Department of

Applied Sciences

LAB MANUAL

Enggineering Physics lab (BTPH 102)

B.Tech 1st Year – All branches [2012-13]

KCT COLLEGE OF ENGG & TECH, FATEHGARH

Punjab Technical University

Instructions for Laboratory

- The objective of the laboratory is learning. The experiments are designed to illustrate phenomena in different areas of Physics and to expose you to measuring instruments. Conduct the experiments with interest and an attitude of learning.
- You need to come well prepared for the experiment
- Work quietly and carefully (the whole purpose of experimentation is to make reliable measurements!) and equally share the work with your partners.
- Be honest in recording and representing your data. Never make up readings or doctor them to get a better fit for a graph. If a particular reading appears wrong repeat the measurement carefully. In any event all the data recorded in the tables have to be faithfully displayed on the graph.
- All presentations of data, tables and graphs calculations should be neatly and carefully done.
- Bring necessary graph papers for each of experiment. Learn to optimize on usage of graph papers.
- Graphs should be neatly drawn with pencil. Always label graphs and the axes and display units.
- If you finish early, spend the remaining time to complete the calculations and drawing graphs. Come equipped with calculator, scales, pencils etc.
- Do not fiddle idly with apparatus. Handle instruments with care. Report any breakage to the Instructor. Return all the equipment you have signed out for the purpose of your experiment.

EXPERIMENT 1

To determine the frequency of AC mains

Aim:

To determine the frequency of AC mains by Melde's experiment.

Apparatus:

- Electrically maintained tuning fork, A stand with clamp and pulley, A light weight pan, A weight box, Analytical Balance, A battery with eliminator and connecting wires etc.

Theory:

STANDING WAVES IN STRINGS AND NORMAL MODES OF VIBRATION:

When a string under tension is set into vibrations, transverse harmonic waves propagate along its length. When the length of string is fixed, reflected waves will also exist. The incident and reflected waves will superimpose to produce transverse stationary waves in the string.

The string will vibrate in such a way that the clamped points of the string are nodes and the point of plucking is the antinode.

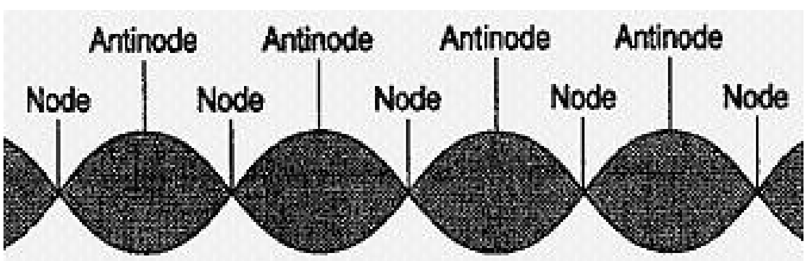


Figure 2. The Envelope of a standing waves

A string can be set into vibrations by means of an electrically maintained tuning fork, thereby producing stationary waves due to reflection of waves at the pulley. The loops are formed from the end of the pulley where it touches the pulley to the position where it is fixed to the prong of tuning fork.

(i) For the transverse arrangement, the frequency is given by

$$n = \frac{1}{2L}\frac{\sqrt{T}}{m}$$

where 'L' is the length of thread in fundamental modes of vibrations, ' T ' is the tension applied to the thread and 'm' is the mass per unit length of thread. If 'p' loops are formed in the length 'L' of the thread, then

$$n = \frac{P}{2L}\frac{\sqrt{T}}{m}$$

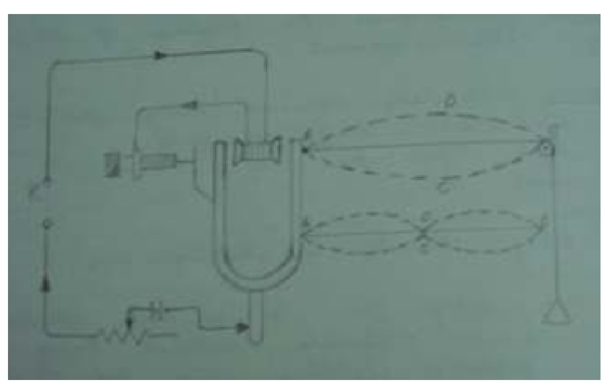
(ii) For the longitudinal arrangement, when 'p' loops are formed, the frequency is given by

$$n = \frac{P}{L}\frac{\sqrt{T}}{m}$$

Procedure:

- Find the weight of pan P and arrange the apparatus as shown in figure.
- Place a load of 4 To 5 gm in the pan attached to the end of the string
- Passing over the pulley. Excite the tuning fork by switching on the power supply.
- Adjust the position of the pulley so that the string is set into resonant
- Vibrations and well defined loops are obtained. If necessary, adjust
- The tensions by adding weights in the pan slowly and gradually. For finer adjustment, add milligram weight so that nodes are reduced to points.
- Measure the length of say 4 loops formed in the middle part of the string. If 'L' is the distance in which 4 loops are formed, then distance between two consecutive nodes is L/4.
- Note down the weight placed in the pan and calculate the tension T.
- Tension, T= (wt. in the pan + wt. of pan) g
- Repeat the experiment twine by changing the weight in the pan in steps of one gram and altering the position of the pulley each time to get well defined loops.
- Measure one meter length of the thread and find its mass to find the value of m, the mass produced per unit length.

OBSERVATIONS AND CALCULATIONS:



For longitudinal arrangement

Mass of the pan, w =……… gm

Mass per meter of thread, m =……… gm/cm

Frequency $n = \frac{P}{L}\frac{\sqrt{T}}{m}$

S.No.	Weight (W) gms	No. of loops (p)	Length of thread (L) cms	Length of each loop (L/P) cms	Tension (T) (W+w) gms	Frequency (n) Hzs
1						
2						
3						
4						
5						
6						

Mean frequency= ---------------- Hzs

<u>For transverse arrangement</u>

Mass of the pan, w =……… gm

Mass per meter of thread, m =……… gm/cm

Frequency $n = \frac{P}{2L}\frac{\sqrt{T}}{m}$

S.No.	Weight (W) gms	No. of loops (p)	Length of thread (L) cms	Length of each loop (L/P) cms	Tension (T) (W+w) gms	Frequency (n) Hzs
1						
2						
3						
4						
5						
6						

Mean frequency= ---------------- Hzs

PRECAUTIONS:

- The thread should be uniform and inextensible.
- Well defined loops should be obtained by adjusting the tension with milligram weights.
- Frictions in the pulley should be least possible.

Experiment 2

Diffraction Grating - Minimum deviation Method

Aim: To determine the wavelength of a given light using a plane diffraction grating in minimum deviation position.

Apparatus: Spectrometer, Sodium Vapour Lamp, Grating (15000<PI), Grating holder

Principle: When a light passes through a small aperture whose dimensions are comparable with the λ of light then light deviates from its rectilinear path and bends round the corner of the placed aperture of its geometrical shadow, this phenomenon is called diffraction. Because the source and the screen are placed effectively at infinite distance from the diffracting element it forms a class of fraunhoffer diffraction

An arrangement consisting of a large member of parallel slits equal opaque space is called diffraction grating. The distance between the centers of two successive slits is called the grating element. If "a" is width of the slit and "b" is the distance between the two slits. Then (a+b) is called the grating element or grating construction.

When a wave from is incident on a grating surface light is transmitted through the slits and abstracted by the opaque portions such a grating is called a transmission grating. In a transmission grating the grooves scatter light and so are opaque while the unruled surfaces transmit and act like slits. Typically a high quality grating (used for studying spectra in the visible range) has about 15000 grooves per inch, which gives a slit spacing of the order of a micron.

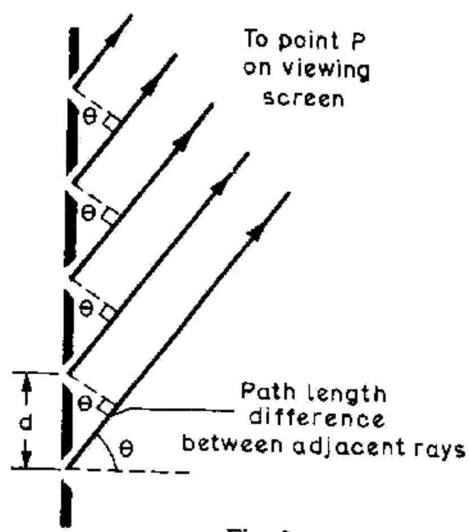
The condition for maximum intensity is

$$2\,(a+b)\sin\left(\frac{\theta}{2}\right) = n\lambda \quad \text{if } a+b = d$$

d→Distance between lines on grating =1/N

N→ Number of lines on the grating = 15000 lines per inch

$$\frac{2\sin\left(\frac{\theta}{2}\right)}{N.n} = \lambda$$



$$\lambda = \frac{2\sin\theta/2}{N.n} A^{\circ}$$

n→ the Order of the Spectrum

θ→ the angle of diffraction

Procedure:

1. Adjust telescope for parallel rays i.e. focus telescope on the object at infinity. Here we can adjust telescope on an object which is at very large distance. Level the spectrometer and prism table on which grating is mounted using a spirit level. Fig. 5 schematically shows the arrangement of the grating and the spectrometer.

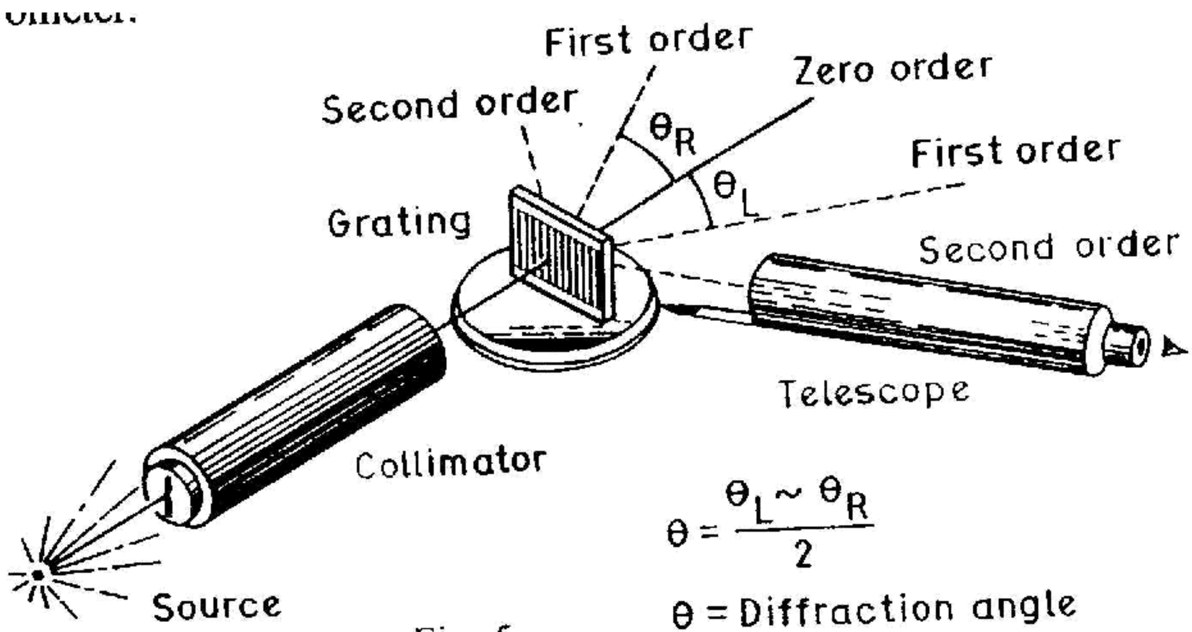


Fig. 5

2. Switch on the power supply for spectral lamp.

3. Place the grating on the prism table such that the surface of the grating is approximately perpendicular to the collimator of the spectrometer (i.e. perpendicular to the incident slit falling on the grating). Fix the prism table in this position. With the Hg source observe first order spectrum on left hand side and right hand side. Measure the angle of diffraction of each line by rotating telescope so that cross-wire coincides with particular spectral line. Note down each

measurement on the observation table I. The diffraction angle is equal to difference between LHS and RHS observation divided by two for a particular spectral line. (See Fig. 5).

4. In first order spectrum of sodium measure the angular position θ_L of yellow 1 (D1) on the left side. Use the micrometer screw to turn the telescope to align the crosswire at the second yellow line (D2) and read its angular position θ_L

5. Likewise measure θ_R on the RHS for D1 and D2.

Method to make light fall normal to the grating surface:

a) First mount grating approximately normal to the collimator. See the slit through telescope and take reading from one side of vernier window. Note down the reading.

b) Add or subtract (whichever is convenient) 90^0 from reading taken in step (a) and put telescope to this position. In this position telescope is approximately perpendicular to the collimator.

c) Now rotate prism table until the slit is visible on the cross-wire of the telescope. At this position the incident light from the collimator falls at an angle 45^0 with the plane of the grating. Note down this reading.

d) Next add or subtract 45^0 to step (c) reading and rotate the prism table so as to obtain this reading on the same window. In this situation, light incident in the grating surface is perpendicular.

Observations and Results:

S.No.	Spectral Line	Wavelength in A^0	Position of Telescope						$\theta = \frac{\theta_L - \theta_R}{2}$	Sinθ
			Left Side θ_L(degree			Right side θ_R(degree				
			Main	Vernier	Total	Main	Vernier	Total		
1	**D1**									
2	D2									

Precautions:

1. The experiment should be performed in a dark room.
2. Micrometer screw should be used for fine adjustment of the telescope. For fine adjustment the telescope should be first licked by means of the head screw.

3. The directions of rotation of the micrometer screw should be maintained otherwise the play in the micrometer spindle might lead to errors.

4. The spectral lams (mercury source) attain their full illuminating power after being warmed up for about 5 minutes, observation should be taken after 5 minutes.

5. One of the essential precautions for the success of this experiment is to set the grating normal to the incident rays (see below). Small variation on the angle of incident causes correspondingly large error in the angle of diffraction. If the exact normally is not observed, one find that the angle of diffraction measured on the left and on the right are not exactly equal. Read both the verniers to eliminate any errors due to non coincidence of the center of the circular sale with the axis of rotation of the telescope or table.

Result: Determined the λ of a given light using a plane diffraction grating in minimum deviation position.

D1= deviation position $\lambda = 5.89 \times 10^{-5}$ cm

D2= deviation position $\lambda = 5.896\times 10^{-5}$ cm

Experiment 3

Diffraction at a Single and Double slit (LASER)

Aim: To determine slit width of single and double slit by using He-Ne Laser.

Apparatus: He-Ne laser, Single Slit, Double Slit, Screen, Scale, tape etc.

Theory: If the waves have the same sign (are *in phase*), then the two waves constructively interfere, the net amplitude is large and the light intensity is strong at that point. If they have opposite signs, however, they are *out of phase* and the two waves destructively interfere: the net amplitude is small and the light intensity is weak. It is these areas of strong and weak intensity, which make up the interference patterns we will observe in this experiment. Interference can be seen when light from a single source arrives at a point on a viewing screen by more than one path. Because the number of oscillations of the electric field (wavelengths) differs for paths of different lengths, the electromagnetic waves can arrive at the viewing screen with a *phase difference* between their electromagnetic fields. If the Electric fields have the same sign then they add *constructively* and increase the intensity of light, if the Electric fields have opposite signs they add *destructively* and the light intensity decreases.

Diffraction at single slit can be observed when light travels through a hole (in the lab it is usually a vertical *slit*) whose width, *a*, is small. Light from different points across the width of the slit will take paths of different lengths to arrive at a viewing screen (Figure 1). When the light interferes destructively, intensity minima appear on the screen. Figure 1 shows such a diffraction patter is shown as a graph placed along the screen. For a rectangular slit it can be shown that the minima in the intensity pattern fit the formula

$$a\sin\theta = m\lambda$$

where *m* is an integer (±1, ±2, ±3…..), *a* is the width of the slit, λ is the wavelength of the light and θ is the angle to the position on the screen. The m^{th} spot on the screen is called

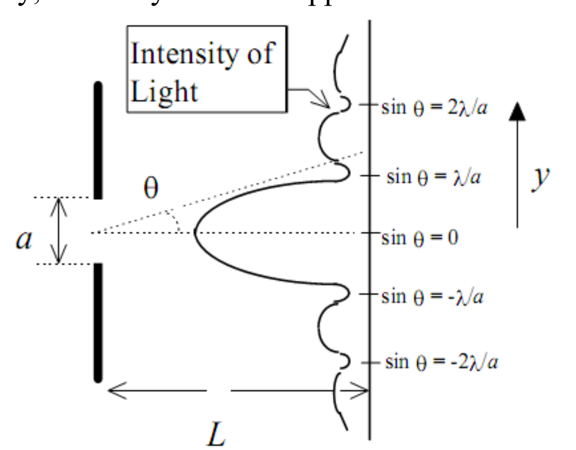


Figure 1: Diffraction by a slit of width *a*. Graph shows intensity of light on a screen.

the m^{th} order minimum. Diffraction patterns for other shapes of holes are more complex but also result from the same principles of interference.

Two-slit Diffraction: When laser light shines through two closely spaced parallel slits (Figure 2) each slit produces a diffraction pattern. When these patterns overlap, they also interfere with each other. We can predict whether the interference will be constructive (a bright spot) or destructive (a dark spot) by determining the path difference in traveling from each slit to a given spot on the screen.

Intensity maxima occur when the light arrives *in phase* with an integer number of wavelength differences for the two paths: $d\sin\theta = m\lambda$ where $m = \pm0, \pm1, \pm2, \ldots \ldots$ and the interference will be destructive if the path difference is a half-integer number of wavelengths so that the waves from each slit arrive *out of phase* with opposite signs for the electric field.

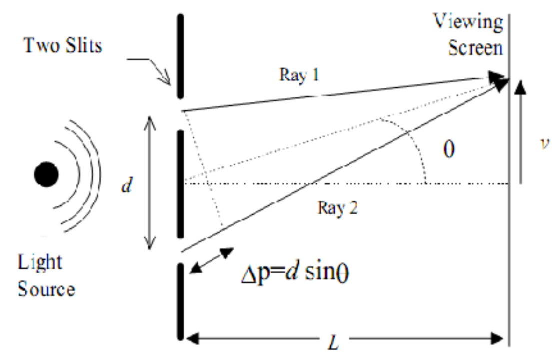


Figure 2: Interference of light from two slits. A maximum occurs when $\Delta p = m\lambda$ and a minimum when $\Delta p = (m + 1/2)\lambda$, where m=0,1,2,...

$$d\sin\theta = \left[m + \frac{1}{2}\right]\lambda \quad \text{where } m = \pm0, \pm1, \pm2, \ldots \ldots$$

Small Angle Approximation: The formulae given above are derived using the *small angle approximation*. For small angles θ (given in *radians)* it is a good approximation to say that $\theta \approx \sin\theta \approx \tan\theta$ (for θ in radians). For the figures shown above this means that $\theta \approx \sin\theta \approx \tan\theta = \frac{y}{L}$

Procedure:

Part A: Diffraction at single slit

The diffraction plate has slits etched on it of different widths and separations. For this part use the area where there is only a single slit.

For two sizes of slits, examine the patterns formed by single slits. Set up the slit in front of the laser. Record the distance from the slit to the screen, *L*. For each of the slits, measure and record a value for *y* on the viewing screen corresponding to the center of a dark region. Record as many distances, *y*, for different values of *m* as you can. Use the largest two or three values for *m* which you are able to observe to find a value for *a*. The He-Ne laser has a wavelength of 633 nm.

Part B: Two-slit Diffraction

Using the two-slit templates, observe the patterns projected on the viewing screen.
Observe how the pattern changes with changing slit width and/or spacing.
For each set of slits, determine the spacing between the slits by measuring the distances between minima on the screen. (The smaller spacings give are from the two slits patterns interfering, if they get too small to measure accurately, just make your best estimate.)
You will need to record distances on the screen *y* and the distance from the slits to the screen, *L*.

Precautions: Look through the slit (holding it very close to your eye). See if you can see the effects of diffraction. Set the laser on the table and aim it at the viewing screen.
DO NOT LOOK DIRECTLY INTO THE LASER OR AIM IT AT ANYONE! DO NOT LET REFLECTIONS BOUNCE AROUND THE ROOM.
Pull a hair from your head. Mount it vertically in front of the laser using a piece of tape. Place the hair in front of the laser and observe the diffraction around the hair. Use the formula above to estimate the thickness of the hair, *a*. (The hair is not a slit but light diffracts around its edges in a similar fashion.) Repeat with observations of your lab partners' hair.

Observations:

Table 1: Single slit

L = …….

λ = ………..

Diffraction Order, m	Distance, y	y/L	Angle θ in *radians*	$\sin\ \theta$	a $\left(=\frac{m\lambda}{\sin\theta}\right)$

Result : Slit width = …….

Table 2: Double slit

L = …….

λ = ………..

Diffraction Order, m	Distance, y	y/L	Angle θ in *radians*	$\sin\ \theta$	a $\left(=\frac{m\lambda}{\sin\theta}\right)$

Result : Slit width = ……

Experiment 4

Magnetic field along the axis of a coil (Stewart & Gees method)

Apparatus: Circular coil, Power supply, Switching keys, Magnetic needle, Sliding compass box etc.

Objective: To measure the magnetic field along the axis of a circular coil and verify Biot-Savart law.

Theory: For a circular coil of a turns, carrying a current I, the magnetic field at a distance x from the coil and along the axis of the coil is given by

$$B(x) = \frac{\mu_0 nIR^2}{2}\frac{1}{(R_2 + x_2)^{3/2}}$$

Where R is the radius of the coil.

In this experiment, the coil is oriented such that plane of the coil is vertical and parallel to the north-south direction. The axis of the coil is parallel to the east-west direction. The net field at any point x along the axis, is the vector sum of the fields due to the coil B(x) and earth's magnetic field B_E (Fig 1)

$$\therefore \tan\theta = \frac{B(x)}{B_E}$$

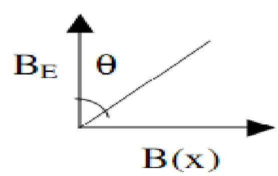


Fig 1.

Procedure:

The apparatus consists of a coil mounted perpendicular to the base. A sliding compus box is mounted on aluminum rails so that the compus is always on the axis of the coil.

1. Orient the apparatus such that the coil is in the north-south plane
2. Adjust the leveling screws to make the base horizontal. Make sure that the compus is moving freely.
3. Connect the circuit as shown in the figure.
4. Keep the compus at the center of the coil and adjust so that the pointers indicate 0-0

5. close the keys K and KR (make sure that you are not shorting the power supply) and adjust the current with rheostat, RH so that the deflection is between 50 to 60 degrees. The current will be kept fixed at this value for the rest of the experiment

6. Note down the readings $\theta_1 and \theta_2$. Reverse the current and note down $\theta_3 and \theta_4$
7. Repeat the experiment at intervals of 1 cm along the axis until the value of the fields drops to 10% of its value at the center of the coil. Repeat on both sides of the coil.
8. Draw following graphs:

   .B(x) as a function of x.

   . $\log(B(x))$ as a function of $\log\left(R^2 + X^2\right)$

Find slope and y-intercept from the graph and results with the expression for B(x).

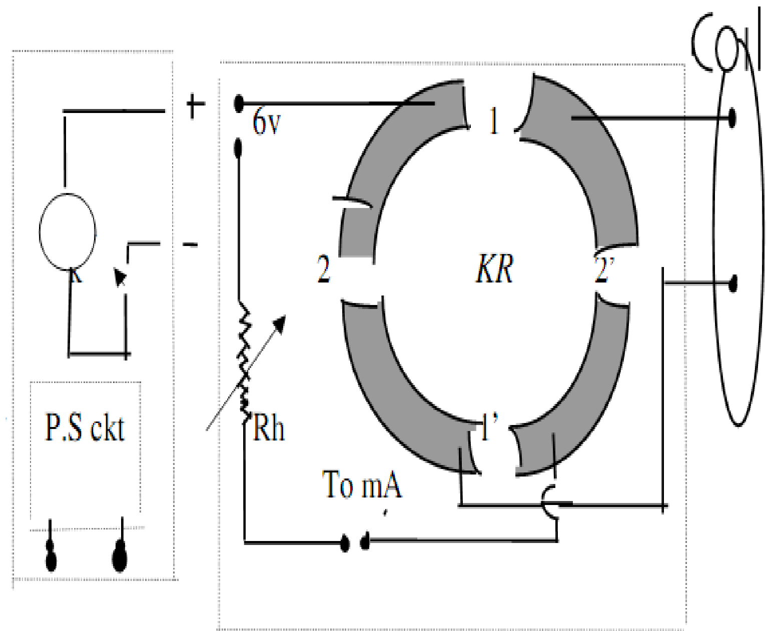


Fig 2.

Observations/Calculations:

Parameters and constants

Least count for x measurement=

Least count for θ measurement=

No of turns of the coil, n=

Radius of the coil, R= 10 cm

Current in the coil, I= …

Permeability of air, $\mu_0 = 4\pi \times 10^{-7} N / A^2$

Earth's magnetic field, $B_E = .39 \times 10^{-4} T$

Table I

x_{cm}	θ_1	θ_2	θ_3	θ_4	θ(average)	$Tan\theta$	$\log(tan\theta)$	$\log(R^2+X^2)$	$B(x)= B_E \tan\theta$ $(T)(10^{-4})$	LogB (x)
1										
2										
3										
4										
5										
…										
….										

Table II

For other side of the scale…………

x_{cm}	θ_1	θ_2	θ_3	θ_4	θ(average)	$Tan\theta$	$\log(tan\theta)$	$\log(R^2+X^2)$	$B(x)= B_E \tan\theta$ $(T)(10^{-4})$	LogB (x)
1										
2										
3										
4										
5										
….										
…..										

Calculation:

From the graph of B(x) vs. log (R^2+X^2), find the slope and intercept from regression analysis. Slope should be -1.5 according to Biot-Savart law, and intercept value should match with the value calculated using μ_o, n, I, and R.

Results:

Experimental value of exponent (slope) =

Theoretical value of slope= -1.5

Experimental value of intercept=

Theoretical value of intercept=…..

Experiment 5

Evaluation of Numerical Aperture of a given fiber

AIM: The aim of the experiment is to determine the numerical aperture of the optical fibers available

EQUIPMENT: 1.Laser Diode Design Module TNS 20EL-TX 2.Laser Diode Design Module TNS 20EA-RX 3.Two meter PMMA fiber patch card 4.Inline SMA adaptors 5.Numerical Aperture Measurement Jig

THOERY: Numerical aperture of any optical system is a measure of how much light can be collected by the optical system. It is the product of the refractive index of the incident medium and the sine of the maximum ray angle.

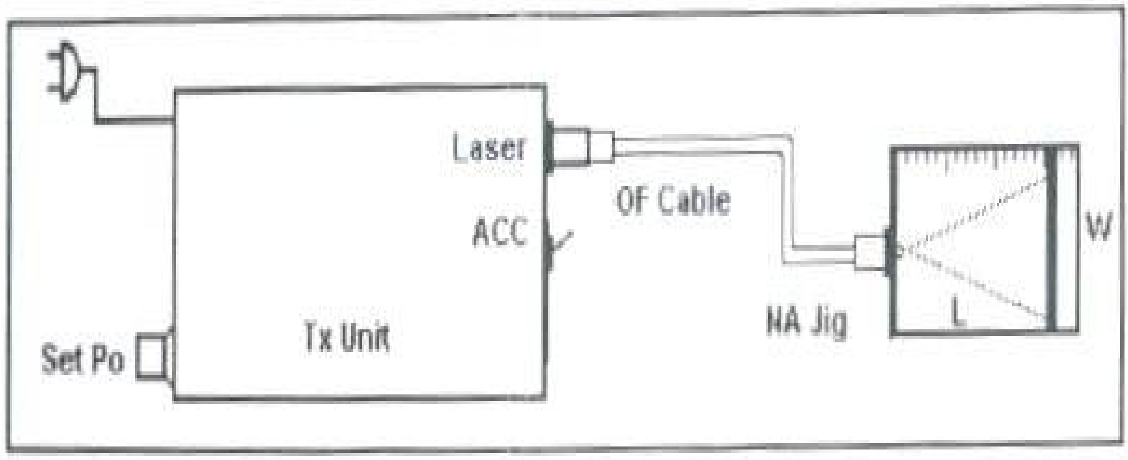
$NA = ni.\sin\theta_{max;}$ ni for air is 1, hence $NA = \sin\theta_{max}$

For a step-index fibre, as in the present case, the numerical aperture is given by $N=(N_{core}^2 - n_{cladding}^2)^{1/2}$

For very small differences in refractive indices the equation reduces to

$NA = n_{core}\,(2\Delta)^{1/2}$, where Δ is the fractional difference in refractive indices. I and record the manufacture's NA, $n_{cladding}$ and n_{core}, and θ.

BLOCK DIAGRAM:



PROCEDURE:

The schematic diagram of the numerical aperture measurement system is shown below and is self explanatory.

Step1: Connect one end of the PMMA FO cable to Po of TNS20EL TX Unit and the other end to the NA Jig, as shown.

Step2: Plug the AC mains. Light should appear at the end of the fiber on the NA Jig. Turn the Set Po knob clockwise to set to maximum Po. The light intensity should increase.

Step 3: Hold the white scale-screen, provided in the kit vertically at a distance of 15 mm (L) from the emitting fiber end and view the red spot on the screen. A dark room will facilitate good contrast. Position the screen-cum-scale to measure the diameter (W) of the spot. Choose the largest diameter.

Step: 4 Compute NA from the formula $NA = \sin\theta_{max} = W/(4L^2 + W^2)^{1/2}$. Tabulate the reading and repeat the experiment for 10mm, 20mm, and 25mm distance.

Step5: In case the fiber is under filled, the intensity within the spot may not be evenly distributed. To ensure even distribution of light in the fiber, first remove twists on the fiber and then wind 5 turns of the fiber on to the mandrel as shown. Use an adhesive tape to hold the windings in position. Now view the spot. The intensity will be more evenly distributed within the core.

OBSERVATIONS:

Sl. No	L (mm)	W(mm)	NA	ɵ (degrees)
1	10	10	0.447	26.5
2	15	14	0.423	25.0
3	20	20	0.447	26.5
4	25	24	0.432	25.64
5	30	-	-	-

RESULT: Numerical aperture of the available optical fibers is Determined

Experiment 6

Losses in Optical fibers

AIM: The aim of the experiment is to study various types of losses that occur in optical fibers and measure **losses in dB** of two **optical fiber patch cords** at two wavelengths, namely, **660nm** and **850nm**. The **coefficients of attenuation per meter** at these **wavelengths** are to be computed from the results.

EQUIPMENT: 1.Fiber optic analog transmission Kit TNS 20EA-TX 2.Fiber optic analog transmission Kit TNS 20EA-RX 3.One meter& two meter PMMA fiber patch card 4.Inline SMA Adaptors

THOERY: Attenuation in an optical fiber is a result of a number of effects. This aspect is well covered in the books referred to in Appendix II. We will confine our study to measurement of attenuation in two cables (**Cable1** and **Cable2**) employing and SMA-SMA In-line-adaptor. We will also compute loss per meter of fiber in dB. We will also study the spectral response of the fiber at 2 wavelengths, 660nm and 850 and compare with the plot in Appendix II.

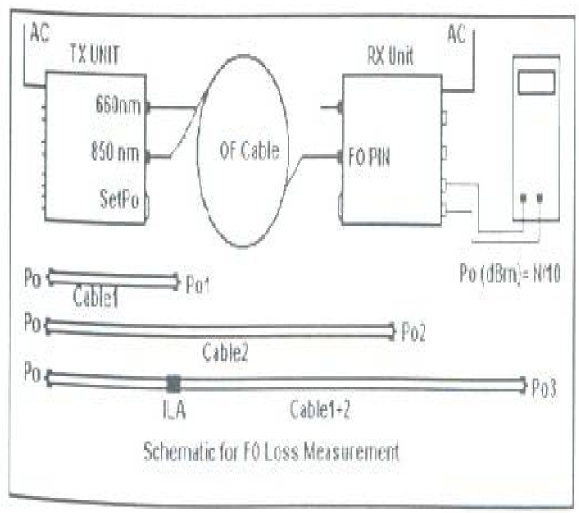
The optical power at a distance, L, in an optical fiber is given by $\mathbf{P_L = P_o\ 10}$ ($-\alpha L10$) where Po is the launched power and α is the attenuation coefficient in decibels per unit length. The typical attenuation coefficient value for the fiber under consideration here is **0.3 dB** per meter at a wavelength of **660nm.** Loss in fibers expressed in decibels is given by $\mathbf{-10\log (Po/P_F)}$ where, Po is the launched power and P_F is power at the far end of the fiber. Typical losses at connector junctions may very from 0.3 dB to 0.6 dB.

Losses in fibers occur at **fiber-fiber joints** or splices due to axial displacement, angular displacement, separation (air core), mismatch of cores diameters, mismatch of numerical apertures, improper cleaving and cleaning at the ends. The loss equation for a simple fiber optic link is given as:

$\mathbf{Pin(dBm)-Pout(dBm)= L_{J1}+L_{FIB1}+LJ_2+ L_{FIB1}+LJ3(db):}$ where, L_{J1}(db) is the loss at the LED-connector junction, L_{FIB1} (dB) is the loss in cable1, LJ_2 (dB) is the insertion loss at a splice or in-line adaptor, L_{FIB2} (dB) is the loss cable2 and L_{J3} (dB) is the loss at the connector-detector junction.

PROCEDURE: The schematic diagram of the optical fiber loss measurement system is shown below and is self explanatory. The step by step procedure is given here:

BLOCK DIAGRAM



Step 1: Connect one and of **Cable1** to the **660nm** LED port of the TNS20EA-**TX** and the other end to the **FO PIN** port (power meter port) of TNS20EA-**RX.**

Step2: Set the DMM to the 2000 mV range. Connect the **terminals** marked **Po** on TNS20EA-RX to the DMM the power meter is now ready for use.

Step3: Connect the optical fiber patchcord, **Cable1** securely, as shown, after relieving all twists and strains on the fibre. **While connecting the cable please note that minimum force should be applied. At the same time ensure that the connector is not loosely coupled to the receptacle.** After connecting the optical fibre cable properly, adjust **SET Po** knob to set power of **660nm** LED to a suitable value, say, - 15.0dBm (the DMM will read 150 mV). Note this as $\mathbf{P_{01}}$

Step 4: Wind one turn of the fiber on the mandrel, and note the new reading of the power meter $\mathbf{P_{o2}}$. Now the loss due to bending and strain on the plastic fiber is **Po1-Po2**dB. For more accurate readout set the DMM to the 200.0mV range and take the measurement. Typically the loss due to the **strain** and **bending** the fiber is 0.3 to 0.8 db.

Step5: Next remove the mandrel and relieve **Cable1** of all twists and strains. Note the reading P01. Repeat the measurement with **Cable2** (5 meters) and note the reading **Po2**. Use the **in-line SMA adaptor** and connect the **two cables** in series as shown. Note the measurement **Po3**.

Loss in Cable1=P_{o3}-P_{o2}-Lila Loss in Cable2=$P_{o3}P_{o1}$-Lila

Assuming a loss of 06 to **1.0dB in the in-line adaptor (Lila=1.0dB)**, we obtain the loss in each cable. The difference in the losses in the two cables will be equal to the loss in **4 meters of fiber** (assuming that the losses at connector junctions are the same for both the cables). The experiment may be repeated in the higher sensitivity range of 200.0mV. The experiment also may be repeated for other **Po** settings such as -20dBm, -25 dBm, -30dBm etc.

OBSERVATIONS FOR 660nm

Sl No	Po1 (dBm)	Po2 (dBm)	Po3 (dBm)	Loss in Cable 1 (dB)	Loss in Cable2 (dB)	Loss in 4 metres fibre (dB)	Loss per metre (dB) at 660nm
1	-15.0						
2	-20.0						
3	-25.0						
4							

Step6: Repeat the entire experiment with **LED2** at **850nm** and tabulate in 1.4.2

NOTE:

The power meter has been **calibrated** internally to read power in **dBm at 660nm**. However the calibration has to be redone manually for measurements at **850nm**. The PIN has a **66% higher** sensitivity at850nm as compared to 660nm for the **same input optical power.** This corresponds to a sensitivity that is **higher by 2.2dB.** To calibrate the power meter at **850nm, deduct 2.2dB** from the measured reading. In computing losses in cables and fibers this gets eliminated while solving the equations.

OBSERVATIONS FOR 850nm

Sl No	Po1 (dBm)	Po2 (dBm)	Po3 (dBm)	Loss in Cable 1 (dB)	Loss in Cable2 (dB)	Loss in 4 metres fibre (dB)	Loss per metre (dB) at 850nm
1	-15.0						

2	-20.0						
3	-25.0						
4							

RESULT: Studied the various types of losses that occur in optical fibers and measured the **losses in dB** of two **optical fiber patch cords** at two wavelengths, namely, **660nm** and **850nm**. The **coefficients of attenuation per meter** at these **wavelengths** are computed from the results.

Experiment 7

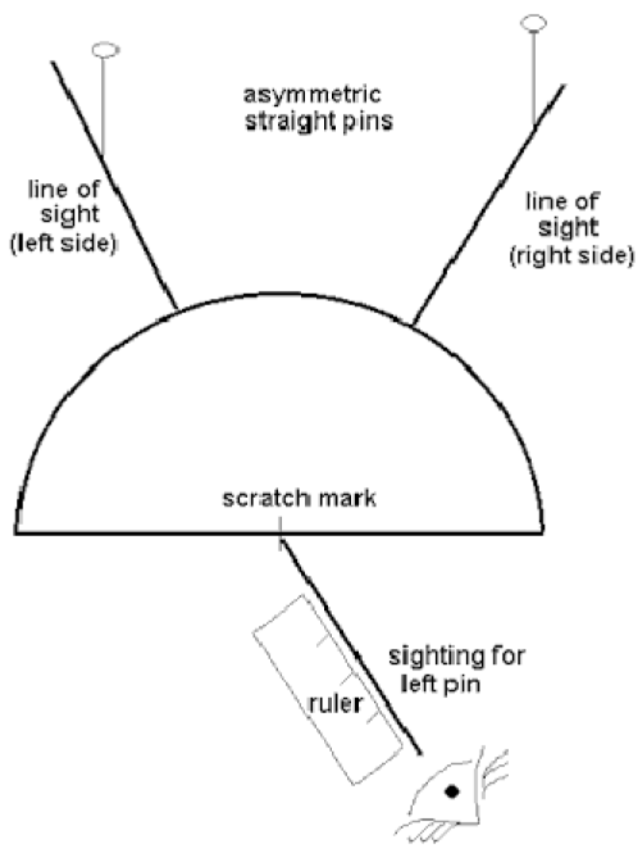
To use ray sightings to calculate the index of refraction of water.

Aim: To use ray sightings to calculate the index of refraction of water.

Equipment:

- semi-circular water trough (D-cell) filled up two-thirds of the way with water
- ruler
- cardboard
- protractor
- green data paper
- 2 straight pins

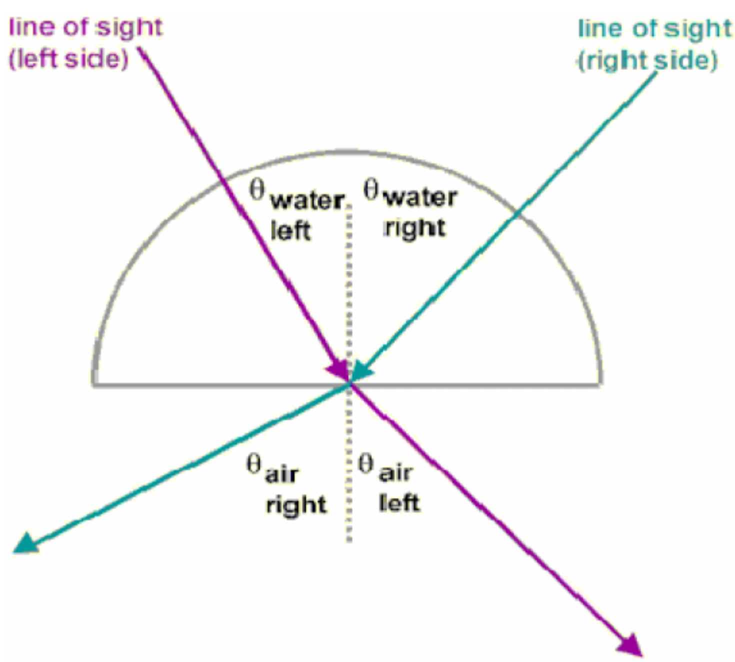
Set-up:



Procedure:

1. Place the green paper on the cardboard.
2. Place the semi-circular water trough in the center of the green paper and trace its outline in pencil.
3. Asymmetrically, place the straight pins into the paper between 5 to 10 cm from the top of the trough's position.
4. Sight the base of the left pin through the water until the edge of the ruler "appears" to line up the pin with the scratch mark in the center of the flat side of the water trough.
5. Using a ruler, sketch this line on your paper - connecting it to the scratch mark on the flat side of the trough.
6. Repeat the above process with the right pin.
7. Remove the water trough and connect the line of sight for each pin to the central scratch mark on the flat side of the trough.

Measurements:



Using your protractor, measure the angle of incidence and the angle of refraction for each pin. Label your diagram and then place your answers in the data table provided. Next use Snell's Law to calculate the experimental index of refraction for water based on the angle data for each pin.

$n_{water} \sin(\theta_{water}) = n_{air} \sin(\theta_{air})$

since $n_{air} = 1.0$

$n_{water} = \sin(\theta_{air})/\sin(\theta_{water})$

Experiment 8

B-H Curve

Aim: To study Hysteresis property of the given magnetic material and hence to determine

a) Energy loss /cycle/ unit volume b) Remnant Flux Density and c) Coercive Field Strength.

Apparatus: Specimen, B-H Curve tracer unit, Cathode Ray Oscilloscope (CRO).

Formula:

Energy loss is determined using the formula *S S A*

P L

E N v H

= 0.5 J/ per cycle/unit volume,

Where N is the Number of turns in the coil (300), P is the resistance in series with the coil (65Ω), L = Length of the coil (0.033m) and SH and SV are the horizontal, vertical sensitivities of the CRO and A= Area of the loop.

The Coercive field is determined from the formula

( ) = *A turns m*-1

P L

H N OC SH

C

The Remnant flux density = ( ) 2

0 0.5 *B* = *OB S Wbm*− *V*

Procedure: Initially the following settings are made for CRO. The CRO is switched on and is set to X-Y mode. The bright spot is adjusted to the centre of the display with the help of Horizontal and Vertical shift knobs. Both the channels (X-Channel (Horizontal,CH1) and Y-Channel (Vertical, CH2) are set to AC mode.

One terminal of the magnetizing coil is connected to point C of the main unit and the other Terminal to any of the point between V1 to V3 (V3 is recommended). Outputs X & Y of the main unit are connected respectively to CH1 & CH2 of the CRO. IC probe and the Supply (P.S) are connected to the main kit. The main kit is switched on. The resistance (P) is set for maximum

value with the help of the given knob. With no specimen, the horizontal gain of the CRO is adjusted until a convenient X deflection is obtained on the CRO display. Specimen is inserted through the coil such that it touches only the probe at the centre not the conducting tracks.
The Y gain of the CRO is adjusted to get appropriate Loop. Trace the loop on the graph paper by reading coordinates of the points A, B, C, D, E, F on the loop in CRO and area of the loop is Measured.

a) Energy loss is determined using the formula *S S A*

P L

E N v H

= 0.5 J/ per cycle/unit

Volume,

b) OC is measured from the graph. The Coercive field is determined from the formula( ) = *A*

turns m−1

P L

H N OC SH

C

c) OB is measured from the graph. The Remnant flux density is determined using the

Formula ( ) 20 *B* =0.5 *OB S Wbm*− *V*

Result: The Energy loss in the specimen= ....J/cycle/cubic meter

The Remnant Induction=.................Wb m-2

The Coercive field = ...A turns m-2

Liquid	Spectral Order (n)	Spectrometer reading(deg)		Angular separation $2\theta_n{}^o$	Angle of diffraction $\theta_n{}^o$	Wavelength λ (m)	Ultra sound Velocity (m/sec)
		$R_{nL}{}^o$	$R_{nR}{}^o$				
H_2O	2						
	1						
CCl_4	2						
	1						

Wavelength of the sodium light = $5893 A^o$

Frequency of the ultrasound =

Wavelength of ultrasound, $\lambda' = \dfrac{n\lambda}{\sin\theta}$ m

=

Velocity of ultrasound, $V = f\lambda'$ ms^{-1} =

Observation: