the magnetization retained by the specimen when the magnetizing field is reduced from saturation value to zero. Similarly, coercive force or coercivity of a magnetic specimen is the magnitude of the demagnetizing field required to reduce the residual magnetism to zero after saturation. In the figure the residual induction, coercive field are shown.



Hysteresis loss is a loss of energy in taking a ferromagnetic body through a cycle of magnetization and this loss is represented by the area enclosed by the hysteresis loop. A study of the hysteresis loop of different magnetic materials helps us, to know their magnetic properties. For example let us see the hysteresis curves for soft iron and steel.



PROCEDURE :

a) Connect the primary terminals of the specimen to P.P. and secondary to S.S terminals.

b) Adjust the CRO to work on external mode (the time base is switched off). Adjust the horizontal and vertical position controls such that the spot is at the centre-of the CRO screen.

c) Connect terminal marked GND to the ground of the CRO. Connect terminal H to the horizontal input of the CRO. Connect terminal V to the vertical input of the CRO. Switch on the power supply of the unit. The Hysteresis loop is formed.

d) Adjust the horizontal and vertical gains such that the loop occupies maximum area on the screen of the CRO. Once this adjustment is made do not disturb the gain controls.

e) Trace the loop on a translucent graph paper. Estimate the area of the loop.

f) Remove the connection from CRO without disturbing the horizontal and vertical gain controls.

g) Determine the vertical sensitivity of the CRO by applying a known AC voltage say 1 volt (peak to peak). If the spot deflects by X cms for 1 volt, the vertical sensitivity is 10^2 / X (volt/m). Let it be S_V).

OBSERVATION TABLE:

Resistance R_1 (Ω)	Horizontal Sensitivity S_H (V/m)	Vertical Sensitivity S_V (V/m)	Area of the loop (m^2)	Energy loss (joule/m^3/cycle)
5				
22				
47				

h) Determine the horizontal sensitivity of CRO by applying AC voltage say 1 volt (peak to peak). Let the horizontal sensitivity be S_H

$$E_L = \frac{N_1}{N_2} \times \frac{R_2}{R_1} \times \frac{C_2}{AL} \times S_V \times S_H \times Area\ of\ the\ loop\ in\ m^2 \quad joules/m^3/Cycle$$

RESULT : The energy loss per unit volume per cycle is ... joule/m^3/cycle.

Discussion of Result

EXPERIMENT 9

MEASUREMENT OF RESISTANCE AND CALIBRATION OF AMMETER USING DC POTENTIOMETER

AIM: To calibrate the given D.C Voltmeter using D.C. Potentiometer.

APPARATUS: R.P.S, A sensitive galvanometer, D.C. Crompton's Potentiometer, Voltmeter, Ammeter, Rheostat, Standard cell and Standard resistance.

THEORY:

A potentiometer is an instrument used for the measurement of unknown EMF by a known potential difference by the flow of current in a network. This is used where precision required is higher than that of ordinary deflection instruments. By using in addition, a standard resistance, current can also be measured.

The potentiometer works on the principle of opposing the unknown EMF by a known EMF. A simple arrangement is shown in the Fig.1.

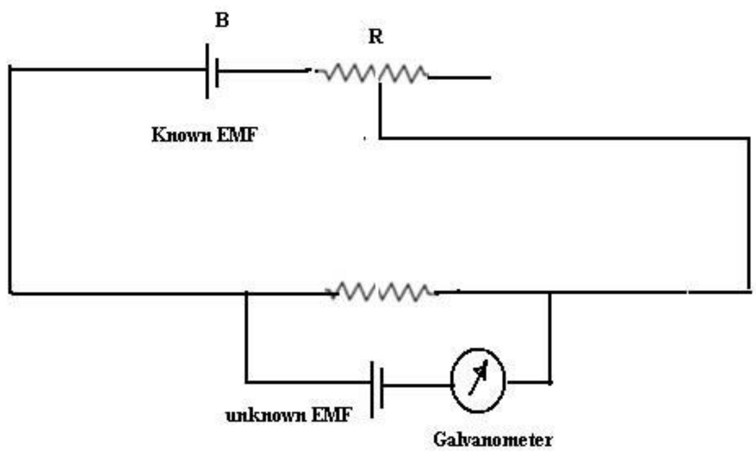
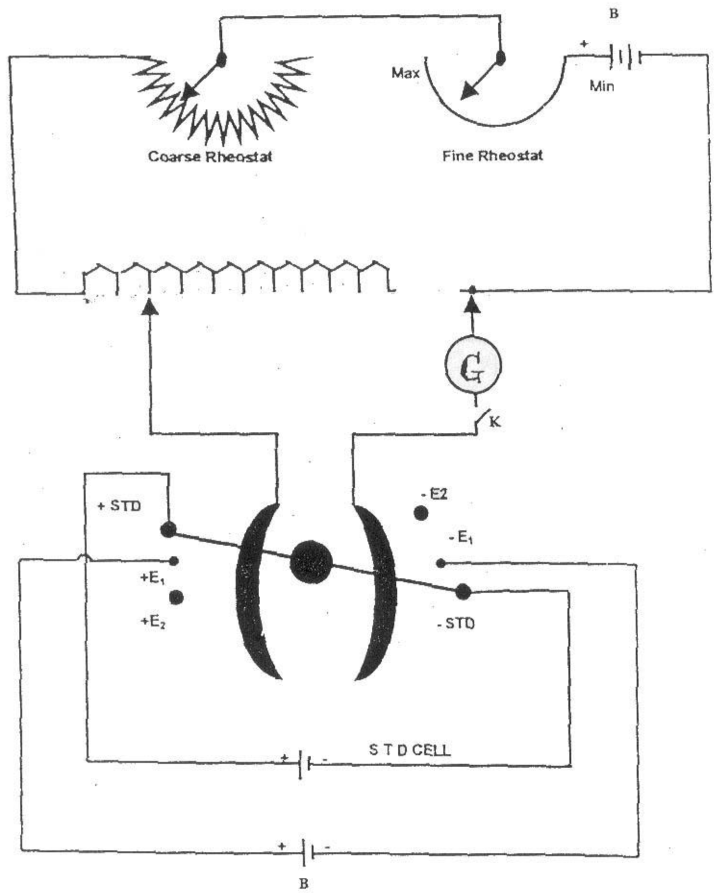


Figure - 1

The unknown EMF is connected in parallel with and in opposition to a voltage drop in a resistor as shown in the Fig. By varying the current in the resistor with fine adjustment, any desired voltage can be obtained. This voltage drop is measured accurately after calibration with a known EMF (standard cell).



a)CALIBRATION OF AMMETER:

PROCEDURE: PROCEDURE:

1. Make the connections as shown in the Fig.2.
2. Switch the D.C. Supply and adjust it to 2V keeping all the potentiometer dials to zero position.
3. Standardize the potentiometer as follows:

   Connect the standard cell whose EMF is 1.0186v to the terminal Std. cell. Set the main knob at 1.0v and the circular dial at 18.6 divisions (since each division corresponds to 0.25/250=0.001v).

   The switch is to be kept at STD position. Now the coarse and fine rheostats are so adjusted that there is no deflection in the galvanometer when Galv. Key is pressed. Now the system is pressed. Now the system is ready.

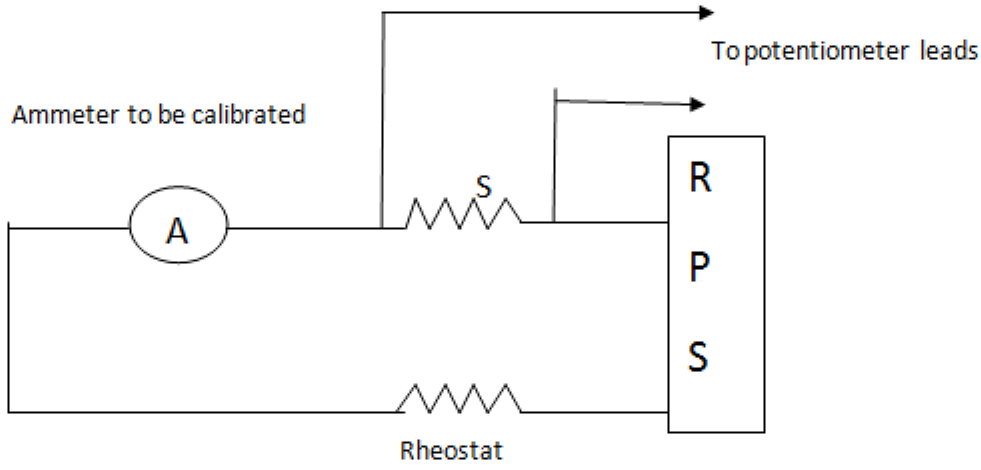


FIG: 3

4.The ammeter to be calibrated is connected as shown in fig-3.the unknown current whose value is to be determined is passed through a standard resistance.

5. Voltage across the standard resistance is obtained by means of the potentiometer, following the procedure described in part-1

$$\text{UNKNOWN CURRENT} = \frac{\text{VOLTAGE ACROSS S(measured)}}{\text{Resistance of S}}$$

6. For different values of the current obtained by varying the series rheostat, tabulate the readings of Ammeter(A), voltage drop and calculate the measured current and %Error.

S.No.	Resistance(R) Ohm	Ammeter reading(I_m)A	Potentiometer reading(E_2)	Current in circuit(I_c)mA	%E= (Im-Ic)/I_m*100
1					

b)MEASUREMENT OF RESISTANCE

The voltage drop across the unknown resistance is V_r

The voltage drop across the resistance is V_s

$V_R=IR$

$V_S=IS$

$V_R/ V_S=IR/IS$

$V_R/ V_S=R/S$

$R= (V_R/ V_S)S$

The accuracy of unknown resistor depends upon the value of standard resistor.

RESULT:

Calibration of D.C ammeter is performed and resistance is measured using D.C potentiometer**.**

DISCUSSION OF RESULTS:

Comment on the calibration of ammeter and explain the need of calibration.