Department Of Physics

National Institute Of Technology, Silchar

Sub. Code: PH – 111 LTPC 0032

ALL EXPERIMENTS ARE COMPULSORY :

1. TO CALIBRATE AN AMMETER WITH THE HELP OF A POTENTIOMETER.
2. TO STUDY THE TWIST IN THE THIN ROD BY STATICAL METHOD USING BARTON'S HORIZONTAL APPARATUS AND THUS TO DETERMINE THE MODULUS OF RIGIDITY OF THE MATERIAL OF THE ROD.
3. TO STUDY THE BENDING OF A BEAM SUPPORTED AT ITS ENDS AND LOADED AT THE MIDDLE AND THUS TO DETERMINE THE YOUNG'S MODULUS OF THE MATERIAL OF THE BEAM.
4. TO DETERMINE THE WAVELENGTH OF SODIUM LIGHT BY SINGLE SLIT EXPERIMENT USING A SPECTROMETER.
5. TO STUDY THE TRANSVERSE WAVES OVER THE SONOMETER WIRES AND HENCE TO DETERMINE THEIR VELOCITY AND MASS PER UNIT LENGTH.
6. TO STUDY THE CHARGING AND DISCHARGING OF A CAPACITOR AND HENCE TO DETERMINE IT'S TIME CONSTANT.
7. TO DETERMINE THE REFRACTIVE INDEX OF THE MATERIAL OF A GIVEN PRISM USING A SPECTROMETER.
8. COMPARISON OF TWO LOW RESISTANCES BY A POTENTIAL DROP METHOD BY USING A METER BRIDGE
9. TO STUDY THE VARIATION OF MAGNETIC FIELD WITH DISTANCE ALONG THE AXIS OF A CIRCULAR COIL CARRYING CURRENT BY PLOTTING A GRAPH.

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Department of Physics

Physics laboratory, BTech 1st and 2nd Semester.

EXPERIMENT NO. 1

AIM

Calibration of a given ammeter using a potentiometer

APPARATUS REQUIRED

Potentiometer, Milliammeters, Rheostats, Keys, Galvanometer, Resistance Boxes, Shunt resistance, Battery, Leclanche cell.

THEORY:

Calibration of an instruments means standardization of the instrument with reference to another standered similar instruments or some calculated theoretical values.

Let i be the current flowing through the low resistance **r** the potential difference at the end of the resistance r is = i.r

This potential difference is balanced by the length L of the potentiometer wire, then

$$i.r = L.e \qquad \text{(i)}$$

Where e= potential difference per cm of the potentiometer wire.

I = current in the potentiometer circuit

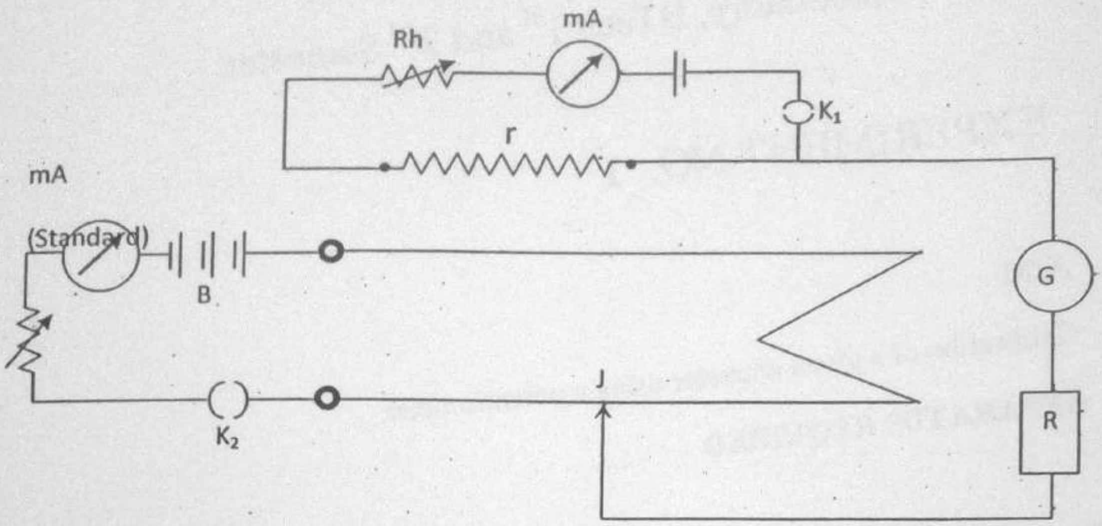
R= total resistance of the potentiometer wire.

Again, $e = I.R/1000$ (Total length of the potentiometer wire = 1000 cm)

Substituting the value of e in equation (i)

$i.r = LRI/1000$

$i = LRI/1000\,r$ mA



Circuit Diagram

PROCEDURE:

1. By adjusting rheostats in the potentiometer and resistance circuit and putting a suitable resistance in r, opposite deflections are obtained in first and last wire.
2. Current in the potentiometer is kept fixed and by adjusting R_{h2} and resistance r a current 'I' is allowed to flow in the resistance circuit. The corresponding null point is noted.
3. This current is found up by calculation (say i) . This I is actually the calculated value of 'I'.
4. The process is repeated by varying the current in the resistance circuit.
5. For calibration of given ammeter the observations for I should be taken corresponding to the whole range of the current in the milliammeter. A graph 'I' is plotted, calibration can be made after analysis of the graph.

TABLE-1

Resistance of the potentiometer wire (R) = ...

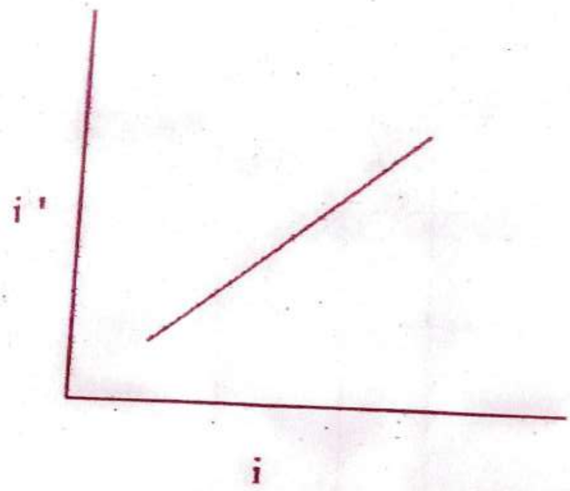
No. of obs.	Reading of the milliammeter to be calibrated i (mA)	Resistance r (box) Ω	Current in the standard milliammeter I (mA)	Balancing length (Lcm)			Calculated Current Reading $i' = IRL/1000r$ (mA)	Corrected $i-i'$ (mA)
				On wire no.	Scale reading	Total(Lcm)		

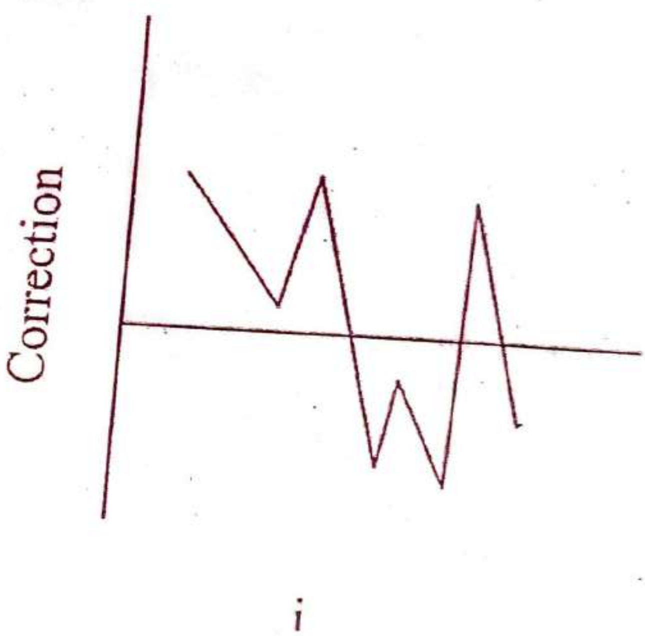
The current is calculated using the formula given. Also the correction (ammeter reading - calculated current) is also found. If the calculated value is less than the ammeter reading, the correction is positive; if greater than the ammeter reading, the correction is negative.

A graph is drawn between ammeter reading (i) and calculated reading .(i').

Result:

The given ammeter is calibrated. The graphs were drawn for i vs i′ and i vs (i-i′). The graph is drawn between ammeter reading (i) and correction (i-i′).





PRECAUTIONS:

1. All connections must be checked and should be tight during experiment.
2. EMF of B must be grater than EMF of C.
3. The $^{+}$ Ve of potentiometer battery B and that of EMF C must be joined to the same end of the potentiometer.
4. The potentiometer circuit should be kept closed only for the time which is necessary to find the null point otherwise null point will shift due to heating of the potentiometer wire.

DISCUSSION:

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EXPERIMENT NO. 2

AIM

To study the twist in the thin rod by statical method using Barton's horizontal Apparatus and thus to determine the modulus of rigidity.

APPARATUS REQUIRED

Barton's horizontal apparatus, Slotted weights, Screw gauge, Inextensible string and Meter Scale.

THEORY:

Barton's horizontal apparatus is sometimes used for the determination of ή for comparatively thick wires. In this apparatus one end of the experimental rod is rigidity clamped to a block and other end is attached to a steel axle fixed at the centre of the pulley of large diameter. Both the block and bearing are firmly fixed to a shout base board. A weight can be hanged on one of the pulley to twist the horizontal rod. The angles of twist of the rod at two different distances from the fixed end of the rod are measured with the help of pointers P_1 and P_2 which on the scale S_1 and S_2.

If a mass M is hanged with a chord on the pulley of diameter D the external torque developed is

$$\tau = MgD/2$$

This torque will produce twist in the rod. At equilibrium, it is to equal to restoring couple $\pi ή r^4 \theta / 2l$

Therefore, $$\frac{\pi\eta r^4\theta}{2l} = \frac{MgD}{2}$$

Or, $\eta = MgDl / \pi r^4\theta$

If θ is in degrees then , θ will be replaced by $(\theta\pi / 180)$, hence

$$\eta = 180MgDl / \pi^2 r^4 \theta$$

For angles of twist θ_1 and θ_2 at distances l_1 and l_2 from the fixed end, we get

$$\eta = 180MgD(l_2 - l_1) / \pi^2 r^4 (\theta_2 - \theta_1)$$

Since the rod is basically a thick wire, therefore weights are placed in steps of 0.5 kg on the hanger , and the angles of twist at distances l_1 and l_2 , are measures with the pointers P_1 and P_2 of the horizontal Barton's Apparatus.

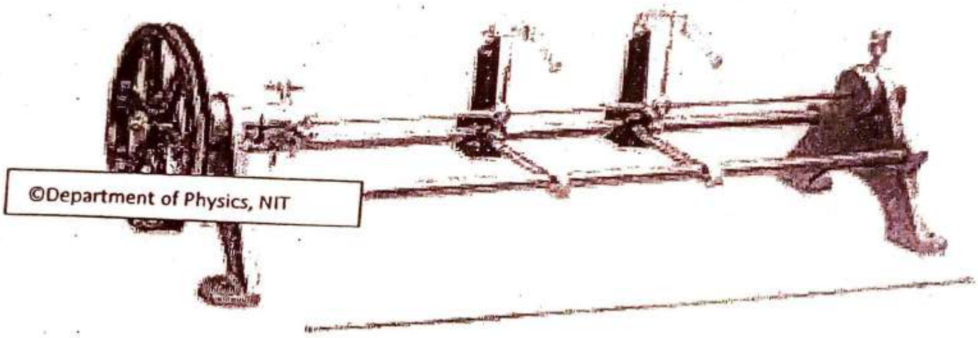


Fig : Barton's Horizontal Apparatus

PROCEDURE	1) The semicircular scales with two pointers are clamed at suitable distances from the end of the rod and the pointers are adjusted at 0-0 readings before starting the experiments. 2) A half kg weight is put on the hanger and readings of both the pointers are noted on the respective scales . The loads are increased by regular steps of half kg till maximum load 3 kg is applied and the corresponding readings are noted time. 3) Now the weights are decreased in regular steps of half kg and the corresponding readings are recorded each time. 4) The hanger is shifted to the other side of the pulley and the steps 2and 3 are repeated.

	5) The mean value of twist θ_1 and θ_2 are obtained for same load. 6) The distance between two scales is measured with a meter scale. 7) The diameter of the rod is measured with a screw gauge. 8) The circumference of the pulley is measured with the help of a thread and a meter scale and thus the diameter of the pulley is calculated.

Observations and Calculations:	Distance of the 1st pointer from the fixed end l_1 :	Cm
	Distance of the 2nd pointer from the fixed end l_2:	Cm
	Distance between two pointers $l_2 - l_1$	Cm

Tabulations:

(A) Load v/s twist data

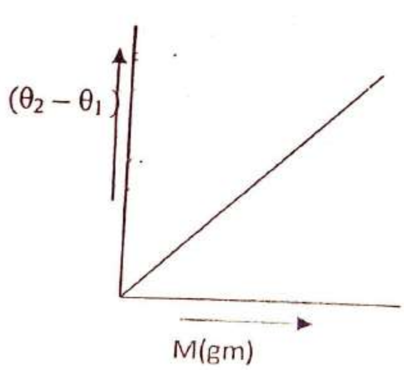
Serial number	Load on each pan	Reading of 1st pointer (Θ_1)				Reading of 2nd pointer (Θ_2)				Mean (Θ_1)	Mean (Θ_2)	Mean ($\Theta_1 - \theta_2$)
		Copy left to pulley		Copy right to pulley		Copy left to pulley		Copy right to pulley				
		Load increasing	Load decreasing	Load increasing	Load decreasing	Load increasing	Load decreasing	Load increasing	Load decreasing			
1.												
2.												
3.												
4.												

B) Table for determination of the radius of the rod

Pitch of the screw gauge	
Least count of the screw gauge	
Zero error of the screw gauge	

	No.of obs..	Linear scale Reading (N)	Circular scale Reading (r)	Value of CSR (r x L.C)	Total reading (N+R x L.C)	Mean diameter(d)	Corrected diameter (d)	
	1.							
	2.							
	3.							

Corrected radius(r)	
Graph	Draw the twist v/s load curve with load along X-axis and the corresponding mean values of $\theta_2 - \theta_1$ along Y-axis . The graph will be a straight line passing through origin.



CALCULATION:

The value of D (Diameter of the Pulley) = ---------
The value of r (Radius of the rod) = -----------
The distance between two pointers $l_2 - l_1$ = -----------
The value of M/ $(\theta_2 - \theta_1)$ from graph =-----------
Acceleration due to gravity g = -----------
Hence, η can be calculated from eqn.(4)

REFERENCE:

1) University Practical Physics, D.C.Tayal, HPH
2) Mechanics D.S. Mathur, S.Chand.
3) A textbook of practical physics , Dr.Samir Kumar Ghosh, Central publishers .

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EXPERIMENT NO. 3

AIM

To study the bending of beam supported at its ends and loaded at the middle and thus to determine young's modulus of the material of the beam.

APPARATUS REQUIRED

A metallic beam of uniform cross-section and of length 1m, spherometer , two sharp edges , a hanger with knife edge, slotted 0.5kg weights, leclanche or dry cell, shunted galvanometer, rheostat , key ,screw gauge , vernier caliper and a meter scale .

THEORY

Let a beam be supported on two knife edges A and B distance L apart and loaded in the middle at O with a weight W as shown in figure.

The upper reaction at each knife edge being W/2 and middle part of the beam being sensibly horizontal. It may be taken to be combination of two inverted cantilevers OA and OB each of the effective length L/2, and fixed at O and bending upwards under a load W/2 acting at A and B.

Considering the section PB of the cantilever OB, say a distance x from its fixed ends O , we have

Moment of bending couple due to load $W/2 = (W/2)(L/2-x)$

The beam being in equilibrium, this must be balanced by the bending moment YI_g/R

Where,

R is the radius of curvature of the section at P.

Y is the value of young's modulus of the material of the beam.

Ig is the geometrical moment of inertia of the beam .

For rectangular cross-section

$Ig = bd^3/12$

Where,

b is the breadth and is the thickness of the beam

Now the curvature ,

$1/R = (d^2y/dx^2)/[1+(dy/dx)^2]^{3/2}$

When dy/dx is small $1/R = (d^2y/dx^2)$

Now ,

$YIg/R = W/2[(L/2)-x]$

$YIg(d^2y/dx^2) = W/2[(L/2)-x]$

Integrating ,

$dy/dx = [W/2YIg[L(x/2)-(x^2/2)]+C$

at $x=0$, $dy/dx=0$, we have $C=0$.

$dy = [W/2YIg[L(x/2)-(x^2/2)]dx$

Integrating between limit $x=0$ to $x=L/2$

$Y = W/2YIg[(L^3/16)-(L^3/48)] = WL^3/48YIg$

Replacing Ig,

$Y = 12WL^3/48Ybd^3$

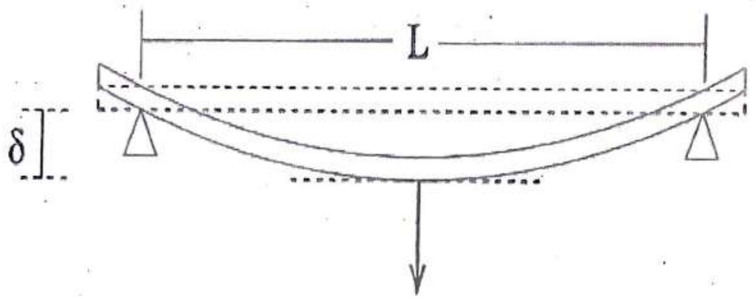
Again W=Mg

Hence,

$$y = MgL^3/4Ybd^3$$

Therefore,

$$Y = (M/y)\, gL^3/4bd^3$$



Beam supported at its two ends and loaded at the middle.

PROCEDURE:

1) The beam AB is placed on the knife-edges K_1 and K_2 symmetrically and horizontally. The distance between the knife-edges are measured with meter scale and the breadth and thickness of the rectangular beam at various positions are measured with vernier caliper and screw gauge respectively.

2) A hanger is suspended from a stirrup, which is resting at the middle of the beam with the knife-edges. A spherometer is placed just above this knife-edge; a cell rheostat, key and galvanometer are connected in series with the spherometer and beam as shown in figure 2.

3) As soon as the central spherometer touches the beam, deflection occurs in the galvanometer. When the central leg or spherometer screw just touches the beam or deflection in the galvanometer is just appeared, the corresponding spherometer reading is noted. Weights are increased on the hanger in steps of 0.5 kg and spherometer readings are observed every time when the galvanometer just shows deflection.

4) The observations are repeated by decreasing the loads in the steps of 0.5 kg and noting each time the spherometer readings. This time the spherometer is rotated in the reverse direction and the readings are taken when the galvanometer readings just disappears.

5) Thus the mean depression δ for the various loads applied on the beam is measured.

6) Graph is plotted between M and δ and from it M/δ is obtained. This result is compared with that obtained from observation table by difference method.

OBSERVATION

(A) Length of the bar/beam between two knife edges = cm

(B) Measurement of the breath of the beam:

Least count of the vernier calipers = cm

Zero error of the vernier calipers = cm

Table:1 Measurement of the Breadth of the beam:

V.S.R=Vernier coincidence x Vernier constant

Sl.no.	MSR(m) (cm)	VS(n) (cm)	Value of VSR(p) P=n*L.C (cm)	Total m+p (cm)	Mean breadth(b) (cm)

Mean Breadth = ...cm

Corrected breadth = ...cm

(C) Measurement of thickness of the beam:

Pitch of the screw=..........cm

Least count of the screw gauge=........cm

Zero error of the screw gauge=........cm

Table: 2 Measurement of the thickness of the beam:

Sl no.	LSR(m) (cm)	CSR(n) (cm)	Value of CSR P=n*L.C	Total(m+p=d) (cm)	Mean thickness(d) (cm)

Corrected mean thickness= ....cm

Corrected thickness= ....cm

(D) Measurement of Depression of the beam:

Pitch of the spherometer=..........cm

Table: 3

	Loading				Unloading					
Load(gm)	Initial CSR(a)	No. of complete rotations of CS(n)	Final CSR(b)	Total(T1) =n*Pitch+(b-a)*LC	Initial CSR(a)	No. of complete rotations of CSR(n)	Final CSR(b)	Total(T2) =n*Pitch+(a-b)*LC	Mean (T1+T2/2)	Depression (δ)

GRAPH

A graph is plotted between the load M and the depression δ.

The slope is obtained from the linear part of the curve.

CALCULATION

Slope M/δ from the graph=.........

For rectangular bar $Y=(M/\delta)gl^3/4bd^3$ =.........

Y is calculated by using $Y=(M/\delta)$ both by difference method and by the slope of the curve .

RESULT

Young's modulous of the beam of the material:

Graphical method = ...N/m^2

Difference method = ... N/m^2

Percentage of error=.........

PRECAUTION AND DISCUSSION:

References:

1.University Practical Physics,D.C.Tayal

2. Mechanics ,D.S.Mathur, S.Chand

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EXPERIMENT NO. 4

AIM

To study the diffraction pattern at a single slit and to determine the wave length of the monochromatic light.

APPARATUS REQUIRED

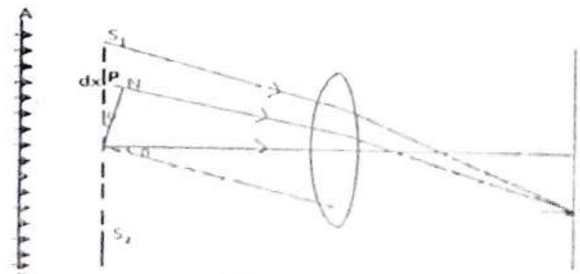
Spectrometer, a single slit, and travelling microscope.

THEORY

Let a plane wave front AB (shown in figure)of monochromatic light of wavelength λ falls normally on the surface of a narrow slit S_1S_2 of width 'a'. Each point of the wave front in the plane of the slit may be regarded as a source of secondary wavelets. The complex light disturbance at the midpoint O of the slit may be represented by $A = Ae^{i\omega t}$ where A is the amplitude and ω is the circular frequency of the wave. The phase difference between the waves at Q coming from O and P (at a distance x from O) is given by

$$\frac{2\pi}{\lambda} \times PN = \frac{2\pi}{\lambda} x \sin\theta = lx \text{ where } l = \frac{2\pi}{\lambda} \sin\theta \text{ ....(i)}$$

Hence the disturbance at Q due to secondary waves from P is proportional to $e^{i(\omega t - lx)}$



Diffraction in a single slit

The disturbance at Q due to element dx is

$$dy = CAdxe^{i(\omega t - lx)} \text{ ....(ii)}$$

Where C is a proportionality constant.

Thus the disturbance at Q due to all the diffracting element

$$y = \int_{\frac{a}{2}}^{\frac{-a}{2}} CAe^{i(\omega t - lx)}\, dx$$

$$= CAa \frac{\sin\frac{la}{2}}{\frac{la}{2}} e^{i\omega t} \text{ ....(iii)}$$

The resultant intensity I at Q is obtained by multiplying y with its complex conjugate. Thus

$$I = y.y^* = I_\circ \frac{\sin^2\alpha}{\alpha^2} \quad \text{where} \quad I_\circ = (CA\alpha)^2 \text{ and } \alpha = \frac{la}{2} = \frac{\pi}{\lambda} a\sin\theta$$

The \ maxima and minima intensities are given by

$$\frac{dI}{d\alpha} = 0$$

Hence either $\sin\alpha = 0$ .... (iv)

Or $\alpha = \tan\alpha$ ....(v)

Condition (i) will give minima and condition (ii) will give mixima.

Thus for minima $\sin\alpha = 0$

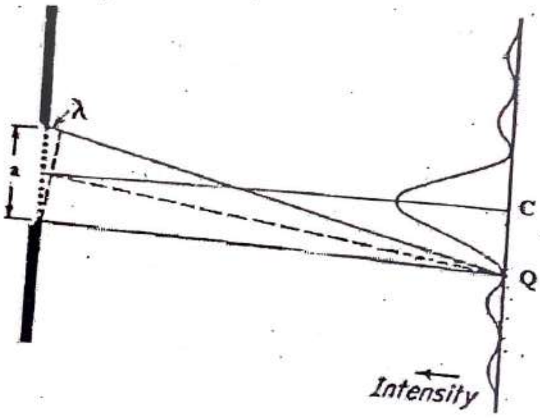
or $\alpha = m\pi$, $m = \pm 1, \pm 2 \pm 3 \pm 4$ ... ... etc

$a \sin\theta = m\lambda$

For mixima equation (ii) has solution

$\alpha = 0$ *or* $\pm (2m+1)\pi$, m= 1,2, 3........ etc.

Figure below shows the intensity distribution in the diffraction pattern due to a single slit



Procedure.

1. Adjust the spectrometer and focus for parallel rays.
2. Mount a single slit and adjust the spectrometer to obtain the diffraction bands.
3. Record the position of the different bright bands on both sides of the central maxima.
4. The diffraction angle θ is half the angular separation between the dark bands of same order.

Observation:

Table 1:

Verification of slit width with travelling microscope

Sl.no	Crosswire to the left end			Crosswire to the right end			Slit width a= | a-b |
	M.S.R	V.S.R	Total (a) =(M.S.R +V.S.R) × v.c	M.S.R	V.S.R	Total (b) = (M.S.R +V.S.R) × v.c	
1							
2							
3							

Table 2:

Measurement of the diffraction angle θ for the slit of width a = ...cm
Least count of spectrometer = ...

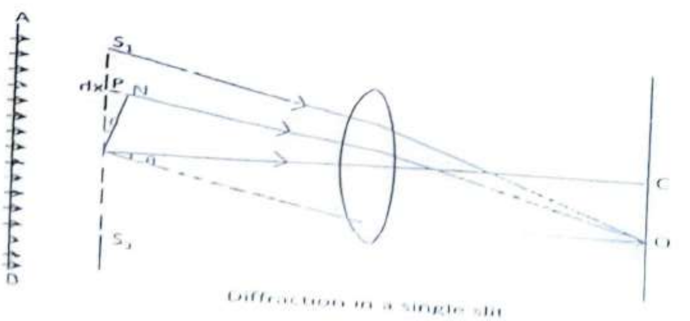
Sl. no	Order of Bright ring(m)	Vernier	Telescope in the left side			Telescope in the right side			2θ = (a-b)	Mean θ	Sin θ
			M.S	V.S	Total (a)	M.S	V.S	Total (b)			
1	5										
2	4										
3	3										
4	2										
5	1										

GRAPH: Plot a graph between $\sin \theta$ and m (no. of the bright band). The slope of this linear curve when multiplied by slit width gives the wave length of light. T

Hence $\lambda = a \sin \theta / m =$ ....

Find the percentage error.

And write precaution and discussion



Diffraction in a single slit

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EXPERIMENT NO. 5

AIM

To study the transverse waves over the sonometer wires and hence to determine their velocity and mass per unit length.

APPARATUS REQUIRED

Sonometer wires of different materials, weights, magnet, step down transformer.

THEORY

When a wire carrying an electric current is placed in a magnetic field acting normally to the direction of the current, the wire experiences a force perpendicular to the direction of the magnetic field and current. For a particular length of the wire it is thrown into resonance and is observed by large amplitude of vibration. If the current is alternating the force also alternates in direction and the periodicity of this force is the same as that of A.C. This condition is achieved when the frequency of the alternating current passing through it matches with the natural frequency of the wire. The frequency of the alternating current can be obtained by the eqn. (1)

$$n = (p/2l)\,[(T/m)^{1/2}] \qquad (1)$$

where,

T = tension on the wire,

$m =$ mass per unit length of the wire

$l =$ resonating length of the vibrating wire

$p =$ number of segments in which the wirevibrates

(say 1,2,3,....etc.)

The velocity v of the transverse wave is given by the relation

$$v = n\lambda. \quad (2)$$

Where, λ is the wave length.

For the vibration in the fundamental mode, there is a single loop between the bridges of the sonometer. Thus, the length of the wire between the bridges $l = \lambda/2$ or, $\lambda = 2l$ for p number of loops between the bridges.

We have,

$$l = p\lambda/2 \text{ or } \lambda = 2l/p.$$

Therefore, $$v = 2nl/p \quad (3)$$

From eqn (1) and (3) velocity of the wire can be expressed as

$$v = (T/m)^{1/2} \quad (4)$$

Thus, for a particular wire with a fixed tension 'T' applied, v remains constant and for a fixed m, v^2 varies with T.

The mass per unit length of each wire can be obtained from the slope of T/v^2 graph

PROCEDURE:

1. A suitable weight is now put on the hanger. After putting the transformer switch on and placing the wire in the magnetic field, the movable bridge is slowly moved. For a particular position of the bridge the wire is thrown into a violent resonant vibration and the amplitude is maximum.
2. The length of the vibrating wire is noted. The tension corresponding to this length which includes the mass of the pan is also recorded.
3. The process is repeated for three or more different tensions..
4. The same procedure is followed and reading are taken for wires of different materials.

OBSERVATIONS:

Mass of the pan(M) = ...

Mass on the pan(m) = ...

Frequency of the vibration (n) = 50 Hz

Tension T = [(M+ m) ×g]

TABLE: 1

No. of Obs.	No. of Loops (p)	Tension Applied (T)	Resonating Length (l)	v=2nl/p	Mean (v)	v^2
1	1	T_1				
	2					
	1	T_2				
	2					
	1	T_3				
	2					

Repeat the same table for other two wires.

GRAPHS:

The graph T Vs v^2 is plotted for the given wires and hence the mass per unit length is obtained.

RESULTS:

Sources of error & Precautions should be mentioned.

PRECAUTIONS & DISCUSSIONS:

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EXPERIMENT NO. 6

Aim of the Experiment:

(i) To study the charging and discharging of a capacitor

(ii) To measure the time constant characterizing charging / discharging process and compare the experimental RC time constant with theoretical RC time constant.

Apparatus: D.C. Voltage source (12V), resistors, a capacitor, digital multimeter, connecting wires.

Theory:

I. The basic circuit for charging and discharging a capacitor is shown in Figure1. If S_1 is closed (by connecting terminal 1 to terminal 2) keeping S_2 open, then the battery charges the capacitor and current flows through the resistor R_1 until the capacitor is fully charged. If the charge on the capacitor at time **t** is **q(t)**, then the voltage across the capacitor **C** is **q/C** and the current through R_1 is i= dq/dt.

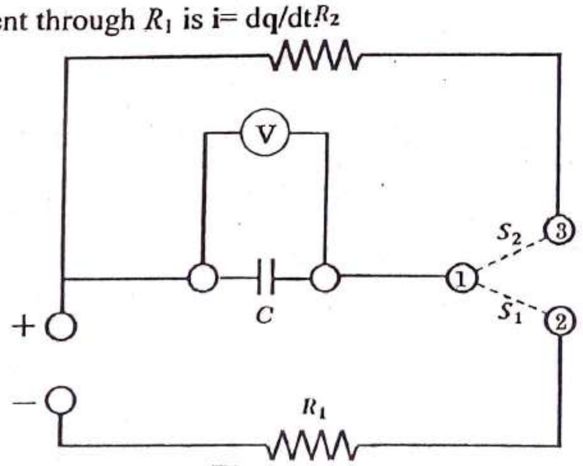


Figure 1

By applying Kirchoff's second law,

$$iR_1 + \frac{q}{C} = \varepsilon$$

$$R_1 \frac{dq}{dt} + \frac{q}{C} = \varepsilon \tag{1}$$

Which has the solution,

$$q(t) = C\varepsilon\left(1 - e^{-\frac{t}{R_1C}}\right) = q_0\left(1 - e^{-\frac{t}{R_1C}}\right) = q_0\left(1 - e^{-\frac{t}{\tau}}\right) \tag{2}$$

Where, $q_0 = C\varepsilon$ and $\tau = R_1C$.

The quantity $\tau = R_1C$is the charging time constant which characterizes the rate at which charge is deposited on the capacitor.As $t \to \infty$, equation (2) shows that $q \to C\varepsilon = q_0$. In practice the capacitor charges to its maximum value q_0(asymptotically) after a time interval equal to a few time constants. Once the capacitor is fully charged then the current i through the resistor become zero.

II. At this point if the switch S_1 is opened (by disconnecting terminal 1 to terminal 2) and S_2 is closed (by connecting terminal 1 to terminal 3) the charge in the capacitor discharges through the resistor R_2.

By Kirchoff's second law, $R_2\left(\frac{dq}{dt}\right) + \left(\frac{q}{c}\right) = 0$,with the solution (taking $q = q_0$ at t=0)

$$q(t) = q_0 e^{-\frac{t}{R_2C}}$$

Thus the charge on the capacitor decays exponentially with time. In fact after a time $t = R_2C$ (equal to the discharging time constant) the charge drops from it's initial value $q_0$by a factor of e^{-1}.

Observations and results:

R_1 = ...

R_2 = ...

C = ...

Table I

(For charging capacitor)

Sl. No.	Voltage (Volt)	Current I (μA)	Charging time t (Sec)
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			

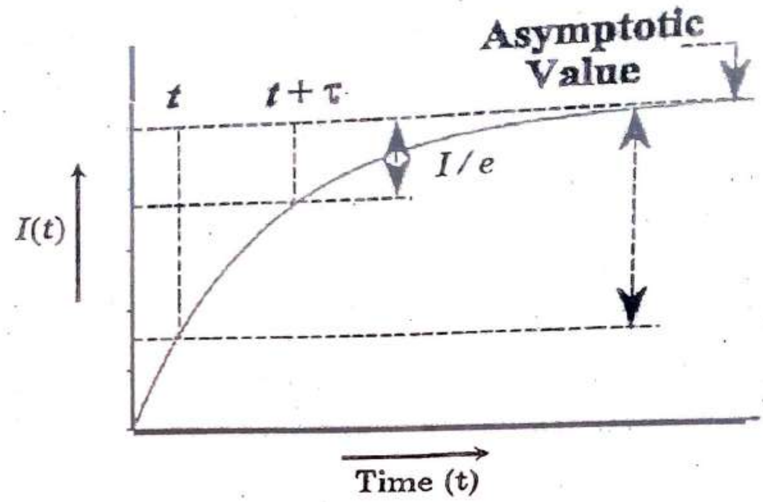
Table II

(For discharging capacitor)

Sl. No.	Voltage (Volt)	Current I (μA)	Discharging time t (Sec)
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			

GRAPH:

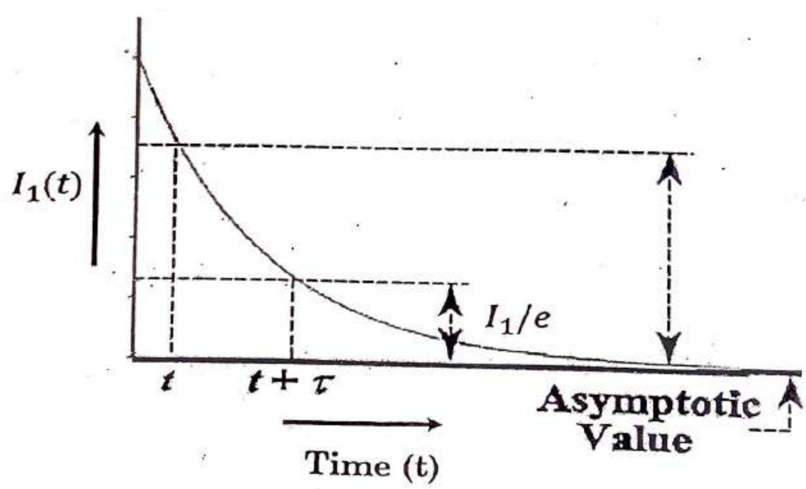
Figure 2 illustrates the variation of current *I(t)* through capacitor during charging. The current increases, but still approaches a constant value asymptotically.



During charging

Figure 2

Figure 3 illustrates the variation of current $I(t)$ throughcapacitor during discharging. The current decreases, but still approaches towards a constant value asymptotically.



During discharging

Figure 3

RESULT:

RC Time constant for given combination

Theoretical value. ($\tau = R1C$) t = ____________ sec

Theoretical value ($\tau = R_2C$) t = ____________ sec

Practical value (from graph) t = ____________ sec

PRECAUTION AND DISCUSSION:

National Institute of Technology Silchar

Department of Physics

Physics laboratory, BTech 1st and 2nd Semester.

EXPERIMENT NO. 7

AIM

To determine the refractive index of a prism by using a spectrometer.

APPARATUS REQUIRED

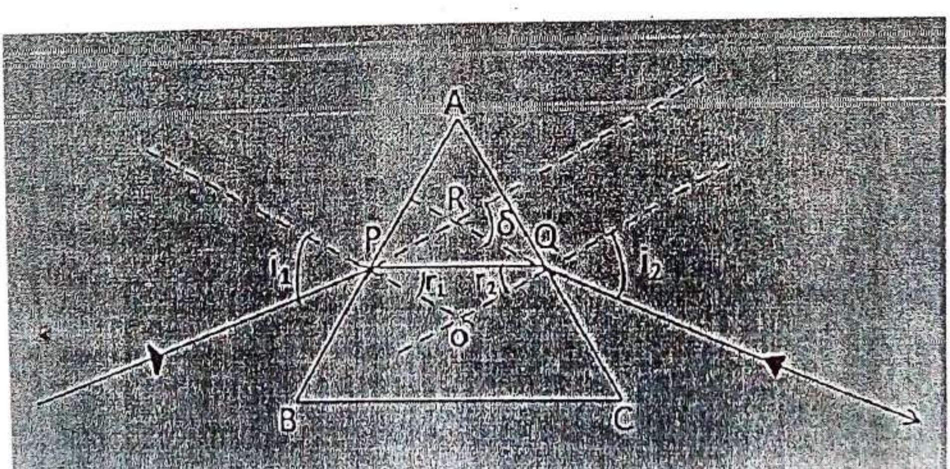
Spectrometer, prism, Sodium vapour lamp, spirit level and reading lens.

FORMULA USED

The refractive index of the prism is given by the following formula:

$$\mu = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

Where A = angle of the prism, δm = angle of minimum deviation.



Let IP be the incident ray falling at an angle of incidence i_1, at the first face of a prism. It is refracted along PQ and emerges out as QE.IP and QE are produced to meet at R. Let δ is the angle of deviation.

$$< OPQ = r_1 \,, < OQP = r_2$$

From the figure ,

$$\delta = <RPQ + <RQP$$

$$= (<RPO - <OPQ) + (<RQO - <OQP)$$

$$= i_1 - r_1 + i_2 - r_2$$

$$= 2i - 2r$$

Also, $$<A + <POQ = 180^0$$

(In minimum deviation position, $r_1 + r_2 = r$, $i_1 + i_2 = i$)

$$r_1 + r_2 + <POQ = 180^0$$

$$r_1 + r_2 = A$$

$$r = A/2$$

$$2i = \delta_m + A$$

$$i = (\delta_m + A)/2$$

PROCEDURE:

The following initial adjustments of the spectrometer are made first.

1. The spectrometer and the prism table are arranged in horizontal position by using the leveling screws.
2. The telescope is turned towards a distant object to receive a clear and sharp image.
3. The slit is illuminated by a mercury vapour lamp and the slit and the collimator are suitably adjusted to receive a narrow, vertical image of the slit.
4. The telescope is turned to receive the direct ray, so that the vertical slit coincides with the vertical crosswire.

(A) Measurement of the angle of the prism:

1. Determine the least count of the spectrometer.
2. Place the prism on the prism table with its refracting angle A towards the collimator and with its refracting edge A at the centre. In this casc some of the light falling on each face will be reflected and can be received with the help of the telescope.
3. The telescope is moved to one side to receive the light reflected from the face AB and the cross wires are focused on the image of the slit. The readings of the two verniers arc takcn.
4. The telescope is moved in other side to receive the light reflected from the face AC and again the cross wires are focused on the image of the slit. The readings of the two verniers are taken.
5. The angle through which the telescope is moved; or the difference in the two positions gives twice of the refracting angle *A* of the prism. Therefore half of this angle gives the refracting angle of the prism.

(B) Measurement of the angle of minimum deviations:

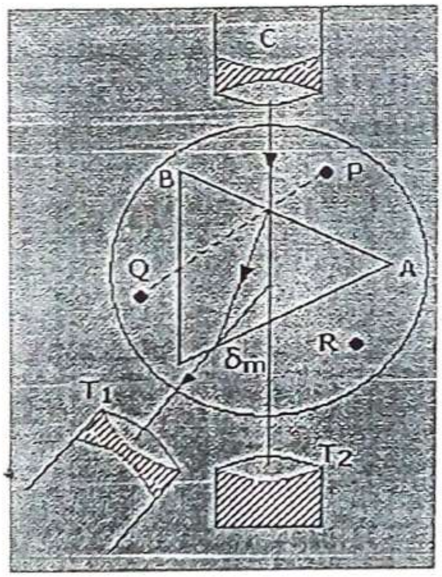
1. Place the prism so that its centre coincides with the centre of the prism table and light falls on one of the polished faces and emerges out of the other polished face, after refraction. In this position the spectrum of light is obtained.

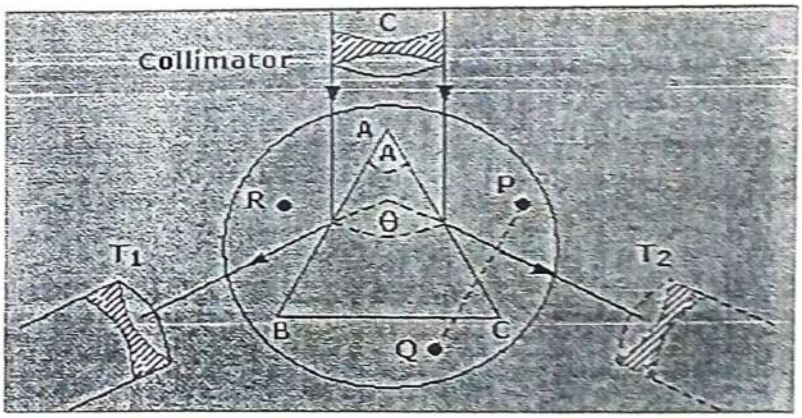
2. The spectrum is seen through the telescope and the telescope is adjusted for minimum deviation position for a particular colour (wavelength) in the following way: Set up telescope at a particular colour and rotate the prism table in one direction, of course the telescope should be moved in such a way to keep the spectral line in view. By doing so a position will come where a spectral line recede in opposite direction although the rotation of the table is continued in the same direction. The particular position where the spectral line begins to recede in opposite direction is the minimum deviation position for that colour. Note the readings of two verniers.

3. Remove the prism table and bring the telescope in the line of the collimator. See the slit directly through telescope and coincide the image of slit with vertical crosswire. Note the readings of the two verniers.

4. The difference in minimum deviation position and direct position gives the angle of minimum deviation for that colour.

5. The same procedure is repeated to obtain the angles of minimum deviation for the other colours.





Arrangement to determine the angle of prism.

Arrangement to determine the angle of minimum deviation

OBSERVATIONS:

(i) Value of the one division of the main scale = ... degrees
Total number of vernier divisions = ...
Least count of the vernier = ... degrees = ... second

(ii) Table for the angle (A) of the prism.

S.No	Vernier	Telescope reading for reflection						Difference $\theta = a - b = 2A$	Mean value of 2A	A	Mean A degrees
		from first face			from second face						
		MSR	VSR	TR (a)	MSR	VSR	TR (b)				
1	V_1										
	V_2										
2	V_1										
	V_2										

(iii) Table for the angle of minimum deviation (δm).

S.No	Vernier	Telescope reading for minimum			Telescope reading for direct image			Difference $\delta m = (a - b)$	Mean value of (δm)
		MSR	VSR	TR (a)	MSR	VSR	TR (b)		
1	V1								
	V2								

MSR = Main Scale Reading, VSR = Vernier Scale Reading,
TR = MSR+VSR = Total Reading.

CALCULATIONS:

Angle of the prism(A) = ...

Angle of minimum deviation(δm) =

RESULT

Refractive index for the material of the prism 'μ':

PRECAUTIONS AND DISCUSSIONS:

1. The telescope and collimator should be individually set for parallel rays.
2. Slit should be as narrow as possible.
3. While taking observations, the telescope and prism table should be clamped with the help of clamping screws.
4. Both verniers should be read.
5. The prism should be properly placed on the prism table for the measurement of angle of the prism as well as for the angle of minimum deviation.

National Institute of Technology Silchar

Department of Physics

Physics laboratory, BTech 1^{st} and 2^{nd} Semester.

EXPERIMENT NO. 8

AIM

Comparison of two low resistances by a potential drop method by using a meter bridge.

APPARATUS REQUIRED

Meter bridge, two low resistances (less than 1 ohm), commutator, four way key, galvanometer, cell, and rheostat.

THEORY

Two low resistances *ab* and *cd*, whose values are respectively R and X ohm, are connected in series and they are connected in parallel with the wire of the meter bridge as shown in the figure. If the whole system is connected in cell then the main current from the cell i is divided and flows through the two branches. One portion i_1 flows through the low resistance branch while the other portion i_2 flows through the meter bridge wire AB. If ρ be the resistance per unit length of the meter bridge wire AB and if a', b', c', d', be the equipotential points with a, b, c and d respectively then the potential difference between a'b' is $l_1 \rho i_2$(where l_1 = a'b') and that between c'd' is $l_2 \rho i_2$ (where l_2= c'd'). But in the low resistance circuit, the potential drop across R (between ab) is Ri_1 and that across X (between cd) is Xi_1. Since a', b', c', d' are equipotential points to a, b, c, d

hence,

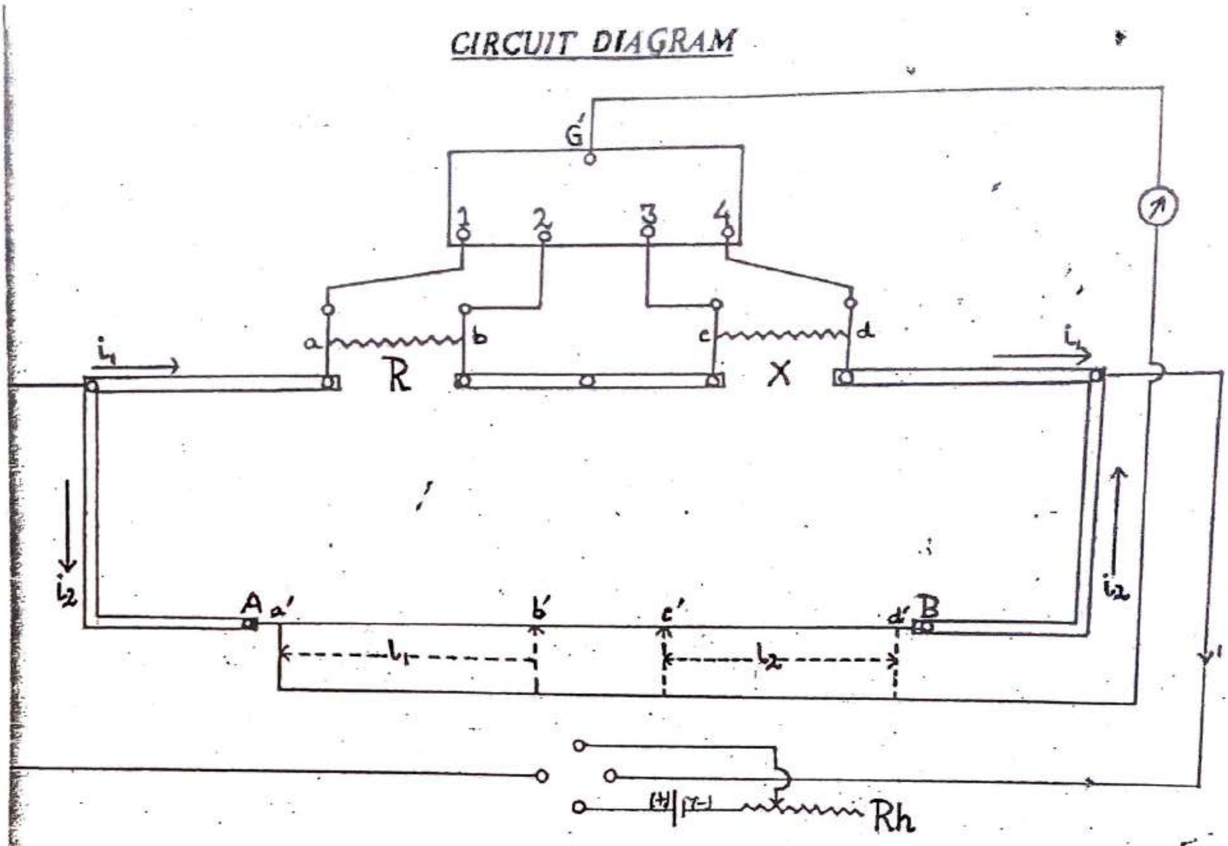
$$R\, i_1 = l_1 \rho\, i_2 \qquad \text{(i)}$$

and $$X\, i_1 = l_2 \rho\, i_2 \qquad \text{(ii)}$$

Hence ,

$$R/X = l_1 \rho / l_2 \rho = l_1/l_2 \qquad \text{(iii)}$$

Thus , by determining the values of l_1 and l_2, the ratio of the values of R and X can be calculated again if one of the values R and X be known , then the values of other unknown can be determined.



PROCEDURE

(i) The circuit connections are made as shown in figure. The connecting wires in the low resistance circuit, should be thick and short in length.

(ii) The points 1,2,3 and 4 of the four way is successively connected to the galvanometer through the point G' of the four way key and null points of the bridge wires are obtained for each point. These null points on the wire are respectively the points a', b', c', and d'. From the scale attached to the bridge the distance between a'b'($=l_1$) and c'd' ($=l_2$) are measured. These values l_1 and l_2 are employed in eq (iii) will give the value of the ratio of R/X.

(iii) The position R and X are interchanged and the whole process is repeated.

(iv) In these way the main current is altered by changing the values of rheostat and for two other values of the main current, the entire process is repeated.

(v) Thus the mean value of the ratio of R/X is obtained from all such values of the ratio R/X so obtained.

OBSERVATIONS:

(A) **Determination of the null points:**

Table: 1

Main Current	Resistance in the		Current	Null point corresponding to a,b,c,and d							
	Left gap	Right gap		a′	Mean of a′	b′	Mean of b′	c′	Mean of c′	d′	Mean of d′
Low	R	X	**Direct**								
			Reverse								
	X	R	**Direct**								
			Reverse								
Medium	R	X	**Direct**								
			Reverse								
	X	R	**Direct**								
			Reverse								
High	R	X	**Direct**								
			Reverse								
	X	R	**Direct**								
			Reverse								

(B) Determination of the ratio of the resistances:

TABLE : 2

No. of obs.	Mean Position of				$b' - a' = l_1$ cm	$d' - c' = l_2$ cm	$\frac{R}{X} = \frac{l1}{l2}$ or $\frac{l2}{l1}$	Mean Value of $\frac{R}{X}$
	a' (c m)	b' (cm)	c' (cm)	d' (cm)				

RESULT:

Hence the ratio $\frac{R}{X}$ = ...

PRECAUTION AND DISSCUSSION:

National Institute of Technology Silchar
Department of Physics

Physics laboratory, B.Tech 1st and 2nd Semester.

EXPERIMENT NO. 9

AIM

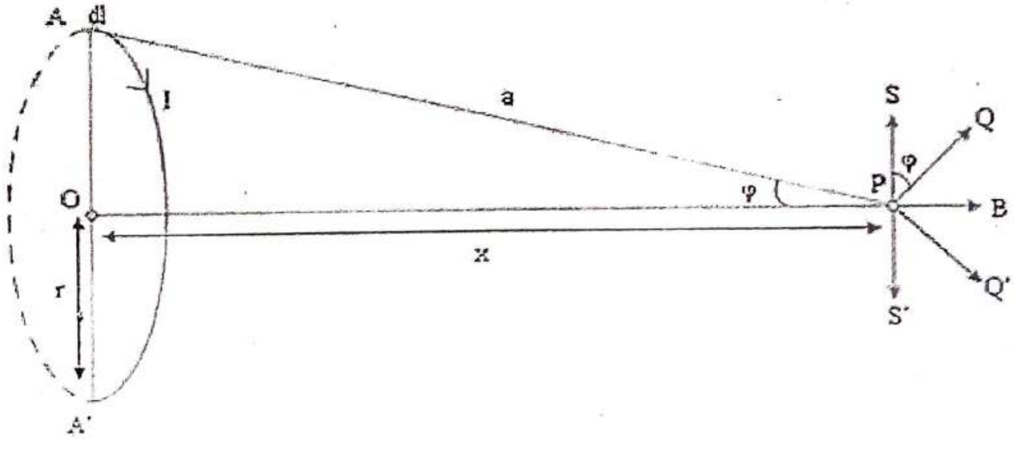
To study the variation of magnetic field with distance along the axis of a circular coil carrying current by plotting a graph.

APPARATUS REQUIRED

Circular coil Magnetic field apparatus, ammeter, rheostat, compass box, commutator, connecting wires.

THEORY

We know a current carrying wire generates a magnetic field. Now let us consider a circular coil of radius r, carrying a current I. Let P be a point , at a distance x from the centre of the coil. We can consider that the loop is made up of a large number of short elements, generating small magnetic fields. So the total field at P will be the sum of the contributions from all these elements. At the centre of the coil, the field will be uniform. As the location of the point increases from the centre of the coil, the field decreases.



By Biot- Savart's law, the field dB due to a small element dl of the circle, centered at A is given by,

$$dB = \frac{\mu_0}{4\pi} I \frac{dl}{(x^2 + r^2)} \qquad (1)$$

This can be resolved into two components, one along the axis OP, and other PS, which is perpendicular to OP. PS is exactly cancelled by the perpendicular component PS′ of the field due to a current and centered at A′. So, the total magnetic field at a point which is at a distance x away from the axis of a circular coil of radius r is given by,

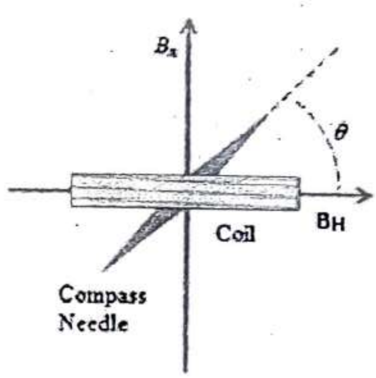
$$B_x = \frac{\mu_0 I}{2} \frac{r^2}{(x^2 + r^2)^{3/2}}$$

If there are n turns in the coil, then

$$B_x = \frac{\mu_0 n I}{2} \frac{r^2}{(x^2 + r^2)^{3/2}}$$

Where, I is the current in amperes flowing through the coil.

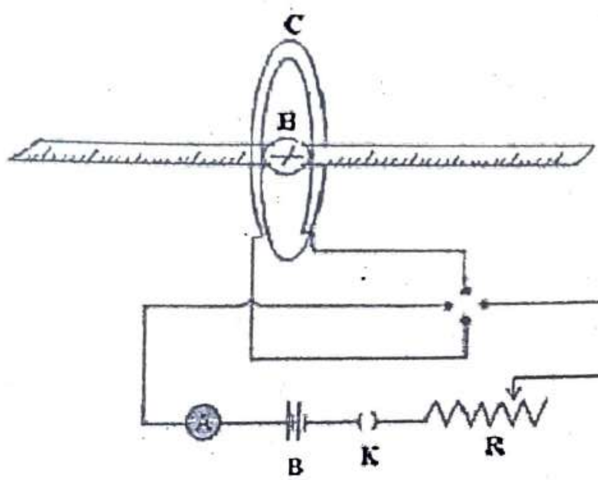
Since this field B_x from the coil is acting perpendicular to the horizontal intensity of earth's magnetic field, B_H, and the compass needle alligns at an angle θ with the vector sum of these two fields, we have from the figure below



Hence, $B = B_H \tan\theta$

Or, $B \propto \tan\theta$

Hence a graph between $\tan\theta$ and x will be similar to the graph between B and x. The horizontal component of the earth's magnetic field varies greatly over the surface of the earth. For the purpose of calculation, we will assume its magnitude to be $B_H = 3.5\times10^{-5}$ T.



C – circular coil

B – Compass box

A – ammeter

B - Battery eliminator

R - Rheostat

PROCEDURE

1. Place the instrument on the table so that the arms of the magnetometer lie roughly east and west and the magnetic needle lies at the centre of the vertical coil . Place the eye a little above the coil and rotate the instrument in the horizontal plane till the coil, the needle and its image in the mirror provided at the base of the compass box all lie in the same vertical plane. The coil is thus set roughly in the magnetic meridian. Rotate the compass box so that the pointer lies on the 0-0 line.

2. Connect the galvanometer to a battery , a rheostat, a one way key and an ammeter through a commutator as shown in fig. 1

3. Adjust the value of the current so that the magnetometer gives a deflection of the order of 60^0 -70^0. Reverse the current and again note the deflection. If the mean deflection in the two cases agrees closely, the coil lies exactly in the magnetic meridian. If the mean deflection in the two cases does not agree closely, slightly turn the instrument till the deflection with the direct and the reversed currents agree closely.

4. Now slide the magnetometer along the axis and find the position where the maximum deflection is obtained. In this position the centre of the needle coincides with the centre of the vertical coil.

5. Note the position of the arm against the reference mark A and also the value of the current as indicated by the ammeter. Read both ends of the pointer in the magnetometer, reverse the current and again read both ends.

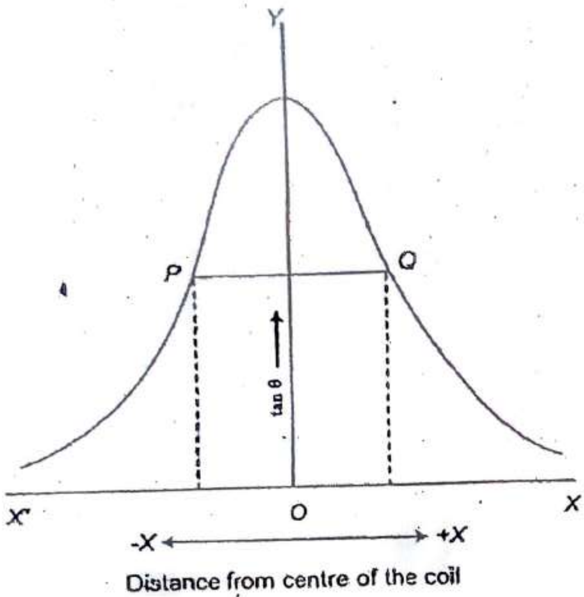
6. Similarly repeat the observation by shifting the magnetometer in the opposite direction and keeping the current const. at the same value

OBSERVATION

Current I =............amp.

Sl no	Distance From the centre(x)	Left side				Mean θ	tan θ	Right side				Mean θ	tan θ
		direct		reverse				direct		reverse			
		1	2	3	4			1	2	3	4		
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
14													
15													

GRAPH



Plot a graph between tanθ and x. The graph shows how the field varies along the axis of the coil.

PRECAUTION AND DISCUSSION: